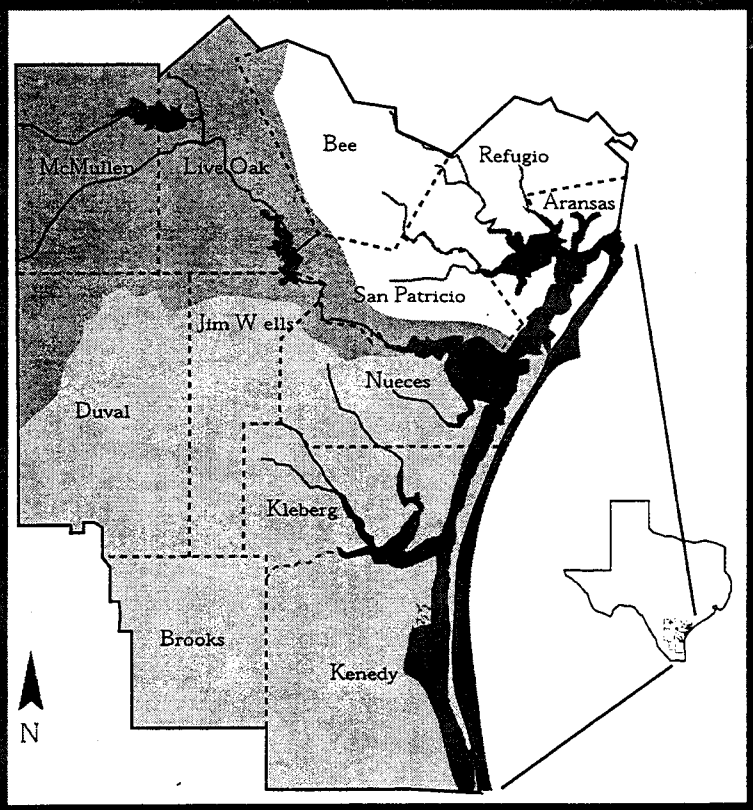
Ambient Water, Sediment, and Tissue Quality of the Corpus Christi Bay Study Area: Present Status and Historical Trends



Corpus Christi Bay National Estuary Program
CCBNEP-23 • November 1997

Ambient Water, Sediment, and Tissue Quality of the Corpus Christi Bay Study Area

Present Status and Historical Trends

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CORPUS CHRISTI BAY NATIONAL ESTUARY PROGRAM

The Corpus Christi Bay National Estuary Program (CCBNEP) is a four-year, community based effort to identify the problems facing the bays and estuaries of the Coastal Bend, and to develop a long-range, Comprehensive Conservation and Management Plan. The Program's fundamental purpose is to protect, restore, or enhance the quality of water, sediments, and living resources found within the 600 square mile estuarine portion of the study area.

The Coastal Bend bay system is one of 28 estuaries that have been designated as an **Estuary of National Significance** under a program established by the United States Congress through the Water Quality Act of 1987. This bay system was so designated in 1992 because of its benefits to Texas and the nation. For example:

- Corpus Christi Bay is the gateway to the nation's sixth largest port, and home to the third largest refinery and petrochemical complex. The Port generates over $1 billion of revenue for related businesses, more than $60 million in state and local taxes, and more than 31,000 jobs for Coastal Bend residents.
- The bays and estuaries are famous for their recreational and commercial fisheries production. A study by Texas Agricultural Experiment Station in 1987 found that these industries, along with other recreational activities, contributed nearly $760 million to the local economy, with a statewide impact of $1.3 billion, that year.
- Of the approximately 100 estuaries around the nation, the Coastal Bend ranks fourth in agricultural acreage. Row crops -- cotton, sorghum, and corn -- and livestock generated $480 million in 1994 with a statewide economic impact of $1.6 billion.
- There are over 2600 documented species of plants and animals in the Coastal Bend, including several species that are classified as endangered or threatened. Over 400 bird species live in or pass through the region every year, making the Coastal Bend one of the premier bird watching spots in the world.

The CCBNEP is gathering new and historical data to understand environmental status and trends in the bay ecosystem, determine sources of pollution, causes of habitat declines and risks to human health, and to identify specific management actions to be implemented over the course of several years. The 'priority issues' under investigation include:

- altered freshwater inflow
- declines in living resources
- loss of wetlands and other habitats
- bay debris
- degradation of water quality
- altered estuarine circulation
- selected public health issues

The **COASTAL BEND BAYS PLAN** that will result from these efforts will be the beginning of a well-coordinated and goal-directed future for this regional resource.

STUDY AREA DESCRIPTION

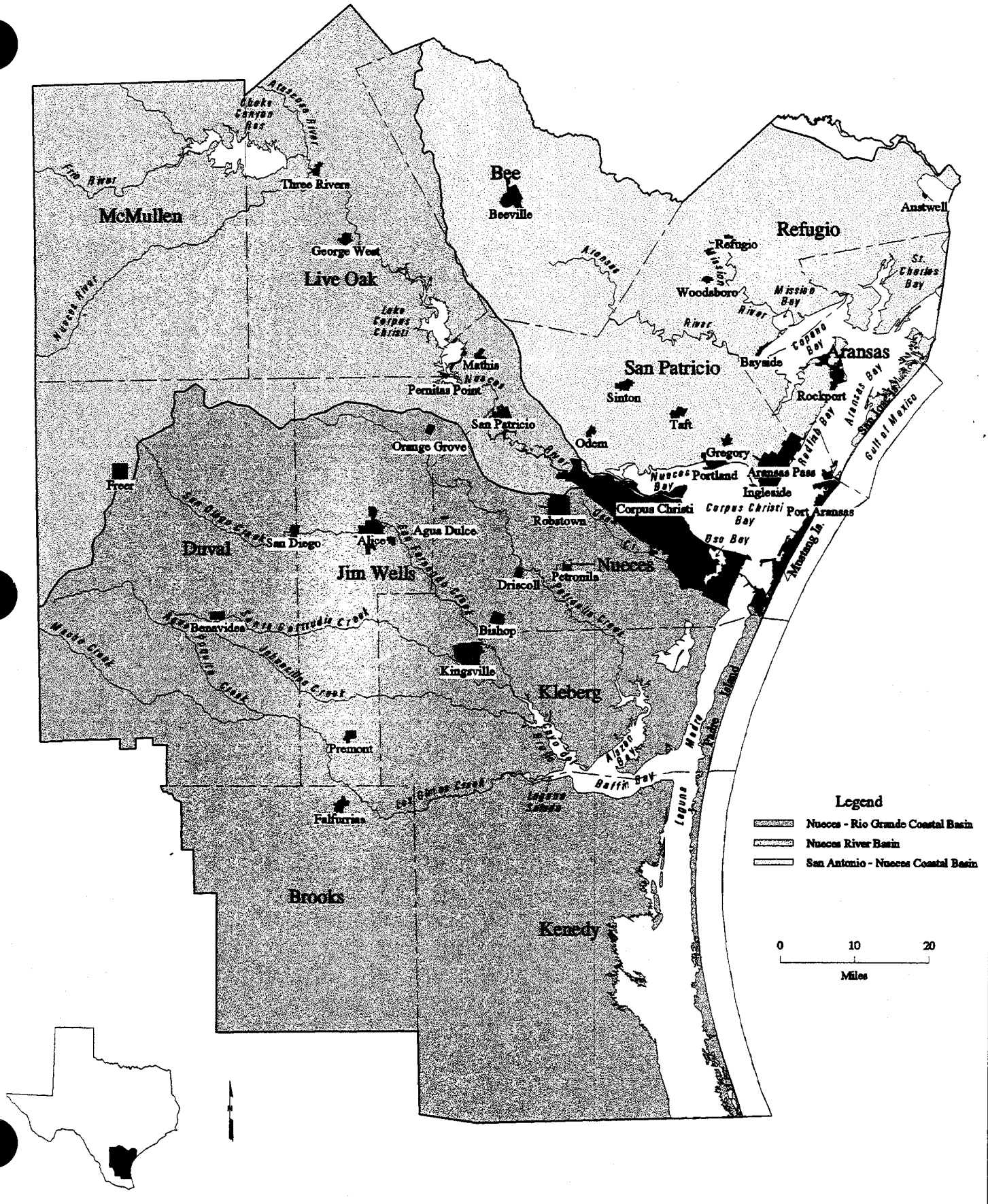
The CCBNEP study area includes three of the seven major estuary systems of the Texas Gulf Coast. These estuaries, the Aransas, Corpus Christi, and Upper Laguna Madre are shallow and biologically productive. Although connected, the estuaries are biogeographically distinct and increase in salinity from north to south. The Laguna Madre is unusual in being only one of three hypersaline lagoon systems in the world. The study area is bounded on its eastern edge by a series of barrier islands, including the world's longest -- Padre Island.

Recognizing that successful management of coastal waters requires an ecosystems approach and careful consideration of all sources of pollutants, the CCBNEP study area includes the 12 counties of the Coastal Bend: Refugio, Aransas, Nueces, San Patricio, Kleberg, Kenedy, Bee, Live Oak, McMullen, Duval, Jim Wells, and Brooks.

This region is part of the Gulf Coast and South Texas Plain, which are characterized by gently sloping plains. Soils are generally clay to sandy loams. There are three major rivers (Aransas, Mission, and Nueces), few natural lakes, and two reservoirs (Lake Corpus Christi and Choke Canyon Reservoir) in the region. The natural vegetation is a mixture of coastal prairie and mesquite chaparral savanna. Land use is largely devoted to rangeland (61%), with cropland and pastureland (27%) and other mixed uses (12%).

The region is semi-arid with a subtropical climate (average annual rainfall varies from 25 to 38 inches, and is highly variable from year to year). Summers are hot and humid, while winters are generally mild with occasional freezes. Hurricanes and tropical storms periodically affect the region.

On the following page is a regional map showing the three bay systems that comprise the CCBNEP study area.



Corpus Christi Bay National Estuary Program Study Area

AMBIENT WATER, SEDIMENT AND TISSUE QUALITY OF CORPUS CHRISTI BAY STUDY AREA: PRESENT STATUS AND HISTORICAL TRENDS

Principal Investigators:

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EXECUTIVE SUMMARY

For many years, data on the physico-chemical quality of water and sediment have been collected in the Corpus Christi Bay system by a variety of organizations and individuals. The purpose of this project was to compile these data, and to perform a quantitative assessment of water and sediment quality of Corpus Christi Bay and its evolution over time. Tissue quality was included as well in the project scope. There were three key objectives:

(1) compilation of a comprehensive data base in machine-manipulable format;
(2) analysis of space and time variation in water, sediment and tissue quality parameters;
(3) identification of probable causal mechanisms to explicate the observed variations.

Their accomplishment provides a foundation for further scientific study of the Corpus Christi Bay system, and for a general understanding of the controls and responses of its water and sediment quality, which must underlie rational management of the resources of the system.

A principal product of this study is the compilation of a digital data base composed of water-quality, sediment-quality and tissue-quality data from 30 data collection programs performed in Corpus Christi Bay. This compilation included data from the three most important ongoing monitoring programs in Corpus Christi Bay: the Texas Natural Resource Conservation Commission (TNRCC) Statewide Monitoring Network, the Texas Parks and Wildlife Department (TPWD) hydrographic observations from its Coastal Fisheries program, and the hydrographic and biochemical data of the Texas Department of Health Seafood Safety Division program. The important surveys and research projects sponsored by the Texas Water Development Board (TWDB) and maintained in its digitized Coastal Data System are included. Several recent federal data-collection projects are represented, namely those of the U.S. Corps of Engineers (USCE) Galveston District, Environmental Protection Agency (EPA), National Ocean Service, and U.S. Fish & Wildlife Service.

This compilation also entailed keyboarding of other major data sets, many of which exist in limited hardcopy and are virtually unobtainable, including the U.S. Corps of Engineers Galveston District water and sediment surveys of the 1970's, data of the Texas Game Fish & Oyster Commission from the 1960's, the Reynolds-sponsored "baseline" surveys of the early 1950's, the Submerged Lands Project of the Bureau of Economic Geology, and the data collections by the now-defunct Ocean Science and Engineering Laboratory of Southwest Research Institute. Other entries in this compilation include research projects whose data are published only in limited technical reports or academic theses, all of which were keyboarded. A major data compilation effort of the project was devoted to determination of latitude/longitude coordinates based upon historical sampling station location information, so that all of the data could be unambiguously georeferenced. In addition to supporting the spatial-distribution analyses of this study, this georeferencing data will facilitate incorporation of the data base into geographical information systems.

All told, the digital compilation is the most extensive and detailed long-term record of water and sediment quality ever assembled for Corpus Christi Bay. The study area for this compilation and analysis extends from the landbridge of the Laguna Madre to the southern limit of San Antonio Bay, and includes Baffin Bay, Corpus Christi Bay proper, the Aransas-Copano system, and Mesquite/Ayres Bay. We refer to Aransas, Copano and their secondary systems (including Mesquite) as the upper bays, and to Baffin Bay and the Upper Laguna Madre as the lower bays. The entire CCBNEP study area is referred to as the Corpus Christi Bay "system," to differentiate it from Corpus Christi Bay proper, unless it is clear in context that the CCBNEP study area is intended (such as the first sentence of this paragraph). The complete data base approaches half a million independent records of which water:sediment:tissue are in the approximate ratios 100:10:2, and about 43% of the water-phase data are the "field" parameters temperature/salinity/pH/dissolved oxygen. Each measurement record includes the date, sample depth, latitude and longitude of the sample station, measured variable, estimated uncertainty of measurement expressed as a standard deviation, and a project code identifying the origin of the data. (For tissue data, the sample depth field is replaced by a code identifying the organism.)

The extant period of record for Corpus Christi Bay, with adequate continuity for trends analysis, extends back only to about 1965, except for some traditional parameters and for certain areas of the bay, for which the record can be extended back to the 1950's. As salinity and temperature are the most easily measured variables, they represent the densest and longest data record. For metals and for complex organics, the period of record may extend back only a decade or so. Many of these measurements are below detection limits. For sediment, the data base is even more limited, amounting to one sample per 50 square miles per year, and extending back in time at most to the 1970's.

Spatial aggregation of the data was accomplished by two separate segmentation systems for Corpus Christi Bay, the TNRCC Water Quality Segmentation of 27 segments, and a system of 178 hydrographic segments devised by this project and designed to depict the effects of morphology and hydrography on water properties.

(The 27 TNRCC segments include the original 15 specified by the Scope of Work, to which we added 5 classified segments and 7 unclassified.) For each segment of both systems, detailed statistical analyses were performed of 109 water-quality parameters and 83 sediment-quality parameters, in addition to supplementary, screened, or transformed variables. Each statistical analysis included basic sampling density information, means and standard deviations, with three different treatments of measurements below detection limits (BDL), and a linear trend analysis over the period of usable record, with confidence limits on the slope. Therefore, statistical analyses addressing water/sediment quality were performed of about 200 parameters in about 200 different segments, a total of about 40,000 independent statistical analyses, since each parameter/segment comprises an independent data set. For tissue data, an even more extensive suite of analytes were compiled, but the statistical analyses were confined to a subset of these analytes because of the sparsity of the data base. In addition to parameter differentiation, tissue data had to be further separated according to organism, portion of organism analyzed (i.e., whole versus fileted), and reporting by dry- or wet-weight, each combination of which represented an independent statistical analysis.

A summary of the findings on the water and sediment quality "climate" begins with salinity, which acts as a water mass tracer and general habitat indicator for Corpus Christi Bay. In contrast to the estuaries on the upper Texas coast, salinity gradients across Corpus Christi Bay from the sea to the regions of inflow are on average rather flat. The most substantial gradient of salinity is, rather, from north to south, from Copano Bay to Baffin Bay, a combined result of diminishing inflow with distance to the south and increasing evaporation. Mean salinities often exceed seawater concentrations, sometimes by large amounts, especially in the lower bays (the Upper Laguna and Baffin Bay). Vertical salinity stratification of bay waters is slight by estuarine standards, generally averaging less than 0.6 ppt/m. There is no apparent correlation between mean salinities and ship channels, suggesting that density currents as a mechanism of salinity intrusion are rarely important in Corpus Christi Bay. While freshwater inflow is the ultimate control on salinity, inflow proves to be a poor statistical predictor of individual measurements of salinity, even with long-term averaging of the antecedent inflow. This illustrates that the variability of salinity is influenced by factors other than simply the level of inflow.

In the bays more influenced by freshwater inflow, *viz.* Copano Bay, the main body of Corpus Christi Bay and Nueces Bay, there has been a general increase in salinity over the three-decade period of record, on the order of 0.1 ppt per year. During the same period there has been a declining trend in monthly-mean inflow to these same bays, over 50% in Corpus Christi and Nueces Bays, less in Copano (which also logged a smaller increase in salinity). Our favored hypothesis is that this decline in mean inflow, which appears to be due to diminishing frequency and magnitude of freshets, is responsible for the increase in salinity. No clear trends in salinity emerged for the Upper Laguna or Baffin Bay.

The principal variation in water temperature in Corpus Christi Bay is the seasonal signal, ranging about 14 to 30°C from winter to summer, which means

that temperature is primarily controlled by surface fluxes, especially the seasonal heat budget, and much less by peripheral boundary fluxes and internal transports. The horizontal gradient across the study area is from north to south, ranging 2-4°C. There is little systematic stratification, on average a slight upward increase on the order of 0.1°C/m, due to near-surface heat absorption. Over the three-decade period of record, water temperature in the upper bays and main body of Corpus Christi Bay, especially in the open waters, has declined at a nominal rate of 0.05°C/yr. There are no clear trends in the lower bays. It is interesting to note that the same decline in temperature, at approximately the same rate, was discovered in Galveston Bay (Ward and Armstrong, 1992a).

TNRCC applies a 35°C temperature standard uniformly to the entire Texas coast, without cognizance of the natural gradient of increasing temperatures toward the south (a gradient to which the indigenous organisms would have presumably acclimated). The shallow, poorly circulated sections of the Corpus Christi system are most prone to higher temperatures, especially those in the lower bays, and exceedances of the TNRCC 35°C standard occur at a low rate–a couple of percent–mainly in summer. Only two regions have substantially higher frequencies of exceedance, in Nueces Bay and Oso Bay, both affected by return flows from power plants. Given this low frequency of exceedance coupled with the general decline in water temperatures over time, we conclude that hyperthermality is not a problem in Corpus Christi Bay.

Dissolved oxygen (DO) consistently averages near (and above) saturation throughout the CCBNEP study area, with frequent occurrence in the data record of substantial supersaturation. Exceptions to this are in poorly flushed tributaries and areas influenced by wasteloads, especially the Inner Harbor. The predominant variation in DO is due to seasonal changes of solubility. In the open, well-aerated areas of the bay, vertical stratification is slight, averaging on the order of 0.1 ppm/m, and is considered to be the result of DO aeration at the surface in concert with water-column and sediment biochemical oxygen consumption.

We examined episodic occurrence of low DO's. Hypoxia (which we define to be DO $\leq$ 2 ppm) is rare, occurring at most in several percent of the data in a minority of regions of the bay, and primarily in measurements near the bottom in deeper water. The exception is the Inner Harbor, where hypoxia has occurred more frequently, in about one-fourth of the measurements, but still primarily near-bottom. Near-zero DO (defined to be DO $\leq$ 0.5 ppm) is rarer yet, representing perhaps half of the hypoxia events, mainly confined to the Inner Harbor and Nueces River.

Most areas of the bay have a relative frequency of DO below the TNRCC standard of 5 ppm (without vertical averaging, diurnal-excursion allowance, or screening by flow, as required for its direct applicability) of a couple of percent, almost always in the summer or early fall. There are scattered higher frequencies of violations, especially in proximity to sources of inflow and wasteloads, and in the shallow, poorly-circulating areas near the barrier island, especially in the Upper Laguna. The apparent contradiction between the observation that the system is at or above saturation much of the time, and yet has a nonnegligible frequency of

standard violation, 10-20% in a few areas, is reconciled by noting that much of the year DO solubility falls very close to the standard, because of the high natural tempera-tures and salinities in this area. This also implies that the clearance between solubility and a level of DO stress is small, so under these conditions the assimilative capacity for oxygen demands may be limited.

Conventional water-phase organic contaminants as measured by biochemical oxygen demand (BOD), oil & grease, volatile suspended solids (VSS) and volatile solids, are generally highest in the Inner Harbor. The frequency of measurement of these parameters has declined substantially in recent years, and trends are therefore uncertain. In the open waters of Corpus Christi Bay, BOD seems to be declining, and wherever adequate data for analysis exist, VSS is declining, probably the result of improved waste treatment.

Like all of the Texas bays, Corpus Christi is turbid. Long-term average total suspended solids (TSS) range 20-100 ppm throughout most of the study area, higher in Nueces, Copano and Corpus Christi Bay, as well as in Baffin. Stratification in TSS is noisy, but on the order of 5 ppm/m declining upward, which is consistent with settling of larger particles to the bottom as well as a near-bottom source of particulates from scour of the bed sediments. The highest TSS concentrations and highest stratification are found in Nueces Bay.

The most remarkable feature of TSS is its decline over time, increasing in significance from north to south across the study area, at a rate sufficient to have reduced the average concentration by about 25% in the upper bays and by about 50% in the lower bays over the last two decades. This could be caused by several factors, including a general reduction of TSS loading to the bay or altered mobilization within the bay system itself. Suspended sediment is an intrinsic and important aspect of the Corpus Christi Bay environment; its decline is not necessarily beneficial.

Nitrogen and phosphorus nutrients in the water column are highly variable. Ammonia nitrogen is generally higher in regions affected by waste discharges, especially the Inner Harbor, while nitrate nitrogen and phosphorus are typically highest in regions affected by runoff and inflow. Concentrations of inorganic nitrogen are about 0.1 ppm, except much higher, around 0.5 ppm, in Copano and in the Inner Harbor (the latter due to high ammonia). Total phosphorus is about 0.05 ppm, except around 0.15 ppm in Nueces Bay, Copano Bay and Baffin Bay. These mean concentrations are more-or-less typical of other Texas bays (e.g., Longley, 1994), though total inorganic nitrogen is about half the levels found in Galveston Bay and total phosphorus is about one-fourth (Ward and Armstrong, 1992a). Generally where the nitrogen species are high in concentration, they exhibit a declining trend. No clear trends are apparent in the phosphorus data. In the sediment phase, highest concentrations of Kjeldahl nitrogen occur in the Inner Harbor region, and the Upper Laguna. Sediment phosphorus is relatively uniform throughout the system.

Generally water-phase total organic carbon (TOC) values decrease southward from 20-30 ppm in Copano to 5-15 ppm in Baffin and the Laguna, with a seasonal

peak in early summer. Larger values (by an order of magnitude) occur in the Inner Harbor. Sediment TOC distributions generally run counter to the water phase, increasing southward across the study area with the lowest values of sediment TOC in the Inner Harbor. Nueces Bay shows substantially depressed values of TOC in both water and sediment. There is a widespread declining trend in water-phase TOC at a rate that would reduce concentrations by about one-fourth over two decades. (The prominent exception to this is in the Inner Harbor, where average water-phase TOC is the highest in the study area, and is increasing in time.) Where sufficient sediment TOC data exist to establish a trend, this trend generally is also declining in time. Unfortunately, the data for chlorophyll-a is too sparse and noisy to determine whether any correlated time trends occur in it as well, so we cannot judge whether the decline in TOC is due to reduced primary production or to reduced loadings.

Contaminants such as coliforms, metals and trace organics show elevated levels in regions of runoff and waste discharge, with generally the highest values in the Inner Harbor, and low values in the open bay waters. The highest average coliforms in the system occur in the nearshore segments of Corpus Christi Bay from Corpus Christi Beach to Oso Bay. Nueces Bay is a region consistently high in metals, in both the water column and the sediment, as are Baffin Bay, Copano Bay, a region of the Upper Laguna around the Bird Islands, the La Quinta Channel, and Redfish Bay near Aransas Pass. The metals copper, nickel and zinc, in particular, have elevated concentrations in water generally throughout Corpus Christi Bay. The water-phase metals data were so sparse and noisy in time that reliable trends could not generally be established. With respect to sediment metals, arsenic, cadmium, mercury, and zinc are elevated, with concentrations generally on the same order as Galveston Bay. Inner Harbor sediment metals are similar to the upper Houston Ship Channel except zinc, for which its sediments are an order of magnitude *higher* than those of the Houston Ship Channel. This raises the speculation of whether the Inner Harbor could be the ultimate source for elevated zinc in the system. For sediment metals in the principal components of the system, where a trend can be reliably established it is generally declining. An exception to the general declining trends is sediment zinc, for which widespread possible increasing trends are indicated in large areas of the open waters of Corpus Christi Bay and Baffin Bay.

No definitive statements can be made about water-phase semi-volatile organics such as pesticides and PAH's, because data is sparse, and very few measurements are uncensored, most being simply reported as below detection limits. For example, the best-monitored pesticide is DDT, for which most areas of the bay do not have data. Only four non-zero average values occur in the entire study area, two in Ayres Bay, and one each in Nueces Bay and Baffin Bay. For toxaphene, only one non-zero value occurs, in Nueces Bay. The situation is similar for the other organics, with only one or a few non-zero values, and inadequate data to determine any trends or spatial variation.

The situation is a little better for sediment-phase data, but still most of the system is unsampled, and much of the data which does exist is below detection limits. The highest concentrations of the common pesticides are found in Baffin Bay and

Copano Bay. Concentrations of sediment pesticides in Nueces Bay are not especially high, except for toxaphene. PCB's and PAH's exhibit very high concentrations in the Inner Harbor. Elevated concentrations of PCB's also occur in Redfish Bay. There are consistent elevated concentrations of some of the PAH compounds in Nueces Bay, Copano Bay, and Mesquite Bay, but not in the Upper Laguna.

Considering the effort required to obtain, digitize and compile the tissue data for the CCBNEP study area, the information yield is disappointing. Pooling and analysis of the data are hampered by the noncomparable attributes of organism sampled, portion of organism analyzed (whole versus edible portions), and reporting convention (wet-weight versus dry-weight), in addition to the usual discriminants of analyte and geographical position. The most-sampled organism is the American oyster, with most samples from Nueces and Aransas Bays, followed by the blue crab, speckled trout, red drum and black drum. There is one sample each of brown shrimp and white shrimp. By far, the greatest quantity of analyses have been performed for the metals. For the oyster, Nueces Bay and Copano Bay exhibit systematically elevated metals in the tissue, Nueces Bay having the highest mean tissue concentrations in the study area for cadmium, copper, lead and zinc. This conclusion generally agrees with the relative concentrations in the sediments, if the Inner Harbor and tertiary bays are discounted. Blue crab data in Redfish Bay and Baffin Bay show elevated levels of most metals. Statistical analysis of the black drum data base was possible only for Nueces Bay, which indicated some elevated metals concentrations, especially for mercury and zinc, and when a time trend could be resolved, it is increasing. The data base of *detected* PAH's and related hydrocarbons is negligible. For only a few, such as pyrene, have there been detects logged in the data.

From a systemic point of view, the most significant potential problems affecting the study area as a whole are suspended particulates, nutrients and salinity. As summarized above, declines of TSS, inorganic nitrogen and TOC were found. More data is needed to determine whether there is a decline in productivity, or what the optimum levels are for Corpus Christi Bay. Salinity of Corpus Christi Bay has been a major source of controversy, especially within the past decade, because of its perceived value as a habitat indicator that also measures freshwater inflow. At this writing, the City of Corpus Christi water supply in the Nueces River reservoirs is threatened by a drought, and the conflict between human water-supply requirements and the needs of the estuary ecosystem has been brought into sharp relief. One result of the present study, disclosure of increasing salinity that seems to be associated with declines in mean inflow, suggests that salinity will continue to be at the center of management issues and strategies for this system, even after the current drought has abated.

Several deficiencies of this data set are noted, as they relate to the interpretation of water and sediment quality. Adequacy of a data base is judged relative to the ability to resolve the various scales of variation, and in this respect Corpus Christi Bay is undersampled. An estuary such as Corpus Christi Bay is subject to a variety of external controls, all of which contribute to variation in space and time. The intermixing of fresh and oceanic waters imposes spatial gradients in both the

horizontal and the vertical. The effects of tides, meteorologically driven circulations, and transient inflows all contribute to extreme variability in time. Superposed upon all of this are the time- and space-varying influences of human activities.

Despite the hundreds of thousands of separate measurements compiled in this study, from extensive and overlapping routine monitoring and survey programs by several state agencies and numerous special surveys, when these data are subdivided by specific parameters, each of which measures a different aspect of the water/sediment quality "climate," aggregated by region of the bay (segments) and distributed over time, the data record is seen to be rather sparse. Continuity in space is undermined by too few stations, and by inconsistency in the suite of measurements at different stations. Ability to resolve long-term trends in the face of high intrinsic variability requires data over an extended period. Continuity in time is undermined by infrequent sampling, and the replacement of one parameter by another without sufficient paired measurements to establish a relation.

After a relative peak in the mid-1970's, data collection, as reflected in the number of sampling programs underway and the density of the network of stations, has been declining. Considering that Corpus Christi Bay is undersampled, this trend is in the wrong direction. (There are some exceptions: there have been recent increases in salinity and DO sampling, mainly due to the activities of TPWD, and in trace constituent sampling, due to increased concern with metals and organic toxicants and to the advancement of instrumental analysis.) To maintain a monitoring project within limited resources requires a compromise between station density, temporal frequency, and the extent of the suite of analytes. Cost for all three have been increasing, the last due to more precise and expensive laboratory methodologies. There is no doubt that economics is one of the prime factors forcing the recent decline in all of these, especially in the spatial and temporal intensity of sampling. That does not mitigate the fact that our ability to understand and manage Corpus Christi Bay is concomitantly diminished.

Data management is generally poor. Both modern and historical data bases have been compromised in various ways. Too many entries in the data record had to be excluded from the analyses presented here because the data were unreliable. It is our belief that much of this unreliability was not introduced in the original measurement but in the subsequent handling of the data. The most pressing management problem for historical data in the Corpus Christi area, as well as in other areas of the Texas coast, is preservation of the older data. Much irreplaceable and invaluable information on the Corpus Christi Bay system has been lost.

Recommendations are offered for data-collection procedures, data management, historical data management, and specific research topics.

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ABBREVIATIONS AND ACRONYMS
(See also Table 2-1 and Section 8.1)

AA	atomic absorption
AE	atomic emission
APHA	American Public Health Association
BaP	benzo(a)pyrene
BDL	below detection limits
BEG	Bureau of Economic Geology, University of Texas
BOD	biochemical oxygen demand
BOGAS	Based On Graphical or Arithmetical Suppositions
CAFO	confined animal feeding operation
CBI	Conrad Blucher Institute of TAMU–Corpus Christi
CCBNEP	Corpus Christi Bay National Estuary Program
CC-NCHD	Corpus Christi-Nueces County Health Department
CCSC	Corpus Christi Ship Channel
CD	compact disc
CD-ROM	compact disc-read-only medium [memory]
CDS	Coastal Data System of TWDB
cfs	cubic feet per second
COD	chemical oxygen demand
CP&L	Central Power and Light
DDT	dichlorodiphenyltrichloroethane
DL	detection limit
DO	dissolved oxygen
EM	electromagnetic
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency, also USEPA
EqP	Equilibrium Partitioning
FTU	Formazin Turbidity Unit
GBNEP	Galveston Bay National Estuary Program
GC-MS	gas chromatograph-mass spectrometer
GIWW	Gulf Intracoastal Waterway
GOM	Gulf of Mexico
GPS	Geographical [Geodetic, Global] Positioning Systems [Satellites]
HDR	Henningson, Durham and Richardson, Inc.
HSPF	Hydrological Simulation Program FORTRAN
TU	Jackson Turbidity Unit
LORAN	Long-Range [Radio] Navigation
LS	least squares (referring to statistical regression)
MGD	million gallons per day
MW	megawatts
NGVD	National Geodetic Vertical Datum
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service of NOAA
NOS S&T	National Ocean Service Status and Trends Program

ABBREVIATIONS AND ACRONYMS
(continued)

NTU	Nephelometric Turbidity Unit
OLS	ordinary least squares (referring to statistical regression)
O&M	Operations and Maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PI	Principal Investigator
POR	period of record
QA/QC	quality assurance and quality control
SEDxxxxx	general abbreviation for sediment quality analyte, see Table 2-1
SEE	standard error of the estimate
SES	steam-electric station
SMN	Statewide [Stream] Monitoring Network
SWRI	Southwest Research Institute
TAMU	Texas A&M University
TDH	Texas Department of Health
TDWR	Texas Department of Water Resources
TGFOC	Texas Game, Fish and Oyster Commission
TXxxxxx	general abbreviation for tissue quality analyte, see Section 8.1
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TPWD	Texas Parks & Wildlife Department
TSS	total suspended solids
TWC	Texas Water Commission
TWDB	Texas Water Development Board
USCE	U.S. Corps of Engineers, U.S. Army Corps of Engineers, U.S. Army Engineer
USEPA	U.S. Environmental Protection Agency, also EPA
USF&WS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSS	volatile suspended solids
WQxxxxx	general abbreviation for water quality analyte, see Table 2-1

1. INTRODUCTION

1.1. Background and project motivation

The Corpus Christi region could be characterized as geographically and culturally transitional. It is near the northern limit of the chaparral brush country and the southern limit of the coastal-plain grassland prairies. Corpus Christi has been a prime terminal supporting the vast coastal-plain ranches of south Texas, but is far enough north to be influenced by the planters from the east. It is also far enough south to be affected by Spanish traditions. The commerce of the port in the late Nineteenth Century included exports of beef and cotton, and imports of fruits and metals from Mexico. Much of this cultural overlap is tied to the transitional hydroclimatology of the region. It is tropical much of the time, but still far enough north to be influenced by the midlatitude westerlies and their synoptic disturbances which fling cold air masses down the Great Plains. It is also usually arid, a result of the eastward extension of the rainshadow of the North American cordillera, and the infrequency of midlatitude disturbances intruding this far south. But the exceptions to this aridity are extreme: freshets on the Nueces and diluvial tropical storms, either of which can result in flooding and render much of the bay fresh. This combination of arid, tropical conditions with intermittent intense rainfall has allowed vigorous agricultural production in the area. These extremes in hydroclimatology are also the primary external forcings of Corpus Christi Bay that ultimately govern its quality.

For Corpus Christi Bay and the adjacent systems of Aransas-Copano Bay and Laguna Madre, concerns about the quality of the system have arisen rather more recently than the urbanized and industrialized bays on the upper Texas coast. In 1841, when the City of Houston was passing an "anti-pollution" ordinance prohibiting the accumulation of sawdust on the shoreline of Buffalo Bayou (Sibley, 1968), the dominant concern of the Kinney-Aubrey trading post on Corpus Christi Bay was defending against raids by Indians and Mexicans. The boom of prosperity in Texas in the last quarter of the Nineteenth Century expressed itself in the Corpus Christi area as expansions in ranching, agriculture, and commercial fishing, in synergism with incursions of railroads and shipping, the trade stimulated by all of these activities, and, of course, tourism. But the population increase attending this expansion was modest in comparison to that of the upper coast. By 1900, Houston and its port had become a major industrial center, while Corpus Christi was regarded as primarily a tourist resort.

Urbanization and industry are relative latecomers to the area. In the early years of this century, while the effects of industrial pollution were being logged in the upper bays (TGFOC, 1928, described the impacts of petroleum operations on Galveston Bay in 1920: "Fishing in the ship channel was ruined, and most of the marine life had been driven from the upper portions of the bay. Bathers often received generous coatings of oil."), an example of industrial concern in Corpus Christi was the loss of the turtle fishery and the canneries it supported. Only in the 1930's did heavy industry begin to be situated on the industrial canal, with

construction of the Southern Alkali Corporation plant (which used oyster shell from Nueces Bay). Oil production began in this same decade of the 1930's near White Point and in the Saxet Field, which stimulated shipping and later refining, and was the major impetus for growth in the area.

For Corpus Christi Bay and the adjacent systems of Aransas-Copano Bay and Laguna Madre, concerns about the quality of the system have arisen rather more recently than for the urbanized and industrialized bays on the upper Texas coast. Up to World War II, there appear no reports or indications of perceived pollution problems, in contrast to the upper coast. (Outbreaks of shellfish poisoning occurred in Galveston Bay in 1944, due to sewage contamination, Wise et al., 1944, 1948. TGFOC, 1946, states "The total catch from the Galveston area is an insignificant per cent of the total production in Texas waters and can be expected to remain so until the heavy industrial pollution of that region is abated.") Far more fish kills have occurred in the Corpus Christi Bay system due to freshets and freezes than to contamination. In the last two decades public attention and concern for the Corpus Christi Bay system has changed. With accelerating urban development, awareness of the potential impacts on the bay has increased, and maintenance of the health of the system–and its reconciliation with goals of municipal growth and industrial development–has become a major issue. With this concern is the recognition that the quality of Corpus Christi Bay must be managed.

The cornerstone of management of a natural system like Corpus Christi Bay is the ability to determine responses of the system to changes in external or controlling factors, i.e. its "controls," in the form of cause-and-effect relations. Qualitative, anecdotal information is interesting from a historical viewpoint, but does not contribute to answering the questions of whether significant problems in water quality presently exist in Corpus Christi Bay and whether there is (or has been) a long-term alteration in water quality. Two elements are needed in order to appraise variation in water quality and to identify its cause. First is a quantitative measure, i.e. identification and analysis of a parameter (or parameters) indicative of water quality, which in principle can provide time-space continuity. Complaints of declines in a fishery, for example, are dramatic evidence of something, but offer little basis for scientific evaluation. Instead, a physical or chemical parameter (or several, or many) is needed upon which the viability of that fishery depends, and which represents the impacts of some natural or human process on waters of the bay. The second element needed is an extensive data base on the parameter. This, of course, is the real obstacle.

The data base must have sufficient spatial and temporal resolution to sample the variability of the parameter. The data base must also extend over a considerable period of time, for two reasons. First, from the standpoint of determining time trends, a long period of record is absolutely indispensable. This is intuitive, but can be demonstrated mathematically. From a statistical point of view, one will recall that the variance of the sampling distribution of the slope of a linear least-squares trend line is:

$$\sigma_r 2 / (N \sigma_t 2)$$

in which t is the independent variable (time) with variance σ_t^2, N is the number of data points in the estimate and σ_r^2 is the variance of the dependent variable (concentration of some indicator parameter, in our case) about the trend line. (For a uniform sampling rate, this becomes exactly $12\sigma_r^2/N^4$.) The variance of t is directly related to the length of the period of measurement, as well as to the uniformity of distribution of measurements in that period. This relation tells us that the statistical confidence in the trend and the explained variance of the trend will each be proportional both to the number of data points N and the variance of the independent variable σ_t^2. Too short a period of record, or too few measurements in time, or especially both, will hamper one's ability to establish a trend with any statistical confidence. If there is no trend line, but one is seeking a harmonic signal in the data, the variance of the estimated amplitude (and, hence, both confidence in its determination and the statistical predictive power of the model) is proportional to $1/(S\ N^3)$, where S is the signal-to-noise ratio (see Walker, 1971). This means that a long series (N) is much more important than a strong signal (S). Or, putting it another way, a sufficiently long series will allow one to discern even weak signals.

Second, a long period of data collection is necessary to encompass the range of variation of external conditions to which the bay is subject and which contribute to the variance in the parameters. Periods of drought and floods, the occurrence of freshets and storms, high-water stands and low-water events, great- and small-declination tides, winds and waves, all contribute to the range of variation in an observed parameter. The mathematical demonstration is the same as that above, except the independent variable is not time but any proposed forcing function such as river flow or waste-loading rate. Only a long period of record assures that the full range of conditions is reflected in the data base. Too short a period will limit the range of variation of the forcing variable, as well as run the risk of biasing the data.

Generally, any single data-collection program lacks the resources and longevity to develop a data base sufficiently comprehensive for analysis of water quality levels and trends in a system such as Corpus Christi Bay. This is due to the extreme natural variability of the water-quality parameters. The best prospect for a definitive study is to begin with a synthesis of data from a number of programs, using the entire spatial and temporal scope of each program. This is the strategy followed here.

1.2 Objectives and prosecution of project

For many years, data relating to the quality of water and sediment have been collected in the Corpus Christi Bay system by a variety of organizations and individuals. The objectives of data collection have been equally varied, including the movement and properties of water, the biology of the bay, waste discharges and their impacts, navigation, geology and coastal processes, and fisheries. While the specific purposes of the individual data collection projects have limited each project in time and space, the data have great potential value to the Corpus

Christi Bay National Estuary Program (CCBNEP) if they can be combined into a comprehensive data base yielding a historical depiction of the quality of the bay environment.

The purpose of this project was to compile and evaluate these data, and to employ these data in a quantitative assessment of water and sediment quality of Corpus Christi Bay and its evolution over time. There were several subordinate objectives in the project, as outlined in the following sections. However, the key objectives were threefold, *viz.*:

(1) compilation of a comprehensive data base in machine-manipulable format,

(2) analysis of time and space variation (including "trends") in quality parameters,

(3) identification of possible causal mechanisms to explicate the observed variations.

Securing these objectives will provide a foundation for further scientific study of Corpus Christi Bay, for identifying and prioritizing specific problems affecting the quality of the Bay, for formulation and specification of future monitoring programs for the Bay, and for a general understanding of the controls and responses of Bay water quality, which must underlie rational management of the resources of the system.

This project was prosecuted according to the Work Plan (Ward and Armstrong, 1994), which in turn generally conformed to the outline of the draft Scope of Work prepared by CCBNEP management. Two separate documents have been developed from this project, because there are two different aspects of the project that would benefit by independent reporting. The present report employs the data base to characterize the Corpus Christi Bay system, including statistical analyses of the data for key water-quality areas and all TNRCC segments, identification of water-quality problems, and an analysis of apparent mechanisms for the variation in space and time of water quality, and for the occurrence of water-quality problems. This report presents the rationale and formulation of the aggregated data base, including the specification of the water-quality areas. This report also provides an assessment of the historical data base and the data collection programs that have produced it, with gaps and inadequacies identified, and specific recommendations for future monitoring programs in Corpus Christi Bay. A companion report (Ward and Armstrong, 1997a) addresses the data base itself, documenting the sources for the data, formatting of the data, methodology, data quality, and spatio-temporal coverage. This report should function as a Users Guide to the data base, to form the foundation for use of the data base by other researchers. In addition, an abridged version of the present report has been published as the project Summary Report (Ward and Armstrong, 1997b), a format which should satisfy the needs of most readers.

The focus of this study was on the quality of water and sediments in the Corpus Christi Bay system. "Quality" is a broad term, referring in general to any quantitative parameter (or suite of parameters, taken collectively) that can serve as an *indicator* for a potential use of water in Corpus Christi Bay. "Use" in this context means "function" and includes the uses of nature as well as the activities of man. By this definition, "quality" would range from physical properties such as current velocity to organisms of the bay, and would include the atmospheric and terrestrial environs. We adopted a narrower definition, consistent with the draft Scope of Work and with the other projects within the CCBNEP that are examining other components of Corpus Christi Bay, that "quality" is defined by physical, chemical and microbiological constituents associated with the Bay waters or its suspensions.

The study area for this project encompasses the estuarine and coastal nearshore areas extending from the mud flats (a.k.a. middle ground, a.k.a. landbridge, a.k.a. landcut) of the Laguna Madre to the southern limit of San Antonio Bay, and includes Baffin Bay, Corpus Christi Bay proper and its secondary embayments, the Aransas-Copano system, and Mesquite/Ayres Bay, see Figs 1-1 through 1-4. As noted in Chapter 3, we have further enlarged the area of study to include tidal and above-tidal reaches of the principal tributaries, the southern segment of San Antonio Bay including Hynes Bay, and the adjacent Gulf of Mexico out to about the 10-fathom contour. This large study area creates a terminological problem. We refer to the entire study area as the Corpus Christi Bay system. The northern bays of Aransas and Copano, and their respective secondary systems, St. Charles, Mission, Ayres, etc., are referred to as the upper bays. Similarly, the southern elements of the system, Baffin Bay and the Upper Laguna Madre are referred to as the lower bays. An important subregion is Corpus Christi Bay *per se*, which can be confused with the overall study area. We attempt to minimize this confusion by referring to the CCBNEP study area as the "system", and Corpus Christi Bay proper as the "main body", or some similar qualification. Hopefully, the context will prevent confusion.

This project sought data from various sources, relating to the general categories of indicator variables (bacteriological and chemical), nutrients, heavy metals, pesticides, organics, suspended matter, and hydrographic variables, including density and salinity, and created a computer-manipulable data base. Generally, the first portion of the project effort concentrated upon acquisition and transmittal of data holdings, and the latter portion with data entry, and the development of the data base. An important task of this portion of the project was that of recovering historical data sets from oblivion, and one major product of this project is consistent, digital forms of the major water/sediment programs from the Bay.

One of the difficulties encountered in the earlier Water Quality Status and Trends Project carried out as part of the Galveston Bay NEP (Ward and Armstrong, 1992a) was the poor response from many of the major agencies responsible for historical data collection in Galveston Bay. As might be anticipated, we encountered the same problem of poor response again. Time periods of months were required to obtain digital copies of data bases; in a few instances over a year elapsed between our (first) request and our eventual receipt of data. In the

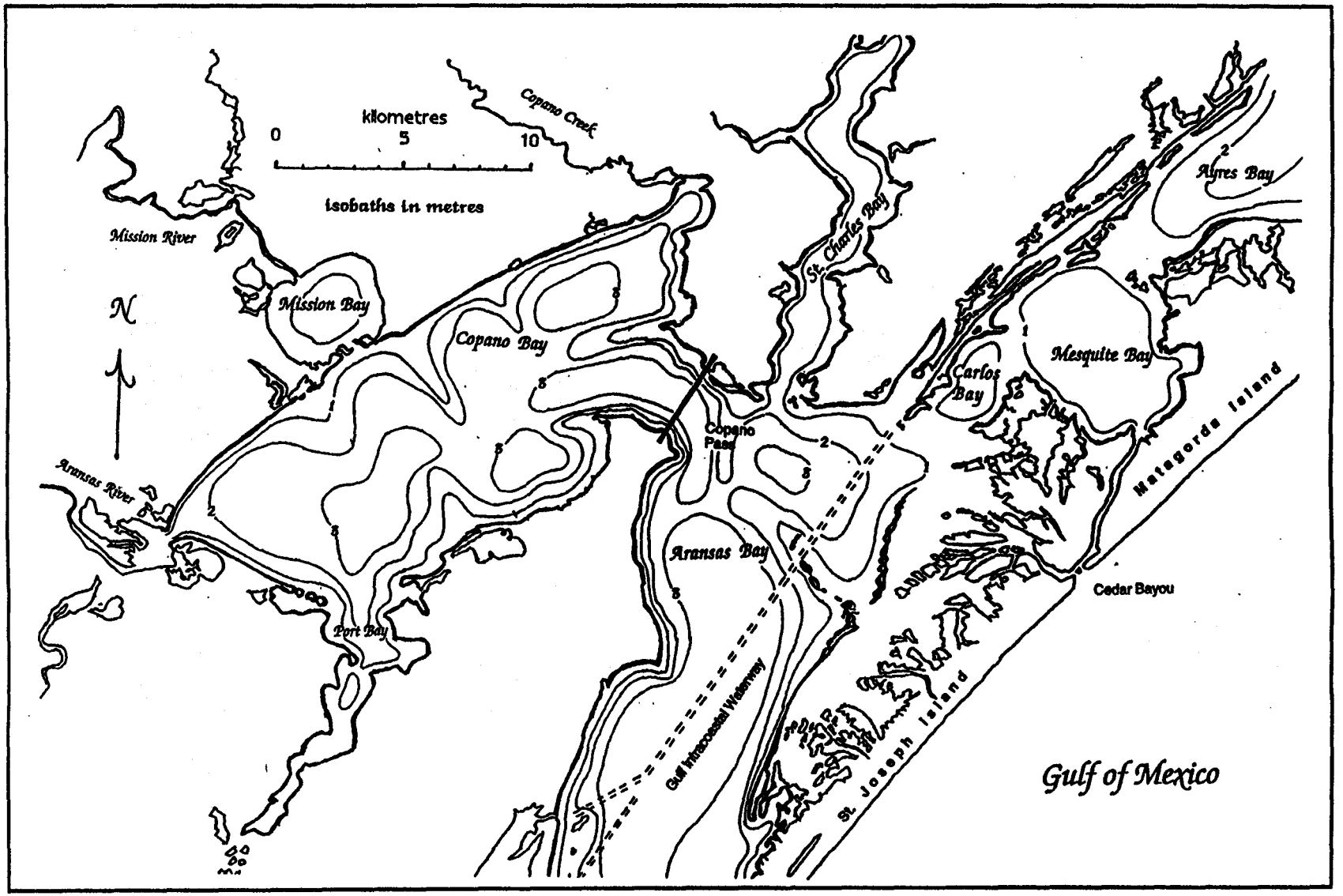


Figure 1-1. Aransas-Copano Bay

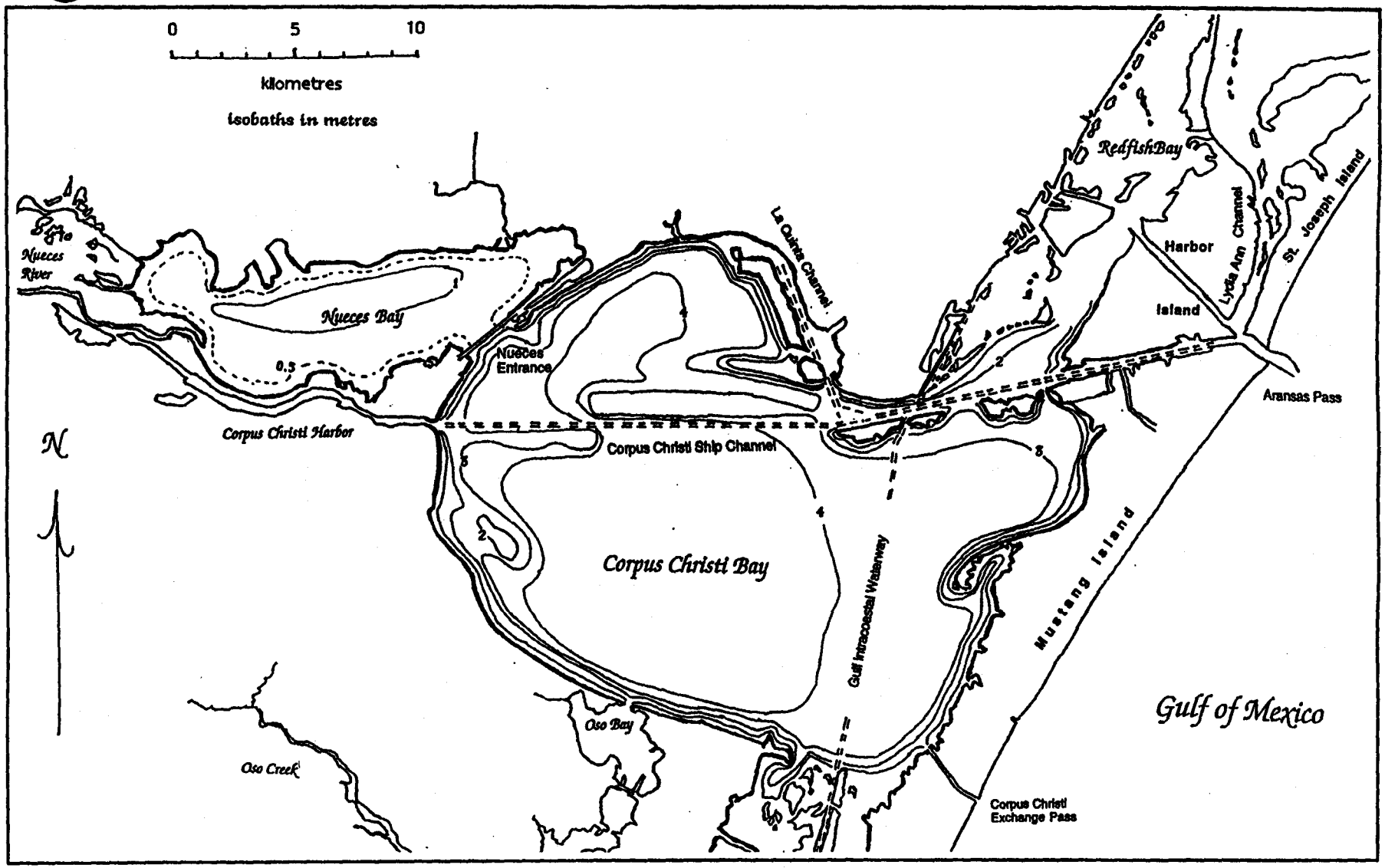


Figure 1-2. Corpus Christi Bay

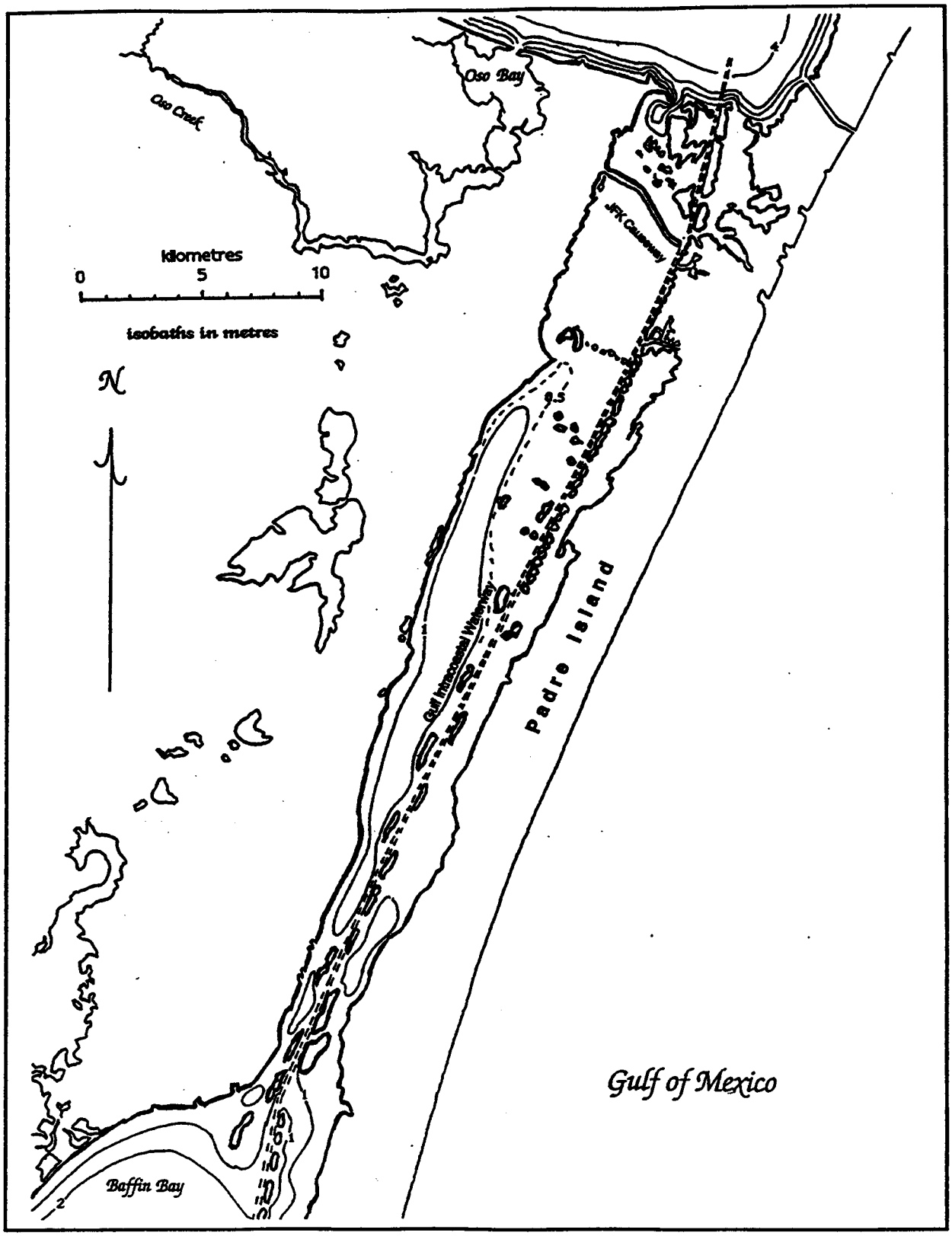


Figure 1-3. Upper Laguna Madre

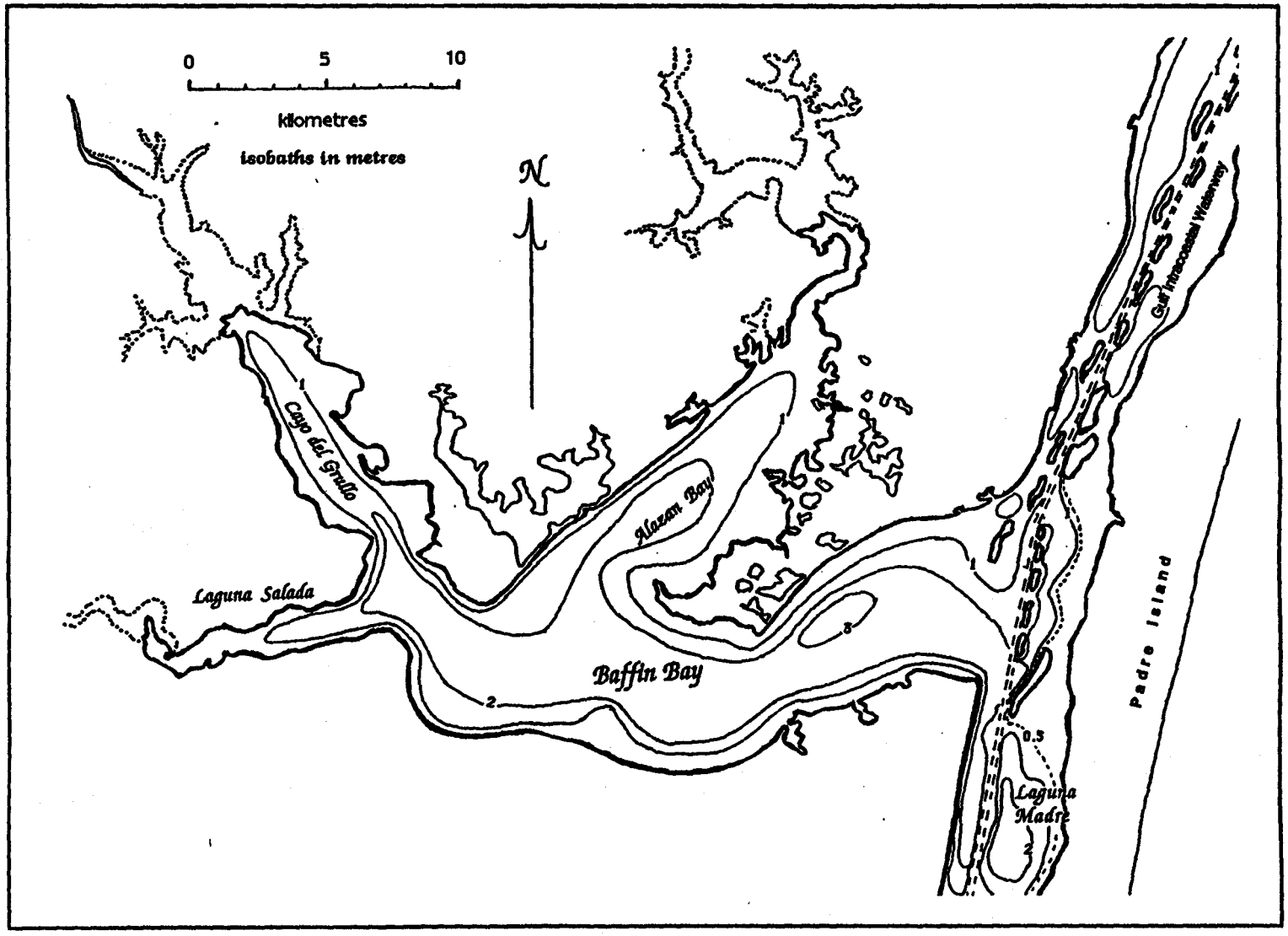


Figure 1-4. Baffin Bay

present status and trends analysis, it was imperative that all data be on hand before we began the analytical aspect of the work; otherwise much of the analysis would have to be repeated. The point in the project calendar at which the data base was declared complete, and analyses began has been referred to as the schedule "hinge point." This poor response directly translated to scheduling problems, and the hinge point was incrementally slid forward in the calendar to accommodate.

Many of the data sets employed in this study exist only in a limited number of hard copies. A major part of the effort of this project was invested in keyboarding this data to create a digital data base. This keyboarding process was delayed by the same problem of poor response, as well as the time necessary in some instances to physically locate the data. The problems of acquiring such data sets would be a formidable obstacle to any future researcher's compiling an adequate data base for Corpus Christi Bay. Therefore, we regard the synthesized digital data base as a major product of the project as it allows future researchers much greater scope in analysis than could be afforded by the data sets normally available to individual scientists.

Procedures of data processing are described in Chapters 3 and 4, the analyzed water and sediment quality data are presented in Chapters 6 and 7 (and appendices), respectively, the possible cause-and-effect processes suggested by associations in the data are discussed in Chapter 9, and a summary of conclusions and list of recommendations are given in Chapter 10. The data base itself is summarized in Chapter 5, along with identified deficiencies and recommendations more directed at monitoring and data management.

Tissue data was included in the Scope of Work for this project. This may have been an afterthought, but it has a logical appeal in that most of the agencies engaged in the collection of tissue chemistry data are also those from which water/sediment chemistry data were sought. This tissue data, however, proved to be more trouble than it was worth. There is very little of it, over a relatively short period of record, and it is reported inconsistently. (This data was more trouble than it was worth at least from the viewpoint of performing a status-and-trends analysis. The data did prove useful to a companion CCBNEP project documenting public health problems, see Jensen et al., 1996.) This part of the data compilation and analytical effort is presented in Chapter 8.

The core of the report is considered to be Chapters 6 and 7. Our philosophy is to present the *facts* of the data in these chapters, reserving the *interpretation* of the data for Chapters 9 and 10. The interpretations postulate conceptual models and may be biased by the predilections of these investigators. Certainly, they will be subject to revision upon additional data collection or more sophisticated analyses. However, the results of Chapters 6 and 7 should stand as *facts*, circumscribed only by the statistical measures employed, and the criteria for rejection or weighting.

2. THE MEASUREMENT OF WATER AND SEDIMENT QUALITY IN CORPUS CHRISTI BAY

The quantification of the quality of water and sediment (and for that matter tissue) in an estuary is accomplished by determination of a suite of chemical and biochemical parameters. Some parameters are routinely measured in the field, such as temp-erature and salinity, but most parameters are determined by laboratory analysis of a water, sediment or tissue sample. Some of these are indicator variables, such as coliforms and BOD, some are constituents which *per se* have major rôles in biochemical processes, such as process compounds, e.g. nitrogen and phosphorus species, or toxic contaminants such as PAH's and pesticides, and some serve in both capacities, such as salinity. This study addressed the following categories of parameters:

- temperature;
- salinity and related parameters;
- suspended sediments, turbidity, and related parameters;
- pH, alkalinity, and related parameters;
- dissolved oxygen and saturation deficit;
- nutrients, *viz.* nitrogen, phosphorus, silica and organic carbon;
- organic contaminants as measured by oil & grease, volatile solids and biochemical oxygen demand;
- chlorophyll-a and phaeophytin;
- coliforms;
- trace metals (total and dissolved);
- trace organics, including pesticides, herbicides, PAH's, PCB's, and priority pollutants

In the present study, data were compiled for 109 water-quality, 83 sediment-quality, and 100 tissue parameters, the more important of which are described below. Complete tabulations of the water quality and sediment quality parameters of this study are given in Table 2-1, and in Tables A-1 and A-2 of the appendix (including sources of data, and uncertainty measures). Some of the more important classes of parameters are discussed briefly in the following sections. Table 2-1 lists the units of measurement employed in this study for each of these parameters, and an abbreviation of up-to-eight characters uniquely identifying the parameter in all of the data presentations in this report, as well as in the digital data files.

This abbreviation is decoded as follows. The first series of 2-3 characters indicates whether the analyte was determined from a water-phase or sediment-phase sample, "WQ" designating the former, and "SED" or "SD" designating the latter. For conventional parameters, the remainder of the abbreviation is a (hopefully) transparent abbreviation for the compound, e.g. WQDO for dissolved oxygen in water, WQFCOLI for fecal coliforms in water, SEDO&G for oil and grease in sediment, etc. For elemental analyses, primarily metals, the compound abbreviation is made up of the prefix "MET" followed by the (1-2 character) chemical abbreviation for the element. In the case of water samples, the sample

Table 2-1
Abbreviations and units for CCBNEP water and sediment parameters

abbreviation	*definition*	*units*
	— water analytes —	
WQALK	total alkalinity (as CaCO3)	mg/L
WQAMMN	ammonia nitrogen	mg/L
WQBOD5	5-day BOD	mg/L
WQCHLA	chlorophyll-a	µg/L
WQCHLB	chlorophyll-b	µg/L
WQCYAN	cyanide	µg/L
WQDO	dissolved oxygen	mg/L
WQFCOLI	fecal coliforms	MPN or colonies/200ml
WQKJLN	total Kjeldahl nitrogen	mg/L
WQNO2N	nitrite nitrogen	mg/L
WQNO3N	nitrate nitrogen	mg/L
WQO&G	oil & grease	mg/L
WQOPD	dissolved orthophosphate (as P)	mg/L
WQOPO4	total orthophosphate (as PO4)	mg/L
WQORGN	total organic nitrogen	mg/L
WQPH	pH	
WQPHEO	pheophytin-a	µg/L
WQSAL	salinity converted from proxy measures	ppt (‰)
WQSECCHI	Secchi depth of water	m
WQSIO2	dissolved silica (as SIO2)	mg/L
WQSO4	total sulfate (as SO4)	mg/L
WQTCOLI	total coliforms	MPN or colonies/200ml
WQTEMP	temperature	degrees C
WQTOC	total organic carbon	mg/L
WQTOTP	total phosphorus (as P)	mg/L
WQTPO4	total phosphate (as PO4)	mg/L
WQTRANS	transmissivity, over 100 cm path	% (1 m)
WQTSS	total suspended solids	mg/L
WQTURBJ	turbidity of water, JTU	JTU
WQTURBN	turbidity of water, NTU	NTU
WQXTSS	TSS converted from proxy relations	mg/L
WQVOLS	total volatile solids	mg/L
WQVSS	volatile suspended solids	mg/L
WQmetagd	dissolved silver	µg/L
WQmetagt	total silver	µg/L
WQmetasd	dissolved arsenic	µg/L
WQmetast	total arsenic	µg/L
WQmetbt	total boron	µg/L

(continued)

Table 2-1
(continued)

abbreviation	*definition*	*units*
	— water analytes continued —	
WQmetbd	dissolved boron	µg/L
WQmetbad	dissolved barium	µg/L
WQmetbat	total barium	µg/L
WQmetcdd	dissolved cadmium	µg/L
WQmetcdt	total cadmium	µg/L
WQmetcod	dissolved cobalt	µg/L
WQmetcot	total cobalt	µg/L
WQmetcrd	dissolved chromium	µg/L
WQmetcrt	total chromium	µg/L
WQmetcud	dissolved copper	µg/L
WQmetcut	total copper	µg/L
WQmetfed	dissolved iron	µg/L
WQmetfet	total iron	µg/L
WQmethgd	dissolved mercury	µg/L
WQmethgt	total mercury	µg/L
WQmetmnd	dissolved manganese	µg/L
WQmetmnt	total manganese	µg/L
WQmetnid	dissolved nickel	µg/L
WQmetnit	total nickel	µg/L
WQmetpbd	dissolved lead	µg/L
WQmetpbt	total lead	µg/L
WQmetsed	dissolved selenium	µg/L
WQmetset	total selenium	µg/L
WQmetsrd	dissolved strontium	µg/L
WQmetznd	dissolved zinc	µg/L
WQmetznt	total zinc	µg/L
WQ-245T	2,4,5 T	µg/L
WQ-24D	2,4 D	µg/L
WQ-ABHC	alpha-BHC	µg/L
WQ-ACEN	acenapthene	µg/L
WQ-ACENA	acenaphthylene	µg/L
WQ-ALDR	Aldrin	µg/L
WQ-ANTHR	anthracene	µg/L
WQ-BNZA	benzo(a)pyrene	µg/L
WQ-BNZE	benzo(e)pyrene	µg/L
WQ-BNZAA	benzo(a)anthracene	µg/L
WQ-BNZB	benzo(b) fluoranthene	µg/L
WQ-BNZGP	benzo(ghi)perylene	µg/L
WQ-BNZK	benzo(k) fluoranthene	µg/L

(continued)

Table 2-1
(continued)

abbreviation	*definition*	*units*
	— water analytes continued —	
WQ-CHLR	total Chlordane	µg/L
WQ-CHLRC	Chlordane cis isomer	µg/L
WQ-CHRYS	chrysene	µg/L
WQ-DBANE	dibenz(a,h)anthracene	µg/L
WQ-DDD	total DDD	µg/L
WQ-DDE	total DDE	µg/L
WQ-DDT	total DDT	µg/L
WQ-DIAZ	Diazinon	µg/L
WQ-DIEL	Dieldrin	µg/L
WQ-ENDO	Endosulfan I	µg/L
WQ-ENDR	Endrin	µg/L
WQ-FLRA	fluoranthene	µg/L
WQ-FLRN	fluorene	µg/L
WQ-HEPT	heptachlor	µg/L
WQ-HEPX	heptachlor epoxide	µg/L
WQ-HEXA	hexachlorabenzene	µg/L
WQ-I123P	indeno(1,2,3-cd)pyrene	µg/L
WQ-LIND	Lindane (gamma-BHC)	µg/L
WQ-MALA	Malathion	µg/L
WQ-MTHP	methyl parathion	µg/L
WQ-MTHX	methoxychlor	µg/L
WQ-NAPT	napthalene	µg/L
WQ-PAH	total PAH's	µg/L
WQ-PARA	Parathion	µg/L
WQ-PCB	total PCB's	µg/L
WQ-PCP	pentachlorophenol	µg/L
WQ-ODDT	o,p'-DDT	µg/L
WQ-PDDD	p,p'-DDD	µg/L
WQ-PDDE	p,p'-DDE	µg/L
WQ-PDDT	p,p'-DDT	µg/L
WQ-PHNAN	phenanthrene	µg/L
WQ-PYRN	pyrene	µg/L
WQ-SLVX	Silvex	µg/L
WQ-TOXA	Toxaphene	µg/L
WQ-XDDT	Total DDT converted from proxy relations	µg/L

(continued)

Table 2-1
(continued)

abbreviation	*definition*	*units*
	— sediment analytes (dry weight)—	
sedcyan	cyanide	mg/kg
sedkjln	total Kjeldahl nitrogen	mg/kg
sedo&g	oil & grease	mg/kg
sedammn	ammonia nitrogen	mg/kg
sedorgn	total organic nitrogen	mg/kg
sedtoc	total organic carbon	g/kg
SEDtotp	total phosphorus (as P)	mg/kg
sedvols	volatile solids (loss on ingnition)	mg/kg
sedmetag	silver	mg/kg
sedmetal	aluminum	mg/kg
sedmetas	arsenic	mg/kg
sedmetb	boron	mg/kg
sedmetba	barium	mg/kg
sedmetcd	cadmium	mg/kg
sedmetco	cobalt	mg/kg
sedmetcr	chromium	mg/kg
sedmetcu	copper	mg/kg
sedmetfe	iron	mg/kg
sedmethg	mercury	mg/kg
sedmetmn	manganese	mg/kg
sedmetni	nickel	mg/kg
sedmetpb	lead	mg/kg
sedmetse	selenium	mg/kg
sedmetsr	strontium	mg/kg
sedmetzn	zinc	mg/kg
sed-245t	2,4,5 T	µg/kg
sed-24d	2,4 D	µg/kg
sed-abhc	alpha-BHC	µg/kg
sed-acen	acenapthene	µg/kg
sed-acyn	acenaphthylene	µg/kg
sed-aldr	Aldrin	µg/kg
sed-anth	anthracene	µg/kg
sed-bnza	benzo(a)pyrene	µg/kg
sed-bnze	benzo(e)pyrene	µg/kg
SD-bnzaa	benzo(a)anthracene	µg/kg
SD-bnzb	benzo(b) fluoranthene	µg/kg
SD-bnzk	benzo(k) fluoranthene	µg/kg
SD-bnzgp	benzo(ghi)perylene	µg/kg

(continued)

Table 2-1
(continued)

abbreviation	*definition*	*units*
	— sediment analytes continued—	
sed-chlr	total Chlordane	µg/kg
sd-chlrc	Chlordane cis isomer	µg/kg
sed-chry	chrysene	µg/kg
sed-ddd	total DDD	µg/kg
sed-dde	total DDE	µg/kg
sed-ddt	total DDT	µg/kg
sed-diaz	Diazinon	µg/kg
SD-dbane	dibenz(a,h)anthracene	µg/kg
sed-diel	Dieldrin	µg/kg
sed-endo	Endosulfan I	µg/kg
sed-endr	Endrin	µg/kg
sed-flra	fluoranthene	µg/kg
SD-flrn	fluorene	µg/kg
sed-hept	heptachloride	µg/kg
sed-hepx	heptachloride epoxide	µg/kg
sed-hexa	hexachlorobenzene	µg/kg
SD-I123p	indeno(1,2,3-cd)pyrene	µg/kg
sed-lind	Lindane (gamma-BHC)	µg/kg
sed-mala	Malathion	µg/kg
sed-mthp	methyl parathion	µg/kg
sed-mthx	methoxychlor	µg/kg
sed-napt	napthalene	µg/kg
sed-pah	total PAH's	µg/kg
sed-para	Parathion	µg/kg
sed-pcb	total PCB's	µg/kg
sed-pcp	pentachlorophenol	µg/kg
sed-pddd	p,p'-DDD	µg/kg
sed-pdde	p,p'-DDE	µg/kg
sed-pddt	p,p'-DDT	µg/kg
sed-oddt	o,p'-DDT	µg/kg
sed-oddd	o,p'-DDD	µg/kg
sed-odde	o,p'-DDE	µg/kg
sed-pery	perylene	µg/kg
SD-phnan	phenanthrene	µg/kg
SD-pyrn	pyrene	µg/kg
SED-slvx	Silvex	µg/kg
sed-toxa	Toxaphene	µg/kg
sed-tbt	tributyltin	µg/kg
sed-xddt	DDT converted from proxy relations	µg/kg

may have been filtered, in which case the analysis is presumed to represent the dissolved metal; or the sample may not have been filtered, in which case the analysis is presumed to represent both the dissolved and suspended portions of the metal. The former is indicated by the letter "D" for "dissolved", and the latter by the letter "T" for "total." For example, WQMETASD refers to the arsenic in a filtered water sample, WQMETSET to the selenium in an unfiltered water sample, and SEDMETPB to lead in a sediment sample. Finally, all volatile organics are flagged by a hyphen in the abbreviation after the water/sediment phase designation. For example, WQ-ACEN refers to acenapthene in a water sample, and SED-LIND to the lindane in a sediment sample.

There are several classes of parameters that measure (or can be interpreted to measure) the same essential property. For example, salinity can be estimated from measurements of chlorides concentration, total dissolved solids, density, conductivity, and light refraction. Different data collection programs in Corpus Christi Bay may employ different measures, depending upon objective, convenience and tradition. The relations between parameters are considered here, for two purposes. First, from an analytical viewpoint, the use of one parameter may have conceptual advantages over another, e.g. DO deficit may be more indicative of oxygen conditions than the concentration of dissolved oxygen itself. Second, while related parameters are technically distinct, the fact that they can be associated and may be converted from one to another means that a much denser and longer-duration data set can be compiled by converting these to a common parameter. These are referred to as "proxy" relationships. For a few of the variables treated in the present study, proxy relationships proved valuable. These are summarized where appropriate in the following sections.

2.1 Hydrographic indicators

The parameters temperature and salinity are easily measured, and have been routinely determined for some time, therefore the data base is most extensive for these variables. Some of the older methods of determination involve water sampling, but the newer methods can be performed *in situ*. These have particularly benefited from the development of field instrumental techniques, by which the parameters are measured by an electrometric probe with meter readout or remote data logger. These probes have also permitted the determination of vertical profiles of these parameters without the need for water sampling. Rather, the probe can be lowered to the desired depth, and the measurement read from the deck readout.

Temperature and salinity exhibit considerable variability in Corpus Christi Bay, temperature due to the local heat-exchange processes at the surface, and salinity due to watermass movement within the estuary in conjunction with high spatial gradients. After temperature and salinity, pH is probably the most commonly measured parameter, again because of its simplicity. Generally, pH exhibits little variability, due to the high buffering capacity of seawater, but for this reason departures from the range 7-9 are especially significant.

Salinity is one of the quintessential quality elements of estuarine waters, being determined fundamentally by the intermixing of fresh and oceanic waters. As a virtually conservative parameter, easily measured, and ubiquitous, it is an excellent watermass tracer. It is also a key ecological indicator, as it affects the suitability of habitat due to varying osmoregulation capabilities of organisms. Salinity further affects many chemical reactions and sedimentation. Any direct impact on salinity has the potential of indirect consequences for ecosystem structure and function.

Since there are large spatial gradients in salinity and it exhibits high temporal variability, for work in estuaries a lower degree of precision in salinity determination can be accepted than the case either in totally fresh or oceanic systems (Head, 1985, Ward and Montague, 1996). This means that data can be employed from a variety of protocols and parameters. For this data compilation, these various parameters were converted to equivalent salinity.

Salinity originally measured the dissolved solids in seawater, which are dominated by halogen salts. A simpler measure was to determine the salts of a single halogen, *viz.* chlorine, and employ the empirical law of constant proportions (Forchhammer's Law). The relation between salinity and chlorinity based upon early work of Knudsen is approximately (Defant, 1961, Wallace, 1974)

$$S = 0.03 + 1.805 \bullet Cl$$

for S and C in ‰. A century later, this relation was re-evaluated as

$$S = 1.807 \bullet Cl \qquad (2\text{-}1)$$

Certainly to the accuracy necessary for estuarine work, this is a satisfactory means of interconverting.

One of the most common methods of salinity measurement is via conductivity. (In fact, in oceanography, the new practical salinity scale *defines* salinity in terms of conductivity.) Conductivity is a strong function of temperature so the temperature at which the measurement applies is essential. Generally, a reported conductivity will be either at ambient temperature, i.e., the temperature of the water when the measurement was taken, or compensated to a standard reference temperature of 25°C. (Modern inexpensive conductivity meters perform this compensation internally.) For a fixed temperature, conductivity varies nearly linearly with salinity. A regression based upon the data of USNHO (1956) is

$$\begin{aligned} S &= 0.000588 \bullet C && \text{for } C < 17{,}000 \text{ µmhos} \\ S &= 0.000679 \bullet C - 1.543 && \text{for } C > 17{,}000 \text{ µmhos} \end{aligned} \qquad (2\text{-}2)$$

where C is conductivity at 25°C and S is salinity in ‰. All of the conductivity data from Corpus Christi Bay were either compensated to 25°C, or have been converted to salinity by the collecting agency, so the further complication of correcting for

ambient temperature was not necessary. (Ward and Armstrong, 1992a, present an equation appropriate for estuaries.) If chlorinity rather than salinity is desired, the above relations must be combined to relate conductivity and chlorinity, *viz.*

$$C = \begin{cases} 2661 \bullet Cl + 2272 & \text{for } Cl > 5.5 \text{ ‰} \\ 3073 \bullet Cl & \text{for } Cl < 5.5 \text{ ‰} \end{cases} \qquad (2\text{-}3)$$

Density is a fundamental physical property of the estuary water. It varies as a function of temperature and salinity. Some determinations of salinity, especially in the early years, are performed by measuring density with precision hydrometers. Again, the oceanic relation is basic. The equation of state for seawater is empirical, and has most recently (UNESCO, 1981) been expressed as a best-fit multinomial with 15 coefficients. For present purposes, we retain only the higher-order terms, to obtain the approximate relation:

$$\rho = (a_4 + b_4 T + a_5 T^2) S + (a_1 + b_1 T + a_2 T^2) \qquad (2\text{-}4)$$

where

$a_1 = 999.8426$ $\quad b_1 = 6.794 \times 10^{-2}$
$a_2 = -9.0953 \times 10^{-3}$ $\quad a_4 = 8.245 \times 10^{-1}$
$a_5 = 7.644 \times 10^{-5}$ $\quad b_4 = -4.090 \times 10^{-3}$

for salinity S in parts per thousand, temperature T in degrees Celsius, and density ρ in kg/m^3. This approximation is more than adequate for the accuracy necessary in estuary work (see Ward and Armstrong, 1992a, who present numerical comparisons between the complete equation of state and that given by the above equation).

One additional field measure of salinity is the refractive index of water. The field instrument used for this purpose is a portable refractometer that is calibrated for a direct read-out of salinity (the Goldberg refractometer). For present purposes, therefore, no units conversion is necessary, but in the data processing procedures of Chapter 4 note is made of when this methodology is employed, for establishing a level of uncertainty in the data. Behrens (1965) carried out an extensive evaluation of the accuracy of the Goldberg refractometer and determined the error to be ±1‰ for salinities < 70‰.

Generally, in the field data from the Corpus Christi Bay system, only one of these measures is employed for determination of salinity, so the only decision available in analyzing the data is the proper conversion. On occasion, there is a choice, which provides an opportunity to cross-compare different measures. In the TNRCC Statewide Monitoring Network data base, both field and laboratory conductivity measurements may be available for a given sample, and occasionally there may be a laboratory determination of chlorides for the same sample as well. Where all three variables were measured, we can test the internal consistency of the data. This was carried out by Ward and Armstrong (1992a, 1992b) in the

Galveston Bay NEP data compilation. For Corpus Christi Bay, this same analytical approach was repeated, and the same problems are evident. However, in this study we gained additional insight into the sources of the discrepancies. This is summarized below; much more detail is given in the companion data-base report, Ward and Armstrong (1997a).

A clear manifestation of a problem is wide scatter in the field versus laboratory measurements of conductivity, as shown in Fig. 2-1. Considering that conductivity probes are among the simplest instruments to maintain and employ, and granting that some noise may be expected due to the hostile conditions of field measurements, this scatter is excessive, and does not engender a feeling of warmth and comfort in the overall quality of the data base. After study of that subset of over 1500 measurements for which simultaneous values for chlorides and both conductivities are given, our conclusion is that most of the "noise" is contributed by the laboratory conductivities originating at the Texas Department of Health. Part of this widespread discrepancy is due simply to inferior accuracy in the laboratory determinations, which were subjected to extreme dilution to bring the conductivity into the narrow, low range of the laboratory meter, then the measured value was scaled back up by the reciprocal of the dilution. This introduces several potential sources of error as delineated in Ward and Armstrong (1997a). Though field conductivity meters are presumably less accurate than low-range laboratory meters, they measure conductivity directly without any necessity for dilution.

Another contributor to the scatter is due to the fact that a significant proportion of the reported laboratory values are not really measurements, but are "invented data," i.e. entries Based On Graphical or Arithmetical Suppositions, BOGAS data. The BOGAS data were discovered in scatterplots of lab conductivity versus either field conductivities or chlorides, in which there appeared two distinct regressions, of which one corresponded to the theoretical relation, equation (2-3). This is particularly evident in the plot of lab conductivity versus chlorides, in which some of the data fall along a line with almost *zero* scatter, see Fig. 2-2. This line proved to be the relation $y = x \cdot 4 = x \cdot 8/2$. The theoretical relation between conductivity and chlorides is given approximately by $y = x \cdot 5/2$. We infer that for much of the data set, only one of chlorides or conductivity was actually measured, and the other was computed based upon the (correct) rule of thumb that conductivity is 5/2 times chlorides, and upon the (incorrect) rule that conductivity is 8/2 times chlorides. A comparison of the *field* conductivities and the chlorides shows a well-behaved relation that centers upon the theoretical oceanographic relation, with realistic scatter, Fig. 2-3.

We conclude that the lab *chlorides* and *field conductivity* values are real and the *lab conductivities* are (potentially) BOGAS. We note that this practice of supplying BOGAS data, apart from corrupting the data base with non-measured values, offers one more degree of freedom for human error, and indeed this is almost certainly the reason for the second spurious regression in Fig. 2-2. In this compilation, we expunged the BOGAS data from the data base by observing the priority of acceptance of salinity measures: chlorides, followed by field conductivity, followed by lab conductivity. This same priority was employed for

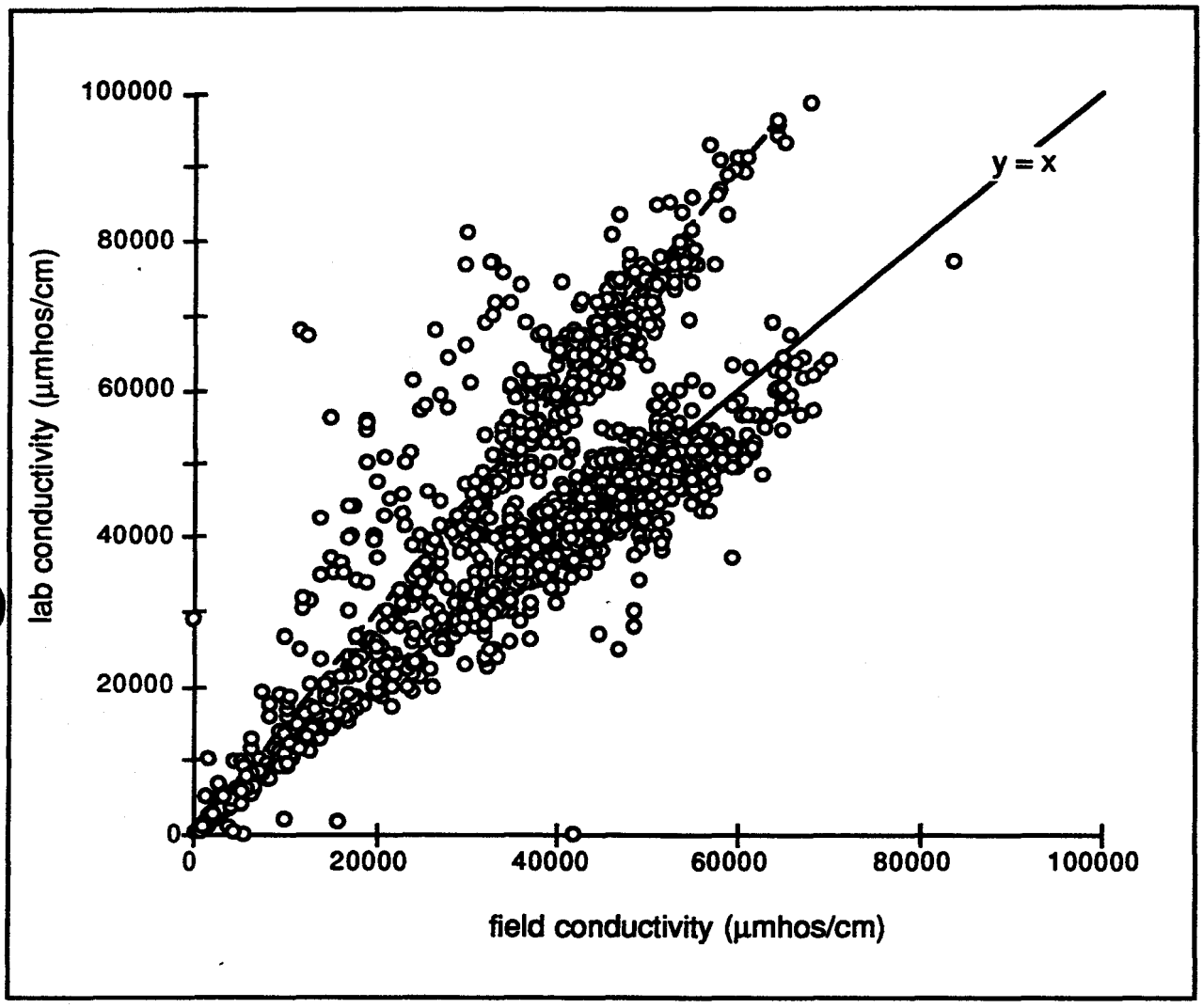


Figure 2-1. Scatterplot of field and laboratory conductivities from SMN data base for Corpus Christi Bay system

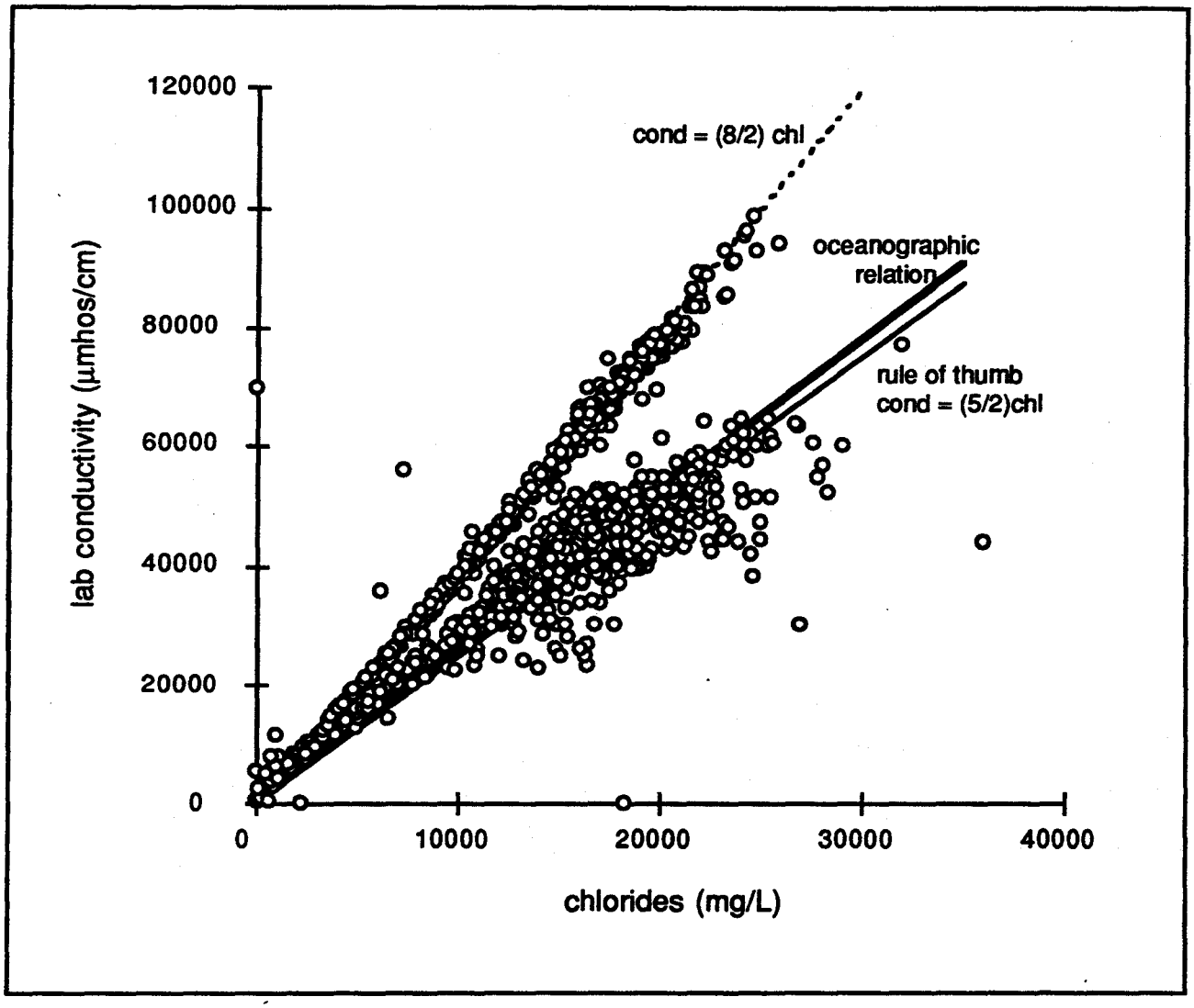


Figure 2-2. Scatterplot of lab conductivity versus chlorides from SMN data base for Corpus Christi Bay system.

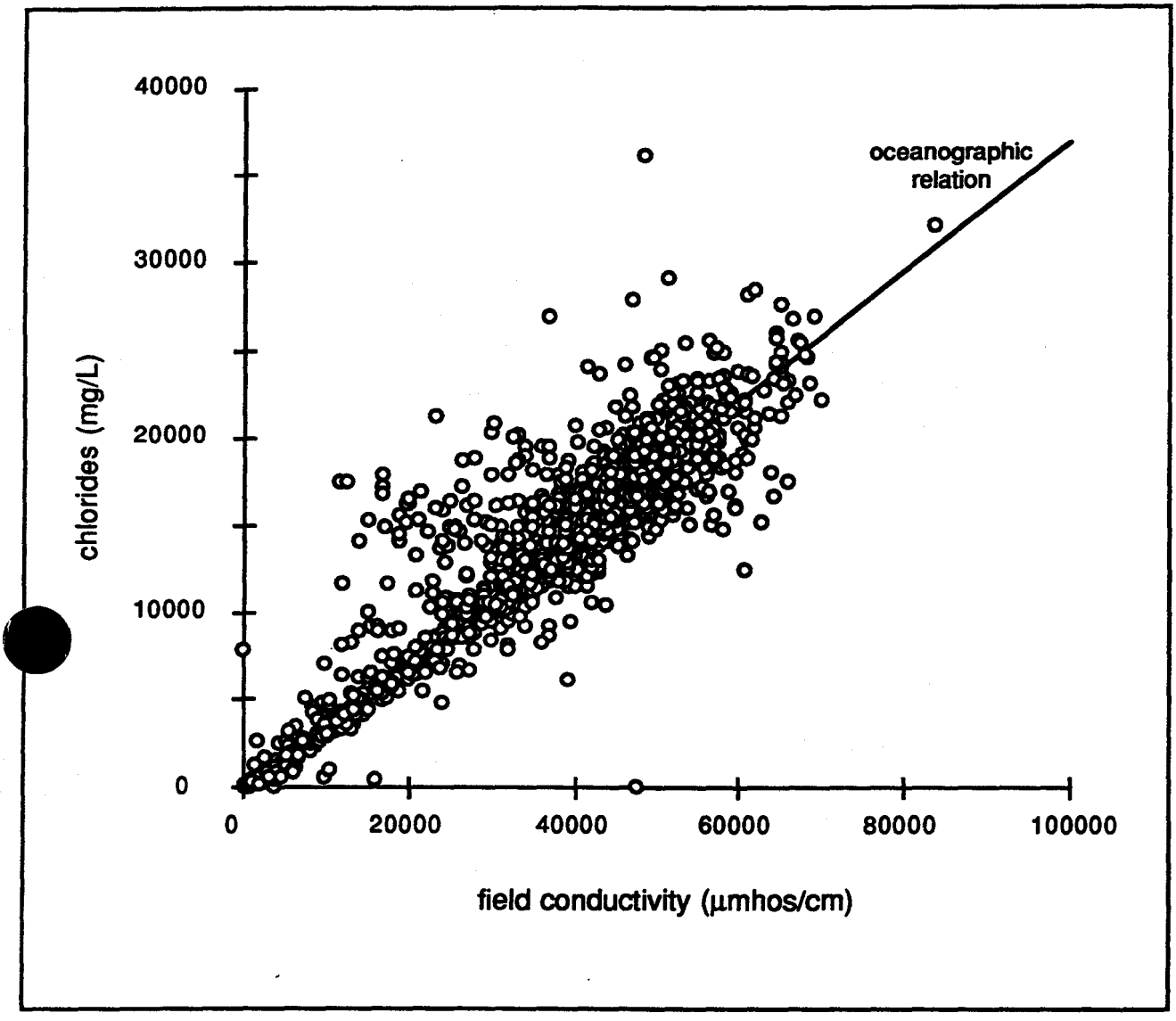


Figure 2-3. Scatterplot of chlorides versus field conductivity from SMN data base for Corpus Christi Bay system.

the older data in both the TWDB Coastal Data System files, and the TDH Seafood Safety data base, for which the TSDH laboratory performed the chlorides and lab conductivity analyses. (The practice of inserting BOGAS data is addressed further in Section 5.3.2.)

Among the data from the Marine Science Institute are field salinities determined both by conductivity and by hand-held refractometer, offering an opportunity for comparison. A scatterplot of those data from the Corpus Christi Bay synoptic surveys is shown in Fig. 2-4. The linear correlation coefficient is 0.825, not particularly high in view of the common assumption that refractometry is a suitable substitute for more precise methods (even for the relatively low precision demands of estuary work). The standard error of the estimate is about 3 ‰, independent of whether the regression is constrained through (0,0). Presuming that the determination by conductivity is the more precise measurement, this standard error would then correspond to the estimated accuracy of the refractometer. It is interesting to compare this to the data of Behrens (1965) who found a standard error of approximately ± 1‰ for the range of salinities represented here, approximately three times better than indicated in the data of Fig. 2-4. His study was carefully executed, and his data represent probably the very best precision that the refractometer is capable of, while the data analyzed in Fig. 2-4 are more typical of the usual field operation of the refractometer.

2.2 Dissolved oxygen

DO is one of the fundamental indicators of aquatic health, since it determines the ability of aerobic organisms to survive. With the development of electrometric probes for DO—a welcome technology for anyone who has ever performed Winklers in a rocking boat—field measurements of DO have increased geometrically, and are now a routine component of most *in situ* monitoring. The data base for DO is therefore approaching that for temperature and salinity, especially in the last two decades, though the data from the 1950's to the 1960's are principally laboratory determinations on water samples.

DO is introduced into the water column principally through "reaeration," the mechanical process of surface transport from the atmosphere, and through photosynthesis. Therefore DO can serve as an indicator of both mechanical aeration and the intensity of primary production. The primary depletion of DO is due to biochemical stabilization of organics through the respiratory process of the biological community (see Section 2.4 below), and low DO's are traditionally linked to the presence of oxygen-demanding pollutants and/or very high rates of primary production.

One of the key controls on the concentration of DO is its solubility, which is a strong function of temperature and salinity. APHA (1985) compiled data on oxygen solubility and offered a nonlinear regression equation with eight coefficients for direct calculation, see also Head (1985) and references therein. This expression is much more precise than is required here, even if the

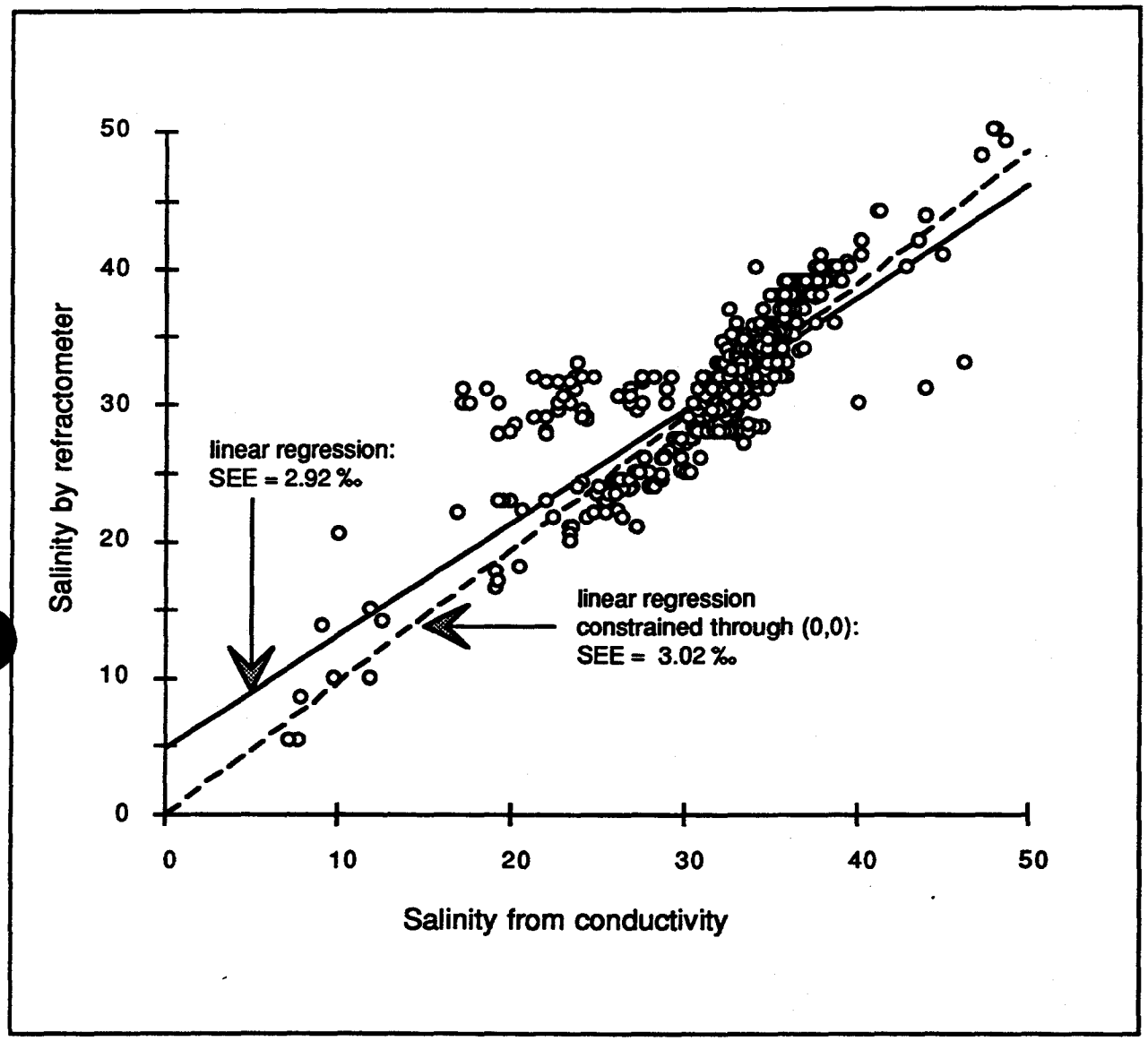


Figure 2-4. Scatterplot of companion salinities determined from conductivity and from refractometer, from data of University of Texas Marine Science Institute (Project 17)

coefficients were correct (which they are not). Ward and Armstrong (1992a) sought a simpler functional equation, finally selecting the expression:

$$C_S = 5\,(100 - Cl) / (T + 35) \qquad (2\text{-}5)$$

as a compromise between simplicity and accuracy (see Fair and Geyer, 1954), being accurate to better than 0.1 mg/L. Here C_S denotes DO saturation in mg/L, Cl is chlorinity in parts per thousand and T is temperature in degrees Celsius. The coefficients were re-evaluated by Ward and Armstrong (1992a) using the data in APHA (1985), who presented tabular comparisons to demonstrate the general accuracy of this relation for the normal estuarine range of chlorinity and temperatures.

The functional dependence of solubility on temperature and salinity given by (2-5) illustrates that saturation—and hence DO concentration—will vary substantially over the year, see Fig. 2-5. As temperatures range from perhaps 5° to 35°C and chlorinity from 0 to in excess of 45 ‰, and if the cold temperature is correlated with low salinity and the highest temperature with highest salinity, a not-unreasonable assumption for Corpus Christi Bay, the total excursion in solubility is from 5 to 14 mg/L. This high range of natural variability can mask variations in DO of importance in diagnosing water-quality problems. Accordingly, two associated parameters of dissolved oxygen are defined: the oxygen *deficit*

$$D = C_S - C \qquad (2\text{-}6)$$

and fraction of *saturation*

$$Sat = 100\,C / Cs \qquad (2\text{-}7)$$

where C is DO concentration and D is DO deficit, both in mg/L, and *Sat* is saturation in per cent. The use of these parameters effectively removes the influence of varying temperature and salinity, and allows a more direct interpretation of the (transformed) DO measurements in terms of water quality.

Interpretation of the DO "climate" requires any two of these three parameters. For present purposes, we employ the DO concentration and the DO deficit. The more important of these is the deficit, because it can be shown that if DO kinetics are first-order (or, more generally, are approximately linear in DO concentration) then the total temperature and salinity variation is absorbed in the solubility: the corresponding DO deficit has no temperature/salinity dependency. Deficit should therefore yield more meaningful statistics and trends, because the "noise" contributed by variations in temperature and salinity is eliminated. Deficit by itself, however, cannot be interpreted biologically: a deficit of a given magnitude, 4 mg/L for example, may be biologically limiting in summer and biologically unimportant in winter.

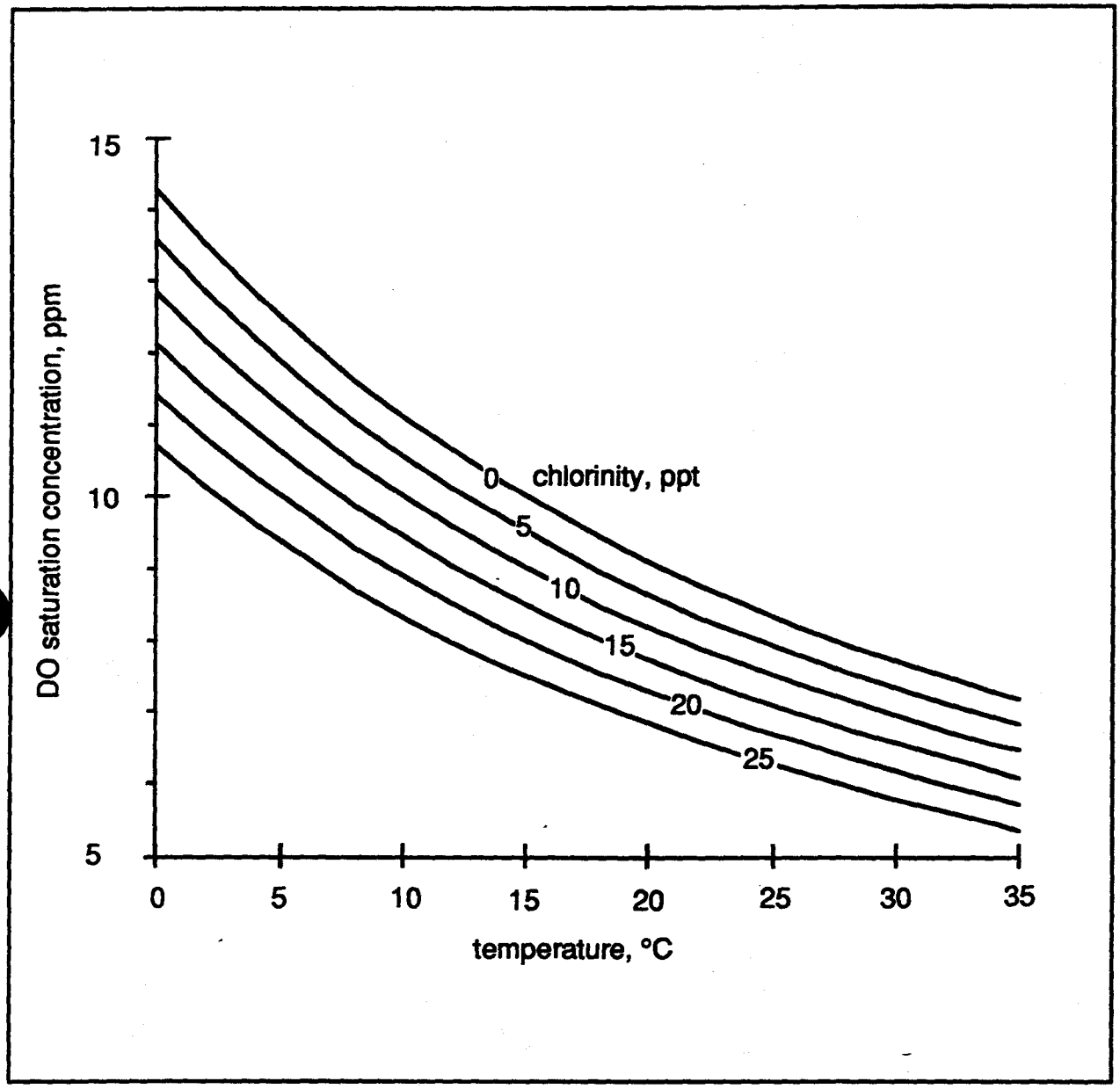


Figure 2-5. DO solubility for ranges of chlorinity and temperature typical of Corpus Christi Bay

2.3 Suspended solids

Solid particles of greater density than water but which are small enough to be carried, perhaps briefly, in suspension by fluid flow are referred to as suspended matter/sediment/solids/particulates or, if clear in context, the adjective "suspended" may be dropped. Suspended solids are traditionally measured by a simple filtration (0.45 microns). Ward and Montague (1996) comment that, unlike the situation in freshwater systems, suspended sediment "is a normal, ubiquitous component of the estuarine environment." This observation cannot be overemphasized, and is especially true for Corpus Christi Bay. Sediments enter the water column by mobilization from the bed, transport into the estuary by freshwater inflows, discharge of waste streams, transport from the nearshore littoral zone by tidal currents, by erosion of the shoreline, and deposition from the aeolian flux in the lower atmosphere.

Suspended solids play an important rôle in determining light penetration and primary productivity in the water column. A closely related property therefore is turbidity, which refers to the interference with the passage of light by suspended matter in the water, and is an indirect indicator of the concentration of such suspended matter. Further, there are methods of making turbidity-related observations in the field. While turbidity has value in itself as a water-quality indicator, our present interest is in its use as a proxy measure of suspended solids. The following review was presented by Ward and Armstrong (1992a).

The traditional method of viewing a candle flame through a vertical tube containing the water sample motivated the definition of the Jackson Turbidity Unit (JTU), see APHA (1985). Modern electrometric optics offer an alternative to the traditional Jackson turbidimeter (e.g., APHA, 1985, Lamont, 1981, Kirk, 1983). The reduction in transmitted light intensity, as measured by a transmissiometer, is expressed as a fraction of the source intensity (per cent transmittance) or in terms of an extinction coefficient. A few measurements of this type exist from Corpus Christi Bay, primarily carried out by the Southwest Research Institute field program. Alternatively, nephelometers measure light scattering at 90° and the measurement is reported in Nephelometric Turbidity Units, which are defined to be numerically about the same as JTU's. Laboratory turbidity measures are calibrated by standard silica suspensions, so as to eliminate the source of variation due to suspended particles of different constituency and geometry. Unfortunately, the numerical equivalence of JTU's and NTU's holds only for the calibration compound. For different types and distributions of suspended matter, NTU's and JTU's depart. Further, each is an index and does not *per se* correspond to a physical property of the water. When the reference suspension in the nepholometric procedure is the formazin polymer, the results are often reported as FTU; for present purposes, we regard these as equivalent to NTU.

The depth of the Secchi disc has for many years been the limnologist's and oceanographer's standard means for field measurement of turbidity (Hutchinson, 1957). Unfortunately, the relation between Secchi depth and conventional measures of turbidity is murky at best. Hutchinson (1957) comments, "we should

not expect to find more than a rough correspondence between the transmission and Secchi disk transparency of a series of lakes," on the basis of a brief analysis of the differing responses of the transmissiometer and the Secchi disk. A deeper analysis offers somewhat more optimism; Preisendorfer (1986) is the last word on the subject. Effler (1988) combined literature optical theory with field measurements from a number of lakes to arrive at the relation

$$SD = N / [\sqrt{(a^2 + 0.256\ ab)} + (a + b)]$$

where a and b are the absorption and scattering coefficients, resp., in dimensions $[L^{-1}]$. Here N is a constant, probably a weak function of other optical properties including spectral distribution of light, in the range 8.0-9.6 . Since b>>a usually, for nephelometric turbidity T (roughly proportional to b, with a constant $\approx 1 \pm 25\%$ for b in m^{-1} and T in NTU) the approximate relation becomes:

$$SD = N'' / T \qquad (2\text{-}8)$$

where N" ranges about 5-10 for SD in meters and T in NTU's, depending on other optical properties of the water. Vis-a-vis application of the relation (2-8) to the turbid waters of a shallow estuary, in contradistinction to the lakes addressed by Effler (1988), the water is muddied if the water is muddy, because SD becomes decreasingly sensitive to T as T becomes large. (Holmes, 1970, developed an inverse exponential relation between SD and an optical parameter related to an extinction coefficient, which has the same asymptotic behavior.)

Relating turbidity to suspended solids is even more opaque. From Mie theory, a relation would be anticipated between suspended particles and the scattering coefficient b of the form

$$b = \pi \Sigma n_i r_i^2 / 4$$

where n_i is number of particles of mean radius r_i per unit volume. This implies b = A•SS for SS the suspended solids concentration. (Actually, b may be taken as the total extinction coefficient.) From British coastal waters A lies in the range 0.25-0.50 for SS in mg/L (Jones and Willis, 1956). Di Toro (1978) found A=0.40 for San Francisco Bay. Since T is proportional to b (some authors assert $T \approx b \pm 25\%$), we have T proportional to SS.

In summary, there is good reason to expect an inverse relation between suspended solids and Secchi depth, SS = B/SD, and a direct proportional relation between suspended solids and turbidity, SS = A T , with constants (from the above literature values) on the order of $10<B<50$ and $0.2<A<0.5$, for SD in meters, SS in mg/L, and T in JTU or NTU. The problem now is to test these relations against data from Corpus Christi Bay to verify the functional form, and to determine the appropriate values of the constants.

Virtually the only extensive paired measurements of Secchi depth, turbidity and TSS are those of the TNRCC SMN data base. The SMN data of paired turbidity and TSS measurements are shown in Fig. 2-6. That each is a noisy measurement

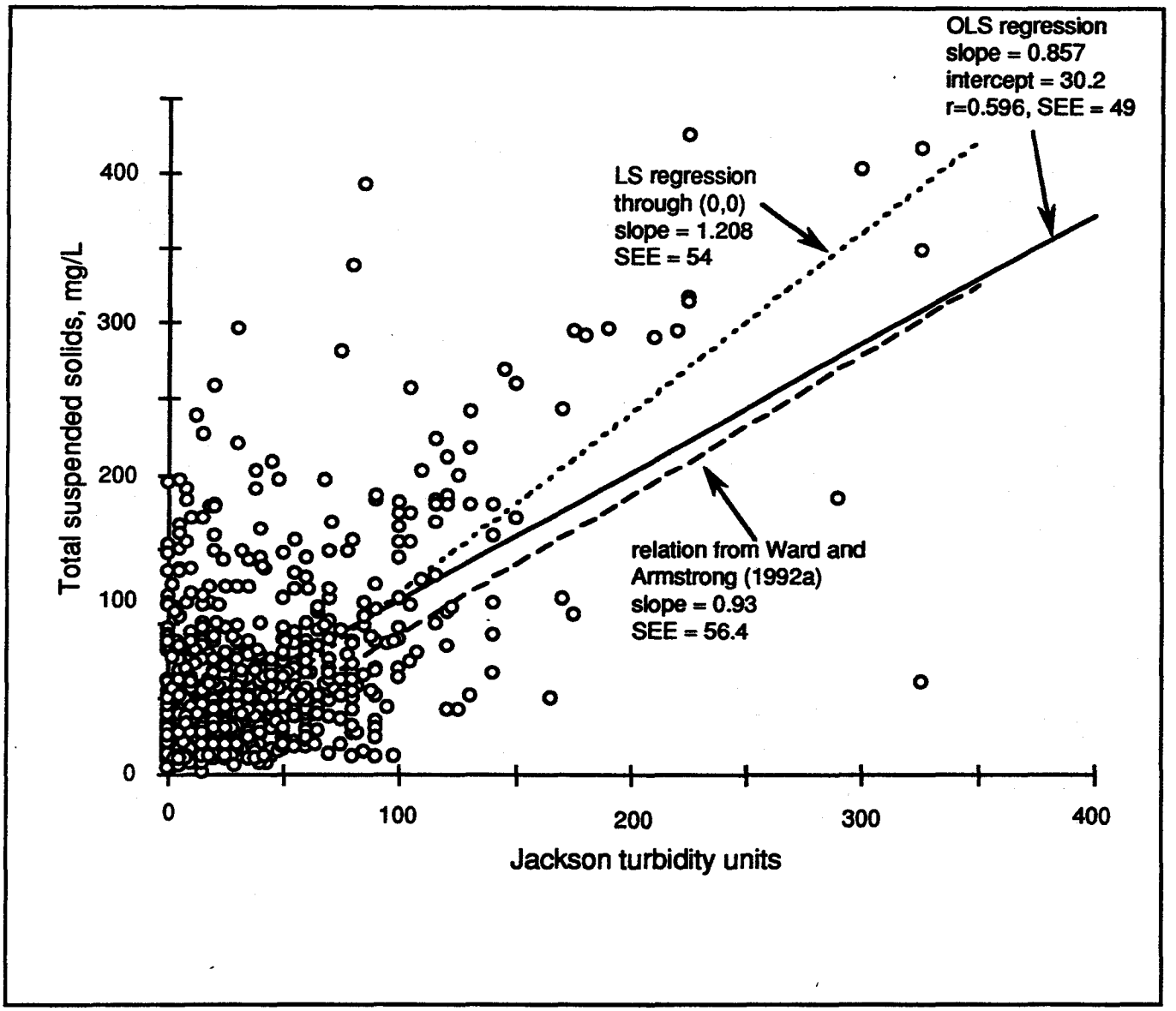


Figure 2-6. TSS versus turbidity in Corpus Christi Bay

is apparent. However, the data (856 data points) of Fig. 2-6 are consistent with the hypothesis of a proportional relation. The zero-intercept least-squares (LS) line has a standard error about 10% larger than that of the ordinary least-squares (OLS) line and is physically better based. The slope of this zero-intercept line is about 1.2, which is about half the value to be expected from the literature values given above. The same basic relation with a slope of about 0.93 was found by Ward and Armstrong (1992a) from 1350 data points for the bays of the Galveston system. This relation applied to the Corpus Christi data base yields a standard error virtually the same as the LS zero-intercept line. Given the insensitivity of the standard error to the slope of the regression, the larger data base for Galveston Bay from which the Ward and Armstrong (1992a) relation was derived, and the fact that this relation is equally consistent with the Corpus Christi data, we have elected to employ it as a proxy relation giving TSS as a function of JTU's.

Figure 2-7 addresses the inverse relation between TSS and SD, by plotting TSS versus $(SD)^{-1}$. Again, the data are noisy, but consistent with a linear relation between the variates. Again, the physically-based zero-intercept LS line is as good a regression as the OLS, differing in standard error by only 0.5 %. The slope of this line is 19.6 based on 1206 data points, and is well within the range of literature values. For 400 data points from Galveston Bay, Ward and Armstrong (1992a) found a slope of 13.0, within but near the lower limit of the range of the literature values. We judge the Corpus Christi relation to be better based, and adopt this as a proxy.

During its three-year program, SWRI performed a number of measurements of fractional transmission for a 10-cm path with a transmissometer. From Beer's Law, with z=0.1 m, the extinction coefficient is given by

$$b = -10 \log\{Tr/100\}$$

Tr denoting percent transmission and log the natural logarithm. While turbidity T, whence SS, can be expected to be proportional to b, the proportionality constant is in doubt. Unfortunately, SWRI did not make any companion measurements of turbidity or suspended solids. TSS data collected by the TWC/TDWR SMN during the same time period in the open waters of Corpus Christi Bay (Segment 2481) suggest that a factor of 10 would be appropriate. The resulting equivalent TSS values along with those measured by the SMN are shown in Fig. 2-8.

Turbidity data determined by nephelometric methods also appear in the Corpus Christi data base, but unfortunately there are no paired measurements of TSS to determine the relation between the two. There are, however, paired measurements of both turbidity measures with Secchi depth. These data are displayed in Fig. 2-9. While there are certainly regression lines that can be fitted to these data, and the variable of SD^{-1} eliminated algebraically, the parameters of the lines prove to be sensitive to the order of regression (i.e., which variable is taken as independent), which introduces considerable uncertainty into the relation between JTU and NTU turbidity. It appears that a reasonable relation for Corpus Christi Bay is JTU = 1.86 NTU, but this should be regarded as provisional.

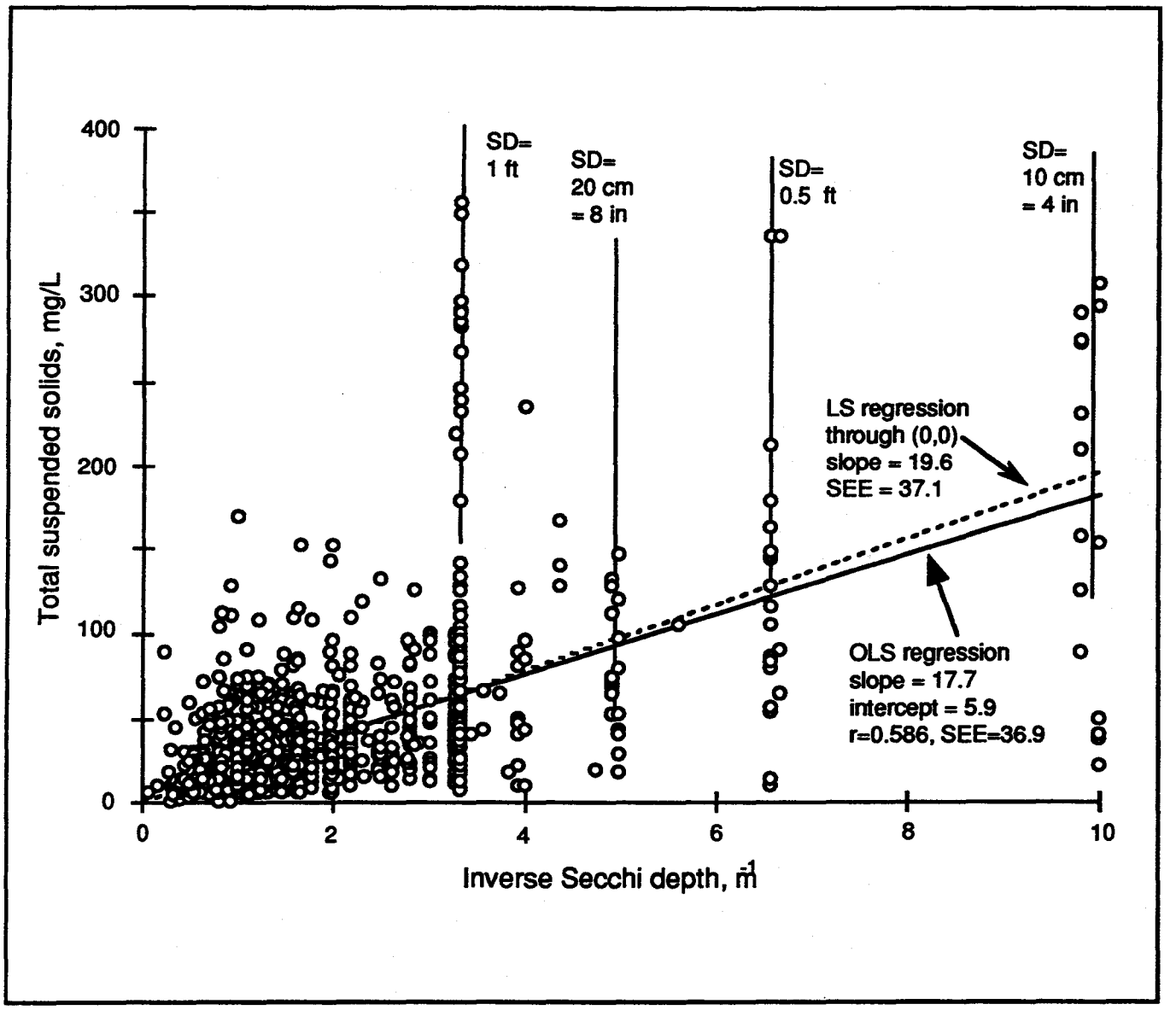


Figure 2-7. TSS versus inverse Secchi depth in Corpus Christi Bay

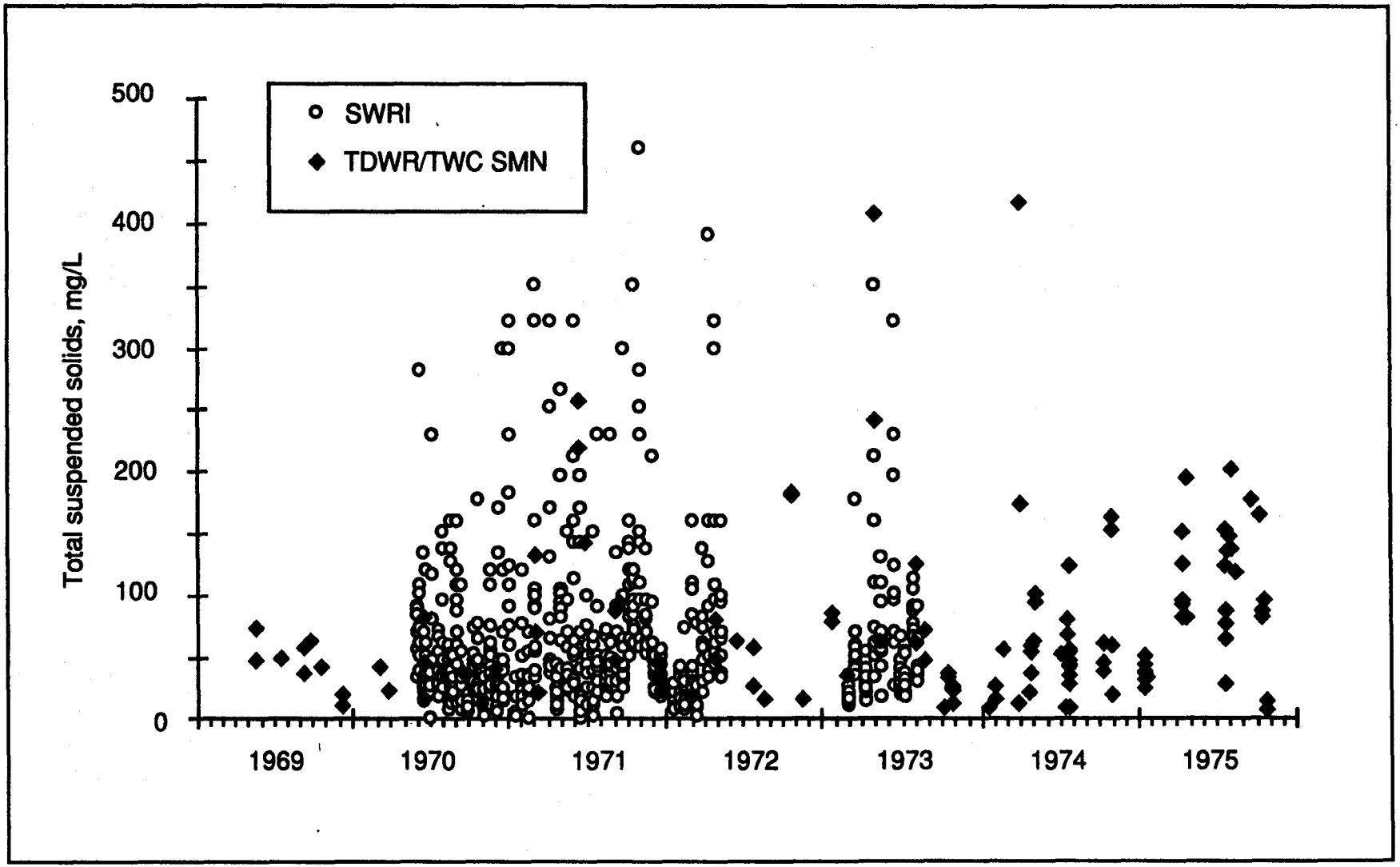


Figure 2-8. Comparison of SMN-measured TSS and value computed from SWRI data

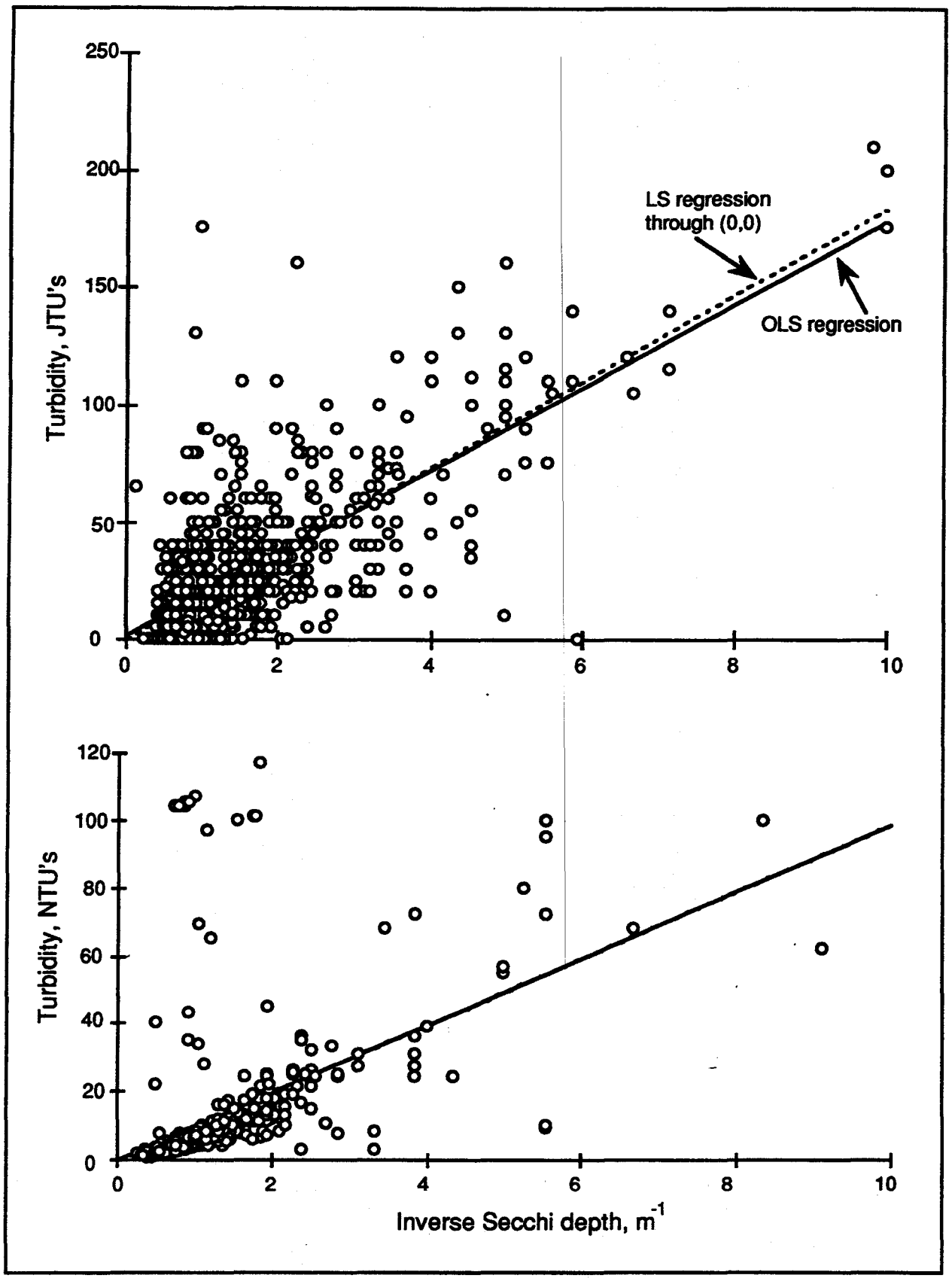


Figure 2-9. Turbidity in JTU and NTU versus inverse Secchi depth

In conclusion, for the present study, the following forms are adopted to serve as proxy relations giving TSS in terms of turbidity measurement, in order of priority (after, of course, the actual measurement of TSS):

$$SS = -10 \log\{Tr/100\} / z$$

$$SS = 0.93\,T \qquad (2\text{-}9)$$

$$SS = 1.73\,TN$$

$$SS = 20 / SD$$

where SS is suspended solids in mg/L, z is the optical path length in meters, Tr is percent transmission, T is turbidity in JTU, TN is turbidity in NTU or FTU, SD is Secchi depth in meters, and log denotes the natural logarithm. These relations are at best approximate and much is left unsettled.

2.4 BOD and related parameters

Biochemical oxygen demand (BOD), oil & grease, and volatile solids are tests which have developed from situations dominated by oxygen-demanding pollutants, and while their merit as water-pollutant parameters continues to be debated, the fact is that these parameters enjoy the longest period of record in most aquatic systems.

Since the classical work of Phelps and Streeter the biochemical oxygen demand (BOD) has become one of the fundamental parameters for estimating the presence of oxygen-demanding organics in a water sample (either from a sewage effluent or from a natural watercourse) and is one of the central parameters in the mathematical modeling of dissolved oxygen in the watercourse. Despite this long history of use, which can be traced back to the 19th Century, the BOD test is in many respects still controversial and is a continuous source of debate regarding the correct laboratory procedures and interpretation of the results. A detailed review is given in Ward and Armstrong (1992a), which is summarized here.

Fundamentally, the BOD is the amount of dissolved oxygen (DO) consumed in a sample of water during some period of time. The standardized test for the 5-day BOD is familiar and detailed in, e.g., *Standard Methods* (APHA, 1971, 1985) and HMSO (1983). We also note that the BOD, as established in a laboratory test such as *Standard Methods*, is a direct measure of a biochemical process at work within a stoppered bottle in equilibrium, a trivial observation at this point but which looms large in the interpretation of BOD data. The basic concept of BOD was to measure the potential oxygen depletion in a natural stream due to an injected waste. Since then the concept has evolved in two separate directions, both of which are referred to as BOD, to compound the confusion. The first is the oxygen consumed within the watercourse by the degradation of organic wasteloads, for which the ultimate BOD is the crucial quantity, with the oxygen depletion directly related through Phelps Law as described below. The second is the evolution of the

BOD bottle test as a measure of the organic wasteload of an effluent, and therefore, as a direct monitor of the operation of a waste-treatment facility and the key design parameter for treatment processes.

The amount of oxygen consumed as consequence of aerobic biochemical processes in a water parcel, whether it be a laboratory BOD bottle on a shelf or a moving parcel of water embedded within the flow of a natural watercourse, is directly dependent upon a number of variables, as follows:

(1) Types of bacteria present in the water;
(2) Initial quantities of each type of bacteria present;
(3) Multiplication or growth rates for each type of bacteria present;
(4) Chemical characteristics of the substrate, i.e., the oxidizable organic constituents within the water;
(5) The quantity, or concentration, of the oxidizable constituents;
(6) Constituents which act as an inhibitor or a stimulant for the bacterial metabolism;
(7) Environmental parameters, most notably pH and temperature;
(8) Other aerobic organisms in the water, notably phytoplankton.

It is apparent that there is a multiplicity of factors that can affect the BOD in the water parcel.

While there are several methods available for determining BOD, it appears (given the poor documentation) that almost all of the measurements from Corpus Christi Bay are based on the traditional dilution-series 5-day BOD either with natural seed or, for those performed by the Texas Department of Health Laboraory, with the cultured "Texas" seed.

The precision of a BOD test is exactly that of the dissolved oxygen measurement compounded by the number of independent DO measurements (there are at least two). The accuracy is another matter, particularly with respect to replicability. The manifold processes underway in a BOD bottle render the oxygen depletion quite complex and problematic. One ubiquitous source of error is in the dilution itself. In many studies employing BOD, the phenomenon has been encountered of increasing BOD (per unit volume) as the sample is subjected to greater dilutions. this is attributed variously to toxicity in the sample water, contamination of the dilution water, and selective stimulation of bacteria by the nutrients in the dilution water, among other hypotheses. In Espey et al. (1971), data from Galveston Bay on the ratio of BOD_5 in 4:1 dilution to that of an undiluted sample were tabulated, and shown to range from 1.5 to 4.5, with the highest values in Galveston Harbor and the lower bay. A possible explanation for the phenomenon lies in the Monod equation for bacterial growth (e.g. Monod, 1949), giving the growth rate as a function of substrate concentration C, which also governs the oxygen consumption rate. If C is initially high, the growth rate is essentially its maximum value. As C is reduced, the growth rate declines. The rate constant for BOD exertion is, therefore, a nonlinear function of the dilution factor, which of course contradicts the basic assumption underlying the dilution approach, that the BOD depletion is simply proportional to dilution. In the present data base,

BOD is reported without any information on dilution, so we must regard the dilution factor as a (considerable) source of uncertainty in the measurement.

The controversy attending the BOD measurement has led some researchers to propose alternatives to the parameter. One such is the total organic carbon (TOC), a suggestion motivated by the notion that BOD measures the organic carbon substrate (Busch, 1966). However, the nature of the carbon compounds as well as the capabilities of the bacteria dictate the oxygen demand. For example, Maier and McConnell (1974) report TOC:BOD ratios in the range 0.5-1.0 for "simple" carbon compounds (e.g., glucose, stearic acid), and in the range 0.5-4.0 for wastewaters of varying treatment levels. Of course, if a relation between TOC and BOD could be established, it would serve as a proxy to extend the record for either parameter. There are some 435 paired measurements of BOD and TOC in the data base for the Corpus Christi Bay system, plotted in Fig. 2-10. It is readily apparent that there is little correlation: the explained variance (TOC on BOD) weighs in at 15.5%.

2.5 Nutrients and indicators of productivity

Nutrients have an ambiguous position in the assessment of water quality, in that they are necessary to support a healthy aquatic ecosystem, but in excess can lead to nuisance conditions such as hyperstimulation of primary production, in which case they are regarded as pollutants. Some of the earliest chemical measurements available for the Corpus Christi system address certain of these nutrients associated with waste discharges.

Two of the principal nutrients, nitrogen and phosphorus in their various forms, play an essential rôle in aquatic biological processes. Further, their concentrations can be significantly augmented by the activities of man, especially through point discharges of municipal and industrial wastes, and through runoff from modified watersheds, especially landscaped areas, agricultural operations using applied fertilizers, or ranching with concentrated herds. While nitrogen exists in four principal species, not all of these are routinely measured. The most frequently measured forms, and therefore the best data base, are ammonia and nitrate; though wherever possible we also present analyses of organic nitrogen and Kjeldahl nitrogen (the sum of ammonia and organic). Nitrite is much less frequently measured, and in the watercourse is rather unstable, being readily oxidized or reduced to other forms (and therefore nitrite concentrations are much less than those of the other species). As the relative proportions of these species are a strong function of origin, transport and microbial kinetics, no relation among them is meaningful for serving as the basis of a proxy equation. (The relations typically used in mass budgeting, e.g. Meybeck, 1982, are strictly applicable to natural waters, not waters potentially subject to abnormal sources of nitrogen or abnormally vigorous populations of chemautotrophs.) Therefore, separate analyses were carried out for each of these. It should be noted that the measurement of organic nitrogen refers in fact to the least refractory components of the organic pool (McCarty et al., 1970).

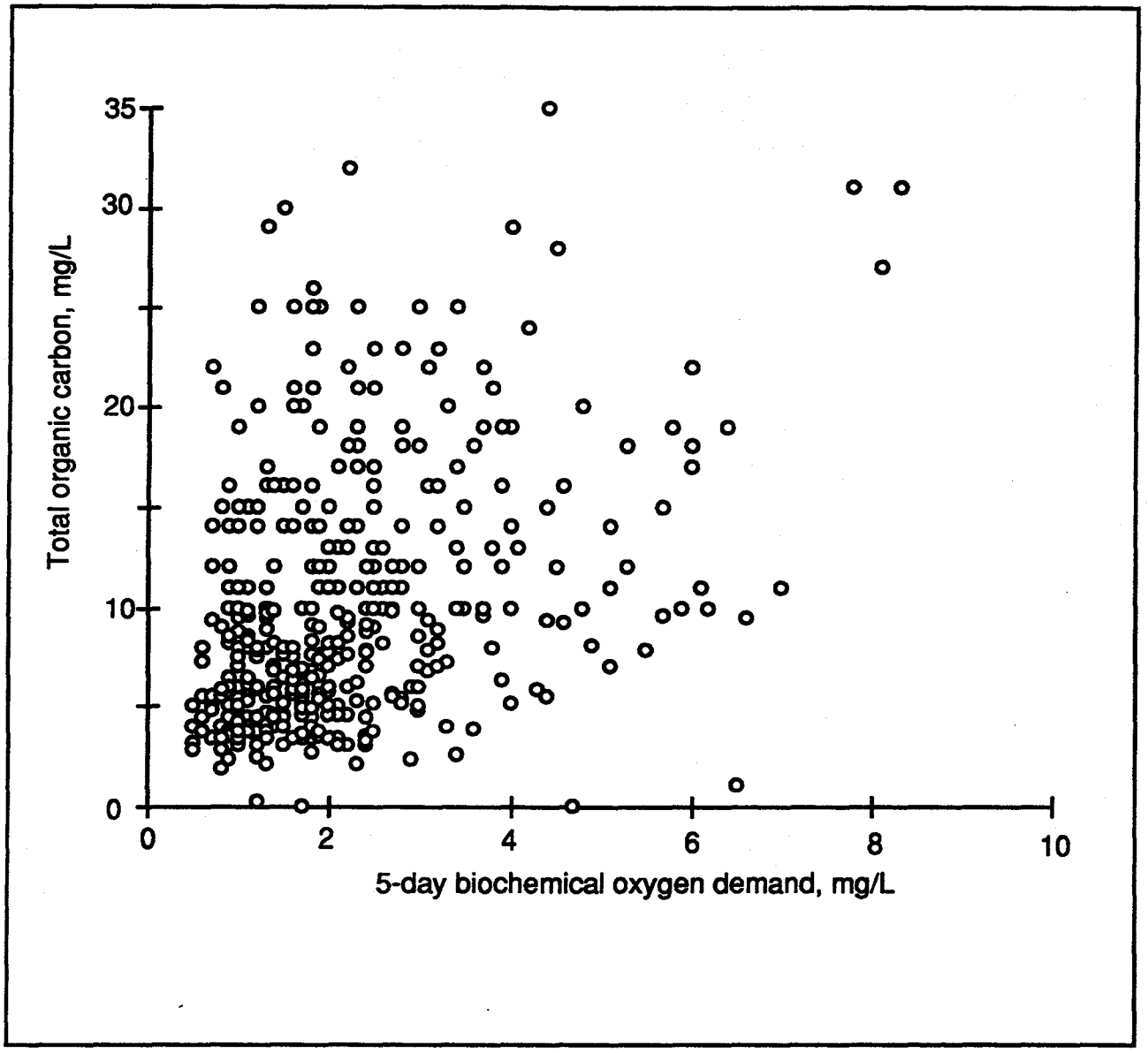


Figure 2-10. TOC versus BOD, paired measurements in Corpus Christi Bay system

The most common measures of phosphorus concentration in the Corpus Christi data base are orthophosphates and total phosphorus. As is the case with nitrogen species, there is no consistent relation among the forms of phosphorus that would serve as a proxy. The proportion of orthophosphate may be quite low in natural waters, but as much as 90% of the total phosphorus in municipal effluents. Also, the natural concentrations in seawater are much different from those in fresh water. Accordingly, we have chosen to focus the analysis specifically upon total phosphorus, although statistical results are presented for all of the phosphorus forms represented in the data base. One potential source of uncertainty in this measurement is the treatment of particulate (versus dissolved) phosphorus. Phosphorus is sorptive and has an affinity for fine-grained suspended sediments. In some of the data sets, it is not clear whether the total-phosphorus analyses are restricted to the dissolved fraction (i.e., whether the sample is filtered) or includes the particulate. Moreover, the sorptivity diminishes with salinity, so the distinction between filtered and unfiltered analyses becomes less important at higher salinities. Dr. Terry Whitledge (pers. comm., 1996) notes that he has compared filtered and unfiltered analyses of these nutrients and found no significant differences, in which case the lack of information on filtering would be immaterial. (Dr. Whitledge observes that this is yet another instance of freshwater dogma being imported into estuarine science.)

As a surrogate indicator of phytoplankton biomass, chlorophyll-*a* has become a common water quality parameter. There are two basic analytical methods applied to water sampling in the Corpus Christi Bay data, spectrophotometric and fluorometric. The TNRCC SMN data are indicated to be the former. (An older method, the trichromatic, was employed in the 1960's and 1970's by the State, but this STORET code does not appear in the Corpus Christi data.) A related parameter is the metabolic product phaeophytin, sometimes loosely referred to as "dead" chlorophyll. This has been measured by the TNRCC SMN program only. Table 2-2 summarizes the statistical association between the two in the Corpus Christi data (for those pairs for which both parameters were above detection limits). It is noted that the coefficient of variation of both chlorophyll and phaeophytin exceeds 200%, no doubt due to the significant space-time variability of phytoplankton in Corpus Christi Bay as well as imprecision in the measurement, and that chlorophyll-a and phaeophytin are virtually uncorrelated. (This is not surprising, since one does not expect *a priori* a correlation between the two.) One other chlorophyll measure in the Corpus Christi data base is that of chlorophyll-b, reported by the SWRI monitoring program of the early 1970's. This program did not measure chlorophyll-a. Chlorophyll-b is a much less useful pigment than chlorophyll-a, it occurs in much smaller concentrations than chlorophyll-a, and methods of determination are less reliable (APHA, 1985, 1989). Why only chlorophyll-b would have been measured is inexplicable (see Chapter 5). This data was not used in the present analyses.

Silicon in its various forms is an important nutrient, especially in supporting the silaceous cells of diatoms, an extremely significant component of the phytoplankton in estuaries. Silicon is derived primarily from weathering of terrestrial landforms and is brought into the estuary by runoff and inflow. In some estuaries, silicon can be as useful a watermass tracer as salinity, see Ward

TABLE 2-2

Statistics of chlorophyll-a and phaeophytin data in SMN data base for CCBNEP study area

Number of paired observations	2312
Number of paired observations above detection limits	730
Chlorophyll-a	
mean	21.96
standard deviation	54.4
Phaeophytin	
mean	6.76
standard deviation	15.1
Linear correlation: phaeophytin on chlorophyll-a	0.289
Explained variance	8.3%

and Montague (1996) and references therein. It has been used for this purpose in a study of the circulation of Nueces Bay by Whitledge (1993).

Total organic carbon is an ambiguous parameter, measuring a portion of the carbon nutrient pool, organic pollutants (cf. the discussion of BOD in the preceding section), and the end product of primary production. Its interpretation as nutrient, pollutant, or base of the food chain therefore must be tempered by the concentrations of other parameters.

2.6 Trace elements and organic pollutants

Trace elements, primarily heavy metals, and volatile organics, including pesticides, are more recent arrivals on the analytical scene. The EPA Priority Pollutant List, per Section 307 of the Clean Water Act, is a means to specify which individual compounds are to be given detailed study due to their high pollutant or toxicological potential, a list which continues to mutate as constituents are listed and de-listed by EPA (see Keith and Telliard, 1979, Finnigan, Hoyt and Smith, 1979). The procedures for measuring these constituents are collectively referred to as "instrumental" methods, in contrast to, say, traditional stoichiometric methods which introduce reactants in known quantities to infer the presence and quantity of the analyte. All instrumental methods require calibration of the instrument to prepared, known standards, in the process for which the reliability of the method as a function of standard concentration is quantified. (This is discussed further in the context of analytical uncertainty in Chapter 4.)

By far, the most common method for elemental analysis used for the measurements in the CCBNEP data base is spectrochemical, consisting of the following generic steps:

- physical alteration of the sample to facilitate radiative behavior
- electromagnetic radiation exposure of or emission by the sample
- monitoring of electromagnetic radiation as a function of frequency
- recording and interpretation of the line spectrum

Atomic absorption methods monitor the selective absorption of EM radiative energy, generally in the UV and visible bands, by the sample. Atomic emission methods monitor the EM radiation emitted by the sample after non-radiational excitation, either thermal or electrical. Atomic fluorescence methods monitor EM radiation emission after excitation by radiation. The principal difference between different AAS methods derives from how the sample is atomized. The simplest is probably flame AAS (FAAS), in which the sample is nebulized into a flame, thus dissociating compounds into atoms. A more accurate procedure is graphite furnace AAS (GFAAS) in which the sample is heated to atomization in a small graphite tube, or "furnace." In either method, the atomized sample is exposed to radiation from a specially designed lamp.

AES methods also mainly differ in the treatment of the sample, i.e. what the source of energy is that "excites" the sample atoms to emit radiation. Generally,

this energy source accomplishes both the atomization of the sample and its excitation, in contrast to AAS methods for which both an atomization energy source and and radiation source are needed. Older AES techniques employed flames (thermal sources) and sparks or arcs (electrical sources), but newer, more accurate procedures use plasma sources. Because of the similarity of the FAES procedure to the FAAS, many instruments can be operated in either configuration. A similar recent hybrid of AES using a graphite furnace source is referred to as GFAES. The most important plasma methods are the inductively coupled plasma (ICPAES), direct current plasma (DCPAES) and microwave-induced plasma (MWIAES). Details of all of these methods are summarized by Vandercasteele and Block (1993).

For present purposes, the two essential facts of these types of spectrometric analyses are: (1) choice of method governs the range of elements that can be detected and the sensitivity of the measurement; (2) no information is preserved as to the compounds in which the element occurs in the sample. With respect to the former, there is generally a trade-off between sensitivity and range (and with cost). With respect to the latter, the "speciation", i.e. the specific compound in which the element appears, can be extremely important in determining the nature of the chemical and biological effects of the element. While there is a general philosophy that larger concentrations of different species are in some way associated with larger elemental concentrations, lack of information on speciation is often a major impediment in interpreting metals data.

In order to analyze the concentration of an organic compound, first a separation of the mixture of compounds in the sample must be achieved. The predominant technique for this is to pass the sample through a chromatograph column, a glass tube coated with thin liquid film, or packed with liquid-coated granular solids. Passage of the sample through the column is facilitated by a carrier gas. The time required ("retention time") for a compound to traverse the column ("elution") depends upon the partitioning of the compound between the carrier and stationary medium, and is generally unique to the compound. The pattern of signal (proportional to concentration) versus retention time (the "chromatogram") is determined by injecting standards of known composition.

A more versatile operation is to couple the output from the chromatograph column into the ion source of a mass spectrometer, referred to as GC-MS. The mass spectrometer determines the rate of ion flow versus the mass of the ion from which specific ions can be identified, hence the, perhaps inappropriate, name "mass spectrum." (See Chau and Afghan, 1982, Cairns and Sherma, 1992, and Vandecasteele and Block, 1993, for details of MS operation, and *Standard methods*, e.g. APHA, 1985, 1989, for set-up procedures.) Quantification again requires a calibration standard, and identifying mass spectra requires access to reference spectra. (A mass spectrometer as a method of ion identification needs only to be coupled to an ion source. The same procedures used to atomize samples in AAS and AES can be coupled with an MS for elemental analyses.) Both chromatograms and mass spectra are produced by GC-MS. The high data generation rate and the need to access reference libraries of known mass spectra have led to coupling the GS-MS to computers, which, in turn, has led to a

considerable automation of the GC-MS procedure, including software for searching and identification as well as quantifying the resultant compound concentrations. Such automated analyses can produce erroneous results if not carefully monitored and cross-checked by competent chemists (see, e.g., Swallow et al., 1988, Alford-Stevens et al., 1988).

The essential facts of GC-MS and related procedures in the context of interpreting data from Corpus Christi Bay are: (1) the sensitivity and accuracy of the method, even when highly automated, are determined by the skill of the operator and the care used in set-up and sample preparation (including how the column is packed); (2) generally, the GC-MS output is searched for specific compounds, according to specified analytes and available information on the chromatogram and mass spectra of those analytes, that is, the method does not produce a census of all compounds in the sample; (3) compounds can be missed, inaccurately identified, or erroneously quantified if they are not adequately separated in elution from the column or if their mass spectra are insufficiently differentiated.

Any analytical method has a limit to its resolution, i.e. to its capability to detect small differences in concentration. The ability to quantify elements or compounds in trace concentrations is particularly limited by the resolution of the method. Part of the calibration and standardization procedure of the above methods is empirical determination of the resolution, expressed as a "detection limit." This is discussed further in Chapters 4 and 5 in the context of data processing and interpretation. For now, it should be noted that the AAS, AES, and GC-MS techniques in fact produce a *number* for a desired element or compound concentration. If this number is considered smaller than the detection limit of the method, the number is deemed to be fictitious, and is replaced by the statement that the substance is "nondetectable", meaning at a concentration below the empirical detection limit. It has been argued that information is sacrificed in "censoring" the data in this fashion (see, e.g., Porter et al., 1988, D'Elia et al., 1989), but the convention is ingrained in current analytical procedures.

For the CCBNEP data base, 48 organic compounds and 31 metals for the water phase were identified for specific compilation and analysis, as listed in Table 2-1. Data for additional compounds, such as the entire suite of priority pollutants and other metals, are in fact available for the system, but the number of such measurements are so few, and the number of concentrations above detection limits fewer yet (almost always zero), that these compounds and elements were excluded from further consideration. Even at this, the data base for many of the compounds listed in Table 2-1, as will be seen, are too sparse to support meaningful analysis. Generally, the metals are analyzed by one of the elemental instrumental methods, usually AAS, while the organic compounds are analyzed by GC-MS and related methods. The organics may be broadly categorized as petroleum-derived hydrocarbons and pesticides.

The utility of these parameters for water-quality analysis continues to be vexed by complex and uncertain analytical procedures. Especially for trace organics (a.k.a. micropollutants, organo-xenobiotics), protocols and procedures are still

evolving, and this is reflected in a confusion of data acquisition. Some of the problem originates in the multiple forms a specific organic can assume: various isomers, analogs and metabolites. Further, the nomenclature for many of these is nonstandard and contributes to the confusion, particularly in data reporting. Lindane, for example, is reported variously as gamma-BHC (benzene hexachloride), gamma-HCH (hexachlorocyclohexane), as well as commercial names such as Lindafor, Lindagram and Lindamul (EPA, 1988). (Most of these problems were mooted in this project because the amount of data available was so limited that little meaningful analysis could be performed.)

The term "total" acquires a new dimension when applied to trace organics, in that it may mean the total of all isomers and analogs for a given compound, or the total of the compound and its metabolic products (with or without all isomers), or the total of an entire class of organic compounds. There is no universal convention, and the meaning of "total" must be considered specific to the intentions of the agency generating the data.

The principal concern with organochlorine pesticides, which include lindane, methoxychlor, endrin, endosulfan, dieldrin and heptachlor, is their long persistence in the environment. In contrast, the organophosphates like parathion and malathion are probably more toxic but also much more short-lived. The insecticide dichlorodiphenyltrichloroethane (DDT) is certainly the most prominent of the organochlorines (a.k.a. chlorohydrocarbons) and the one for which the available data base in Corpus Christi Bay is greatest. The use of DDT was banned in the U.S. in 1972. There are several metabolic products, the most important of which (and the only two considered in this compilation) are DDE and DDD (a.k.a. TDE); others include DDNS and DDOH. DDT as a technical product is comprised of as many as 14 analogs and isomers. By far the most important are p,p'-DDT and o,p'-DDT. The relative proportion of the two is a function of the proportion in the initial source, and of the relative kinetics and metabolism in the receiving water. Neither of these proportions is particularly well-defined, though the former is probably better established than the latter, to be about 70% p,p'-DDT and 20% o,p'-DDT in technical grade DDT (Buechel, 1983). This is roughly consistent with the rule-of-thumb of a 3:1 ratio of p,p'-DDT to o,p'-DDT that seems to be current now. Both forms are hydrophobic and sorb readily to fine particulates, both sediments and phytoplankton (Crompton, 1985). Apparently microbial assimilation is stimulated by sorption (Chau and Afgan, 1982, Crompton, 1985) but appears to affect both isomers equally. Treatments of the kinetics (including volatilization) of DDT make no differentiation between the isomers (e.g., Moore and Ramamoorthy, 1984) so we assume that their ratios will be preserved in the receiving water and sediment. Many agencies report simply total DDT. Usually this means the total for all isomers. On the basis of the above proportion, the relation between total DDT and p,p'-DDT is taken to be:

$$\text{Total DDT} = 1.4 \bullet (\text{p,p'-DDT}) \qquad (2\text{-}10)$$

While this appears to be a workable proxy relation, we have no reported paired measurements by which we can test it. In the subsequent analyses, we present separate treatments of the total DDT data as reported, the individual analog

analytes, and the extended "total DDT" data set (designated WQ-XDDT and SED-XDDT) using the above proxy relation.

In the CCBNEP data base, the pesticides best represented after DDT are toxaphene and chlordane. Each is an insecticide, and each is a mixture of compounds whose analysis is confused by poorly defined composition. Toxaphene is a mixture of chlorinated camphenes, estimated to be made up of at least 180 separate compounds (Rice et al. 1986, Cairns and Sherma, 1992). The fact that its principal compounds degrade ("weather") at different rates complicates the analysis and identification problem, It was the insecticide of choice after the ban on DDT, until it was also banned in 1982. Technical chlordane, an organochlorine, includes two isomers, cis- and trans-chlordane (gamma-chlordane), as well as heptachlor and heptachlor epoxide, each of which is a pesticide in its own right. Chlordane is toxic and persistent in the environment, with an estimated half-life of 5-15 years. The principal degradation product is nonachlor (several isomers, Chau and Afghan, 1982). Chlordane is metabolized in most organisms to two epoxides (heptachlor epoxide and oxychlordane) but the degree of metabolization is highly variable (Dearth and Hites, 1991). Since the mid-1980's, the use of chlordane as well as the individual component pesticides has been widely curtailed (EPA, 1988) and the use of chlordane was finally stopped in 1988.

Polychlorinated biphenyls (PCB's) is a class of biphenyl compounds containing up to 10 chlorine atoms (10 being the maximum number of sites available). There are 209 possibilities ("congeners"), and the horrible formulaic names are avoided by international convention of numbering the congeners from 1 to 209 (Alford-Stevnes, 1986) increasing with the level of chlorination. In the United States, virtually all PCB's were manufactured by Monsanto, under the trademark name Aroclor. PCB's are not pesticides *per se*, but are usually addressed with pesticides because of their similar chemical nature and analytical signatures (e.g., Murty, 1986). (In fact, PCB's can interfere with the determination of pesticides, and it is possible that early pesticide data, prior to about 1970, included poorly differentiated GC peaks due to PCB's and are therefore overestimated.) PCB's in fact had a wide range of commercial uses, from inks and NCR paper to fire retardants and dielectrics (Hutzinger et al., 1974, Erickson, 1986). Because of this, PCB use became widespread, until 1976 when Congress banned their manufacturing and sale, and limited their use to totally enclosed systems such as transformers. They are still widely used in capacitors, transformers and electromagnets.

PCB's are frequently analyzed by component Aroclors, which are identified by 4-digit product numbers, e.g. Aroclor 1221. In fact, PCB's often referred to interchangeably as Aroclors, a convention that is fortunately declining, because the two are not equivalent. Each Aroclor is a complex mixture of PCB's and other compounds (Hutzinger et al., 1974). (There are even a few Aroclors that are non-PCB's.) The Aroclor compounds are identified by the *pattern* of peaks as the PCB's in the mixture elute from the GC column. But this chromatogram pattern is complex and can be obscured by GC techniques with poor resolution. Even when supplemented by a sensitive detector, the analyst must judge the identity of

the compound by its component retention times, in comparison to a standard chromatogram, and this judgment can be confused by other compounds with similar retention times. (Pattern-recognition software is now available that performs this judgment; opinions vary about its ability to reduce the margin of error, Schwartz et al., 1987, Swallow et al., 1988, Alford-Stevens et al., 1988.) The identification accuracy is improved with a mass spectrum. When a mixture of Aroclors is present the problem becomes even more complex. To make matters worse, the components of an Aroclor mixture degrade in the environment at different rates, so the resulting chromatogram may not agree with the standard, and therefore be liable for misidentification (Schwartz et al., 1987, Alford-Stevens, 1986).

It is much preferable to analyze and report PCB's as individual congeners. Since there are potentially 209 such congeners, this can be a major analytical effort. It is made more demanding by the fact that different methodologies may be needed to resolve the entire range of retention times. The analytical effort can be moderated by limiting the analysis to a specific subset of the congeners. For example, Schwartz et al. (1987) analyzed 105 isomers, Baker and Eisenreich (1990) analyzed 35, Bergen et al. (1993) analyzed 13. Another means of reducing the analytical effort is to analyze and report PCB's by levels of chlorination, i.e. by isomer groups. In this approach, a representative congener for each chlorination level is used to calibrate the MS for all isomers in that chlorination class; ideally, the representative is near the mean detector response for its class.

PCB's are ubiquitous pollutants. This is due to their widespread use, but also to their mobility. Like chlorinated pesticides and many other organics, they are hydrophobic, have an affinity for very fine-grained particulates, and are leached from landfills, carried by runoff from watersheds, and transported by wind. They are persistent, their half-life generally increasing with level of chlorination, and many are toxic. The atmosphere is a particularly important means for PCB transport. (A recent review of the PCB literature, emphasizing analytical procedures, is provided by Erickson, 1986.)

Another important class of trace organics is polynuclear aromatic hydrocarbons (PAH's), which include polycyclic aromatic hydrocarbons as a subset. (Some authorities refer to the polynuclear class as PNA's and reserve PAH specifically for the polycyclic compounds, e.g. Bjørseth, 1979.) Most studies focus on a relatively small number of "indicator" compounds, primarily to simplify the analytical effort. These usually are a subset of the following:

fluoranthene	pyrene
anthracene	benz(a)anthracene
benzo(b)fluoranthene	benzo(a)pyrene
benzo(e)pyrene	acenapthene
perylene	benzo(ghi)perylene
fluorene	phenanthrene
chrysene	coronene

Probably the most important physicochemical aspect of a PAH is its molecular weight. The light end of the range includes napthalene ($C_{10}H_8$), fluorene and anthracene, and the heaviest, benzo(a)pyrene, chrysene and coronene ($C_{24}H_{12}$). Sometimes PAH's are analyzed and reported in molecular weight classes.

PAH's are introduced into the environment as combustion products, especially from fossil-fired power generation, emissions from petrochemical operations especially petroleum catalytic cracking and the production of asphalt and coke, and through release and degradation of petroleum compounds. Like PCB's, PAH's are widely dispersed in the atmosphere, and enter aquatic systems through rainout and fallout. They are directly injected through waste discharges and spills. (There are also natural sources of PAH's.) The relative distribution of concentrations, or the ratios of pairs of PAH's, have been used as a "pattern" to identify the source of the PAH's (Bjørseth, 1979, Neff, 1979). This obviously is made more difficult when many multiple sources are involved. Moreover, kinetic processes in the environment can modify the component PAH's and obscure their original pattern.

PAH's vary in their kinetic behavior in the environment. Some, like pyrene, perylene, anthracene, and naphthacene, are readily photolysed, but others like phenanthrene and chrysene are unaffected by exposure to light. Some, especially the higher molecular weight species, are readily oxidized, and react with oxides of nitrogen and sulfur. PAH's are hydrophobic and sorb to particulates. There is some indication that when sorbed, PAH's are more stable and less likely to be kinetically degraded. A useful, comprehensive review of PAH's in aquatic environments is presented by Neff (1979).

The environmental concern with PAH's has focused mainly on their features as carcinogens, especially the higher molecular weight species. One of the most carcinogenic is benzo(a)pyrene (BaP), which has received considerable study in the past, and is sometimes used as an indicator for the entire PAH class. Although PAH's are considered to be toxic, especially the lower molecular weight species, there is relatively little information extant on their toxicity to marine organisms.

Frequently, agencies and analysts report "total" PCB's and "total" PAH's. This means the arithmetic concentration sum of the compounds analyzed. If six Aroclors are sought, the total PCB's will be the sum of concentrations of these six. If eight chlorination levels are determined (out of ten), total PCB's means their sum. If 35 congeners are analyzed, total PCB's means the sum of the 35 concentrations. Clearly, "total" is a relative term, and cannot be presumed to be comparable between two different sources of data. On the other hand, if we have reason to believe that the representation of PCB's is dominated by a few Aroclors, then it may be appropriate to combine data on total PCB's analyzed by these Aroclors with totals based upon, say, chlorination levels. Caution must be applied, however, lest apples be mixed with oranges. Similarly, with PAH's the "total PAH" is the arithmetic sum of the compounds analyzed. Neff (1979) observes that the lower molecular weight PAH's, which are more volatile and soluble, are not handled efficiently by many collection and extraction techniques,

and therefore the "total PAH" reported by many labs do not represent the low molcular weight species. Some of the data sources for Corpus Christi Bay analyze only 4-6 PAH's, while others determine an extensive suite. One data source, the EMAP/REMAP program of EPA, presented two different "total PAH" values, corresponding to different suites of measurements (dictated by the practice of two laboratories); these totals often differed substantially. Parameters for total PAH and total PCB are included in the CCBNEP list. However, data sources for these were limited to those that reasonably approximated the same analytes.

2.7 Coliforms

The reader has no doubt noticed that this chapter has addressed water and sediment parameters in general order of increasing uncertainty. Therefore, it should be no surprise that coliforms are treated last. The specification of two basic classes of bacterial growth-response referred to as "total coliforms" and "fecal coliforms" is a controversial, low-precision measure, originally intended to provide an index to the extent of contamination by pathogens of enteric origin. There is, due to the extensive aquatic recreational activities as well as shellfish harvesting, a considerable data set for Corpus Christi Bay.

Sometimes, total coliforms are measured, sometimes fecal, occasionally both. The question is whether there is a stable relationship between the two that will allow us to proxy a data set for one or the other. To the extent that both are dominated by an origin in discharge of sewage, the answer would be anticipated to be affirmative. However, both—especially total coliforms—are the result of a large, varied community of microorganisms with various non-sewage, non-anthropogenic, and even non-mammalian sources. (This, in fact, is the nub of the controversy surrounding the efficacy of coliforms as an indicator organism.) This question was explored by Ward and Armstrong (1992a) using data from Galveston Bay for which an extensive data base exists for paired measurments of both total and fecal coliform.

There is a rule-of-thumb about, that fecal coliforms are approximately one-fifth of total coliforms (e.g. Kenner, 1978) but there seems to be little published support. Ward and Armstrong (1992a) argue that this relation arises from the uncritical use of statistics. In the Galveston Bay data, Ward and Armstrong (1992a) present a regression analysis, in which

$$F = 0.352\,C + 1056$$

(where F denotes fecal coliforms and C total coliforms per 100 mL) with a correlation coefficient of $r = 0.889$. However, by the nature of the coliform test, $0 \leq F \leq C$. This relation induces a spurious correlation. If F and C are completely random variables, with uniform probability distribution, bound only by this inequality, Ward and Armstrong (1992a) show there is an "artificial" linear correlation of 0.65. For real coliform data, it is even worse, since the natural distribution is highly skewed, with most of the data clustering in the smaller values. Ward and Armstrong (1992a) assumed a lognormal distribution and

computed $r^2 = 0.75$. With this much spurious correlation, the $r^2 = 0.79$ of the Galveston Bay coliform data is seen to have no significance at all. Instead, they examined the ratio F/C, and found that this ratio has a mean of 0.325 and a standard deviation of 0.306. For practical purposes, this ratio approximates a uniform distribution over the range 0 to 1. That is, the ratio is totally random. They conclude that there is no useful ratio by which fecal and total coliform may be related, and the two should be treated as independent measures. This same conclusion should apply as well to Corpus Christi Bay.

3. SEGMENTATION

As an estuary, the Corpus Christi Bay system is a watercourse that is transitional between a freshwater and a marine system. This transitional character implies a substantial gradient in the bay environment, as reflected in the water quality and sediment quality parameters addressed here. In order to carry out a trends analysis on the bay, the aggregation of an enormous amount of data is necessary, but in order to exhibit the spatial variation in these data, they must be disaggregated in some way to be representative of geographical position. One time-honored approach is to subdivide the system into segments. The specific strategies of water-quality segmentation are considered here, preliminary to the formulation of criteria and delineation of segments in Corpus Christi Bay. Reference is made to Ward and Armstrong (1992a) for a more extensive discussion of segmentation in estuary water-quality management.

3.1 Purposes of segmentation

Segmentation refers to the subdivision of an estuary into regions, and represents a compromise between the resolution of physical detail in the natural system, and the expediency of dealing with a small number of geographical units. Any segmentation system therefore entails a coarse level of spatial aggregation. The question is how coarse a resolution can the objective of the analysis tolerate, and therefore how small can the number of defined segments be.

There are two broad objectives for imposing a segmentation system on an estuary: administrative and analytical. The administrative objective refers to administration of laws and regulations. Therefore, part of the criteria for an administrative segmentation is an alignment of segment boundaries with jurisdictional boundaries, which can include:

State boundaries
county and district boundaries
state tract boundaries
geographical boundaries

For a large watercourse like Corpus Christi Bay, the segment boundaries can also reflect boundaries that are readily identifiable in the field, such as narrows, passes, and bridge crossings, and can also be based on the need for efficient access to the region for inspection or enforcement purposes. Therefore proximity to marinas and boat docks, or to highways and bridge crossings can form part of the criteria for segmentation.

The second broad objective of segmentation, *viz.* analytical, refers to the aggregation and analysis of data of some sort from the subregions of the bay. This segmentation is related to the nature of the data (or, equivalently, the objective of

the analysis). Economic or demographic analyses will require different spatial aggregation, hence different segmentations, than, say, geological or climatological analyses. Independent of the nature of the data, it must be emphasized that the imposition of a system of segmentation is a compromise between some minimum level of spatial resolution (which carries with it a statistical level of confidence) and a minimum number of spatial units for analysis.

The definition of segments for an estuary becomes especially complex when the property of interest, say distribution of an organism in the bay, is dependent upon another variable, say water quality, which has its own spatial variability. Further, a segmentation system may in fact reflect both broad objectives listed above. The regulation of shellfish harvesting and the regulation of water quality, for example, have both an administrative objective, which may subject the segmentation to criteria of political boundaries and field-operations efficiency, and an analytical objective, which may require delineation of spatial variability of the target parameters.

One of the earliest, and therefore best-known, approaches to segmentation of an estuary for water quality purposes is that of Bostick Ketchum (1951a,b), who subdivided the estuary into segments of length equal to the tidal excursion. His segmentation is hydrographic in principle (see Section 3.2), and is based upon two fundamental postulates: (i) advection by the tidal current is the dominating transport, (ii) mixing is complete over each segment during each tidal cycle. On closer consideration, it will be seen that these two postulates conflict, in that to the extent that one is satisfied the other is violated. Of course, Ketchum's segmentation was devised to support *computational* analysis, which frequently imposes some rather strong conditions on the segmentation.

The most prominent example of segmentation for computational purposes is the gridding of a numerical model. Such segmentations basically observe the same philosophy stated above, in that a computational segmentation is a compromise between the need for a fine resolution of physical and water quality detail, and the need for as few a number of segments as possible in order to minimize computational overhead. However, the computational scheme imposes conditions of its own. For instance, the actual location of physical boundaries is altered to conform to the position of computational elements. For a finite-difference grid, such as that developed for Corpus Christi Bay by the Texas Water Development Board (TDWR, 1981), the segments are square regions one-nautical-mile on a side. A finite-element model repairs this geographical distortion to some extent (e.g., Klein and Ward, 1991, Longley, 1994), but still replaces the shoreline with straight-line segments. Further, in either type of numerical grid, the concentration of constituents is taken to be homogeneous within segments. (Actually, the mathematics of mass budgeting may assume some spatial distribution across a segment, linear in low-order finite-difference models, and linear or parabolic in finite-element models, but when the model is applied to real data, e.g. in validation, the data are generally averaged across the segment.) In general, however, a computational segmentation observes different criteria and is

not as effective a schema for the analysis and depiction of water quality data as a segmentation expressly formulated for this purpose.

The General Land Office, and several other state agencies, employ the state tract system for segmentation. This is an example of a segmentation system that is purely administrative, and in which the constraints of operational surveying completely determine segment boundaries. The Texas State Department of Health employs a rather gross segmentation of the bays for monitoring and regulating shellfish harvesting. The segments generally correspond to large geographical subdivisions of the bay and have little correspondence to hydrographic or water quality features of the system. Again, it is a system devised for its administrative benefits, rather than analysis of water quality.

The most important administrative water-quality segmentation system is, of course, that of the Texas Natural Resource Conservation Commission (nee Texas Water Commission). The Corpus Christi Bay system, including the tributaries, is subdivided into nineteen segments. The TNRCC WQ Segments (also referred to as Classified Segments or Designated Segments) represent one of those instances of a segmentation system that reflects both objectives named above, i.e. it is used both for regulation and for analysis. In the regulation arena, the Water Quality Segments are the basis for setting water quality standards, hence underlie discharge permitting, compliance enforcement, and administrative actions. In the analytical arena, the Water Quality Segments are the basis for establishing monitoring stations and determining ambient water quality. The rationale for TNRCCC WQ segmentation boundaries is a combination of geography, tradition and politics.

The requirements of the CCBNEP Work Statement is that status-and-trends analyses be carried out for each of the Texas Natural Resource Conservation Commission Water Quality Segments in the Corpus Christi Bay system. However, to secure the objectives of this project, it is necessary to perform analyses on a finer spatial scale than possible with the TNRCC segments. Therefore, we have devised a system of "Hydrographic Segmentation" for Corpus Christi Bay to form the basis for detailed analysis. The criteria underlying the formulation of this (or, in general, any) analytical segmentation are developed by Ward and Armstrong (1992a) and summarized below, prior to presentation of the segmentation schema itself.

3.2 Principles of water quality segmentation

Just as different data collection programs have different objectives which inform the procedures and methodologies, so also are the sampling areas and sampling stations in general different from one agency to the next. Yet in many areas of the bay, *to within a certain level of confidence* (in the statistical sense), there is no difference between measurements taken at one position and those from another, perhaps even several kilometers removed. From the standpoint of identifying temporal trends in water quality and in characterizing regional water quality within the system, it is desirable to aggregate sampling stations from different

programs. (Indeed, even within the same program, the same sampling station is not occupied precisely from one sampling run to the next.) With different data sets so aggregated, a sufficiently extended and dense set of data may be created to allow statistical characterization of these specific water quality regions.

The basic principle of such aggregation can be stated succinctly as follows. Aggregation of data should be based upon the determination of regions of homogeneity (within some statistical threshold), and zones or loci of sharp gradients in properties. The former should correspond to the *interior* regions of segments and the latter to *boundaries* between segments.

In order to minimize errors introduced by spatial aggregation, and to maximize its physical significance, the areas in which sampling stations are to be aggregated must be carefully delineated. This delineation should take into account transports, bathymetry, waste sources (where appropriate), inflows, and in general the distribution of physicochemical features which will either homogenize the parameter (to define the region encompassed by a water quality segment) or create steep gradients (to define the boundary between segments). It is useful to formalize these notions as specific criteria of segmentation, both to guide the specification of segments for the bay, and as a means of evaluating the suitability of existing agency segmentation systems.

Since water quality is a property of the fluid medium, one of the determinants of water quality is the pattern of transport within the estuary system. Therefore, variables which must be included in the definition of water quality segments are morphology and hydrography, *viz.*:

(1) Morphology: constraints on, or barriers to, flow and exchange:

(1.1) Physiography should comprise the principal boundaries of segments wherever the fluid zone intersects emergent landforms or shorelines. Moreover, when no other conditions are constraining, the segment boundary should be oriented along readily identifiable landmarks.

(1.2) Submerged reefs and shoals should form a boundary between segments, even when substantial flow over the shoal occurs, because the presence of the shoal will affect detention and circulation both upcurrent and downcurrent.

(1.3) Channels frequently differ in water quality from the open, shallow bay, and can act as a preferential conduit for flow. Therefore a channel should be included well within the interior of a segment, or be itself an independent segment. Because channels are well-marked by navigation aids, there is frequently a spatial bias of sampling in channels, which should be considered in defining segments that contain channels.

(1.4) Inlets typically are zones of strong currents. When the inlet is of limited spatial extent, e.g. the entrances to Oso Bay or to Nueces Bay,

it is best to separate the zones on either side of an inlet as different segments with the inlet serving as the boundary. When the inlet has considerable spatial extent (or is the site of an extensive base of observations), such as Aransas Pass from the jetties to Harbor Island, the inlet zone should be delineated and identified as a separate segment.

(2) Hydrography:

(2.1) Horizontal gradients in water density, as indicated by temperature and salinity, should be used to define segment distributions, with the zone of shallow (or zero) horizontal gradient lying within the segment interior, and the zone of steep gradient lying on the boundary. Because of the extreme variability of salinity, this definition may have to apply to average or long-term distributions.

(2.2) Any zones of systematic density stratification should be segregated from those of zero or unsystematic stratification. As with (2.1), because of the extreme variability of salinity, this may be a condition to apply to long-term mean density distributions.

(2.3) Current structure, especially current shears, should be employed, when the data are available, to define circulation patterns; generally segment boundaries should lie either parallel to or orthogonal to current trajectories, and should not be oblique.

(2.4) Tidal variation in an estuary can affect water mass retention and water-quality differences. If data permit, regions of particularly dramatic changes in tidal range, and conversions from progressive- to standing-wave properties should be identified and used as a basis for segmentation.

(2.5) Tidal current trajectories are a special case of (2.3) that become especially important in defining segments which contain or are adjacent to inlets or tidal conduits. The complex shoals and channels in the Redfish Bay-Harbor Island area are a good example.

(2.6) Fetch under dominant wind regimes can govern regions of the bay which are well-mixed and those that are not, due to the importance of wind-driven waves in effecting mixing. A subtler effect may be the generation of large-scale wind-driven gyres, but on the Texas coast definitive data on these forms of circulation are lacking.

(2.7) Turbulence derived from bed roughness is an important source of mixing and dispersion, and therefore can be important in delineating areas of differing mixing intensities. To the extent that information exists on bedforms, this should be incorporated into the segment definition.

(2.8) Inflows are a prominent source of systematic (throughflow) currents, and under sufficiently high flows can lead to extensive water-mass replacement. Segment boundaries should therefore take into account the normal region of influence (i.e., the outflow plume) from a point inflow. For large-scale inflows, such as the Nueces River, this is obviously a feature that will vary with river hydrograph, and at times encompass all of Nueces Bay or even Corpus Christi Bay proper, so some judgement may be required. Another type of inflow to consider is the large-volume discharge from an outfall, e.g. the cooling water return of a power plant.

While these hydrographic principles can be articulated, the fact is that the data base upon which these kinds of decisions must rely is usually lacking. Indeed, many of the hydrographic judgements must revert to morphological considerations or to the application of fluid-dynamics intuition.

Water quality is in fact a suite of parameters, each of which is subject to its own complex of sources and sinks, and kinetic processes. To a varying degree, however, transport processes underlie all of these, so the hydrographic properties enumerated above form a set of minimal criteria for segmentation. In addition, water quality segmentation must also reflect the following properties specific to water quality constituents:

(3) Water quality:

(3.1) Regions of homogeneity are one of the most important factors in the definition of segments. Ideally, a segment should encompass a region which is largely homogeneous in water quality. At the same time, water quality parameters in the real world are extremely variable and rarely homogeneous (the term implying a certain threshold of statistical variability which is deemed acceptable). Segment definition is based first upon relative differences in water quality—some regions having a greater tendency toward homogeneity than others—and second upon the kinds of transport and mixing processes that would tend to promote homogeneity.

(3.2) Regions of steep gradients, in contrast, should be the defining property for a boundary between segments. As with (3.1), this is a relative measure which may be frequently belied by data, depending upon external conditions, and must be supplemented by identifying the kinds of transport and mixing processes that would tend to promote steep gradients.

(3.3) Proximity to loads should be considered in defining water quality segments, since this would entail a large-scale difference in water quality that is superposed upon whatever ambient mixing processes are operative.

(3.4) Systematic degradation of a region of the bay, as exhibited directly in trends of water quality or indirectly in anthropogenic influences, is sufficient reason to segregate an area as a specific segment. Reaches of the Corpus Christi Ship Channel and Inner Harbor, and some of the secondary bays, such as Oso, are good examples. This criterion is also related to (3.3), in that proximity to new discharges may be sufficiently compelling to anticipate degradation of water quality.

(3.5) Finally, any region in which there is a systematic trend toward degradation, even though the water quality indicators may still lie within the normal or "healthy" range may be beneficially monitored by being defined as a separate segment. This is a more subtle differentiation of the same philosophy expressed in (3.4).

Ideally, a separate segmentation would be defined for each water-quality parameter, e.g. dissolved oxygen, sediment mercury, BOD, but such an approach would be manifestly unworkable, therefore the definition of segments needs to consider the principal water quality parameters taken collectively.

The application of criteria (1), (2), and (3) without further constraints would result in a veritable plethora of segments. From the opposite direction, we wish to minimize the number of segments in order to: (i) maximize the number of data points per segment, hence the statistical strength of the conclusions, (ii) improve the conceptual value of the analysis, by presenting the results for as few, large segments of the bay as possible (a reflection of the poor ability of the human mind to assimilate numerous facts simultaneously, requiring some degree of pre-digestion). There is an additional practical criterion lurking here as well, *viz.* to decrease the effort of analysis, which will proceed on a segment-by-segment basis and therefore is proportional to the number of such segments, but this is probably subsumed within (ii). This criterion can be expressed as follows:

(4) Maximal spatial aggregation:

(4.1) Definition of segments should be cognizant of the conceptual value of organizing the system into a small number of quasi-autonomous regions. Further, the boundaries of these regions should correspond to natural physiographic boundaries and be defined by well-established, easily determined landmarks or landforms.

(4.2) Dimension of a segment should take into account the minimum number of data points within the segment required to characterize a spatially representative value. This would be based upon the distribution of historical sampling stations in the region and typical variability in water quality.

(4.3) Dimension of a segment should also consider the minimum number of data points over time needed to resolve principal temporal variability, and the available period of record at the established monitoring stations.

(4.4) One element of establishing acceptable spatial dimensions is the intrinsic variability at a given point in water quality versus variability across the segment area.

(4.5) The segmentation scheme should be comprised of non-overlapping segments, so that every point in the watercourse falls within a unique segment.

Criterion (4.1) appears different in character from the other three, in that it is more qualitative and can be applied from a purely morphological viewpoint, while (4.2)-(4.4) have a strong statistical flavor, and would require a fair data base for their application. Implicit in (4.1) is the concept of areal scale of depiction, which is not an absolute measure but is, rather, at least partially determined by the objectives of the analysis in which the segmentation is to be employed. For some purposes, a rather gross segmentation might appear satisfactory. The extreme example would be analyzing bay-wide parameters, in which the entire bay is regarded, in effect, as one segment. This sort of analysis is done, for example, when bay-wide water budgets are carried, in tidal prism analyses, and in computing bay-wide salinities (cf. the annual reports on bay salinities of the Texas Parks and Wildlife Department). Upon closer analysis, however, these "global" depictions of the bay really amount to accepting a rather large statistical variance in the answers. (Some users of such a gross approach may, of course, be unaware of the enthymeme.) The key point is that the intended spatial scale of the analysis, determined by the objectives of the analysis, in effect imposes a level of statistical variance—a confidence level—on the results.

Criterion (4.5) is not required by the statistical methods of data analysis. Indeed, for scientific purposes, it is perfectly acceptable to have overlapping segments, with sampling stations counted among the aggregated data for more than one region. On the other hand, by requiring disjoint segments, it then becomes possible to carry out a census of data availability, and to avoid problems of weighting of measurements, due to the same measurement being counted in more than one aggregation. Further, the administrative function of segmentation would be greatly complicated by overlapping segment definitions. (In the Corpus Christi Bay segmentation, this requirement is deliberately violated for the Gulf of Mexico hydrographic segments, see Section 3.3.3.)

The definiteness of these criteria is somewhat meretricious, in that the information base for their quantitative application is not extant. This is especially true for the statistical measures underlying (4). For most parameters, these measures are *ab initio* unknown and in any event relatively spongy, varying with intended purpose of the analysis and the cultural bias of the investigator, and varying over time. However, their enumeration serves the good purpose of providing an objective set of criteria that can be applied intuitively, and on the basis of gross characteristics of the bay and past experience with data from the bay. Because these criteria are rather intuitive, the present TNRCC WQ Segmentation more or less conforms to them.

The notion of a scale of analysis emerged in the formulation of criteria. This aspect of segmentation cannot be overemphasized. Underlying any segmentation scheme is a dominant spatial scale of analysis, which carries with it an associated level of confidence one is willing to accept in the aggregation of samples over a region of the estuary. For someone studying the variation of water quality in Corpus Christi Bay on a scale of tens of kilometres, it is appropriate to depict Nueces Bay as one or two segments. Another researcher with the different purpose of studying the kinetics of a constituent within Nueces Bay itself would find this scale of representation much too coarse, and would employ a much more refined spatial segmentation. Either level of segmentation would be inappropriate and unworkable for the other's purpose. (Note that the use of field data from a network of stations implicitly assumes a segmentation, in that each sampling station is presumed to represent water quality over some extended area in which the station is located.)

3.3 Project segmentations of Corpus Christi Bay

3.3.1 Numerical schema of segments

Not only must we define a system of segmentation for analysis of water quality, we must devise a means by which this segmentation may be imposed in automatic data processing. That is, there must be a computational means for determining into which segment a sampling station would fall. The method adopted here is to define each segment as the union of quadrilaterals encompassing the portion of the watercourse defined to lie within that segment. The corners of each quadrilateral are given by latitude/longitude pairs, and an algorithm was developed which determines whether a given station, specified by its latitude-longitude coordinates, lies within the quadrilateral. We note that (1) these quadrilaterals are not parallelograms, but can be any four-sided figure distorted as necessary to conform to the shape of the watercourse, (2) only the watercourse is considered to be within the segment, even though the quadrilateral may cover substantial land area as well, (3) a series of quadrilaterals taken together can better approximate complicated geometry. The last is the reason that a conjunction of such quadrilaterals is used. Because many segments, especially TNRCC segments, have complex shapes, a single quadrilateral was not practical.

Figure 3-1 shows an example of the depiction of segments by quadrilaterals, Segment 2472, Copano Bay. The main body is one segment and is adequately depicted by a single quadrilateral, as indicated. Segment 2003 is Aransas Creek Tidal from its mouth at Copano Bay to approximately Rincon Bend. Segment 2001, Mission River Tidal, extends northward from Copano Bay, and is defined by a large elongated quadrilateral. The key sides of both of these quadrilaterals are those that intersect the watercourse at the boundaries of the segments with Copano Bay. Placement of the other corners is arbitrary and is adjusted to optimize the fit and to simplify the corner coordinates. Nueces Bay, Segment 2482, is represented by three quadrilaterals, as shown in Fig. 3-2.

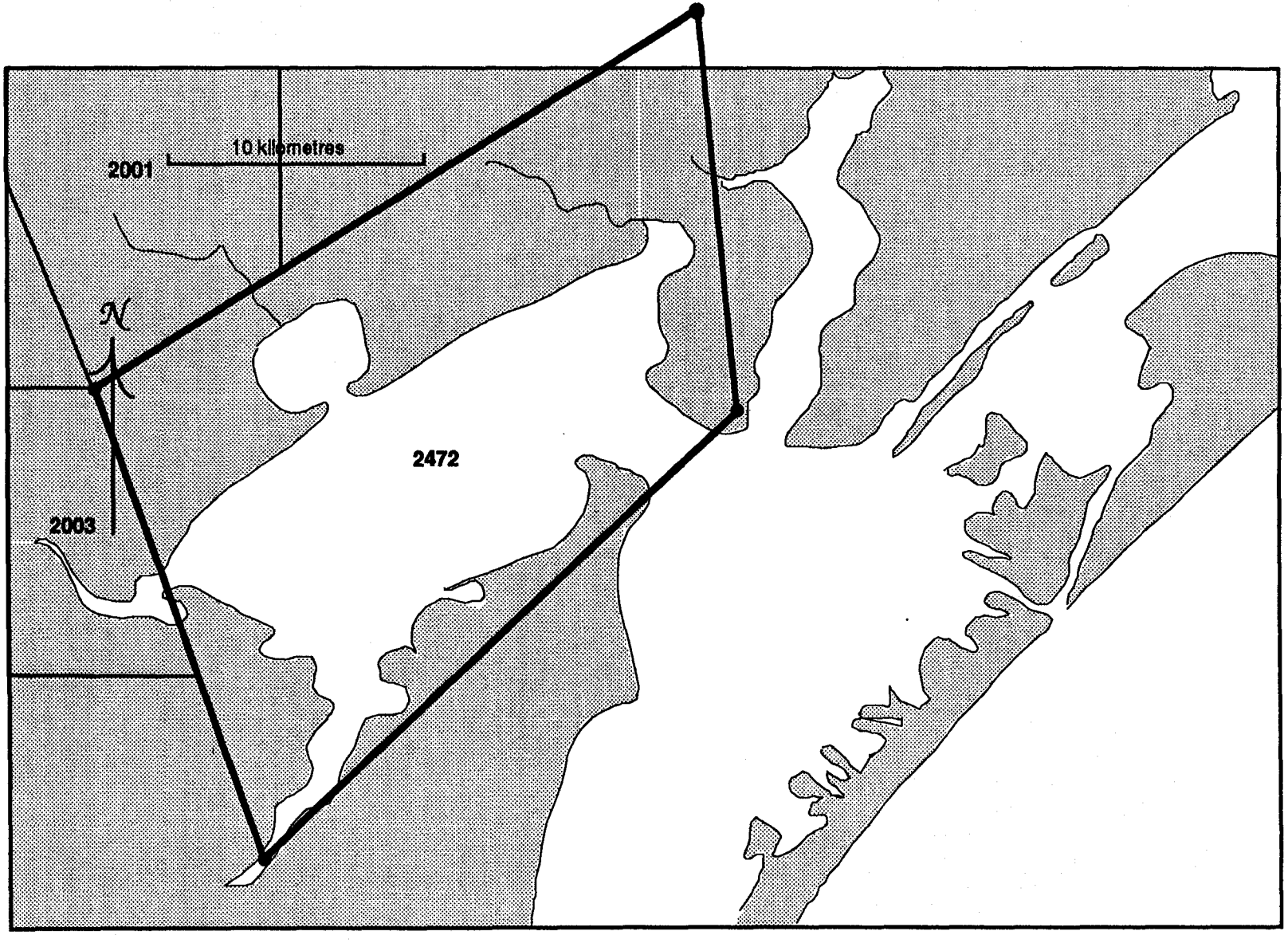


Fig. 3-1. Quadrilateral definition of TNRCC segments in Copano Bay

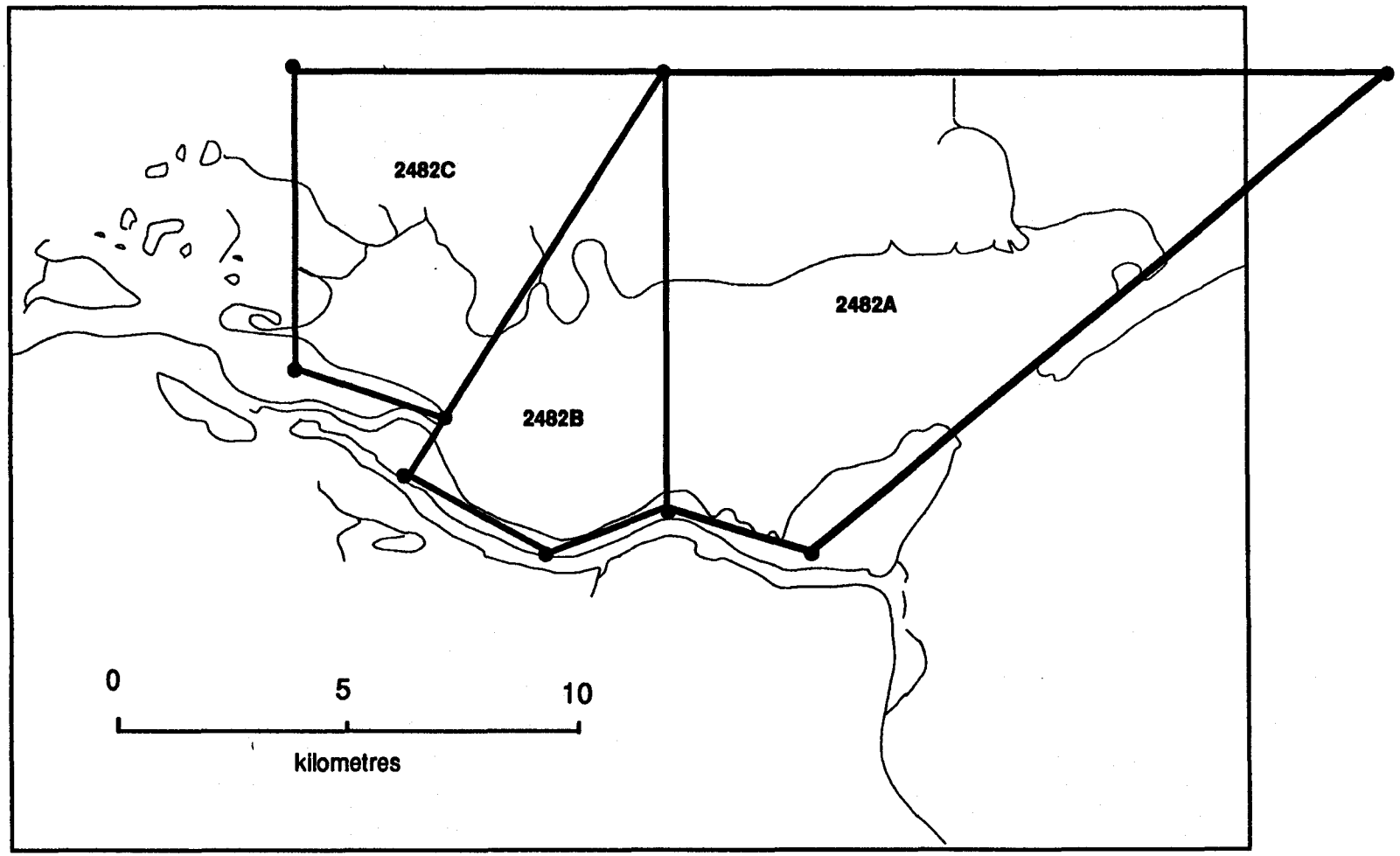


Figure 3-2. Quadrilateral definition of Segment 2482, Nueces Bay

In addition to providing a quantitative mechanism for processing large data bases, the quadrilateral depiction of segments has another benefit: it is a means of precisely and quantitatively defining the boundaries of a segment. The nearly universal practice of using small-scale maps to depict segment locations is a continuing problem, especially in open waterbodies where there is no obvious morphological boundary, as these maps are subject to drafting and printing errors, and introduce uncertainty in the precise location of boundaries. With a quadrilateral-based definition, the quadrilateral corners can be specified to whatever accuracy is needed, and become an unequivocal means of communicating segment boundaries. While in this report, we will display maps of the hydrographical segments employed, it should be understood that these are graphic vehicles only, and the segments themselves are precisely defined by the applicable quadrilaterals.

3.3.2 Texas Natural Resource Conservation Commission Water Quality Segments

As noted earlier, the Texas Natural Resource Conservation Commission system of segmentation forms the basis for water management in the state. The Corpus Christi Bay estuarine system *per se* is represented in this system by sixteen (16) segments, ten (190 in the open bays (including Oso), five (5) in the tidal tributaries (including the Inner Harbor), and one in the Gulf of Mexico. These are summarized in Table 3-1. The spatial scope of this project was extended to include three designated freshwater segments, seven undesignated (both fresh and tidal), and one comprising a portion of the next bay system (San Antonio), added to facilitate the State's assessment of the coastal basin. The undesignated tributaries are administratively taken to be part of the segment into which they conflow, but were added as independent watercourse segments for this study. (The division into tidal and above-tidal is ours.) Those TNRCC segments within and in immediate proximity to the principal components of the Corpus Christi Bay study area are depicted on Figs. 3-3 through 3-7. The boundaries for the open-bay segments are not well-defined and are established qualitatively (i.e., by approximate location on crude maps, e.g. TWC, 1990). Thus far, this has not presented an administrative problem, because the routine monitoring stations of TNRCC generally are placed well in the interior of these segments.

The quadrilaterals used by this project to define the TNRCC Water Quality Segments are given in Table A-4 in the Appendix.

3.3.3 Hydrographic segmentation

It was necessary to formulate a segmentation system suitable for use in this project. The primary purpose of the segmentation is analytical, i.e., for data aggregation by area of the bay, to support statistical and trend analyses. For the establishment of general levels and trends in water quality, the spatial resolution

Table 3-1
Texas Natural Resource Conservation Commission
Water Quality Segments
for CCBNEP Study Area

Estuarine & marine segments	
2001	Mission River Tidal
2003	Aransas River Tidal
2101	Nueces River Tidal
2203*	Petronila Creek Tidal
2462*	SW San Antonio Bay & Hynes Bay
2463	Mesquite & Ayres Bays
2471	Aransas Bay (including Lydia Ann Channel)
2472	Copano Bay
2473	St. Charles Bay
2481	Corpus Christi Bay
2482	Nueces Bay
2483	Redfish Bay
2484	Corpus Christi Inner Harbor
2485	Oso Bay
2491	Upper Laguna Madre, JFK Causeway to Yarborough Pass
2492	Baffin Bay
2501	Gulf of Mexico nearshore
Freshwater segments	
2002*	Mission River above tidal
2004*	Aransas River above tidal
2204*	Petronila Creek above tidal

Undesignated segments, estuarine & freshwater

Copano Creek*	Oso Creek*
Los Olmos Creek*	Oso Creek Tidal*
Los Olmos Creek Tidal*	San Fernando Creek*

Poesta Creek, upstream from Aransas River to Beeville*

* added to segments specified in project Scope of Work

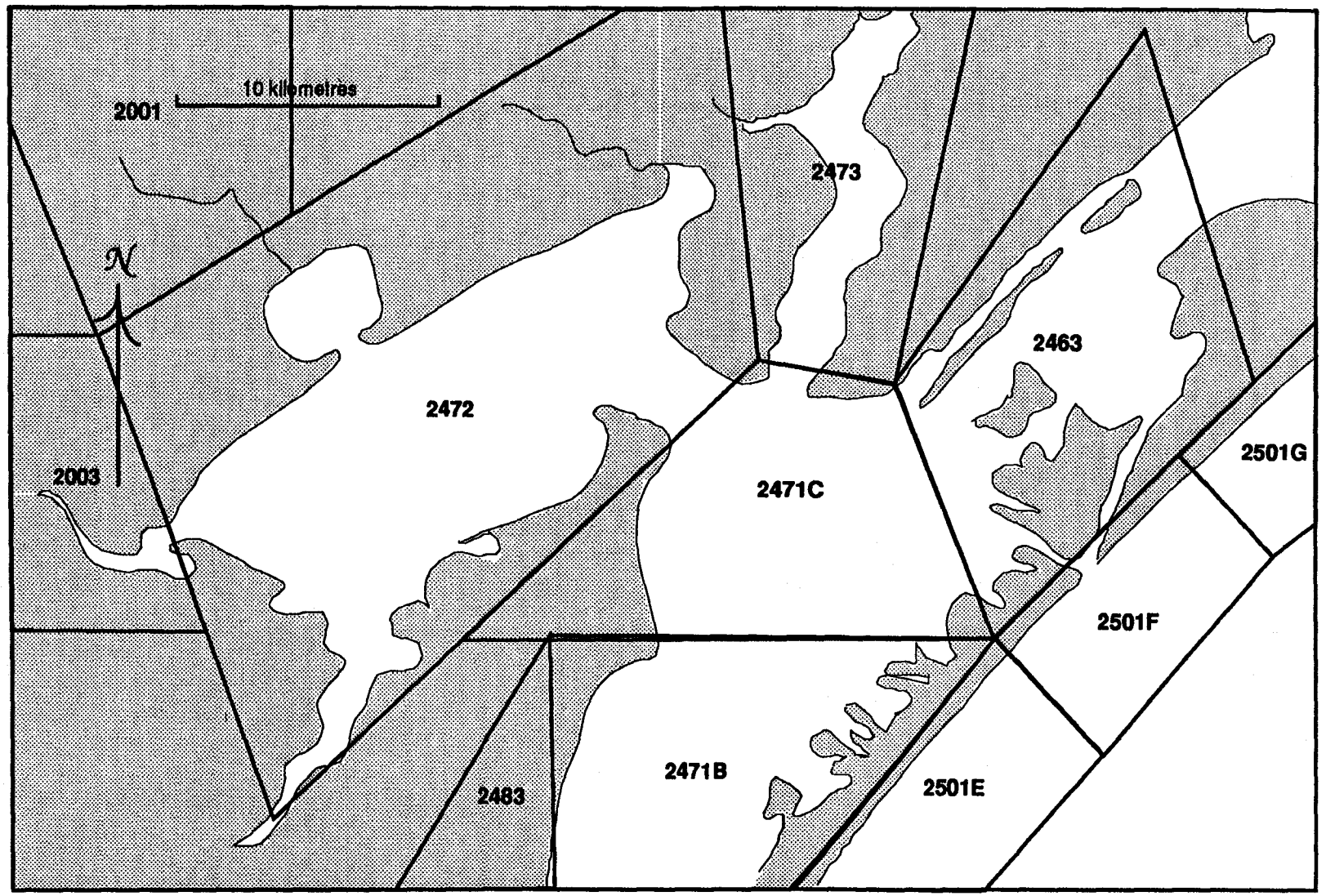


Figure 3-3. Quadrilateral definition of TNRCC segments in Aransas Bay area

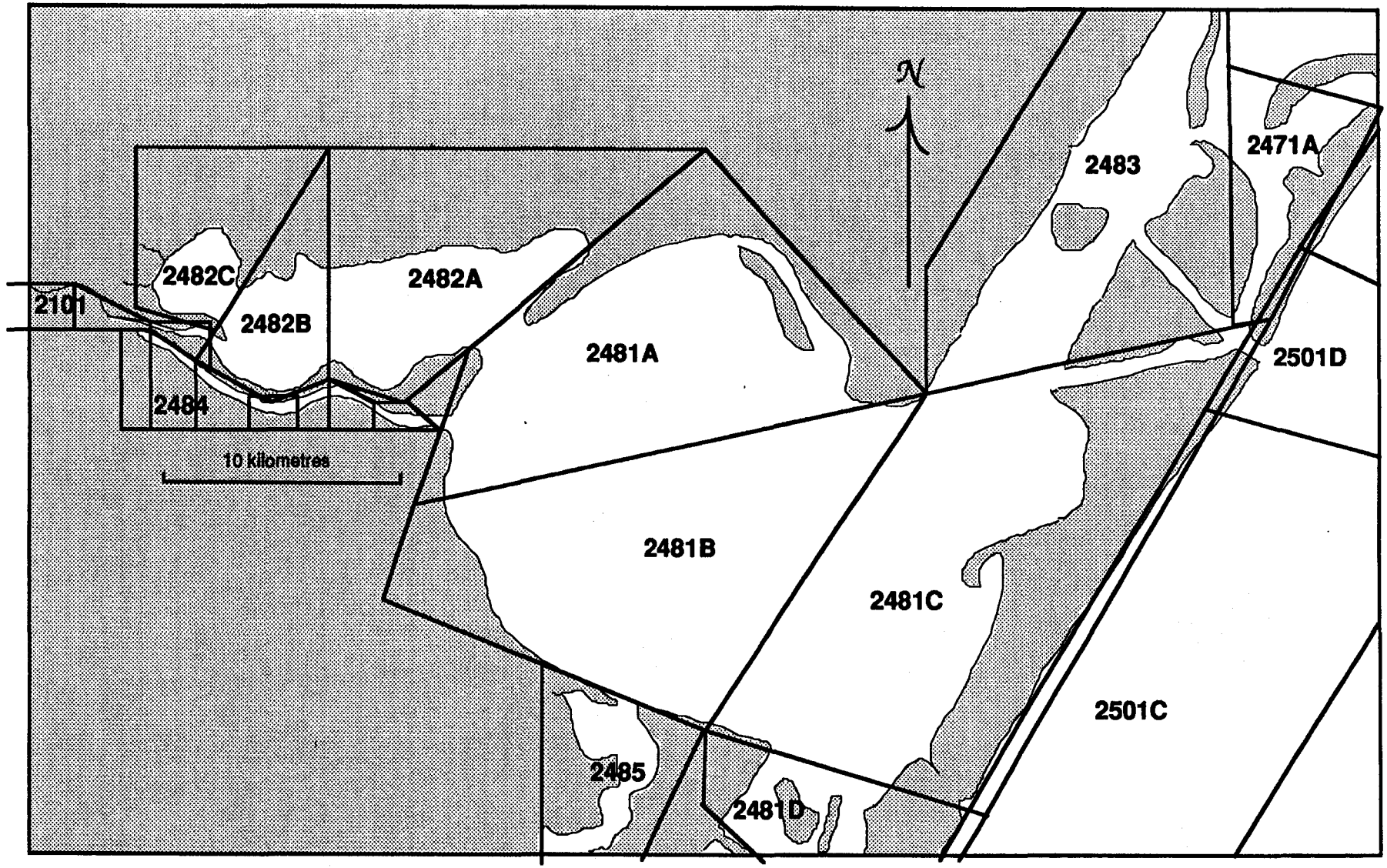


Figure 3-4. Quadrilateral definition of TNRCC segments in Corpus Christi Bay area

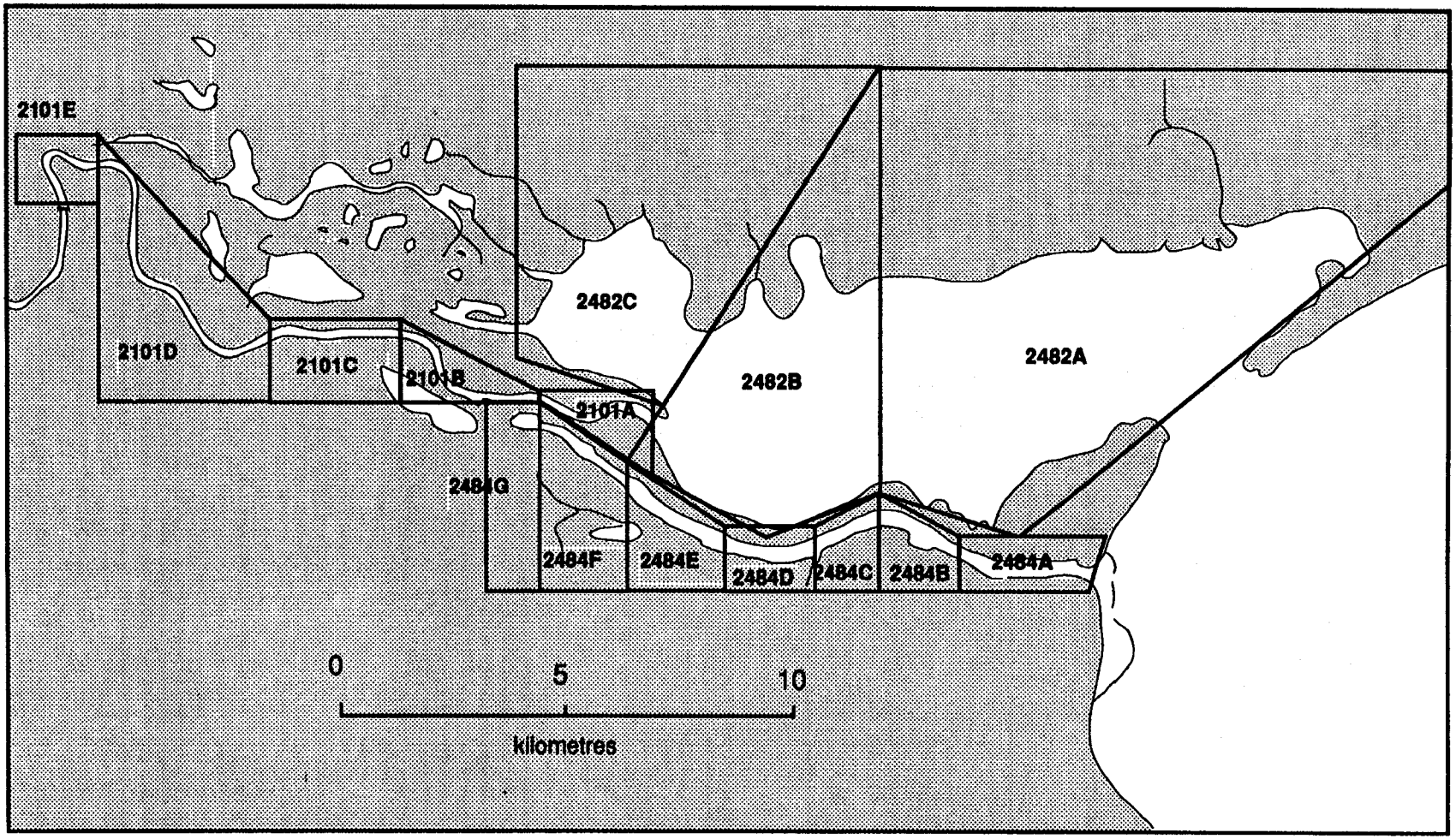


Figure 3-5. Quadrilateral definition of TNRCC segments in Nueces Bay area

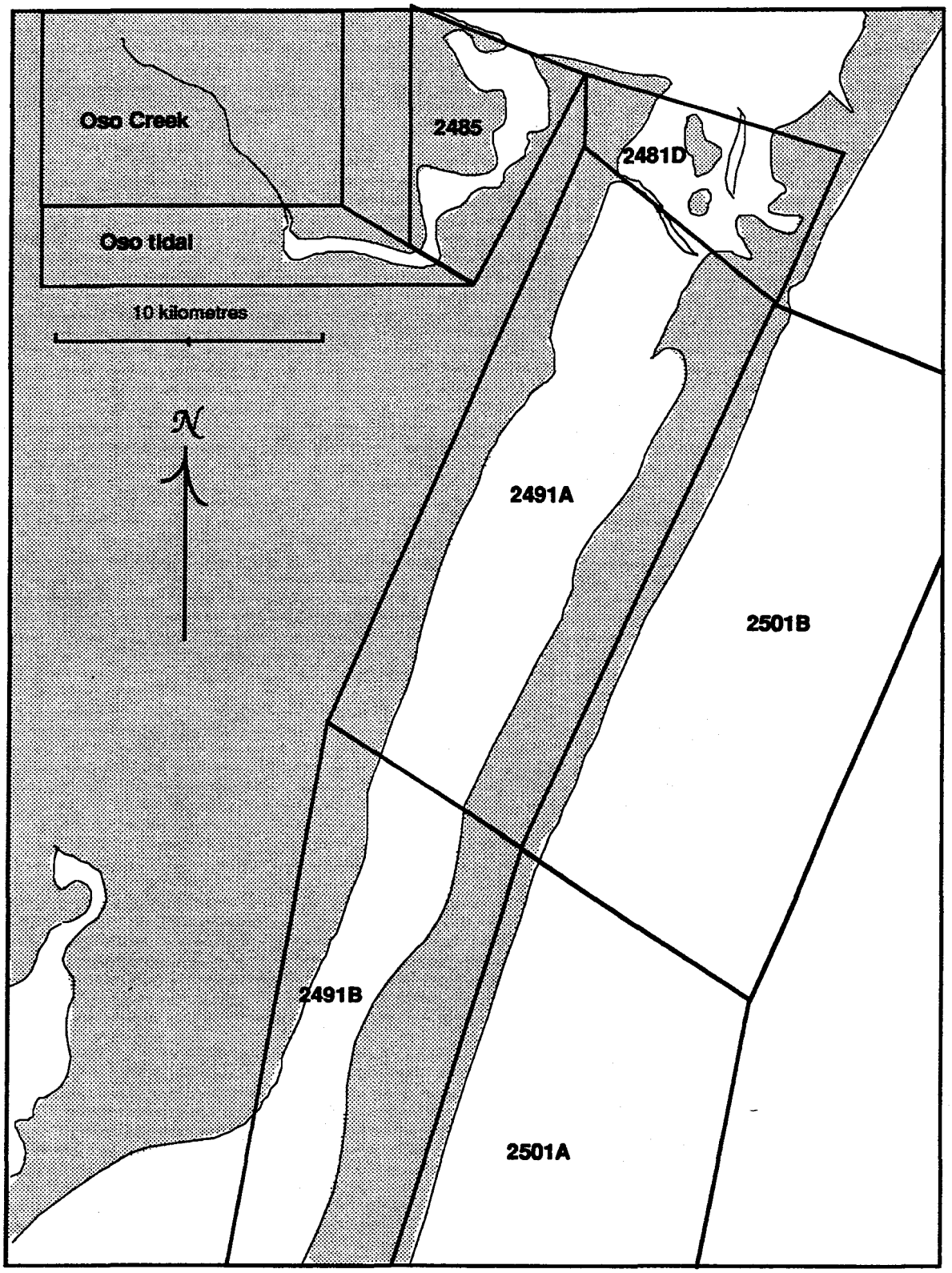


Figure 3-6. Quadrilateral delineation of TNRCC segments in Upper Laguna Madre

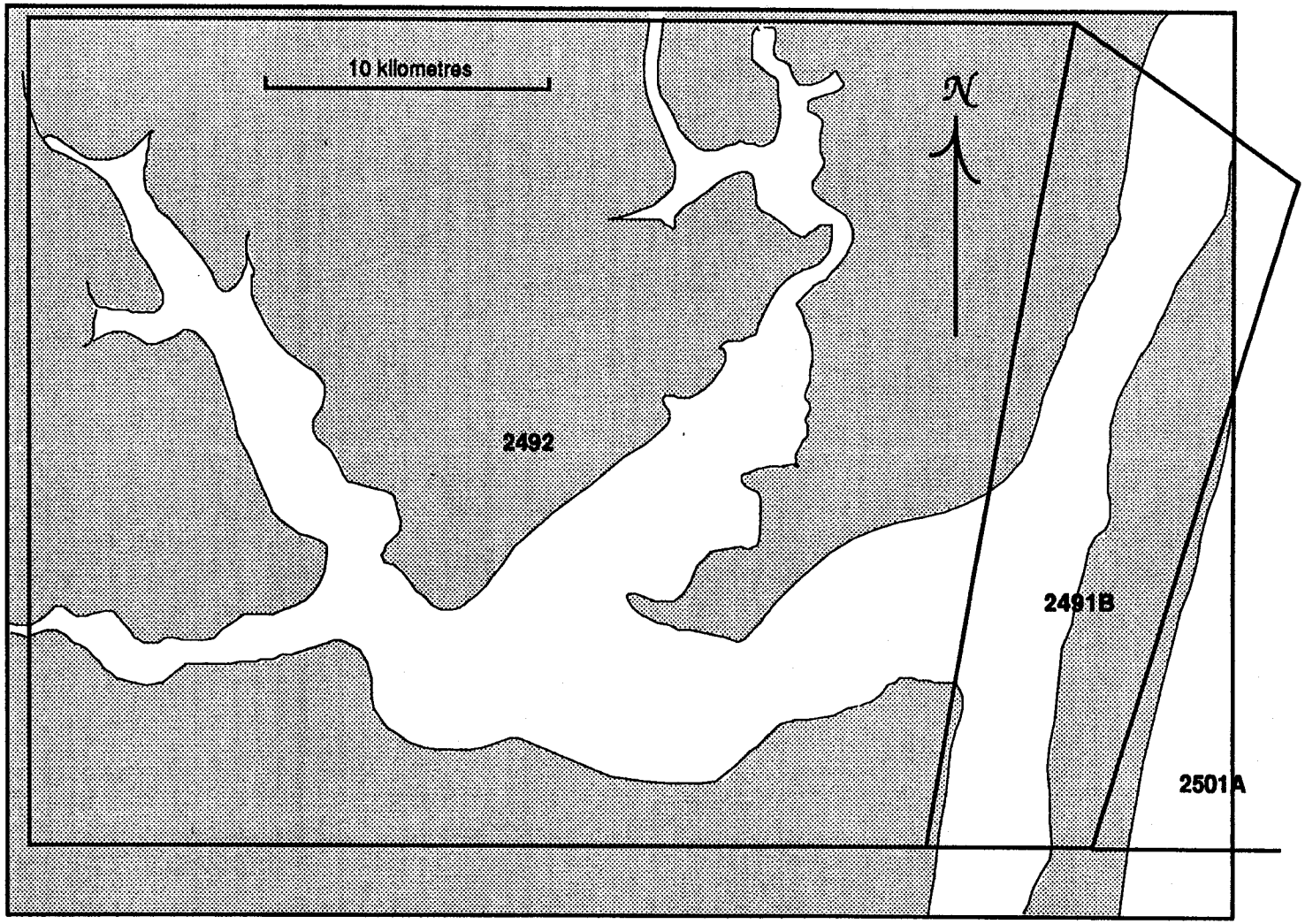


Figure 3-7. Quadrilateral definition of TNRCC segments in Baffin Bay

needed to be on the order of 5-10 kilometres, except when hydrographic properties demand a smaller scale. From a practical standpoint, application of the principles enumerated in Section 3.2 meant basing the segmentation largely upon the hydrographic criteria (1) and (2) of Section 3.2, along with the data management criteria (4). This segmentation considered the criteria (3) to the extent that experience and data on specific water quality variables permitted.

The final hydrographic segmentation for the study area is depicted in Figs. 3-8 through 3-12. This segmentation was limited only to the estuarine and marine portion of the study area. Those segments lying upstream from the areas shown on Figs. 3-8 through 3-12 were considered to be adequately depicted by the TNRCC segmentation analyses. It will be noted that generally the hydrographic segments (HS) of Figs. 3-8 through 3-12 are considerably smaller than those of the TNRCC, so a finer level of spatial analysis is permitted, especially in the open bay areas. There are a total of 178 hydrographic segments, distributed as indicated in Table 3-2. The coordinates precisely defining the locations of these hydrographic quadrilaterals are given in Table A-5 of the Appendix.

These hydrographic segments formed the fundamental organizational units for the water quality and sediment data in the present project. Some particular features of this segmentation warrant mention. The Corpus Christi Ship Channel in the open bay occupies its own segments, a narrow strip of approximately 2 km width centered on the dredged channel. Similarly, the La Quinta Channel and prominent reaches of the Gulf Intracoastal Waterway (GIWW) are also embedded within narrow segments. This is due to the peculiar hydrodynamics of salinity intrusion and increased tidal response dictated by the deeper water, and also due to the isolating effect of dredge disposal areas on the lateral boundaries of these channels. One rather odd-appearing segment NB7 encloses the return from a major power plant. The orientation of the segments in Corpus Christi Bay follow the curvature of the bay with the narrow dimension perpendicular to the shoreline. This is in anticipation of gradients in quality produced by runoff and discharges from the bay periphery. The boundaries of several of the segments are dictated by reefs or other bathymetric features. For example, CP03 in Copano Bay is bounded on the east by Shellbank Reef, CP06 is bounded on the west by Copano Reef and on the east by Lap Reef, and RB1 through RB9 encompass the complicated bar, channel and shoal complex of Redfish Bay. ND1 through ND4 are the Nueces marsh/delta area, and NR1 through NR5 comprise the channel of the Nueces River below Calallen Dam.

In the nearshore Gulf of Mexico there are no physiographic boundaries other than the barrier island complex that would control segmentation. Segmentation here was based upon two features: water depth and proximity to a tidal inlet. Fig. 3-13 shows a typical depth profile extending from the barrier island out into the Gulf of Mexico. There are two prominent breaks in the slope of the seabed, one at approximately 10 m (5 fathoms) and one at approximately 20 m (10 fathoms). Hydrographic segments were defined to extend between these two breakpoints.

Table 3-2
Distribution of Hydrographic Segments
in principal subdivisions of the study area

system	*segments*
Mesquite/Ayres Bay	9
Aransas-Copano Bay	36
Redfish Bay and Aransas Pass	16
Corpus Christi Bay proper*	42
Nueces Bay and Nueces River tidal reach	18
Inner Harbor	7
Upper Laguna Madre	23
Baffin Bay	9
Gulf of Mexico nearshore	18

* including Oso and La Quinta Channel

The innermost zone, from the shore out to the 10 m contour, is one of relatively steep slope, and extends about 2 km into the Gulf, encompassing the surf zone and the larger zone in which substantial refraction of the longer-length waves occurs. The outer zone, from the 10 m to the 20 m contours, extends out about 10 km into the Gulf. In the vicinity of tidal inlets, the water quality can be expected to be influenced by exchange with the adjacent estuary. Therefore, hydrographic segments were defined to correspond to the main extant and historical passes. All together, the Gulf nearshore is divided into nine (9) sections, each of which has an inner and an outer segment, for a total of 18 hydrographic segments. These are shown schematically in Fig. 3-14. A close inspection of these segments and those defined for the estuarine areas will disclose that the inlet segments overlap to a certain extent. Therefore sampling stations located within the inlet will be captured in both the estuarine segment and the Gulf of Mexico segment. This is deliberate. These transitional stations are considered to be indicative of both the nearshore Gulf of Mexico environment as well as that within the inlet itself, and therefore need to be included in both data subsets. (This is discussed further in Chapter 6.)

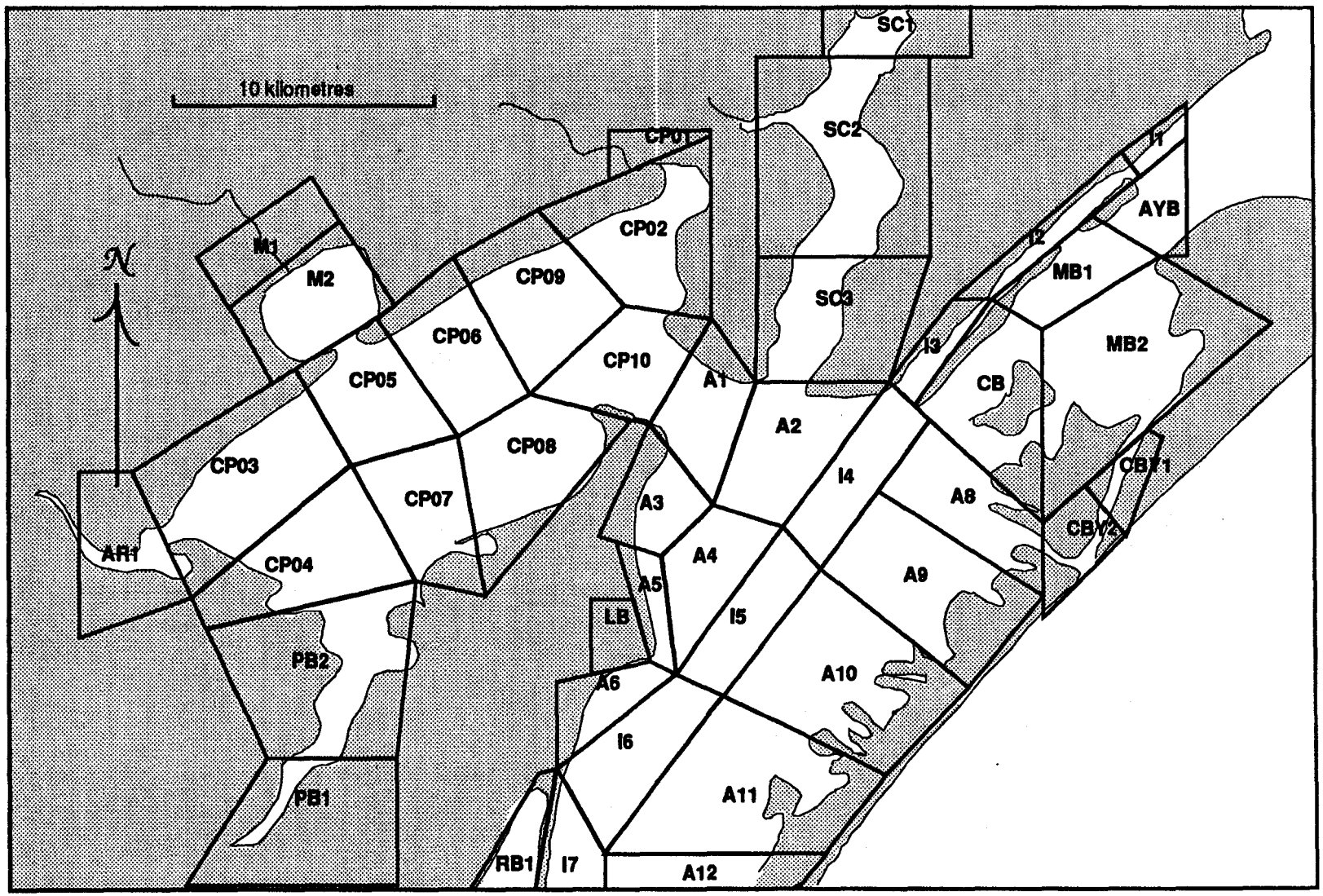


Figure 3-8. Hydrographic areas for Aransas-Copano system

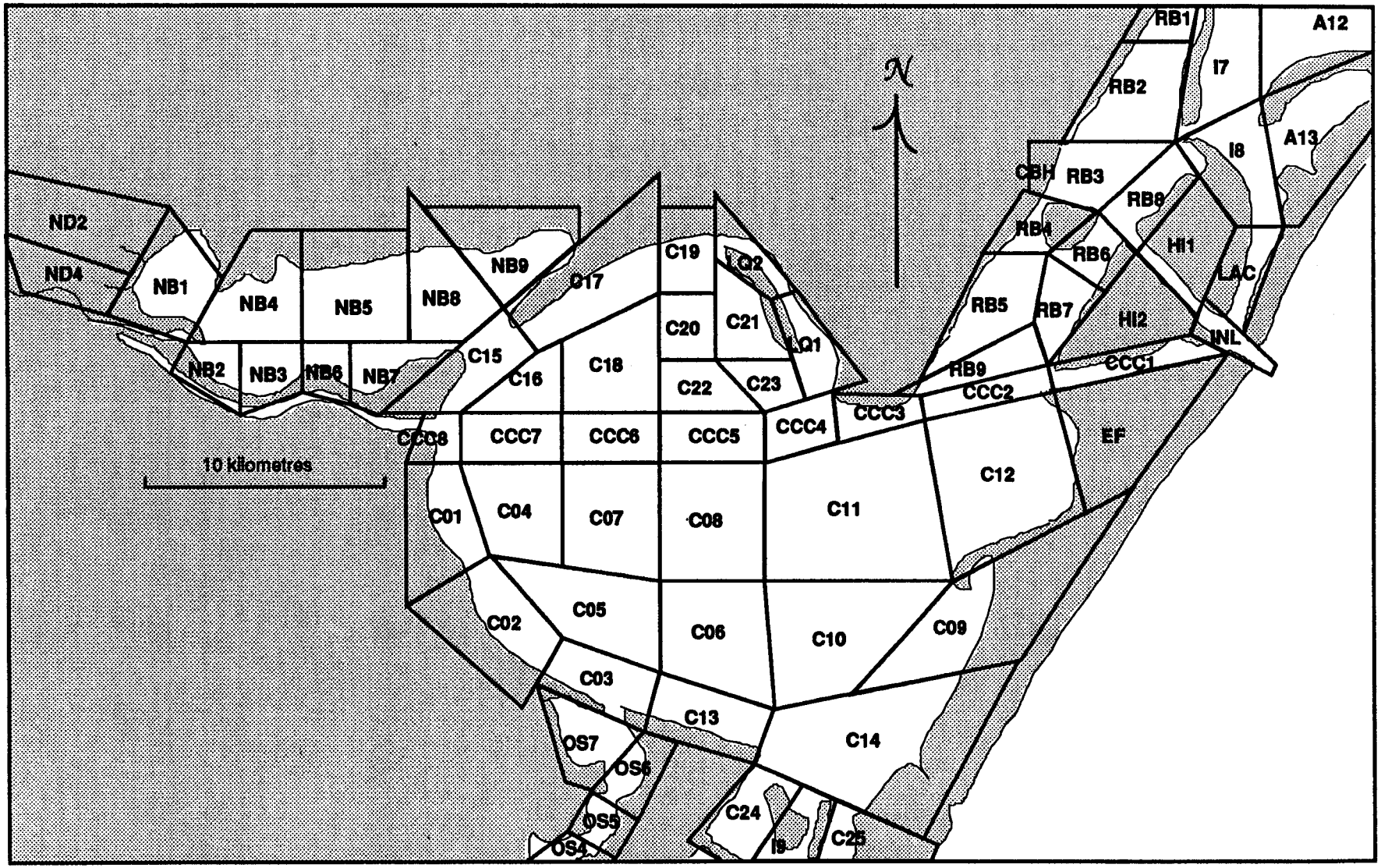


Figure 3-9. Hydrographic areas for Corpus Christi Bay

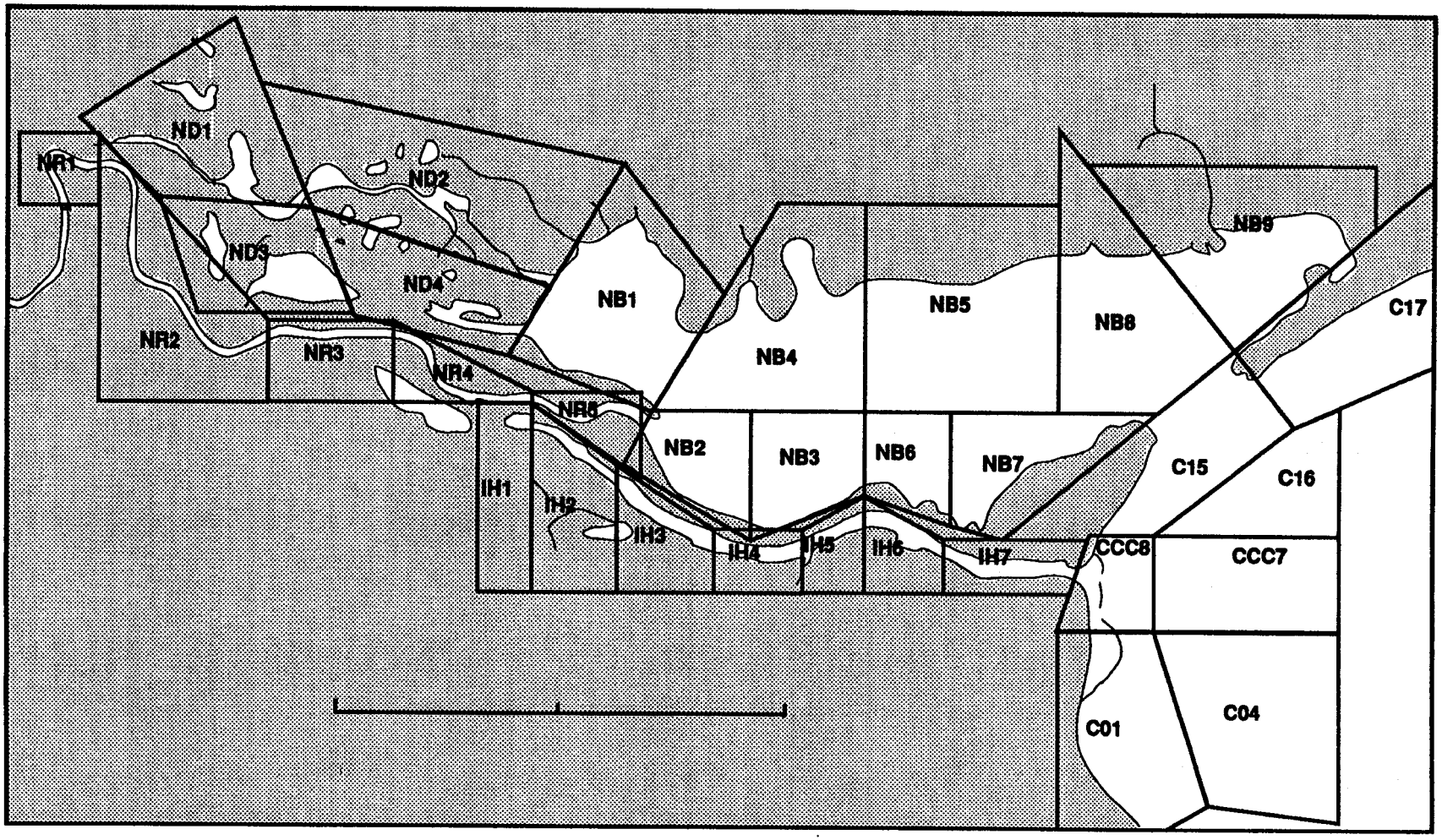


Figure 3-10. Hydrographic areas for Nueces Bay region

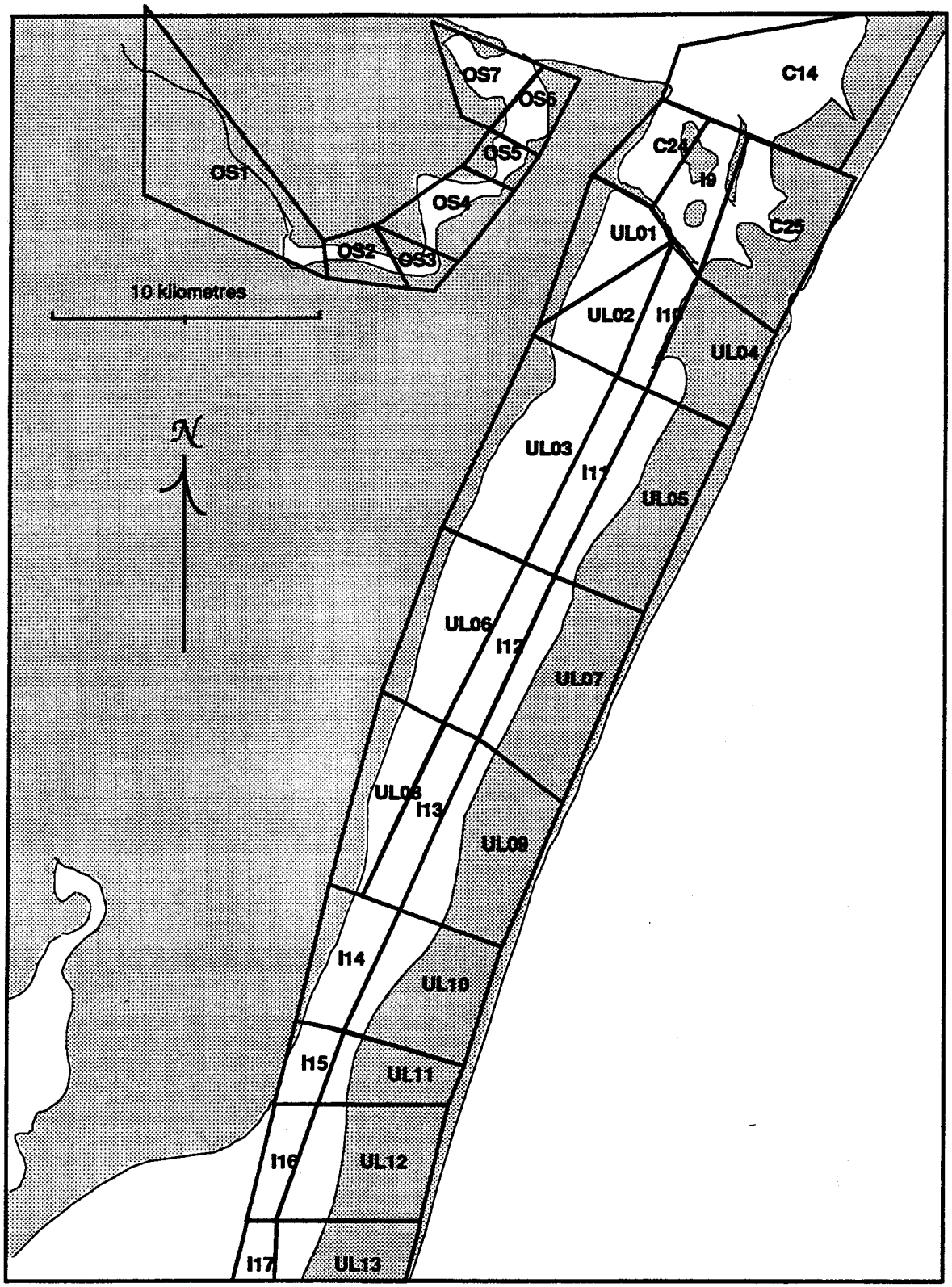


Figure 3-11. Hydrographic areas for Upper Laguna Madre and Oso Bay

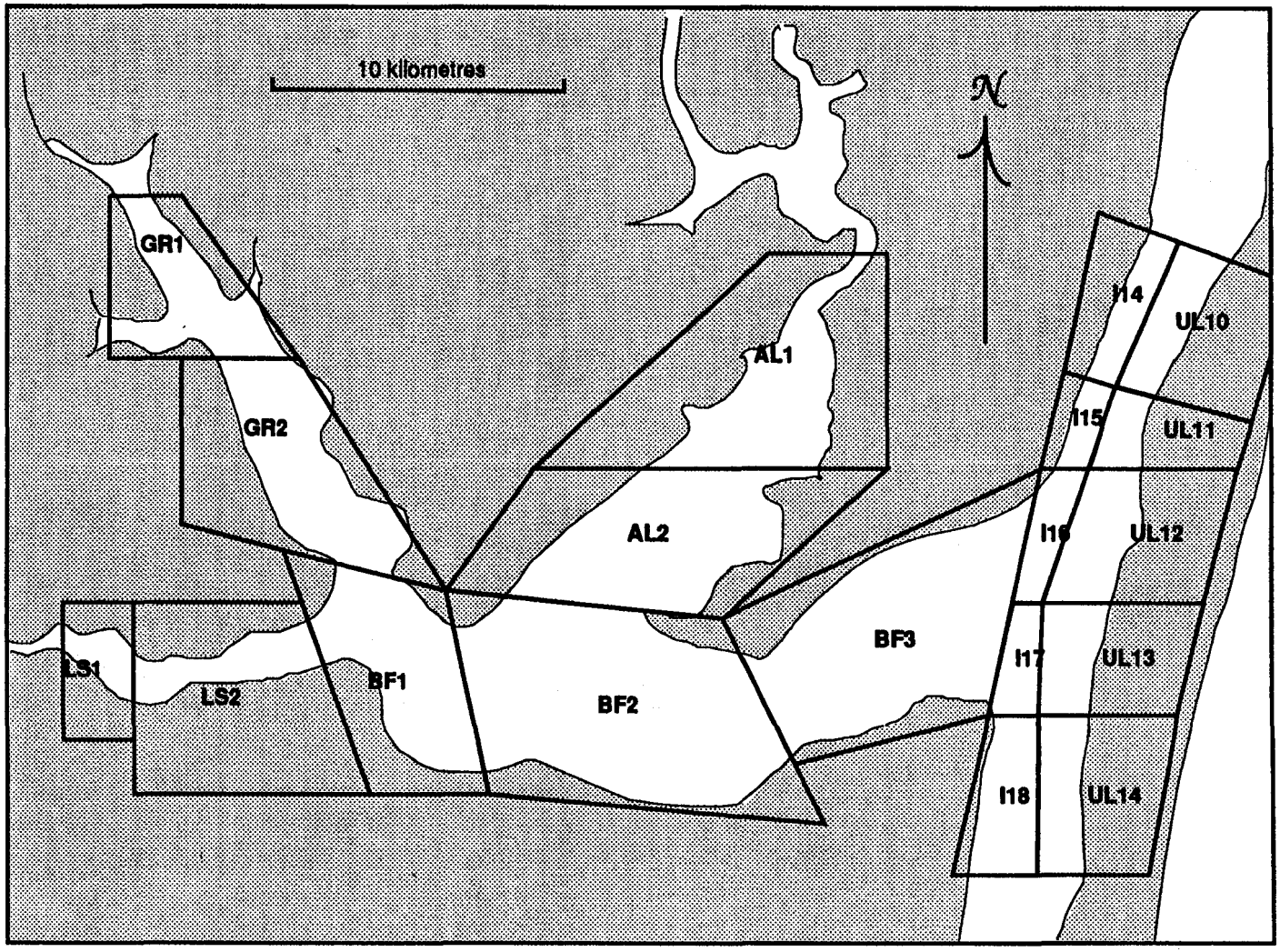


Figure 3-12. Hydrographic areas for Baffin Bay and adjacent Laguna Madre

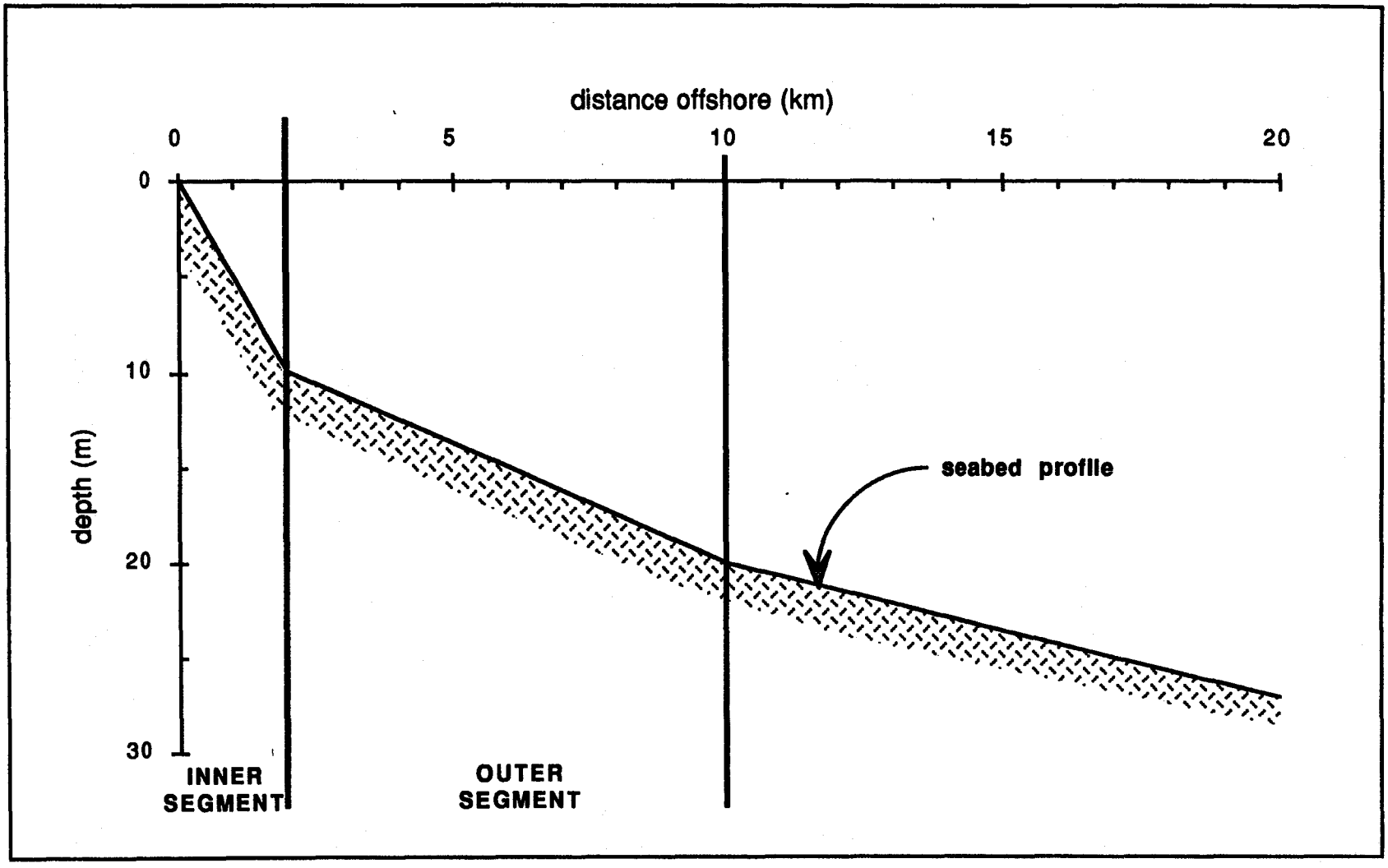


Figure 3-13. Definition of hydrographic segmentation in Gulf nearshore.

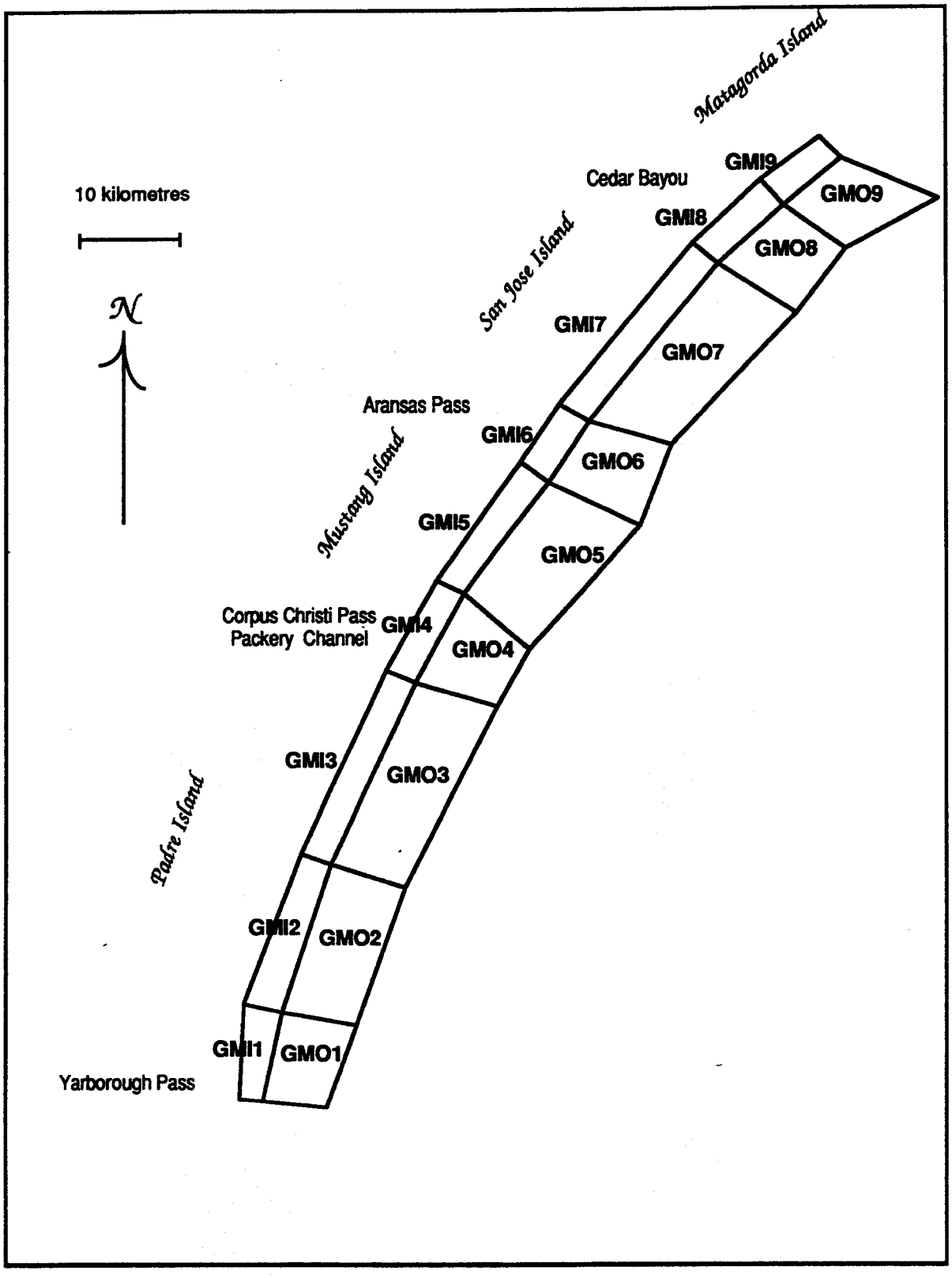


Figure 3-14. Hydrographic areas for Gulf of Mexico nearshore

4. DATA COMPILATION AND PROCESSING PROCEDURES

A major task of this study was the acquisition, compilation and digitization of historical data relating to the quality of water and sediment within the Corpus Christi Bay system. The data acquired in this project can be broadly categorized as digital format and hard-copy format. The former refers to any medium capable of manipulation on the digital computer, e.g. magnetic tape, floppy disks, CD's, Internet-accessible digital data files, etc. The latter refers to field sheets, typewritten tabulations, and (sadly) computer printout from digital files that no longer exist. In the case of the hard-copy data, all of the significant data sets, and most of the insignificant (that we had access to), were keyboarded as a part of this project effort. This proved to be an extensive process, undertaken by the employ of a welter of data-entry gnomes who hammered away at the data sets over a period of months. It is probably not inaccurate to observe that the probability of marshalling this kind of data-entry effort in the future is unlikely, so certainly one of the major products of this project is the digital data base itself, which is described below. The further analysis of these data requires their conversion, combination and transformation in various ways, all of which can circumscribe the interpretation of the data. The general procedures used in this project are outlined here.

4.1 Data Set Construction

Because the data in this compilation was to be analyzed in later tasks of the project, part of the effort was invested in integrating the data into a computer-manipulable data base. The same data format was used that was designed for the Galveston Bay National Estuary Program project (Ward and Armstrong, 1992a), to facilitate transfer and use of the data by other workers. In designing this format, emphasis was placed on data structure that is transferrable and manipulable via microcomputers (especially PC's and workstations), i.e. compact ASCII files. It may be noted that Tetra Tech (1987) recommends a specific hierarchical format for NEP data sets. While certain aspects of this format are satisfactory—or at least workable—the recommendation suffers from two great deficiencies: (1) the data structure contains numerous redundant fields, which will greatly expand the storage requirements for a data set, (2) the structure is specific to the statistical software package SAS, which will necessitate either that software for its use or specific codes for conversion. (SAS has a fairly robust repertoire of input formats, so this is not so serious a limitation as for some other softwares, especially the data base managers, but the SAS requirement that missing data be represented by a decimal in the otherwise blank field will require pre-processing any ASCII files not observing that convention. It would be straightforward to create a program to read the data sets from this project and generate data files in the format of Tetra Tech, 1987.) Details on the data sets themselves, the formatting of the data base, and related processing information are given in a companion report, Ward and Armstrong (1997a), which is intended to serve also as a User's Guide to the Corpus Christi data base.

One of the principles observed in the construction of the Corpus Christi Bay data base was the maintenance of integrity of the original data from individual surveys. That is, in the compilation of data for a given parameter, say nitrogen series, the coded information included identification of the data source, say TNRCC Statewide Monitoring Network versus Corps of Engineers versus TWDB Coastal Data System, and was input without any modification, including retention of the original units of measurements. While the various data sources were later combined in various ways as a part of different analyses, it is mandatory that the data compilation be capable of separating and identifying, say, nitrogen data from divers agencies, as they may differ in accuracy, methodology and procedure, differences which could become crucial in interpreting apparent trends or in more specialized analyses.

This is one aspect of differentiating the *source* data base from *derivative* data bases. The source data base codifies (in machine format) the original measurements as reported by the originating agency. This data base therefore contains exactly the information in the original: nothing is lost or added. Even an apparently innocuous conversion of measurement units can introduce a distortion. For example, many units carry an implicit level of precision that is modified when converted to another system, such as converting depths in feet to depths in meters. Of course, in adapting the data file to the needs of the project, the source data file may be re-formatted. This might entail re-ordering of the variables, removing unneeded or redundant fields, or re-writing in a more compact format.

An excellent example is use of data from the Texas Natural Resource Conservation Commission Statewide Monitoring Network (SMN) data file. This data was provided as a Internet ftp download of separate records of variable length corresponding to sampling "point-events," e.g. a station-depth-date/time record. The record included a listing of the parameters measured, each concentration preceded by the STORET code identifying the variable. In our processing, data were extracted from this massive file and used to build up ASCII data bases of selected suites of variables that then functioned as the *source* data files for further analysis. These *source* files contain exactly the measurements in the original master ftp files, in the original units: only their format of ordering/storage is altered. One specific re-formatting to which all files were subjected was to be ordered in time; the resultant file we refer to as a *primary* file, but it is nothing more than a chronological source file.

For various analytical purposes, however, these data must be modified, for instance converted to common units, averaged in the vertical, aggregated, or screened out according to some criterion. The data set so processed is a *derivative* data base. Any number of derivative data bases can be created according to the needs of a scientific investigation; it is our opinion, however, that the source data base, once established, should remain inviolate and sacrosanct. Thus the basic approach in this project was to first create the source data base for a given parameter through the data compilation effort. Then various derivative bases were formed to selectively include certain subsets subjected to specific processing.

The goal of this data compilation, simply put, is to create a derivative record of time/space/concentration for each water/sediment-quality variable of concern. That is, each data entry must identify a point in space-time at which the measurement was performed and the associated parameter magnitude. (This in turn introduces a sense of scale, or resolution, dictated by the resolution in the data as well as our conception of space-time variation in water/sediment quality, and underlying the analyses to be performed. This is discussed with respect to resolution and errors below.) Each data record also includes coded information identifying the data source, e.g. TNRCC SMN, Corps of Engineers, or TWDB Bays and Estuaries Program.

Almost all of the data sets include the time of sampling, at least to some resolution. The point in space of sampling is more problematic. Most sampling programs express position by an alphanumeric station name. In order to be able to process the data spatially, this point must be expressed quantitatively. In this project, latitude/longitude coordinates were used to locate the horizontal position of the sample, and depth (i.e., distance below the water surface) to locate the vertical position. The former required precisely plotting the sampling stations from descriptions or from project maps and determining by manual measurement the coordinate positions, which were then keyboarded into a digital data base. This station location data is entered into a separate file, and the horizontal coordinates merged with the measurements at a later stage of the processing into the derivative files.

In a minority of instances, the data-collecting agency or source included latitude/longitude coordinates for the sampling stations. Even in these cases, we plotted the coordinates as provided by the agency and compared them to descriptions of the sample stations or location maps, or, lacking these, to logic as to where the samples were likely (or unlikely) to have been taken. We have encountered numerous errors, and were forced to plot and re-measure many of these, after receiving corrected information from the source. These problems are described in detail on a data source-by-source basis in Ward and Armstrong (1997a).

4.2 Quality Assurance, Reliability and Uncertainty

The limits of resolution of measurements and the associated imprecision, and the extent of infection of a data set with errors contribute a degree of uncertainty to each entry in the data record. The obverse concept is the reliability of that data set for scientific analysis. The need for determining the reliability of historical data and discounting measurements that are judged to be "unreliable" is clearly important. This is recognized by EPA and general methods for accomplishing this are outlined by Tetra Tech (1987). Further, this need was identified specifically in the NEP Scope of Work for this project. It is the PI's conviction that such judgements must be formulated carefully, and the rejection of data be given close consideration.

In data compilation and processing in this study, a major concern was the detection of errors capable of elimination and the quantification of the residual uncertainty in the data. This includes, but is not restricted to, the procedures commonly referred to as Quality Assurance/Quality Control.

4.2.1 Data screening and data-transfer quality assurance

The CCBNEP primary data bases were compiled from various original data sources, some digitally and some manually, and because a transfer of information is involved, there is the possibility of error. Therefore, specific measures were introduced to minimize the occurrence of error, and maximize its detection, as follows:

(1) All data available in machine readable form from an originating agency were obtained, manipulated and entered in that form. Further, intermedia transfers were minimized, i.e., copies were sought as ASCII or WK1 files that could be downloaded by ftp via the Internet or transferred on diskettes.

(2) Data entry by hand employed standardized formats that mimicked the hard-copy sources, and the data entry methods employed standard, simple software, *viz.* EXCEL or LOTUS-123. The data entries were verified by line-by-line comparison of a hardcopy printout of the entry form with the original data source. (*NB*, screen-versus-original comparison is prone to misinterpretation and fatigue, hence the emphasis on comparison of the two hardcopies.) Following the entry and verification steps, the data were scanned and spot checked personally by one of the PI's.

(3) Each new data set that involved a large file of information (and hence especially prone to errors of fatigue or oversight) was subjected to machine screening to verify that the variables lie within expected ranges and exhibit "natural" variability. When aberrancies were detected, the entries were verified against the original source. In many instances this screening detected apparent blunders in the source file itself. These are discussed separately in Ward and Armstrong (1997a). Further, additional steps in the data processing process included various error traps and cross checks, which serve as further error-checking.

Early in the NEP project work on the Galveston Bay Project, i.e. around 1990, an attempt was made to use optical scanners for data transfer. It was quickly learned, by experimentation with several scanners of varying easel dimensions and manufacturer, that the error rate (i.e., character-recognition problems or noise responses) was unacceptably high, even when the source document was clean and high-contrast. Therefore, manual entry had to be pursued. In this project, the possibility of using scanners with OCR software was tried again. Though much progress has been made in five years, we determined that the error rate was still so high that the labor of correcting these errors, combined with the

time to carry out the scanning itself, would equal or exceed the effort of simple manual entry of the entire data set. So once again, we opted for the latter.

Particular note should be given the term "mimicked" in (2) above. This is a significant departure of the procedure of this project from that recommended by Tetra Tech (1987), who require that re-formatting into a uniform format, as well as conversion and/or mathematical transformation, be carried out as part of the data-entry process. We believe this strategy is seriously flawed. The entry of thousands of numbers by keyboarding personnel demands maximizing efficiency and accuracy. Any differences between the keyboard format and the hard copy source are an invitation to misinterpretation and transcription mistakes. Further, since keyboarding personnel are rarely equipped to interpret the numbers they are entering, they should not be expected to carry out calculations of any kind, but to simply input what they see. The Tetra Tech procedure, we believe, reduces efficiency and requires an additional level of oversight that could be totally replaced by machine screening. Moreover, we take exception to the philosophy of altering the source data, even by units conversion or rounding, as discussed above, and this is precisely what Tetra Tech recommends.

4.2.2 Data screening and data-base quality

The errors introduced by the data transfer procedures of this project were the simplest to deal with, because their existence (i.e., that they were in fact errors of entry) could be confirmed by comparison with the original source, and corrections could be expediently implemented. The same screening process, i.e. testing for values within "reasonable" bounds (discussed below), spatial continuity (as reflected by simultaneous data from different depths or nearby stations) and temporal continuity (comparison with measurements at the same station before and after the sampling time), occasionally detected aberrant values in the source data files themselves. When possible, we contacted the agency source to verify the reported information. For most of the data files, however, there is no longer an authoritative source with which to compare the reported data: the original field sheets are discarded, or the principal investigator or originating agency is not accessible (or even extant). This forced us to make probability judgements. Consonant with our philosophy of leaving the source data files sacrosanct, "corrections" were introduced into these data files only when the typographical error was "patently obvious." For example, obviously misplaced (or omitted) decimal points, ppm entered instead of ppt (or vice versa), dropped or inverted digits in a date where there are other data from the same sampling run to confirm the date, are regarded as "patently obvious," and represent the limit to which we entered corrections into the source data files. If there is any reasonable possibility that the source data could be entered correctly, or if it is probably wrong but we have no logical, near-certain means of supplying the correct value, then the entry was allowed to stand. Clearly, most apparently aberrant values fell into this category. In the process of creating the derivative data bases later, and certainly in the later analyses, there is the opportunity to reject apparently aberrant data, so leaving such values in the source files causes no harm to the analyses and preserves the integrity of the source data base.

Latitude and longitude coordinates were also subjected to screening. This employed a "range of limits" screen to verify that the positions fell within the broad latitude range of the Corpus Christi Bay study area of 26° 30' to 28° 30' (which helped in identifying wildly incorrect points as well as data from other bay systems that had crept into some of the source files) and a comparison of station descriptions to where the station coordinates actually plotted. Generally, finer corrections were reserved for the derivative data-base screening unless some independent information was available.

Errors in the positions determined by this project proved to be rare, due to the procedures of cross-checking and proofing used during the georeferencing work, and were easily corrected. However, the latitude/longitude coordinates provided by some of the agencies exhibited problems. For the TNRCC SMN data, for example, some stations were obviously wrong. Station 13420 plotted out in a mudflat on Indian Point. Station 13287 plotted in the center of Commercial Street in downtown Aransas Pass. For some of the stations, the description was too vague to unambiguously position the station. The best information available for each station was used for a "best-guess" position on USGS 7.5-minute quads, and copies of the maps were sent to the TNRCC District Office for verification or correction. Jim Bowman of this office helped immeasurably by going through these maps and marking the real locations of his sampling stations. For the Parks and Wildlife Department hydrographic data base, latitude/longitude coordinates were provided by the agency, but with no independent information on station location information. In this data set, the "range of limits" screen disclosed a number of erroneous coordinates (one such point plotted off the coast of North Africa). While the incidence of error is on the order of 0.1%, positions this much in error were obviously due to incorrect digits in the degrees position. Errors in minutes or seconds would not be so easily detected, if detectable at all. This does give an indication of the probable fraction of location errors in this data set due to simple data entry or map-reading errors.

A new source of station location error encountered in this data compilation that was not manifested during the earlier Galveston Bay data compilation is due to increasing use of high-technology positioning systems. Some, like LORAN navigation, have been in use in marine operations for years. Others, like Geographical (a.k.a. Geodetic) Positioning Systems (a.k.a. Satellites), GPS, are a relative newcomer. These are now being embraced by field sampling operations, because of the recent availability of economically priced receivers and processors. These positioning systems as a source of error are addressed in Section 5.3.1 and in more detail in the Data Base Report (Ward and Armstrong, 1997a). In the present context, we note a proclivity to utilize these systems without adequate understanding of their principles of operation and their limitations, to regard the results with unquestioning veneration as absolute, and to employ no backup or verifying independent location data.

4.2.3 Uncertainty measures

The screening procedures outlined in the two preceding sections address data errors of the typographical or "blunder" variety. There remains, of course, a residual error in any set of measurements, deriving from the omnipresent sources of imprecision, inaccuracy and mistakes (including data-entry errors). In this project, data bases for specific variables were created by the combination of data sets from different sources, with differing analytical methodologies, different agency objectives, and differences in field procedures. In order to be able to attach a degree of uncertainty (or its complement, a level of confidence) to such a data set, it is necessary to assess the uncertainty in each of the component data sets, and devise a means of transferring this information to the composite data set. A data user then has the basic information to further determine how the uncertainty is affected by whatever processing of aggregation, units and proxy transformations, and averaging the data may be subject to.

Clearly, the first step is to define carefully and precisely the formulation of uncertainty, i.e. if we denote the measured value of some parameter as

$$v \pm e \qquad (4\text{-}1)$$

the "error" number e must be defined unambiguously and its dependence upon the value of v and other factors carefully specified. Unfortunately, there is terminological chaos in the practice of reporting uncertainty in science and engineering. In the above expression, e may mean the standard deviation of measurements about their mean, the standard error about the "true" value, the tolerance of measurement, the absolute bounds on the range of v, or the magnitude of some fixed multiple of standard deviation or standard error. With careful definition, the measures relative to the mean are usually interconvertible (the exception being the absolute bounds on range). The problem is that in the literature "±e" frequently appears without any associated clarification. Here we will define how the expression is used in this report, and what meaning we will assume when the data source or reference uses but does not define the expression.

In this report, we will employ the error bound e to be the magnitude of the population standard deviation (σ) about a fixed value of the variate. Specifically, for a given measurement procedure under a static set of controls (same concentration, same lab, same personnel, same equipment, same coffee), e is the standard deviation about the known value of the variate for a theoretically limitless set of replications. For practical purposes, we usually have to estimate e by the standard deviation about the mean of the measurements under the same idealized limitless conditions. (The distinction is one of accuracy versus precision.) This standard deviation is estimated in practice by a finite set of measurements: if the set is large then the estimate is good; if the set is small, the sample standard deviation may have to be corrected to estimate the population standard deviation. For many of the trace organics of current concern in water quality, e.g. the priority pollutants, available precision data may be limited to only 3 or 4 replicates for a given set of controls, so the correction may be substantial.

Technically, the correction is the factor $\sqrt{[N/(N-1)]}$; further, other statistical inferences must be altered if the sample standard deviation departs significantly from the population standard deviation. This and related matters are treated in any standard textbook on statistical methods, e.g. Mood (1950), Hamilton (1964).

Standard Methods (APHA, 1971, 1985, 1989) and ASTM Standards (ASTM, 1976, 1980) have historically recommend the use of "±e" as a standard deviation. Unfortunately, these proposals for a uniform reporting of precision compete with practice and intuition in the literature. Many authors use "±e" to specify, in effect, tolerance limits, i.e., the range in which "most" of the measurements fall. "Most" seems to mean substantially more than 95%. Tolerance specification has traditionally assigned a level to e of about 3σ (e.g., Kennedy and Neville, 1976); exactly 3σ implies a 2.7% probability of a measurement with normally-distributed error falling outside the indicated range, while 3.09σ implies exactly a 2% probability of violation. This usage seems to lie much closer to the intuitive connotation of precision expressed as ±e than the use of standard deviation, especially among water resources scientists. Another competing concept is the precision latent in the expression of significance. A measurement reported as 5.36, for example, with no additional qualifiers, implies a tolerance (in the above terminology) of ±0.01 or no worse than ±0.02: by writing the third digit, the author is indicating relatively strong certainty of its significance (EPA,1979). (Mathematicians are generally more fastidious, demanding a tolerance < 0.5 times the last significant unit, e.g. ± .005 in the above example, Scarborough, 1966: then the statement "correct to *n* significant figures" means *correct* to *n* significant figures. Skougstad et al., 1979, state that the last significant digit is the "first doubtful digit," but the meaning of "doubtful" is not elaborated.) Thus, for a worker known to be scrupulous in the expression of significance, some measure of that worker's judgment of precision can be inferred.

The National Institute of Standards and Technology (NIST) has attempted to bring order into chaos by a new (October 1992) policy on expressing measurement uncertainty, based upon recommendations of the International Committee for Weights and Measures (1992). In these authors' view, NIST has furthered the chaos by introducing new, unnecessary terminology:

standard uncertainty	-	an estimated standard deviation
Type A evaluation	-	based on "any valid statistical method"
Type B evaluation	-	based on "scientific judgment using all relevant information"
combined standard uncertainty	-	estimated standard deviation from the standard uncertainties of both Type A and Type B
expanded uncertainty	-	the interval about the measurement within which the true value is "confidently" expected to lie
coverage factor	-	the ratio of the expanded uncertainty to the combined standard uncertainty

The basic idea of Type A and Type B uncertainty (not to be confused with Type I and Type II errors of statistical inference) is to quantify "random" and "systematic" errors as standard deviations. The expanded uncertainty is nothing but the square root of the sum of the variances, and the coverage factor is nothing more than the number of standard uncertainties in the interval encompassing the measurement. By "international convention" NIST adopts a coverage factor of 2. If the reader has suffered through this chain of definition, he now realizes that the NIST policy boils down to: (1) e in equation (4-1) is a standard deviation; (2) e is made up of random and systematic components, each of which is quantified by its own standard deviation. None of the philosphical issues raised above is addressed, and there are theoretical reasons prohibiting expression of systematic error as a standard deviation. There appears to be no wholesale rush in water-quality monitoring to embrace the NIST policy.

The uncertainty may vary with the magnitude of the measurement, and the dependency may be generalized as

$$e = a + mv \qquad \text{for } v_0 < v < v_1 \qquad (4\text{-}2)$$

Actually, e may vary nonlinearly with mean value v of the measured parameter, but for present purposes an at-most-linear variation is sufficient (because the limited data usually available on precision will not support the assignment of a nonlinear variation). This formulation calls explicit attention to a range of applicability of the measurement from v_0 to v_1. Any analytical method has limits on its range of validity, though for some procedures these limits are so broad relative to the natural range of the variate that they are non-limiting in practice.

For a specific parameter, often the constant term a or the linear variation m v will dominate the dependency of error e on variate value v, and the other can be neglected. In the case of the former, the precision is constant over the range of applicability, and may be expressed simply as a constant value with the units of v. In the case of the latter, e may be conveniently stated as a fraction (a percentage) of v. (The suggestion appearing in recent editions of *Standard Methods* to report standard deviation as a percentage of the mean is unfortunate, in that it suggests that e varies directly with v , when in fact it may not.) Frequently there is inadequate data to determine which, if either, dominates. Sometimes, both may be important. For example, in Skougstad et al. (1979), the analysis for sediment boron is stated to have a precision (as a standard deviation) of about 7 mg/kg at the lower end of the range of applicability at 10 mg/kg, and about 50 mg/kg at the upper end of the range at 250 mg/kg. Substitution of these values in the above equation yields: $a \approx 5$ mg/kg and $m \approx 20\%$, so that the total precision is

$$e = 5 + 0.20v \qquad \text{mg/kg}$$

It is of course even better if there are multiple values of e for a range of values of v, whereupon a regression line can be estimated, and the best-fit values of a and m determined statistically. This is the format used in the most recent USGS manual (Fishman and Friedman, 1989) for dissolved analyses (see also Friedman and Erdmann, 1982), and when data warrant in the ASTM Annual.

One element in the above formulation that has special significance is the threshold value v_0, which v must exceed for the analysis to be meaningful. Even for measurements that apply down to a value of zero, such a threshold value always exists, due perhaps to mechanical friction in a gauge or the limits of resolution of a probe. It may be much smaller than the lowest value of v encountered, or be much smaller than e for $v \approx 0$, and thus be practically negligible. This threshold value is referred to as the *detection limit*, and its operational definition is the value of analyte concentration that can be discriminated from the value determined from a laboratory blank at some pre-set probability. Clearly, in order to determine this, one must know how the analytical method behaves statistically for blanks, and all of the procedures for determining detection limits require data on statistics of measurements of blank samples. It has long been traditional in analytical chemistry (Vandecasteele and Block, 1993) to use a probability level of 99% that a value exceeding the detection limit represents a non-zero concentration, and this is in fact the definition adopted by EPA (EPA, 1992, Kimbrough and Wakakuwa, 1993) for determination of Method Detection Limits for its various analytical procedures. Therefore, if s is the standard deviation for blanks, the so-called background standard deviation, i.e. s = a in eqn. (4-1), then the detection limit is approximately $v_0 = 3$ s.

For trace concentration determinations based upon instrumental methods however, especially those of hazardous or toxic contaminants, the method detection limit of the analysis takes on a singular importance in the reporting procedure because of the practice of *censoring*. By definition a measured concentration exceeding the level of 3s has a 1% chance of being in fact blank (zero). For measured concentrations less than 3s, the probability rises that these could in fact be zero. The practice is to report these values as "nondetects," i.e. below detection limits (BDL). The analytical procedure, it should be noted, will produce numbers less than the detection limit, even negative numbers. They are simply not reported quantitatively. Censored values present a great problem in water-quality analysis, detailed in Section 4.3.2 below, and their use has been criticized (e.g., Porter et al., 1988, D'Elia et al., 1989).

We note in passing that if one is intent upon censoring data, then setting a detection limit to limit the risk of a "false positive" is only a part of the censoring problem. One should also address the companion question of the risk of "false negatives," i.e. reporting as a nondetect when the analyte is in fact nonzero. For example, if the real concentration is exactly equal to the method detection limit (as defined by EPA, above), the measured concentrations for repeated measurements will scatter about this value, roughly half being less than the real value. Therefore, half of the measurements will be reported as nondetects. There is, therefore, both a type-I and a type-II delineation that must be made, and critical probability levels assigned to each. How this is handled has led to a number of alternative definitions of "critical level," "decision limit,""detection limit," "level of quantitation," "determination limit" and others (e.g., Vandecasteele and Block, 1993).

In order to completely characterize a measurement, we must include an estimate of the uncertainty, including any limiting values, such as the detection limit. In the Galveston Bay Status and Trends study (Ward and Armstrong, 1992a), a considerable effort was invested in determining the uncertainty of each of the analytes. The present project did not have the resources to repeat the effort of Ward and Armstrong (1992a), nor was it considered necessary since many of the data sources and parameters were the same in both studies.

Determination of parameter uncertainties was approached by Ward and Armstrong (1992a) in several ways depending upon the extent of documentation for the data set, in decreasing order of preference:

(a) review of QA/QC procedures observed by the collecting agency, as reflected in practices memos, manuals and directives,

(b) identification of the specific methodologies used and their established accuracy,

(c) statistical variation of the measurements themselves, relative to some external standard, e.g. a more accurate proxy relation or data from a contemporary, independent source.

(d) judgement, based upon experience with the method or equipment, and upon the practice of workers in the field using that methodology, as inferred from their explicit or implicit uncertainty statements.

For recent data with well-established procedures and QA/QC protocols, this was generally straightforward (though many agencies have no written descriptions and information had to be obtained from personal communications). For older data, the methodologies and probable care of the observers had to be judged. Published sources of precision data for specific analytical methods were used, especially *Standard Methods*, the ASTM annuals, and the USGS Techniques of Water-Resources Investigations. Generally, there was more information—and more quantitative scope—on precision in the later editions than the earlier, which raised a dilemma: when precision information changed, should the data contemporaneous with the measurements be used, i.e. assumed to be reflective of the technology and procedures of the time, or the more recent data derived from a larger base of measurements and presumably representing an improved estimate of precision applicable to the older techniques as well? Considering that the reported precision for many trace metals and organics is *lower* (i.e., greater standard deviations) in more recent publications (e.g., Fishman and Friedman, 1989) than in the older (e.g., Skougstad et al., 1979), this is not a merely pedantic concern. No doubt there are elements of truth in either alternative, but the former was elected. Ward and Armstrong (1992a) note that this is not an irreversible decision, as any later user of the data base has the option of employing a different measure of precision. The basic measurement itself is of course unaffected by the level of uncertainty assigned to it.

Also, we note that the precision data available is generally much more complete and accurate for the water-phase analytes than the sediment. Indeed, in the USGS manuals (Wershaw et al, 1987, Fishman and Friedman, 1989), for each of the bottom-material analyses there is simply the statement: "It is estimated that the percent relative standard deviation for [parameter name] in bottom material will be greater than that reported for dissolved [parameter name]." When precision data are presented for water-suspended sediment mixtures, we have used that preferentially over the dissolved data to estimate uncertainty for the sediment analysis.

Tables A-1 and A-2 in the appendix summarize the measures of uncertainty assigned in this study. As noted above, these uncertainty criteria were drawn from the compilation of Ward and Armstrong (1992a) for the Galveston Bay National Estuary Program, based upon available information on precision of various methodologies and procedures for different parameters (summarized in Table A-6 of the Appendix to Ward and Armstrong, 1992a, but not repeated in this report), suitably rounded and supplemented by estimates of accuracy from analysis of data from Galveston Bay when available, by precision data from similar compounds if primary data were not available (e.g., total DDT estimated from precision data for p,p'-DDT), and judgement of the Principal Investigators when no solid information was available.

In this section we have concentrated upon the analytical uncertainty of a measurement as though that is the central control on the accuracy of the data. The comparison of alternative methods of measuring salinity given in Section 2.1 above should be considered. Each of the methods of chlorides titration and conductivity measurement should be capable of yielding analytical accuracy to better than ±0.1‰, yet the actual realized accuracy is much poorer than this. This reinforces two points. First, we rarely have the luxury of simultaneous determinations of two related variables, by which we can evaluate the consistency and probable error of the data, as is the case in Figs. 2-1 *et seq*. What then of the many programs in which only a single measure of salinity, say, was made, and there is no means of cross-checking the data? Second, the precision of the methodology notwithstanding, it is the procedures and technique of the field crew, the laboratory and the data-entry personnel that are controlling in the level of accuracy attained. Even for as straightforward and commonplace a measurement as reading a conductivity meter or titrating for chlorides, the potential for error is substantial, as shown in Section 2.1. What then can be expected of more complex and demanding analyses of trace metals or organics? Any data point should be regarded with suspicion, and the cross-comparison with other nearby, contemporaneous measurements, even from different programs, should be an indispensable guide to weighing the reality of a measurement.

4.2.4 Data rejection

A separate concern in data processing is the handling of anomalous values lying well beyond the expected range of the variate. Most of these are the result of human error at some point in the process from laboratory or field measurement

to entry into the data base. A frequent manifestation is a decimal point mislocation, resulting in multiplying the true value by one or several orders-of-magnitude. A screening rule can be formulated to reject such points. The problem is how to assign a rejection trigger so as to exclude points certainly in error, but not to exclude points that happen to deviate widely from "normal" values, since such deviations may in fact be real and therefore significant.

It has become traditional in data processing to differentiate between values that are so extreme as to be rejected as "unlikely" (including "impossible") and those that are "unusual" but within the realm of possibility, see, e.g., Bewers et al. (1975). This is the approach recommended by Tetra Tech (1987) who provide "A" and "B" values for an extensive list of estuarine variables, corresponding respectively to "unusual" and "unlikely." It must be noted that the normal strategy is to use these limits to identify anomalous points *during the data analysis and entry process*, to provide feedback to the originators of the data for verification and correction. In the present study, there is no prospect of tracing back to the originator of the data (except for verifying data entry performed during this project), so we need to determine a criterion for data rejection. We also note that in the present study any such rejection trigger would be applied at the earliest to the compilation of the Derivative Data Files, see Section 4.3 below, not to the source data (except, of course, for the "patently obvious" category described earlier).

Generally, as a matter of personal philosophy, we reject very little data even in the formulation of the Derivative Files, and reserve further data screening for the specific analyses to which the Derivative Data Bases are subject. Data were rejected from the source files if the date or position were obviously impossible and there were no satisfactory means of judging the correct value. For compilation of the Derivative Data Bases, rather broad ranges of admissable values were defined as bounds, and any values outside these bounds were screened out. These bounds are given in Table 4-1, along with the number of measurements actually eliminated by their application. As is apparent from this table, generally we did not reject data at this stage based on the parameter value, but reserved that for later steps in the analysis. For most of the parameters, there is no rejection whatever. Where there is rejection, the bounds are liberal enough that only extremely high values are affected, which are assuredly incorrect. Some, like the temperature of 100°C or the DO of 69 mg/L, are impossible. Four sediment volatile solids exceed 20%. Though lying within the range of *possibility*, these lie outside the range of *probability*. (Surely there would have been reports of lab technicians lacking eyebrows.) Beyond these unambiguous cases, though, the demarcation between probable and improbable is less certain: the 10 ppb values for water-phase 2,4,5-T and Silvex, or the 640 µg/kg of sediment BaP may be more unlikely than unusual, but we are hesitant to dismiss them on strictly an *a priori* basis.

Rejection triggers for later stages in the analysis were assigned to many (not all) of the variables based upon the suggestions of Tetra Tech (1987) or on judgement of the PI's. These are given in Tables A-1 and A-2 of the Appendix. (We note that some of the values in the Tetra Tech report are inapplicable to Corpus Christi Bay, e.g., a temperature limit of 30°C.) Both the uncertainty and the rejection triggers

are provided more as guidance to the future users of these data sets than as absolute bounds on data inclusion, and reflect as much our judgement of the quality of the different data programs as statistical constructs.

Data rejection can be performed based upon either the level of uncertainty of the measurement or its magnitude relative to the rejection trigger (when one is provided). Each measurement in the Derivative Data Base is accompanied by the specified level of confidence, transformed into units of the variable and scaled (when appropriate) to the magnitude of the measurement. Thereafter, any data processing can be preceded by an assignment of acceptable accuracy of measurement; any measurements failing this level would be excluded from that analysis. But these measurements would still be retained in the data base. We believe this to be a superior approach to merely deleting data, especially older data, by a sharply defined criterion of "reliability." This is closely related to the notion of preservation of data integrity discussed above.

A separate problem is presented by the presence of anomalous zero values for trace organics and metals, primarily in the TWDB and SMN data bases from the 1970's. This is discussed in 5.2.2 below. One source for these zeroes, we believe, is replacement of "censored" analytical reports, that the analyte was "below detection limits," with a value of zero. To retain the zero values would clearly bias trend analyses, since "detects" become more frequent later in the period of record due to improved analytical accuracy, which would create an increasing trend line with no basis in reality. Yet to delete these from the data base would be to lose potential information. While the zeroes were allowed to stand as reported in the Derivative Data Bases, for the analyses we replaced these with "below detection limit" flags. Unfortunately, no information has survived as to the actual detection limits of the methods used. Therefore, we postulated detection limits based upon the laboratory methodologies current at the time (see Appendix A-6 of Ward and Armstrong, 1992a), and/or reported by contempo-raneous labs in other data sets. The parameters affected and these estimated detection limits are tabulated in Table 4-2.

4.3 Data Set Processing

4.3.1 Preparation of data files

The principal steps in data-processing in this study to create data files suitable for statistical analyses were:

(1) For each historical data program in the Corpus Christi Bay system, compile a Primary Data File, consisting of the digital record of measurements ordered chronologically;

(2) For each parameter of concern, sift through the Primary Data Files, applying whatever screening, proxy relationships, and units conversions are necessary, to create a Master Derivative File for that parameter;

Table 4-1
Acceptable-range bounds for water/sediment parameters
for inclusion in Derivative Data Bases

parameter/units		*bounds*		*rejected**	*parameter/units*		*bounds*		*rejected**
WQALK	ppm	0	1000		WQTPO4	ppm	0	50	
WQAMMN	ppm	0	50		WQTRANS	1 m %	0	100	1
WQBOD5	ppm	0	100		WQTSS	ppm	0	5000	
WQCHLA	ppb	0	2000	2	WQTURBJ	JTU	0	1000	
WQCHLB	ppb	0	50		WQTURBN	NTU	0	1000	
WQCYAN	ppm	0	50		WQVOLS	ppm	0	10000	
WQDO	ppm	0	25	5	WQVSS	ppm	0	500	
WQFCOLI	MPN/200ml	0	500000		WQmetagd	ppb	0	100	
WQKJLN	ppm	0	50		WQmetagt	ppb	0	1000	
WQNO2N	ppm	0	5		WQmetasd	ppb	0	100	
WQNO3N	ppm	0	20		WQmetast	ppb	0	1000	
WQO&G	ppm	0	100		WQmetbt	ppb	0	5000	2
WQOPD	ppm	0	20		WQmetbd	ppb	0	5000	5
WQOPO4	ppm	0	50		WQmetbad	ppb	0	1000	4
WQORGN	ppm	0	10		WQmetbat	ppb	0	1000	
WQPH		4	12	3	WQmetcdd	ppb	0	50	
WQPHEO	ppb	0	1000		WQmetcdt	ppb	0	100	4
WQSAL	ppt	0	350		WQmetcod	ppb	0	10	
WQSECCHI	m	0	15		WQmetcot	ppb	0	50	
WQSIO2	ppm	0	50		WQmetcrd	ppb	0	100	
WQSO4	ppm	0	8000	5	WQmetcrt	ppb	0	500	
WQTCOLI	MPN/200ml	0	500000		WQmetcud	ppb	0	100	
WQTEMP	deg C	0	45	4	WQmetcut	ppb	0	500	
WQTOC	ppm	0	100	17	WQmetfed	ppb	0	500	
WQTOTP	ppm	0	50		WQmetfet	ppb	0	10000	

(continued)

Table 4-1
(continued)

parameter/units		*bounds*		*rejected**	*parameter/units*		*bounds*		*rejected**
WQmethgd	ppb	0	5		WQ-CHLR	ppb	0	10	
WQmethgt	ppb	0	20		WQ-CHLRC	ppb	0	10	
WQmetmnd	ppb	0	500		WQ-CHRYS	ppb	0	10	
WQmetmnt	ppb	0	4000		WQ-DBANE	ppb	0	10	
WQmetnid	ppb	0	50		WQ-DDD	ppb	0	10	
WQmetnit	ppb	0	500		WQ-DDE	ppb	0	10	
WQmetpbd	ppb	0	50		WQ-DDT	ppb	0	10	
WQmetpbt	ppb	0	500		WQ-DIAZ	ppb	0	10	
WQmetsed	ppb	0	5		WQ-DIEL	ppb	0	10	
WQmetset	ppb	0	50		WQ-ENDO	ppb	0	10	
WQmetsrd	ppb	0	10000	4	WQ-ENDR	ppb	0	10	
WQmetznd	ppb	0	1000		WQ-FLRA	ppb	0	10	
WQmetznt	ppb	0	5000		WQ-FLRN	ppb	0	10	
WQ-245T	ppb	0	10		WQ-HEPT	ppb	0	10	
WQ-24D	ppb	0	10	1	WQ-HEPX	ppb	0	10	
WQ-ABHC	ppb	0	10		WQ-HEXA	ppb	0	10	
WQ-ACEN	ppb	0	10		WQ-I123P	ppb	0	10	
WQ-ACENA	ppb	0	10		WQ-LIND	ppb	0	10	
WQ-ALDR	ppb	0	10		WQ-MALA	ppb	0	10	
WQ-ANTHR	ppb	0	10		WQ-MTHP	ppb	0	10	
WQ-BNZA	ppb	0	10		WQ-MTHX	ppb	0	10	
WQ-BNZAA	ppb	0	10		WQ-NAPT	ppb	0	10	
WQ-BNZB	ppb	0	10		WQ-ODDT	ppb	0	10	
WQ-BNZGP	ppb	0	10		WQ-PAH	ppb	0	10	
WQ-BNZK	ppb	0	10		WQ-PARA	ppb	0	10	

(continued)

Table 4-1
(continued)

parameter / units		*bounds*		*rejected**	*parameter / units*		*bounds*		*rejected**
WQ-PCB	ppb	0	10		sedmetcu	ppm	0	300	
WQ-PCP	ppb	0	10		sedmetfe	ppm	0	50000	
WQ-PDDD	ppb	0	10		sedmethg	ppm	0	50	
WQ-PDDE	ppb	0	10		sedmetmn	ppm	0	1500	
WQ-PDDT	ppb	0	10		sedmetni	ppm	0	300	
WQ-PHNAN	ppb	0	10		sedmetpb	ppm	0	300	
WQ-PYRN	ppb	0	10		sedmetse	ppm	0	50	
WQ-SLVX	ppb	0	10		sedmetsr	ppm	0	7000	
WQ-TOXA	ppb	0	10		sedmetzn	ppm	0	10000	1
sedcyan	ppm	0	2		sed-245t	ppb	0	50	
sedkjln	ppm	0	10000	1	sed-24d	ppb	0	50	
sedo&g	ppm	0	10000	3	sed-abhc	ppb	0	50	
sedammn	ppm	0	1500		sed-acen	ppb	0	1000	
sedorgn	ppm	0	1500		sed-acyn	ppb	0	1000	
sedtoc	ppt	0	100		sed-aldr	ppb	0	50	
SEDtotp	ppm	0	10000		sed-anth	ppb	0	1000	
sedvols	ppm	0	200000	4	sed-bnza	ppb	0	1000	
sedmetag	ppm	0	100		sed-bnze	ppb	0	1000	
sedmetal	ppm	0	50000		SD-bnzaa	ppb	0	1000	
sedmetas	ppm	0	100		SD-bnzb	ppb	0	1000	
sedmetb	ppm	0	500		SD-bnzk	ppb	0	1000	
sedmetba	ppm	0	3000	3	SD-bnzgp	ppb	0	1000	
sedmetcd	ppm	0	300		sed-chlr	ppb	0	100	
sedmetco	ppm	0	50		sd-chlrc	ppb	0	50	
sedmetcr	ppm	0	300		sed-chry	ppb	0	1000	

(continued)

Table 4-1
(continued)

parameter / units		*bounds*		*rejected**	*parameter / units*		*bounds*		*rejected**
WQ-PCB	ppb	0	10		sedmetcu	ppm	0	300	
WQ-PCP	ppb	0	10		sedmetfe	ppm	0	50000	
WQ-PDDD	ppb	0	10		sedmethg	ppm	0	50	
WQ-PDDE	ppb	0	10		sedmetmn	ppm	0	1500	
WQ-PDDT	ppb	0	10		sedmetni	ppm	0	300	
WQ-PHNAN	ppb	0	10		sedmetpb	ppm	0	300	
WQ-PYRN	ppb	0	10		sedmetse	ppm	0	50	
WQ-SLVX	ppb	0	10		sedmetsr	ppm	0	7000	
WQ-TOXA	ppb	0	10		sedmetzn	ppm	0	10000	1
sedcyan	ppm	0	2		sed-245t	ppb	0	50	
sedkjln	ppm	0	10000	1	sed-24d	ppb	0	50	
sedo&g	ppm	0	10000	3	sed-abhc	ppb	0	50	
sedammn	ppm	0	1500		sed-acen	ppb	0	1000	
sedorgn	ppm	0	1500		sed-acyn	ppb	0	1000	
sedtoc	ppt	0	100		sed-aldr	ppb	0	50	
SEDtotp	ppm	0	10000		sed-anth	ppb	0	1000	
sedvols	ppm	0	200000	4	sed-bnza	ppb	0	1000	
sedmetag	ppm	0	100		sed-bnze	ppb	0	1000	
sedmetal	ppm	0	50000		SD-bnzaa	ppb	0	1000	
sedmetas	ppm	0	100		SD-bnzb	ppb	0	1000	
sedmetb	ppm	0	500		SD-bnzk	ppb	0	1000	
sedmetba	ppm	0	3000	3	SD-bnzgp	ppb	0	1000	
sedmetcd	ppm	0	300		sed-chlr	ppb	0	100	
sedmetco	ppm	0	50		sd-chlrc	ppb	0	50	
sedmetcr	ppm	0	300		sed-chry	ppb	0	1000	

(continued)

Table 4-1
(continued)

parameter	*units*	*bounds*		*rejected**	*parameter*	*units*	*bounds*		*rejected**
sed-ddd	ppb	0	100		sed-napt	ppb	0	1000	
sed-dde	ppb	0	50		sed-pah	ppb	0	5000	
sed-ddt	ppb	0	50		sed-para	ppb	0	50	
sed-diaz	ppb	0	50		sed-pcb	ppb	0	50	
SD-dbane	ppb	0	1000		sed-pcp	ppb	0	50	
sed-diel	ppb	0	50		sed-pddd	ppb	0	50	
sed-endo	ppb	0	50		sed-pdde	ppb	0	50	
sed-endr	ppb	0	50		sed-pddt	ppb	0	50	
sed-flra	ppb	0	1000		sed-oddt	ppb	0	50	
SD-flrn	ppb	0	1000		sed-oddd	ppb	0	50	
sed-hept	ppb	0	50		sed-odde	ppb	0	50	
sed-hepx	ppb	0	50		sed-pery	ppb	0	1000	
sed-hexa	ppb	0	50		SD-phnan	ppb	0	1000	
SD-I123p	ppb	0	50		SD-pyrn	ppb	0	1000	
sed-lind	ppb	0	50		SED-slvx	ppb	0	50	
sed-mala	ppb	0	50		sed-toxa	ppb	0	50	
sed-mthp	ppb	0	50		sed-tbt	ppb	0	500	

* Blank signifies no measurements rejected

Table 4-2
Estimated detection limits for parameters with zero values
in CCBNEP data base
(See Table 2-1 for parameter name definitions and measurement units)

parameter	*DL*	*parameter*	*DL*
WQmetagd	1	WQ-MTHP	0.2
WQmetasd	1	WQ-MTHX	1
WQmetcdd	1	WQ-PARA	0.5
WQmetcdt	2	WQ-PCB	0.1
WQmetcod	1	WQ-SLVX	0.01
WQmetcot	2	WQ-TOXA	0.5
WQmetcrd	1	sedmetcd	0.1
WQmetfed	20	sed-245t	20
WQmetfet	20	sed-24d	0.5
WQmethgd	0.1	sed-aldr	0.2
WQmetmnd	10	sed-chlr	1
WQmetnid	1	sd-chlrc	20
WQmetpbd	1	sed-ddd	0.2
WQmetpbt	2	sed-dde	0.2
WQmetsed	1	sed-ddt	0.2
WQmetznd	2	sed-diaz	5
WQ-245T	10	sed-diel	0.2
WQ-24D	50	sed-endr	0.2
WQ-ALDR	0.02	sed-hept	1
WQ-CHLR	0.1	sed-hepx	1
WQ-DDD	0.01	sed-lind	1
WQ-DDE	0.01	sed-mala	5
WQ-DDT	0.01	sed-mthp	5
WQ-DIAZ	0.01	sed-mthx	20
WQ-DIEL	0.02	sed-para	5
WQ-ENDO	0.01	sed-pcb	2
WQ-ENDR	0.01	sed-pddt	5
WQ-HEPT	0.01	sed-pery	3
WQ-HEPX	0.06	SED-slvx	20
WQ-LIND	0.03	sed-toxa	50
WQ-MALA	1		

(3) Sort the Master Derivative Files into geographic segments for the Corpus Christi Bay system;

After Step 3, for each parameter there would be created a chronological record of measurements of that parameter for each geographical segment of the bay. This is now considered to be an autonomous data set which can be subjected to various additional pairing, sorting and statistical analyses as necessary to expose time-space variations. The general processing procedures are shown schematically in the flow charts of Figs. 4-1 through 4-3.

The construction of the Primary Data File was described in Section 4.1 above. Because the ultimate product is to be a chronological Derivative File, and the process of chronologizing a file can be resource-intensive, it was decided to chronologize the data records as early in the process as feasible, then to design subsequent data handling in such a way that ordering is preserved. This is the principal difference between the Primary File and the Source File, the digital record in the format and units of the agency that obtained the data, i.e. the Primary File contains exactly the same data records except ordered chronologically. A secondary difference is that the first tier of the Q/A screening is applied in this process, see Fig. 4-1, so that the Primary File will have entry errors and "patently obvious" data errors corrected or deleted.

The creation of the Derivative Data Files is fundamentally a matter of merging information from various files and re-formatting the product. The various steps in this procedure are shown in Fig. 4-2. The sampling station latitude/longitude coordinates are collected in a separate file, and accessed according to the agency station designations to merge the coordinates with the data taken at that station. At this stage, all units conversions are applied, as well as any proxy relationships by which one parameter may be transformed into another. Because we anticipate analyzing data on a time scale of days to weeks, the information on clock time (i.e., time of day) of each sample is not carried through to the Derivative Data Files, but the full date is retained. In addition to the parameter value itself, the uncertainty is estimated and included in the data record.

The format of each record in the Derivative Data Files is:

DATE LATITUDE LONGITUDE DEPTH MEASRMT UNCRNTY PRJ

where DATE, LATITUDE AND LONGITUDE are 6-digit fields (YRMODA and the latitude/longitude coordinates are degrees/minutes/seconds), the sample depth is in meters, MEASRMT is the measured value of the parameter (retaining three significant figures), UNCRNTY is the uncertainty as a standard deviation following the convention of Section 4.2.3 above (to two significant digits), and PRJ is a 3-digit integer flag that identifies the agency or project that was the source of the measurement. Thus, each record of the Derivative Data File represents a point in time (to resolution of a day) and space (horizontal and vertical position), together with the measurement and its uncertainty. Each such record requires 50 bytes of storage.

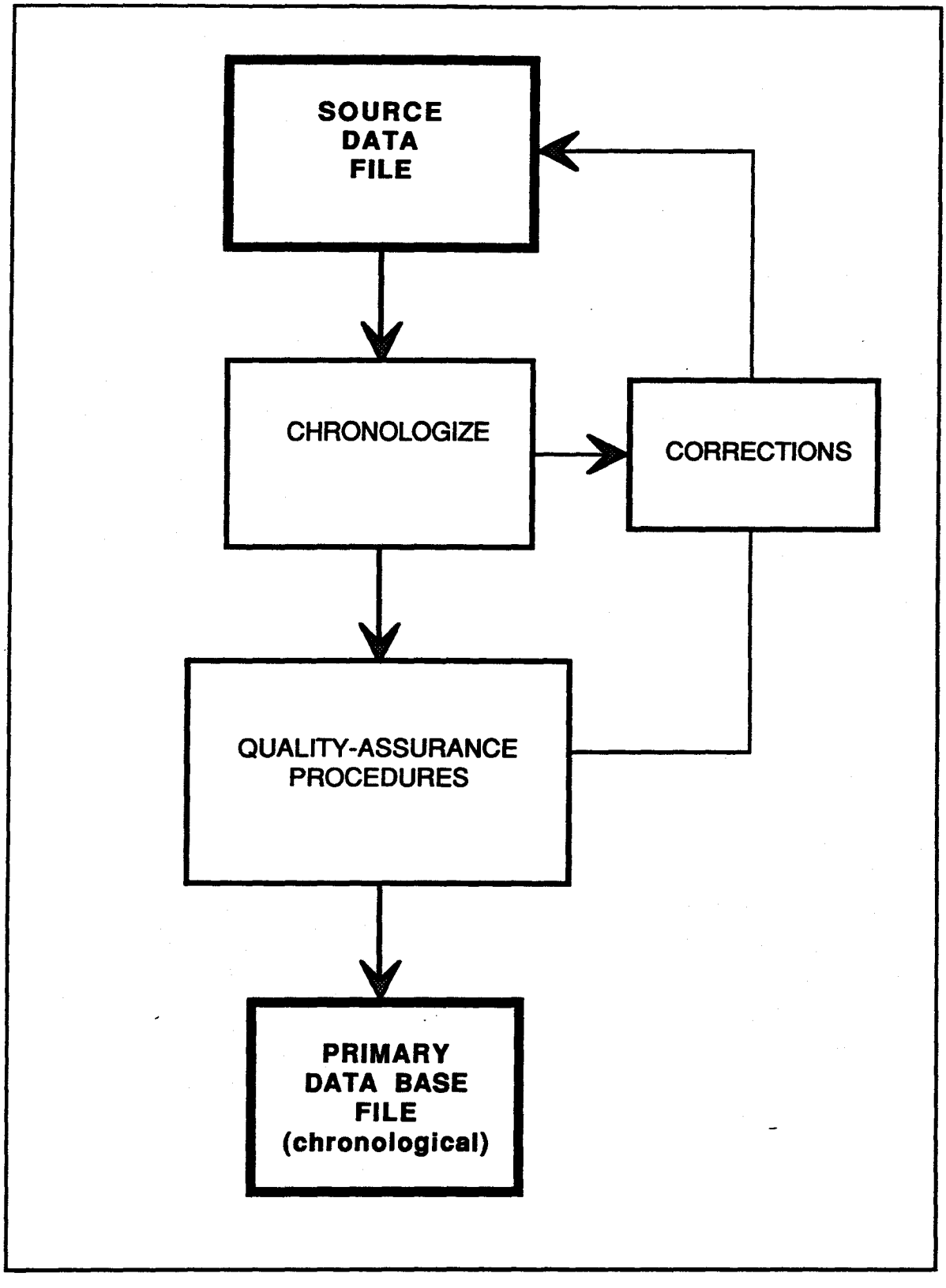


Fig. 4-1 Procedure for pre-processing and generation of primary data file

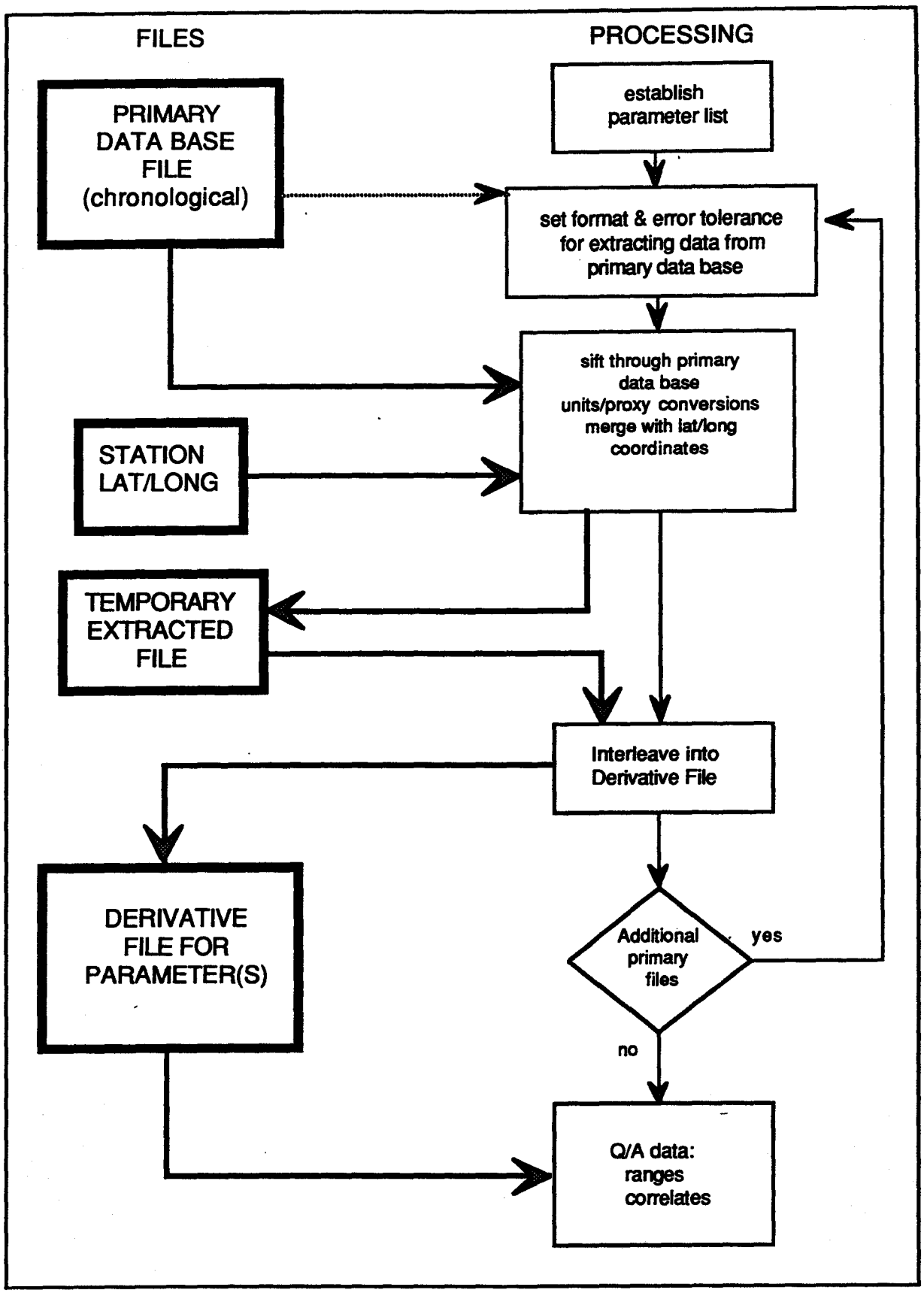


Fig. 4-2. Procedure for creation of derivative data bases

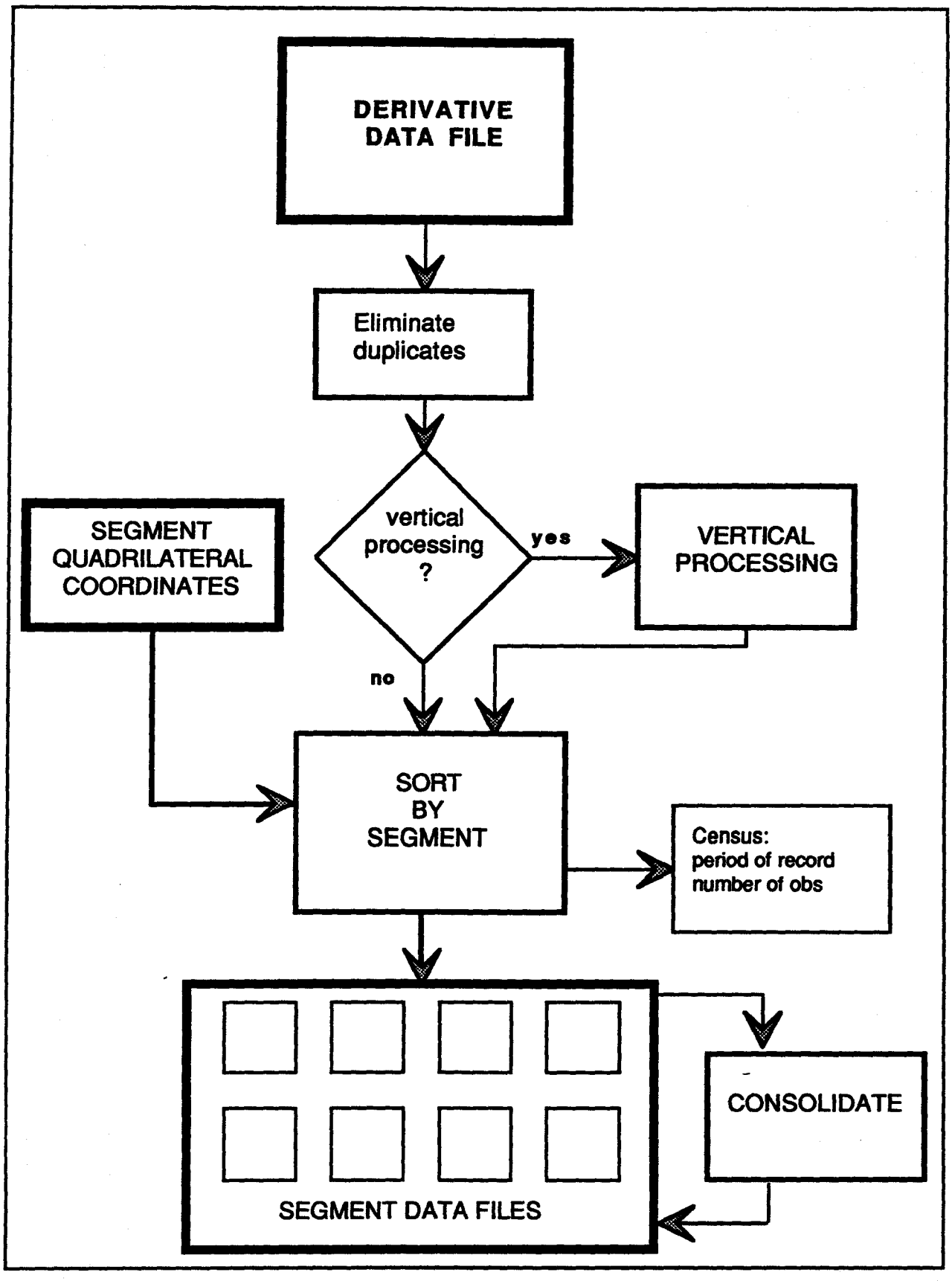


Fig. 4-3. Post-processing of Derivative Data File

Throughout this process there are numerous error traps and cross-checks, not only to ensure that the data is not corrupted by a bug in the processing but also to detect entry errors or aberrancies in the data as reported by the agency. The temporary extracted file shown in Fig. 4-2 contains the data in the above format from a single source. This file is examined closely for errors or anomalies before it is interleaved into the Master Derivative File. Once the Derivative File is created, it can be subjected to various screenings and data rejection, according to the preferences of the researcher.

We regard the Master Derivative Data files to be our principal data resource product from this study. These contain all of the data for each parameter that we were able to locate and digitize, and incorporate our judgment on which data should be retained or rejected. In order to address the concerns of characterizing the ambient quality of Corpus Christi Bay and its historical trends, these data bases are subjected to additional processing, as indicated in Fig. 4-3. Principally, this involves further filtering of the data and sorting the data into the separate geographical segments. Because the source data files can contain duplicate measurements, e.g. the TWDB Coastal Data System may contain TWC measurements that are also in the Statewide Monitoring Network system, some research projects may share the same data files, keyboarding personnel may have inadvertently duplicated entries, etc., there is the possibility that duplicate measurements may be present in the file. Therefore, there is a preliminary screening step to detect such duplicates. (This is repeated after the data are sorted by segment to detect "near-duplicates.") "Vertical processing" in Fig. 4-3 refers to selection of data from only one depth (or range of depths) or to averaging data in the vertical.

Finally, the defining quadrilaterals for a system of segmentation are applied to the data to sort into the various segments. For this project, two segmentation systems were employed, as discussed in Chapter 3. The first is the Texas Natural Resource Conservation Commission water quality segments, which are defined and their associated geographical quadrilaterals given in Tables A-3 and A-4, resp., in the Appendix. The second is the system of hydrographic segments shown in Figs. 3-3 through 3-7 and defined by the quadrilaterals of Table A-5 in the Appendix. As some of the TNRCC segments are represented by the union of two or more quadrilaterals, once the initial sorting is completed these quadrilaterals must be consolidated into a single data record for that segment, hence the process of "consolidation" in Fig. 4-3. At this point, the data files are in a form suitable for statistical analysis.

4.3.2 Data analyses

As described above, once the data is sorted into segments, for each parameter and each segment, there is created a data record for that segment, considered as an autonomous data file. These data may have been further screened in the process, e.g. by limiting only to "near-surface" values. Also various derivative calculations may have been carried out to create new data files, for example

vertical stratification or dissolved oxygen deficit. The next stage in the processing is the analysis of these individual data files.

Generally, a two-tier statistical analysis was performed. The first is descriptive in nature, computing statistical indicators such as arithmetic average, standard deviation and variance, and extrema. The second is to determine historical trends by methods of linear regression. All of these are discussed in more detail in Chapter 6 in association with the interpretation of the results. The results of all of these analyses are presented in tabular form in Appendices B and C, for both the TNRCC segmentation and the Hydrographic Area segmentation, respectively.

It is worth-while to re-emphasize the distinctions between these segmentations. The TNRCC segmentation carries the weight of tradition, having formed the basis for water quality management in the system for many years. The segments tend to be rather coarse in space, however, as evidenced by the fact that the study area, including several freshwater tributaries, total 43 segments, counting 10 that were added to the 32 specified in the original project scope of work. The hydrographic areas, on the other hand, are much more spatially refined, totalling 160 in the estuarine portion of the study area, and 18 in the nearshore Gulf of Mexico. However, these generally do not include the freshwater tributaries or the tidal reach of these tributaries.

The treatment of detection limits in analysis of water quality is particularly vexing. As noted in Section 4.2.3 above, the practice in analytical chemistry has been to censor data whose magnitude is small enough that the probability of it differing from zero exceeds some preset threshold, typically 1%. This is the detection limit, and the measurement is replaced by the statement that the value is below detection limits. In the data collected roughly since the mid-1970's, detection limits are generally reported as part of the data set. Thus a real measurement (with, of course, an associated uncertainty) is replaced with a "statement." The analytical problem is how to recover quantitative information from the simple statement that the concentration is "below detection limits."

There are three logical alternatives, each of which has a rational basis. First, the measurements BDL can be simply ignored, as providing essentially no quantitative information. Second, the BDL values can be replaced with zero in the analyses, on the argument that for practical purposes the parameter is not present. This is probably the most commonly elected alternative. It is, for example, the approach adopted by the National Ocean Service in its National Status & Trends Program (NOS, 1991). Third, the BDL values can be taken to be the reported detection limits, on the basis that the actual concentration could be as high as the detection limit.

In our view, the selection is dependent upon the purpose at hand. The non-BDL statistics can provide some insight into the precision and variability of the parameter, which the more constant DL values would corrupt or even mask. However, to completely ignore BDL results is to lose information, albeit non-quantitative. The fact is that a water or sediment sample was obtained (usually at

t effort), a careful analysis performed, and an upper bound established on the concentration of the parameter. This information should not be dismissed cavalierly. The latter two alternatives use that information, either optimistically or pessimistically, depending upon the intent of the analyst. In this project, with typical equivocation, we decided to employ all three, i.e. to compute *appropriate* statistics with only above-DL data, with the BDL values set to zero and with the BDL values set to the DL, thereby establishing a probable *range* of the statistic. The "appropriate" statistics include averages and variability for the above-DL data, but do not include calculations of variability for the latter two, since the largely invariant values of either end of the the range (i.e. either value assumed for a BDL measurement) would distort the results. Even in a trends analysis (which is variability in time), to incorporate 0 or DL values might either mask any vestige of a real trend by padding the data with zeroes or displace the real trend with a trend of measurement sensitivity. The user of these results therefore can choose among them whichever best serves the purpose of the analysis.

We note in passing that other options for treating BDL's exist in the literature. One is to replace the BDL with a value that is equal to one-half the detection limit. If one doesn't believe in sea monsters, would one accept half a sea monster? On a more sophisticated level, there are theories in which the values above detection limits are used to fit the lower tail of a probability distribution, usually log-normal, which is then sampled to incorporate the measurements below detection limits. Would one accept the existence of sea monsters if extrapolated from the existence of fish? These theories (see, e.g., Gilbert, 1987, Gilliom and Helsel, 1984, Helsel, 1990) are an outgrowth of probit theory (Finney, 1952), and clearly work better when the BDL's are in the minority of the measurements. In any event, the two assumptions employed in the present study (setting BDL's =0 and setting BDL's = detection limit) will bound the answer that would have been obtained from these more complicated analyses. For present purposes, we believe that is sufficient.

5. THE DATA BASE FOR CORPUS CHRISTI BAY

5.1 Data sources and data acquisition

The present Status & Trends project was in many ways at a disadvantage in comparison to its earlier counterpart in the Galveston Bay National Estuary Program (GBNEP). The study area is much larger, the scope of the program was enlarged, both in terms of target parameters and in including tissue data as an additional scope-of-work item, and the budget and study period were both reduced. Moreover, the GBNEP preceded its Status & Trends Project (Ward and Armstrong, 1992a) with a comprehensive one-year data-inventory project (Ward and Armstrong, 1991) during which the major sources for data were identified and inventoried, and some of the rare, inaccessible data sets were acquired. But one significant advantage to this project deriving from the earlier work in Galveston Bay is that many of the data sources and contacts are the same for the Corpus Christi Bay system, including the Texas Natural Resource Conservation Commission (TNRCC), Texas Water Development Board (TWDB), Texas Parks and Wildlife Department (TPWD), Texas Department of Health (TDH) and U.S. Corps of Engineers (USCE). Just as important, the GBNEP Data Inventory project entailed an enormous amount of agency and individual contacts, many of which proved to be unfruitful for data relating to water and sediment quality. In this project, therefore, the needless expenditure of energy in seeking data from these sources was avoided. Thus, for many of the key data sources for Corpus Christi Bay, we could proceed to acquire the data for Corpus Christi Bay much more efficiently, as beneficiaries of the GBNEP experience.

Another significant benefit to this project which we believe to have derived, at least in part, from the earlier Galveston Bay work is a heightened awareness of the lamentable state of preservation and management of older data among many of the resource agencies and workers. In some cases, this heightened awareness has led to improved data management, and/or a greater willingness to provide data to the present study. This is addressed in more detail in the concluding section of this chapter.

In the GBNEP Data Inventory work, an index of "information content" was proffered to provide a bases for quantifying the data resource as a function of time and discipline. This lay beyond the scope of the present study, but it is our intuition from working with the CCBNEP data sets that the same general conclusion would follow, that the data resource for the bay as a whole is dominated by a few large-scale collection activities, with numerous much smaller projects. This does not imply, however, that the smaller projects may be ignored. The *cumulative* information in these smaller studies can equal that in many larger projects. Further, these smaller projects may fill important gaps in the space-time record. Unfortunately, in a project of limited resources such as this one, the effort necessary to track down the raw data has to be tempered by the law of diminishing returns.

An important feature of prosecuting a project of this nature is the fact that most of the principal tasks in this project are *serial* in nature, i.e. data acquisition must precede data compilation, which in turn must precede statistical analysis, which in turn precedes cause-and-effect analysis. (There is some opportunity for parallel efforts during the various work tasks, but this is minor compared to the overall serial nature of the effort.) The central constraining milestone in the project schedule is the point of completion of the compiled digital data base. This is the schedule *hinge point*. The analytical phases of the project cannot begin until this point. After this point, no additional data can be added to the data base (without, of course, entailing a complete repetition of all the analytical tasks carried out thus far). The project was originally given a 12-month schedule (compared to 2.5 years required for the same work in the Galveston Bay project), and work on the project started several months in advance of the actual contract period. Despite this, the infeasibility of meeting the original schedule was almost immediately recognized. As literature review, agency contacts, data acquisition and data compilation proceeded, we continued to revise the schedule, and move the hinge point ahead, like a carrot receding before a hungry donkey.

One factor affecting prosecution of the work which unfortunately did not change from the experience in Galveston Bay was the generally unsatisfactory response to the inquiries of the Principal Investigators, especially among some regional agencies and individual researchers. Despite follow-up letters, telephone calls and e-mail, some of these responded only months after the original inquiry and some not at all. In fact a substantial amount of historical data, of immense potential value in extending the data density and period of record, are still in the hands of individual researchers, but we could not afford to delay this work any longer awaiting its receipt. Even after the data compilation was declared finished, and the work proceeded into the analysis phase, data sets continued to dribble in. Some of these, unfortunately, simply could not be included in the present analysis (though they will be incorporated into the master data base for future studies).

5.2 Data collection in Corpus Christi Bay

The data analyzed in this project were drawn from numerous past programs in Corpus Christi Bay. These programs are summarized in Table 5-1. Each of these comprises measurement of some of the water or sediment quality variables within a part of Corpus Christi Bay for some definite sampling interval and period. Apart from this general statement, the programs differ in objectives and procedures.

At the most basic level, we differentiate between the objectives of monitoring, survey and focused research. *Monitoring* programs are put in place for a protracted or indefinite period for the purposes of sampling a suite of variables. The data from such a program generally serves more than one purpose. A key characteristic of a monitoring program is consistency in the suite of variables acquired, since it is the accumulation of a long-period data base that is the

Table 5-1
Current and historical sampling programs in Corpus Christi Bay study area providing data for CCBNEP Status and Trends analysis

Code	*Abbre-viation*	*Agency or source*	*Project or Program*	*Format of source*	*Comments*
1	SMN	TNRCC	Statewide Monitoring Network	ASCII-coded data from TNRCC	Transferred by ftp via Internet, reformatted with special-purpose programs
2	CDS	TWDB	Coastal Data System	ASCII files	Multiple files, some combined some separated by contractor.
3	TPWD	TPWD	Coastal Fisheries Hydrographic obs	ASCII	Transported by diskette. Reformatted with special-purpose codes
4	TGFOC	TPWD	Older hydrographic data from 1950's-1960's	hardcopy tables or field notes	Keyboarded by this project.
5	SWRI	Southwest Research Inst.	Corpus Christi Bay Project mid-1970's	hardcopy typed images of field sheets	Keyboarded by this project.
6	TDH EST	Texas Dept of Health	Estuarine Data File	ASCII zipped from TSDH	Re-formatted with special-purpose codes
7	TSDH	Texas Dept of Health	Water chemistry program of 1960's and 1970's	ASCII archive files	Re-formatted with special-purpose codes

(continued)

Table 5-1 (continued)

Code	*Abbre-viation*	*Agency or source*	*Project or Program*	*Format of source*	*Comments*
8	USCE7	Corps of Engineers Galveston District	O&M Division water & sediment 1970s data	hard-copy tabulations	Keyboarded by this project.
9	USCE8	Corps of Engineers Galveston District	O&M Division water & sediment 1980s data	hard-copy, some LOTUS	Keyboarded by this project. Some re-formatted.
10	USCE9	Corps of Engineers Galveston District	O&M Division water & sediment 1990s data	delimited-text ASCII from USCE	Some keyboarded by this project.
11	USGS	U.S. Geological Survey Corpus Office	Sediment chemistry & some hydrographic data	Digital QUATROPRO	Major re-formatting with special-purpose codes
12	BEG	Bureau of Econo-nomic Geology, UT	Submerged Lands Study sponsored by GLO	ASCII files	Minor re-formatting required.
13	SWRI TRL	Southwest Research Institute	Hydrographic data from 1976-77 Trawl Study	hard copy tables	Keyboarded by this project.
14	TAMU -40	Dept. Oceanogr. Texas A&M Coll.	Reynolds Metals Baseline Study	hard copy tables	Keyboarded by this project.
15	OXY CHEM	CCB Foundation/ Oxychem	La Quinta Channel Survey	hard copy	Keyboarded by this project.

(continued)

Table 5-1 (continued)

Code	*Abbre-viation*	*Agency or source*	*Project or Program*	*Format of source*	*Comments*
16	MSI-LM	Marine Science Inst.—Whitledge	Laguna Madre nutrients data	digital EXCEL	Minor reformatting required.
17	MSI-NB	Marine Science Inst.—Whitledge	Corpus Christi & Aransas nutrients data	digital EXCEL	Minor reformatting required.
18	NOS	National Ocean Service of NOAA	National Status & Trends Project	digital down-load, but a mess	Extensive re-formatting required
19	USFWS	U.S. Fish & Wild-life Service	Corpus Christi Bay Project (late 1970's)	hard copy & graphical, very disorganized	Keyboarded by this project.
20	JMA	James Miertschin Associates	Hydrographic surveys of Nueces Bay 1990's	digital EXCEL	Minor reformatting required.
21	EMAP	Environmental Protection Agency	EMAP/REMAP	digital diskettes	Minor reformatting required.
22	CBI	Blucher Inst./ TAMU–CC	Hydrosonde data from CCBNEP area	digital ASCII Internet ftp	See discussion in text
23	TWDB	Texas Water Development Board	Hydrosonde data	digital ASCII Internet ftp	See discussion in text
24	MISC	TGFOC, Humble Oil, Sun Oil and others	Data from Laguna Madre surveys of 1940's and older data	hard copy	Keyboarded by this project. See discussion in text.

(continued)

Table 1 (continued)

Code	*Abbre-viation*	*Agency or source*	*Project or Program*	*Format of source*	*Comments*
25	NCDH	Corpus Christi – Nueces County Health Department	Routine shoreline water quality surveys (coliforms only)	hard copy lab reports	Keyboarded by this project.
26	UTA-GEOL	Geology Dept Univ. of Texas	Masters thesis of Suter	hard copy tables	Keyboarded by this project.
27	USFWS-CCB	U.S. Fish & Wild-life Service, Corpus Christi lab	Contaminants assessment	Digital: spreadsheets	Minor reformatting required. (some parameters missing.)
28	TDH-TIS	Texas Department of Health	Seafood Safety Division tissue data	Hard copy tables	Keyboarded by this project.
29	TAMU-72	Texas A&M Univ. College Station	Estuarine systems Project	Hard copy tables in report	Keyboarded by this project.
30	TAMU-CCS	Texas A&M Univ. Corpus Christi Center for Coastal Studies	Nueces Marsh Mitigation Studies	Report and diskettes	Minor reformatting required.

purpose of the program. Important monitoring programs in Corpus Christi Bay include the Texas Natural Resource Conservation Commission Statewide Monitoring Network sampling, the Texas Parks and Wildlife Department Coastal Fisheries Program, and the Texas Department of Health Shellfish Sanitation data-collection program.

A *survey*, in contrast, is characterized by a definite limit in time. It may be a one-time sampling run, or may be a few such runs carried out within a relatively short calendar period. The objective generally emphasizes spatial distribution, and the characterization of the suite of parameters at a point in time. Examples are the Bureau of Economic Geology Submerged Lands Project and the U.S. Fish & Wildlife Service survey of sediment contaminants, in which each of a network of stations in the bay was sampled once to determine a basic suite of chemistry. A survey and a monitoring program share the feature that a suite of measurements is obtained that can be used to support different analyses and studies.

Finally, a *focused research* program is formulated to address a specific hypothesis, that in turn dictates the suite of measurements. As a practical matter, most focused research programs are limited in time, due to the nature of the funding process. While we differentiate between these three general strategies of sampling, it must be noted that there is considerable overlap: many monitoring programs provide data for research, many research programs comprise monitoring, and either can contain surveys as a part of the program. Some are ambiguous, such as the Corps of Engineers O&M sampling performed in association with dredging projects. These involve the occupation of a fixed network of stations, and with the same regularity as the need for maintenance dredging. But this is at such long intervals that one could argue that this program is in fact a series of surveys, rather than a monitoring program. Also, since the objective is to determine the effects of dredging on water and sediment quality, the program has many attributes of focused research. While there may not be clear differentiation between monitoring, surveys and focused research, the emphasis here is on the difference in philosophy underlying the program strategy, which can clarify the management and prosecution of various programs.

Extremely important to the present project are the presentation and dissemination of the basic data. Monitoring programs generally have provision for data storage and dissemination, nowadays digital. Surveys usually have some form of hard-copy presentation, and research programs may not publish or even preserve the basic measurements, but rather present analyzed or reduced data in a professional publication, or may extract the answer sought and file the data away.

Since this project seeks to compile and analyze a combined data set, machine processing is indispensable, and we therefore require all data in a machine-readable format. Where digital databases existed we sought copies from the managing agencies. In some instances, the digital record has been lost or destroyed. For a few of these we were able to recover the data record, in whole or in part. Where only hard copy or field notes existed, the data were keyboarded.

Even when a digital data base existed, transfer of the data for use in the present project was not necessarily straightforward. Just as the strategies of sampling programs may differ in basic objectives, so also may the strategies of digital data bases vary. There are two broad strategies observed in the maintenance of water and sediment quality data bases. First is the archiving and preservation of the basic data from a data-collection program. Second is support of various analytical procedures, such as basic statistical computations, or model validation. The same data base can achieve both strategies if either the measurements originate from a single program, or special care is taken in the development of the data base. If, however, data from more than one data-collection enterprise is involved, it is possible for the two objectives to become conflicting.

The distinction is exactly the same that was made in Chapter 4 between source files and derivative files. An *archival* data base is intended to preserve the measurements of a data-collection program, maximizing the information retained, without modifying or corrupting the data in any way. This includes compiling all ancillary data (such as time of sampling, observation of conditions, etc.), employing no units conversions (that cannot be simply reversed), and not pre-processing the basic measurements in any way (such as depth-compositing, time averaging, interpolating to standard space-time intervals, substituting values for BDL's, etc.). An *analytical* data base, in contrast, manipulates the basic measurements however necessary to facilitate the desired analyses. This may include averaging, smoothing, subsampling the basic data, or combining the measured data with measurements from programs of other agencies.

In the modern world of digital technology, all data-collection programs should have an archival data base. Examples include the U.S. Geological Survey STORET data base, which is the archival framework for streamflow and water quality data collected in the nation's streams and rivers by USGS, the EMAP data base maintained by EPA for archiving of data from the EMAP/REMAP project, and the data bases of Texas Department of Health and Texas Parks and Wildlife. Many agencies will also require various analyses based upon combined and processed data. The derivative data files developed for this CCBNEP Status & Trends project is an example of such an analytical data base. When an agency attempts to have a single data base serve both objectives, conflicts arise which limit the utility of the data, examples of which are cited below.

5.2.1 Principal Data-Collection Programs

Of central importance to Corpus Christi Bay are the existing monitoring programs, since these are the vehicles for continued, routine acquisition of data, and therefore form the backbone for determining the present water quality and any time trends. There are three major monitoring programs under way which contribute information on water and sediment quality of the bay, operated by the following agencies:

- Texas Natural Resource Conservation Commission
- Texas Parks & Wildlife Department
- Texas Department of Health

The Texas Natural Resource Conservation Commission Statewide Monitoring Network (SMN) is a principal continuing source of a broad spectrum of data. The SMN sampling program is a program of sampling at fixed stations at regular intervals, carried out by headquarters, field and/or District offices of the Texas Natural Resource Conservation Commission (TNRCC), and represents a continuity of activity through its predecessor agencies, the Texas Water Commission, Texas Department of Water Resources, and Texas Water Quality Board, back to approximately 1965. Generally, field parameters are obtained *in situ*, by means of electrometric probes or portable analytical kits, and water/sediment samples are shipped to external laboratories for analysis. (The laboratory used has varied over the years according to the parameter suite desired and to funds available for contracting. Past laboratories included the Texas State Department of Health, TNRCC/TWC Houston lab, Lower Colorado River Authority, Nueces County Health Department, and U.S. Corps of Engineers.) Parameters have been expanded from conventional variables in the early 1970's to trace constituents, pesticides and priority pollutants in recent years.

The term Statewide (a.k.a. Stream) Monitoring Network also refers to a data management system. The SMN data base is a digitized comprehensive data management program implemented on the TNRCC mainframe computer. The SMN data base includes all sampling activities of the Statewide Monitoring Network, as well as special studies (including microbiology and benthos) and Intensive Surveys. It also includes data from other agencies, notably Texas Water Development Board and the U.S. Geological Survey. There are over 1200 separate constituents with entries in the SMN data base, including water and sediment parameters, and biological parameters. In the five years since the Galveston Bay NEP Status & Trends project, the TNRCC has implemented sweeping changes in the structure and operation of this data base. Ward and Armstrong (1992b) were highly critical of the SMN protocols and data retrieval formats in place at that time, the latter being huge files of printer line images requiring magnetic tape for their transfer and manipulation. We are happy to report that these cumbersome procedures have been largely scrapped, in favor of a new system, presently under development, employing Internet file transfer protocols.

The Texas Parks & Wildlife Department or its predecessor agencies, the Texas Game and Fish Commission and the Texas Game, Fish and Oyster Commission, has monitored the fishery resources of the system for many years, and in association with this obtained a limited suite of water-quality variables. These tend to focus on estuarine habitat characteristics, e.g. salinity, dissolved oxygen, turbidity and temperature. While the range of variables is obviously much more limited than that of the TNRCC SMN, the temporal intensity of the program is much greater. The TPWD program obtains data somewhere in the system on virtually a daily basis, in contrast to the sampling interval of the SMN of one to several months. Further the spatial intensity is also greater. On the other hand, the TPWD samples a random network of stations, so there is no time continuity at

a fixed point in the bay. The data is now entered into a digital data base at TPWD headquarters for detailed statistical analyses.

In order to regulate the harvesting of oysters in Corpus Christi Bay, the Seafood Safety Division (nee Shellfish Sanitation Division) of the Texas Department of Health (TDH) samples the bay at regular stations at varying temporal intensity, depending upon the season of year and upon the antecedent hydrological conditions. For the purpose of this program, the sampling is now limited to coliforms and a few associated hydrographic variables, salinity, temperature and pH. Like the TPWD, this program samples more intensely in space and time than the TNRCC SMN and has accumulated data from many years from Corpus Christi Bay. The collected data is maintained in a digital data base at TDH headquarters in Austin.

In addition, there are important recent or ongoing data collection programs in Corpus Christi Bay, also listed in Table 5-1, however these are not *monitoring* programs because they do not exhibit the regularity and time continuity implied by that term. One of the more important of these is the sampling performed by Galveston District Corps of Engineers in association with its Operations and Maintenance Program on navigation projects. This is intense sampling emphasizing sediment quality that is performed in association with dredging activities. The sampling interval is therefore dictated by the condition of the channel, i.e. sediment accumulation, and may be as long as several years. The Corps data program has been subdivided in Table 5-1 according to the suite of parameters obtained. Generally, there has been an evolution from an emphasis on conventional chemistry and metals to specific hydrocarbons.

Of the historical programs available, there are several which are noteworthy. The Texas Game, Fish and Oyster Commission (TGFOC) is the predecessor organization of the present TPWD, and has sampled the system on a routine basis back to the early 1950's, and on an occasional basis back to the Nineteenth Century. Data antedating 1975 is extremely inaccessible. Most of it is stored as hard-copy records (i.e., original field sheets) in a state warehouse in Olmeto. Unfortunately, the resources of this project did not permit the major effort that would be required to exhume and keyboard this old data. We did have access to some of this data copied in special project reports of the TGFOC, and extracted from older annual reports of the Coastal Fisheries Branch. This data was digitized and incorporated into the data base. It is urgent that an effort be made to recover the original data holdings and render them in a digital form for future researchers. (See Section 5.4.2, below.)

One of the major historical studies developed from the operation of the Ocean Science and Engineering Laboratory of Southwest Research Institute (SWRI) in Corpus Christi from the late-1960's to the mid-1970's. In concert with this lab, a routine monitoring program in Corpus Christi Bay was operated from 1970-75 with hiatuses due to shortage of funds. Also, several special-purpose studies (an example of focused research projects) were performed by the labs under sponsorship of regional agencies and industries. When SWRI closed the lab, all of its data holdings were removed and probably destroyed. SWRI would not

disclose to these investigators whether or where the data presently exists. Fortunately, John Buckner of the Coastal Bend Council of Governments made available to this project his considerable archive of data from the system, that included reports from SWRI reproducing most of the measurements. These data were keyboarded for this project.

Another noteworthy program is the Submerged Lands Study of the University of Texas Bureau of Economic Geology, sponsored by the Texas General Land Office. This program, which focused entirely upon sediment, falls into the category of a survey, because it involved one-time only sampling. However, it is the only data set extant which sampled the *entirety* of Corpus Christi Bay at a uniform station distribution (1-mile), irrespective of the location of shoals, channels, navigation aids and reefs (which tend to spatially bias most measurements from the system).

5.2.2 Summary of the data base

The data programs of Table 5-1 formed the basis for the analysis reported here. Most of these programs, it will be noted, are small-scale focused research activities, though most of the data is dominated by the few large-scale programs summarized above. The approach of this project was to combine and merge these programs to synthesize a more comprehensive data base for the system. Details on the data sets of these individual programs are given in the companion data base report (Ward and Armstrong, 1997a), along with any problems encountered in the data and how those problems were resolved (or reconciled). Particular note should be made of the programs which were keyboarded into a digital format for this project. As noted earlier, this digital data set, which is capable of much more analysis than it is subjected to here, is considered one of the chief products of this project.

The data bases for water quality and for sediment quality are summarized on a baywide basis in Tables 5-2 and 5-3, resp. The only values screened from analysis at this stage are those that exceed the (rather liberal) bounds on variables given in Table 4-1. (Parameter names are abbreviated for compactness; their definitions are given in Table 2-1.) These tables are information-dense, and largely self-explanatory. These tables do provide a ready index to the relative intensity with which different variables have been measured, and the extant period of record. Because of the large spatio-temporal variability in most of these parameters, the baywide means have little significance; however they are useful in typifying the magnitudes of the different variables (provided the spurious values do not seriously corrupt the mean).

Because only the bounds of Table 4-1 are used to screen data, the summary of data in Tables 5-2 and 5-3 reflects some probably-incorrect values. There is such a large range of possible values in the Corpus Christi system that the demarcation between probable and improbable is not at all certain: the 10 ppb values for water-phase 2,4,5-T and Silvex, or the 640 µg/kg of sediment BaP may be more unlikely than unusual, but we are hesitant to dismiss them on strictly an *a priori* basis.

Table 5-2
Summary statistics for water analytes for entire CCBNEP study area

*Parameter**	*No.of obs*	*Avg >DL*	*St dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
Conventional parameters													
WQALK	2506	154	66	2506	100	0	770202	11	930511	830	910808	154	154
WQAMMN	9221	0.177	0.88	8138	88	0	711111	0.00014	930415	30	750422	0.156	0.163
WQBOD5	2069	2.37	2.8	2049	99	0.19	720707	0.19	720707	90	701119	2.34	2.35
WQCHLA	5492	13.2	31	4823	88	0	730615	0.1	740417	1100	880412	11.6	12.1
WQCHLB	62	2.1	1.5	62	100	1	720919	1	720919	10	751030	2.1	2.1
WQDO	49280	7.47	2.2	49280	100	0	681121	0.05	710825	25	890417	7.47	7.47
WQFCOLI	6010	569	13000	5219	87	0	740612	1	720918	340000	761104	495	499
WQKJLN	2042	1.02	1.2	1981	97	0	750827	0.01	760212	34	841018	0.99	0.995
WQNO2N	7239	0.0196	0.1	6365	88	0	711105	0.00014	880707	4.8	680326	0.0173	0.0205
WQNO3N	9136	0.148	0.79	8021	88	0	710609	0.00014	880714	19	720817	0.13	0.134
WQO&G	115	6.94	8.9	71	62	0.2	870331	0.2	870331	38	751209	4.28	4.67
WQOPD	4425	0.204	0.77	4057	92	0	720918	0.003	860102	12	860428	0.187	0.188
WQOPO4	4316	0.428	1.7	4003	93	9.5E-4	871020	0.00095	871020	27	741218	0.397	0.399
WQORGN	1402	0.556	0.34	1402	100	0	750827	0.005	740416	5	760128	0.556	0.556
WQPH	22586	8.15	0.36	22586	100	4	850930	4	850930	10	730518	8.15	8.15
WQPHEO	3841	5.39	9.8	2480	65	0	770719	0.1	871210	280	930427	3.48	5.05
WQSAL	58109	26.1	11	58108	100	0	730615	0.0036	920728	300	850922	26.1	26.1
WQSECCHI	4732	0.772	0.5	4664	99	0	800701	0.0004	830512	7.7	750604	0.761	0.765
WQSIO2	3726	4.06	3.6	3726	100	0	720918	0.015	880510	32	690325	4.06	4.06
WQSO4	4581	1740	1100	4569	100	1	740531	1	740531	4900	900807	1730	1730
WQTCOLI	3250	442	7200	2906	89	0	740612	0.01	821118	240000	610927	395	396
WQTEMP	58085	23.1	6	58084	100	0.1	731029	0.1	731029	39	850918	23.1	23.1
WQTOC	4741	10.6	9.3	4157	88	0	860507	0.24	720328	84	740417	9.34	9.79
WQTOTP	6627	0.241	0.85	6593	99	0	710608	0.006	750106	28	860428	0.24	0.24

(continued)

Table 5-2
(continued)

Parameter	*No.of obs*	*Avg >DL*	*St dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
Conventional parameters continued													
WQTPO4	2259	0.972	2.8	2221	98	0	760729	0.02	750106	34	820505	0.956	0.957
WQTRANS	3536	62	22	3536	100	0	701212	1	700610	100	720514	62	62
WQTSS	2964	60.8	110	2904	98	0	860507	0.27	790810	2000	710903	59.5	59.7
WQTURBJ	12709	48.1	61	12627	99	0	730815	1	720724	1000	830420	47.8	48.1
WQTURBN	11851	16.6	26	11851	100	0	870518	0.8	870110	1000	870401	16.6	16.6
WQVOLS	16	4380	250	16	100	3900	751209	3900	751209	4900	751209	4380	4380
WQVSS	3233	16.8	21	2718	84	0	720115	0.1	910116	320	900213	14.1	15.6
Metals													
WQMETAGD	95	1	1.5	23	24	0	791017	1	880809	7	860903	0.242	1.81
WQMETAGT	191	51.6	120	40	21	0.36	930109	0.36	930109	790	770105	10.8	16.6
WQMETASD	151	6.04	5.8	143	95	0	720918	1	891017	31	820525	5.72	6.14
WQMETAST	460	10.8	19	168	37	0.35	771228	0.35	771228	220	770105	3.96	6.29
WQMETBAD	134	253	170	89	66	18	761025	18	761025	620	830824	168	221
WQMETBAT	59	50.6	17	58	98	11	940804	11	940804	92	940316	49.8	49.8
WQMETBD	93	1690	1200	93	100	0.21	680226	0.21	680226	5000	711109	1690	1690
WQMETBT	20	2210	2000	20	100	4.4	770727	4.4	770727	5000	740723	2210	2210
WQMETCDD	158	1.45	4.6	103	65	0	720918	0.94	910808	30	801022	0.943	1.32
WQMETCDT	473	16.8	20	74	16	0	741017	1.3	920422	70	930216	2.63	4.95
WQMETCOD	52	0.0385	0.19	52	100	0	731015	1	731016	1	731016	0.0385	0.0385
WQMETCOT	12	1.58	2	12	100	0	741017	3	741024	5	741024	1.58	1.58
WQMETCRD	144	8.07	15	94	65	0	720918	1	840409	80	850122	5.27	7.39

(continued)

Table 5-2
(continued)

Parameter	*No.of obs*	*Avg >DL*	*St dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
						Metals continued							
WQMETCRT	463	44.9	32	76	16	1.2	940316	1.2	940316	100	740731	7.36	16.7
WQMETCUD	167	7.63	11	150	90	0	791017	1	820210	80	801022	6.85	7.19
WQMETCUT	472	26.1	37	162	34	0.6	720321	0.6	720321	240	761101	8.96	11.8
WQMETFED	83	72.8	55	83	100	0	720918	10	741017	210	810324	72.8	72.8
WQMETFET	191	523	700	186	97	0	750917	1	750814	5000	830810	509	510
WQMETHGD	70	0.348	0.56	29	41	0	811020	0.1	811119	3	871013	0.144	0.229
WQMETHGT	457	0.832	1.4	69	15	0.1	811119	0.1	811119	11	770216	0.126	0.427
WQMETMND	87	40	31	87	100	0	720918	10	811209	120	741023	40	40
WQMETMNT	136	99.2	340	127	93	6	860528	6	860528	3700	820819	92.7	93.5
WQMETNID	108	2.6	5.6	80	74	0	751103	1	840117	31	910808	1.93	3.16
WQMETNIT	123	28.4	48	50	41	1	811119	1	811119	280	740712	11.6	20.3
WQMETPBD	154	3.24	5.7	103	67	0	720918	1	840117	36	751103	2.17	3.36
WQMETPBT	465	45.6	46	111	24	0	741017	1	741017	200	830810	10.9	22.2
WQMETSED	91	0.831	0.46	29	32	0	791016	1	811119	2	840709	0.265	1.26
WQMETSET	297	6.68	10	37	12	1	811119	1	811119	49	930109	0.832	2.64
WQMETSRD	21	147	250	21	100	0.09	670927	0.09	670927	860	731017	147	147
WQMETZND	156	45.6	89	141	90	0	720918	2	720928	820	731017	41.2	43.1
WQMETZNT	469	88.3	170	263	56	1	720321	1	720321	2000	771228	49.5	53.7
						Organics							
WQ-245T	116	0.122	1.1	83	72	0	750623	0.01	751103	10	760922	0.0875	1.8
WQ-24D	115	7.6E-3	0.029	82	71	0	750623	0.01	741024	0.2	711105	5.4E-3	7.67
WQ-ABHC	62	0	0	0	0							0	2.49

(continued)

Table 5-2
(continued)

Parameter	No.of obs	Avg >DL	St dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Average BDL=0	with =DL
						Organics continued							
WQ-ACEN	247	0	0	0	0							0	2.62
WQ-ACENA	12	0	0	0	0							0	2.5
WQ-ALDR	107	0.0002	0.0014	50	47	0	720918	0.01	830629	0.01	830629	9.4E-5	0.864
WQ-ANTHR	19	4.15	2.6	2	11	1.6	840508	1.6	840508	6.7	840508	0.437	1.12
WQ-BNZA	243	0	0	0	0							0	1.29
WQ-BNZAA	12	0	0	0	0							0	1
WQ-BNZB	12	0	0	0	0							0	0.1
WQ-BNZGP	12	0	0	0	0							0	0.1
WQ-BNZK	12	0	0	0	0							0	0.1
WQ-CHLR	325	0.0049	0.02	49	15	0	720918	0.05	891219	0.1	830629	7.4E-4	1.45
WQ-CHLRC	5	0	0	0	0							0	0.185
WQ-CHRYS	16	0	0	0	0							0	0.625
WQ-DBANE	12	0	0	0	0							0	0.5
WQ-DDD	50	0.0002	0.0014	50	100	0	720918	0.01	830629	0.01	830629	0.0002	0.0002
WQ-DDE	50	0.0002	0.0014	50	100	0	720918	0.01	830629	0.01	830629	0.0002	0.0002
WQ-DDT	50	0.0004	0.002	50	100	0	720918	0.01	830629	0.01	830629	0.0004	0.0004
WQ-DIAZ	46	0.0744	0.41	32	70	0	720918	0.01	731015	2.4	871104	0.0517	0.15
WQ-DIEL	107	0.0002	0.0014	50	47	0	720918	0.01	830629	0.01	830629	9.4E-5	0.86
WQ-ENDO	20	1.7E-3	0.0037	6	30	0	791017	0.01	830629	0.01	830629	0.0005	4.51
WQ-ENDR	75	0.0002	0.0014	50	67	0	720918	0.01	830629	0.01	830629	1.3E-3	1.24
WQ-FLRA	219	0	0	0	0							0	0.5
WQ-FLRN	20	2.1	1.1	3	15	0.7	840508	0.7	840508	3.5	840508	0.315	0.865
WQ-HEPT	128	8.9E-4	0.0054	56	44	0	750623	0.01	830629	0.04	760922	4E-4	0.715

(continued)

Table 5-2
(continued)

Parameter	*No.of obs*	*Avg >DL*	*St dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
						Organics continued							
WQ-HEPX	55	0.0035	0.013	20	36	0	750623	0.01	830629	0.06	7609220.00127		0.0525
WQ-HEXA	10	0	0	0	0							0	0.0198
WQ-I123P	12	0	0	0	0							0	0.5
WQ-LIND	86	3.3E-3	0.0094	9	10	0	720918	0.03	760922	0.03	7609220.000349		1.07
WQ-MALA	87	0.0271	0.19	52	60	0	750623	0.01	830629	1.4	760922	0.0162	0.315
WQ-MTHP	40	0	0	31	77	0	720918					0	0.0517
WQ-MTHX	57	0.0925	0.3	12	21	0	750623	0.01	830629	1.1	760922	0.0195	2.01
WQ-NAPT	247	7.4	0	1	0	7.4	840508	7.4	840508	7.4	840508	0.03	2.64
WQ-ODDT	5	0	0	0	0							0	0.126
WQ-PAH	219	0	0	0	0							0	3.77
WQ-PARA	72	0.0135	0.081	37	51	0	750623	0.5	760922	0.5	7609220.00694		0.173
WQ-PCB	342	0.126	0.38	58	17	0	750623	0.1	720918	2	740505	0.0213	0.502
WQ-PCP	31	0	0	0	0							0	33.8
WQ-PDDD	41	0	0	0	0							0	2.28
WQ-PDDE	41	0	0	0	0							0	2.21
WQ-PDDT	265	7.78	0.88	8	3	6.2	930216	6.2	930216	8.8	930216	0.235	0.623
WQ-PHNAN	16	0	0	0	0							0	1
WQ-PYRN	12	0	0	0	0							0	0.5
WQ-SLVX	112	0.121	1.1	83	74	0	750623	0.01	830629	10	760922	0.0895	1.67
WQ-TOXA	299	0.0435	0.2	23	8	0	741017	1	830629	1	8306290.00334		0.954

* Abbreviations & units defined in Table 2-1

Table 5-3
Summary statistics for sediment analytes for entire CCBNEP study area

*Parameter**	*No. of obs*	*Avg >DL*	*Stdev >DL*	*No.> DLs*	*%> DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average with BDL=0*	*with =DL*
Conventional parameters													
SEDAMMN	61	89.1	66	38	62	3.1	840508	3.1	840508	280	770621	55.5	55.9
SEDCYAN	38	0.629	0.34	38	100	0.2	760421	0.2	760421	1.8	760420	0.629	0.629
SEDKJLN	264	988	900	259	98	20	731029	20	731029	6800	880426	969	969
SEDO&G	438	893	1100	401	92	0	720716	5	880127	9600	840508	817	823
SEDORGN	11	834	170	11	100	500	770621	500	770621	1200	770621	834	834
SEDTOC	1251	7.26	6.7	1180	94	0.0031	950111	0.0031	950111	64	760924	6.85	6.85
SEDTOTP	267	573	950	266	100	0.1	740723	0.1	740723	8900	771229	571	572
SEDVOLS	270	55600	39000	270	100	0	740723	1	740723	190000	830505	55600	55600
Metals													
SEDMETAG	657	1.57	7.4	165	25	0.033	930109	0.033	930109	90	860527	0.395	2.44
SEDMETAL	273	11600	8800	273	100	320	880615	320	880615	47000	880615	11600	11600
SEDMETAS	950	4.31	5.3	740	78	0	720918	0.06	780607	75	770105	3.36	3.49
SEDMETB	578	37.3	31	554	96	0.69	800825	0.69	800825	340	880615	35.8	35.9
SEDMETBA	845	345	270	842	100	3	810831	3	810831	2700	760331	344	344
SEDMETCD	960	5.61	12	453	47	0	731015	0.02	920729	110	760406	2.65	2.81
SEDMETCO	28	6.98	3.6	28	100	1.2	720918	1.2	720918	11	731017	6.98	6.98
SEDMETCR	1243	19.2	22	1143	92	0	840823	0.3	800819	260	720716	17.6	18
SEDMETCU	1253	11.1	16	1147	92	0.3	880615	0.3	880615	220	940316	10.2	10.4
SEDMETFE	674	11900	8500	674	100	490	880615	490	880615	39000	890902	11900	11900
SEDMETHG	944	0.294	0.81	573	61	0	750129	0.01	741220	8.5	750115	0.179	0.246
SEDMETMN	956	276	180	956	100	8.6	731029	8.6	731029	1200	860814	276	276

(continued)

Table 5-3
(continued)

*Parameter**	*No. of obs*	*Avg >DL*	*Stdev >DL*	*No.> DLs*	*%> DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
Metals continued													
SEDMETNI	1223	8.8	6.7	1028	84	0.2	760902	0.2	760902	80	770105	7.39	8.35
SEDMETPB	1095	27.1	48	868	79	1	860507	1	860507	450	720716	21.5	22.5
SEDMETSE	656	0.675	0.86	173	26	0.067	930109	0.067	930109	7.2	890424	0.178	0.92
SEDMETSR	584	299	410	584	100	13	880615	13	880615	3500	760921	299	299
SEDMETZN	1286	180	630	1175	91	0.6	760902	0.6	760902	6200	720716	165	166
Organics													
SED-245T	71	0.25	0.35	6	8	0	741024	0.7	720918	0.8	720918	0.0211	26.3
SED-24D	70	1.06	1.3	5	7	0	741023	2.6	720918	2.7	720918	0.0757	63.6
SED-ABHC	54	0	0	0	0							0	40
SED-ACEN	309	2.25	2.8	23	7	0.11	910805	0.11	910805	11	910805	0.168	33.5
SED-ACNY	58	1.9	3.4	22	38	0	860715	0.08	910805	15	880715	0.721	10.4
SED-ALDR	340	0.115	0.31	95	28	0	731015	0.01	860715	2	880715	0.0321	6.75
SED-ANTH	146	25.7	60	36	25	0	880715	0.2	930720	350	860715	6.35	21.1
SD-BNZAA	60	27.9	34	33	55	10	880615	10	880615	120	880615	15.4	25.7
SED-BNZA	369	52.7	100	74	20	0.06	920729	0.06	920729	640	940316	10.6	30.2
SD-BNZB	12	85.3	92	3	25	16	910822	16	910822	220	910822	21.3	41.5
SD-BNZGP	12	24	16	2	17	8	910822	8	910822	40	910822	4	24.3
SD-BNZK	12	48	51	3	25	8	910822	8	910822	120	910822	12	32.2
SED-CHLR	513	1.28	4.2	75	15	0	731015	0.01	930720	20	760831	0.188	17.8
SD-CHLRC	50	6	1	2	4	5	880523	5	880523	7	880525	0.24	3.69
SED-CHRY	143	33.1	65	70	49	0	880615	0.5	930720	490	880615	16.2	28.1

(continued)

Table 5-3
(continued)

*Parameter**	*No. of obs*	*Avg >DL*	*Stdev >DL*	*No.> DLs*	*%> DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average BDL=0*	*with =DL*
						Organics continued							
SD-DBANE	12	16	0	1	8	16	910822	16	910822	16	910822	1.33	23.8
SED-DDD	195	0.455	1.2	77	39	0	751030	0.1	791016	7.6	711105	0.179	3.08
SED-DDE	198	2.01	6.7	83	42	0	751030	0.02	741017	55	830712	0.845	2.61
SED-DDT	215	0.666	3	96	45	0	731015	0.016	920729	28	750414	0.298	3.21
SED-DIAZ	157	0.375	1.3	40	25	0	751103	5	760831	5	760831	0.0955	4.69
SED-DIEL	346	0.256	0.7	80	23	0	731015	0.0023	920729	3	760831	0.0593	7.2
SED-ENDO	22	0.15	0.05	2	9	0.1	830629	0.1	830629	0.2	940724	0.0136	54.9
SED-ENDR	252	0.282	0.83	61	24	0	731015	0.1	830629	3.6	830331	0.0684	10.2
SED-FLRA	347	48.5	84	95	27	0	840930	1	930720	450	880615	13.3	32.6
SD-FLRN	147	7.38	8.6	29	20	0.2	930720	0.2	930720	30	880615	1.46	13.7
SED-HEPT	274	0.0846	0.23	54	20	0	751030	0.00059	920729	1	760831	0.0167	4.86
SED-HEPX	314	0.0922	0.23	86	27	0	731015	0.01	880715	1.1	870715	0.0253	3.54
SED-HEXA	57	32	0	1	2	32	860716	32	860716	32	860716	0.561	15.3
SD-I123P	12	40	0	1	8	40	910822	40	910822	40	910822	3.33	25.8
SED-LIND	310	0.119	0.28	39	13	0	750604	0.01	930722	1	760831	0.015	7.51
SED-MALA	62	0	0	20	32	0	751103					0	5.32
SED-MTHP	156	0.596	2.2	47	30	0	751103	5	760831	13	770914	0.179	2.67
SED-MTHX	158	1.95	5.9	31	20	0	750604	0.1	830629	20	760831	0.384	18.3
SED-NAPT	363	11.3	26	29	8	0.54	920729	0.54	920729	140	860715	0.905	39
SED-ODDD	49	0	0	0	0							0	3.56
SED-ODDE	50	0	0	0	0							0	2.23
SED-ODDT	50	0	0	0	0							0	3.55

(continued)

Table 5-3
(continued)

*Parameter**	*No. of obs*	*Avg >DL*	*Stdev >DL*	*No.> DLs*	*%> DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Average with BDL=0*	*with =DL*
Organics continued													
SED-PAH	237	226	670	27	11	0.2	870331	0.2	870331	3500	940316	25.8	26.2
SED-PARA	148	0.484	1.5	31	21	0	750604	5	760831	5	760831	0.101	3.76
SED-PCB	520	40.3	79	117	22	0	751103	0.1	910805	420	790808	9.06	25.4
SED-PCP	68	0	0	0	0							0	347
SED-PDDD	216	0.352	1.1	47	22	0	870715	0.0035	920729	7	900715	0.0766	11.2
SED-PDDE	216	0.818	2.1	53	25	0	870715	0.0067	920729	12	900715	0.201	10.7
SED-PDDT	437	0.704	1.5	45	10	0	870715	0.01	860715	7	900715	0.0725	7.48
SED-PERY	65	20.7	18	46	71	0	890902	0.21	920729	63	840930	14.6	20.8
SD-PHNAN	140	61.7	170	39	28	0.6	930720	0.6	930720	1000	860715	17.2	32.4
SD-PYRN	125	55.7	82	69	55	0.7	900715	0.7	900715	360	880615	30.8	44.6
SED-SLVX	111	1.81	5.7	34	31	0	750604	0.7	720918	20	760831	0.554	10.9
SED-TBT	18	5.93	9.1	12	67	0.07	930720	0.07	930720	29	930722	3.95	5.22
SED-TOXA	497	3.48	12	46	9	0	751103	10	830629	50	760831	0.322	41.1

* Abbreviations & units defined in Table 2-1

The highest value of chlorophyll-a of 1100, measured by the TNRCC, is so large that one might suspect a data-point error. One of the highest values of DO was an unrealistic 22.5. Both of these measurements might have been legitimately screened out. But when one reflects that they were both obtained from the *same* water sample, the possibility is admitted that, though unlikely, they may be real.

There are three different averages presented in these tables. The first is the average of those measurements excluding the censored data (i.e., below detection limits, BDL's). In the last two columns, two additional averages are presented, the first based upon assuming all BDL data to be zero (0), the second assuming all such censored data to be equal to the specified detection limit. (See Section 4.3.2 for discussion.) Clearly, for those parameters which have not been censored, the three averages are equal.

One problem facing a user of this data set is the interpretation of zero values. We are concerned that some of the zero values may in fact have originated from blank entries (i.e., no measurement) that in the process of agency transcription and digitization were replaced with a zero. This was especially a problem in the early days (the 1960's) of digital processing, in which most of the software was special-purpose FORTRAN codes. The FORTRAN editing specifications will interpret a blank field as a zero, unless special (and complicated) provision is made in the code, provisions which were usually not indulged in by programmers of the 1960's. While this anomaly was probably provided for in the first stage of data processing, as the data was passed through additional FORTRAN codes, we suspect that the differentiation between a blank field and a zero was lost. Parameters such as TSS and water-phase nitrogens exhibit these too-frequent values of zero.

Another problem with zeroes in the data record arises from measurements that were below detection limits. For many of the trace parameters, such as metals and pesticides, the lower range of measurement in the data base is delimited by the detection limits of the procedure. Despite this, several of the data sets, especially those from the Texas Water Development Board, include zero values especially for data from the early 1970's. We suspect that these were introduced for analytical purposes to replace the censoring statement "below detection limits" (BDL). Some may have also been blanks misinterpreted as zeroes, as described above. The data analyzed to produce Table 5-2 and 5-3 have not been screened for such anomalies. For trace constituents whose records include zero values, the zeroes are interpreted in these averages as being *above* the detection limit. In the detailed analyses of Chapter 6 and 7, these anomalous zero values were replaced with an estimated detection limit, see Section 4.2.4.

It should be noted that some of the EPA priority pollutants do not appear in Tables 5-2 and 5-3. Very few measurements have been made in Corpus Christi Bay of most of the priority pollutants. In some instances, there may be a scattering of measurements, such as from the recent OxyChem program (Project Code 15 in Table 5-1), but not enough to use in any meaningful way in a status-and-trends analysis. For example, there were two measurements of water-phase Endrin aldehyde from the entire Corpus Christi Bay system. Similarly, most of the

individual PAH's were represented only by a handful of data, mainly from the EPA EMAP program or from the NOS Status & Trends Project. Those variables for which the sample base is totally lacking or inadequate are excluded from these tables and from this analysis. For those parameters for which there is at least a minimum analyzable data base, most of those measurements are below detection limits (BDL), as indicated in these tables. (There is no *a priori* means of specifying how many measurements comprise a "minimum analyzable data base." We have arbitrarily required at least 10, taken over a period exceeding one year. Given the uncertainty in the analytical measurement itself, to say nothing of variability in the bay, the statistical resolving power of such a small data set is feeble.)

Figures 5-1 *et seq.* display graphically the sampling intensity throughout the bay for the more important of the water and sediment parameters. Sampling intensity is measured by the number of observations within each Hydrographic Segment (see Section 3.3.3) for the period of record. The amount of data available is strongly dependent upon the parameter. Salinity and temperature, referred to as "hydrographic parameters," are easily measured in the field, and so the data holdings are large, approaching 60,000 independent measurements. Dissolved oxygen and pH are practically in the same category, as electrometric probes suitable for field use became common in the late 1960's. Conventional water-quality chemical parameters, for which a water sample is returned to a laboratory and subjected to straightforward wet-chemistry techniques (including filtration, ignition, titration, incubation, etc.), are represented by BOD (Figs. 5-19 through 5-24), ammonia, total phosphorus, total suspended solids, and fecal coliforms (Figs. 5-43 through 5-48). As would be expected, the data holdings for these parameters are about an order-of-magnitude less than the hydrographic parameters, and significant areas of the system have never been sampled. Cadmium and the proxy data file for DDT are presented as representative of the metals and organics parameters, as the data holdings are largest for these parameters. It is apparent that, in comparison to the conventional parameters, only a handful of measurements of metals and organics are available.

Several observations may be made about these figures. First, what might appear to be a large number of historical samples for a given parameter on a baywide basis, from Tables 5-2 and 5-3, is shown to be quite modest—even inadequate—when related to specific areas of the bay. Second, it is apparent at once from Figs. 5-1 *et seq.* that sampling intensity is highly heterogeneous in space, some areas of the bay having been subjected to relatively frequent sampling, and some rarely sampled. There is a particular bias, as might be expected, for the main navigation channels (ease of access and of positioning) and for those areas with historical pollution problems such as the Inner Harbor. The period of record generally ranges over many years so the number of samples *per year* is a considerably smaller number.

There is roughly an order of magnitude less sediment data from Corpus Christi Bay than water quality data. This does not, however, imply that the data base for sediment is an order of magnitude less useful. On the contrary, sediment is much less mobile than water and sedimentary processes proceed much more

slowly than those in the aqueous phase. For parameters bound to sediment, which include most of the nutrients and practically all of the trace organics and metals, sediment can be considered a long-term integrator of water-phase concentrations. Also, concentrations accumulate in sediment, and because they are larger than those in the overlying water, can be measured with a higher degree of confidence. For these reasons, generally less data per unit time is considered to be necessary to characterize sediment concentrations compared to those in water. On the other hand, sediment is usually more heterogeneous in space than water, so the spatial sampling density can be a limitation to analysis of sediment concentrations.

Density of sediment samples is exemplified by sediment oil & grease in Figs. 5-61 through 5-66, zinc in Figs. 5-67 through 5-72, and the proxied DDT in Figs. 5-73 through 78, as indicators of conventional sediment chemistry, sediment metals and sediment organics, respectively. Metals have generally received the greatest attention by the monitoring projects, so almost all areas of the system have been sampled at least a few times for some of the metals. For conventional parameters and organics, many areas of the bay have never been sampled. More so than for water samples, there is an investment of time and equipment in obtaining a sediment sample, so large suites of parameters are typically run for each sample. This means that there is a high correlation in the sampling density among most metals parameters, and among most volatile organics. Therefore, these three sets of figures are very representative of their respective classes of analytes.

5.3 Data Base Deficiencies

The general adequacy of coverage in Corpus Christi Bay for each parameter is an important dimension of this compilation. This includes identification of data gaps in the record and their associated implications for application of the record to long-term trend analysis (seasonal bias is a common problem, for example). It also includes procedural shortcomings that prejudice or limit the applicability of data collected. These are discussed in Section 5.3.1 for specific parameters and classes of parameters.

Even after the efforts of this project to locate, compile and synthesize a "complete" digital data base, the period of record extends back only to about 1965 for conventional indicators, and 1975 for metals and organics. For some traditional parameters, and for certain areas of the bay, e.g., the Inner Harbor, the record can be extended back to the late 1950's. Earlier than this, what data still survive are sporadic in time, e.g. some temperature and salinity measurements in the early 1950's, a few from the 1940's, one set of dissolved oxygen measurements from Laguna Madre in 1948, etc. This earlier data is generally inadequate in space and time continuity for any reliable characterization or trends analysis: data prior to 1950 are therefore excluded from analyses of the data base.

At least for standard hydrographic parameters and some of the traditional quality indicators, much more data than this has been taken from the Corpus Christi Bay system. The data base available to this project represents a fraction of the data

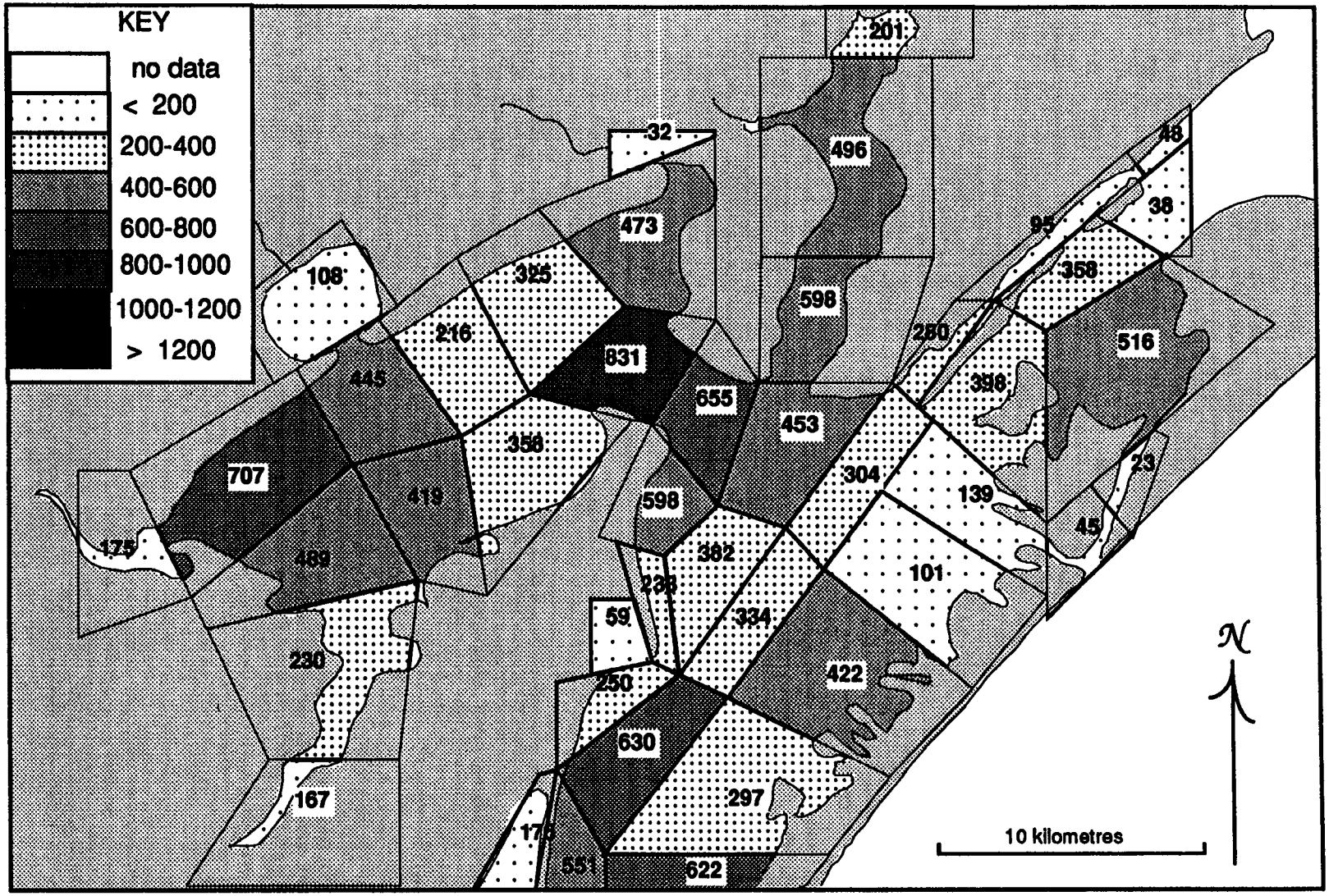


Figure 5-1. Sampling density (total number of measurements) of WQSAL for Aransas-Copano system

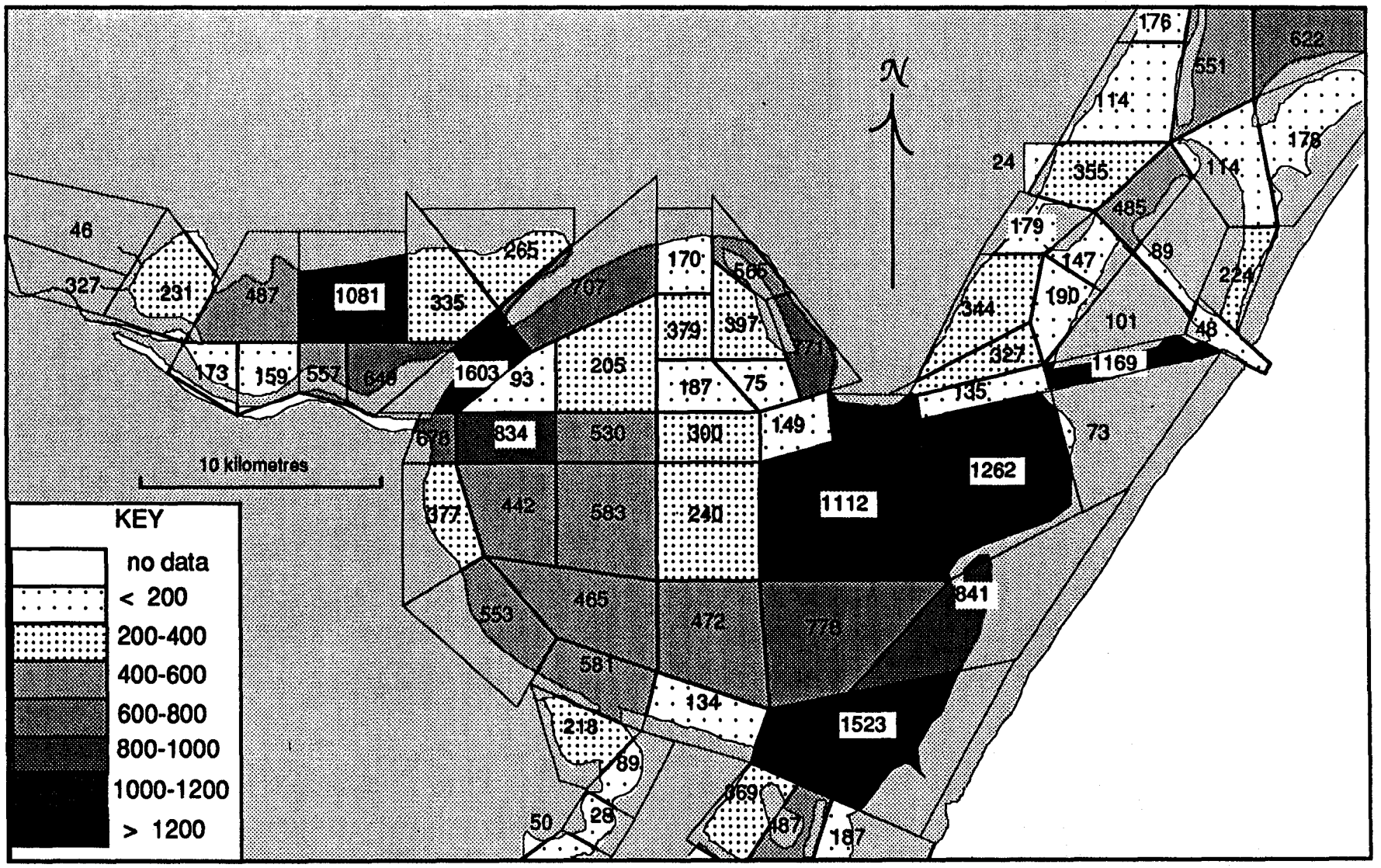


Figure 5-2. Sampling density (total number of measurements) of WQSAL for Corpus Christi system

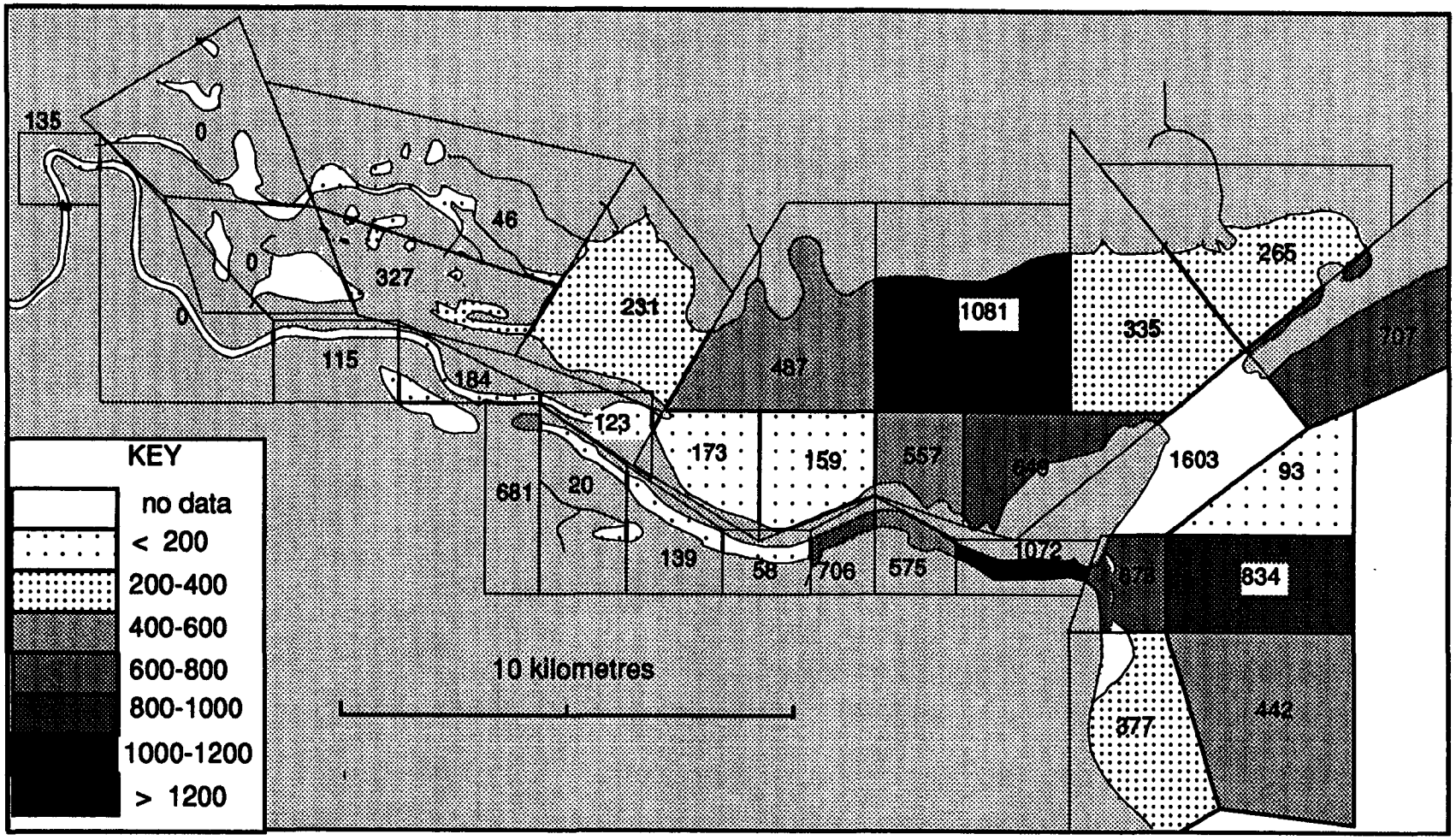


Figure 5-3. Sampling density (total number of measurements) of WQSAL for Nueces system

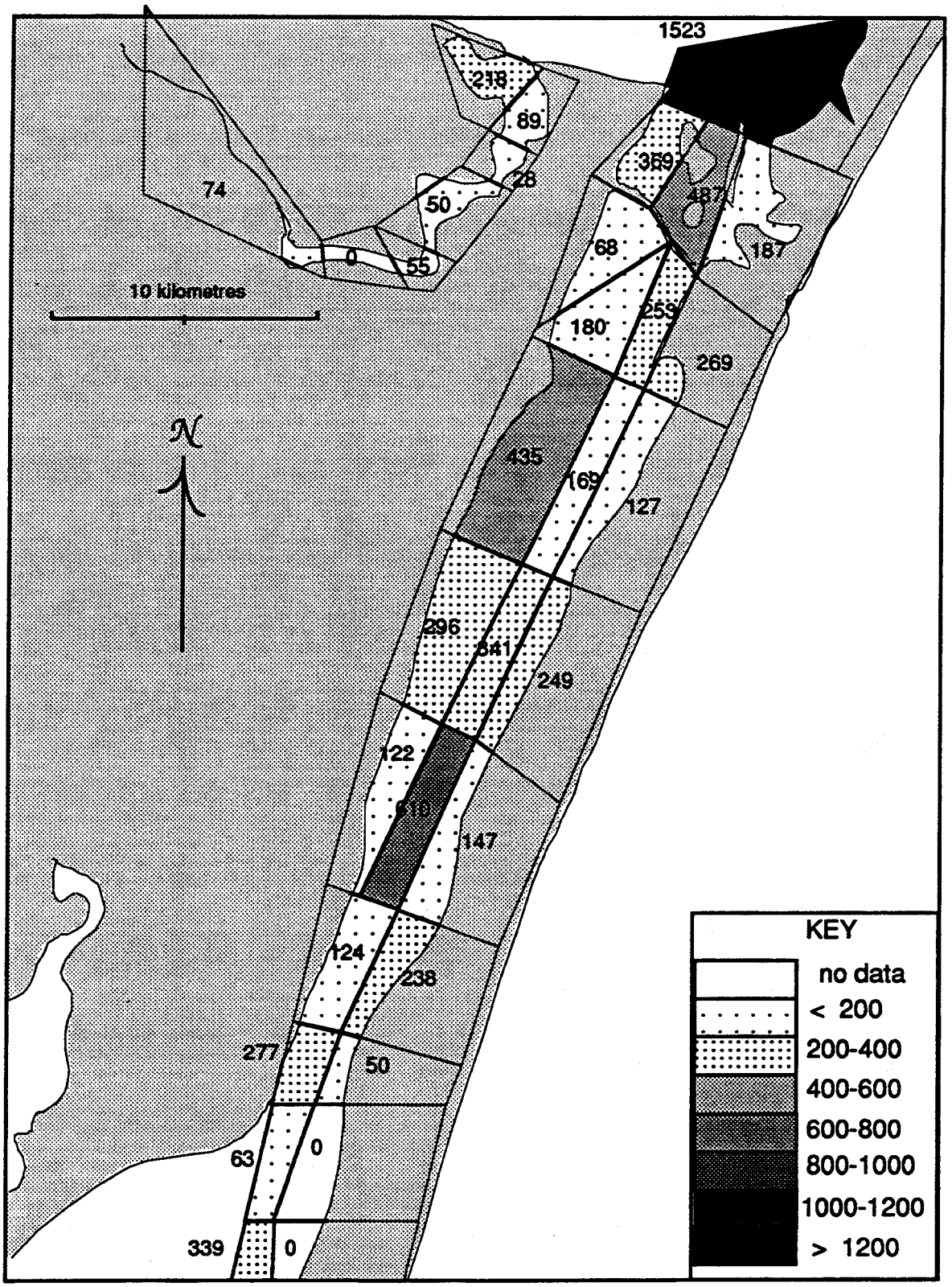


Figure 5-4. Sampling density of WQSAL for Upper Laguna Madre

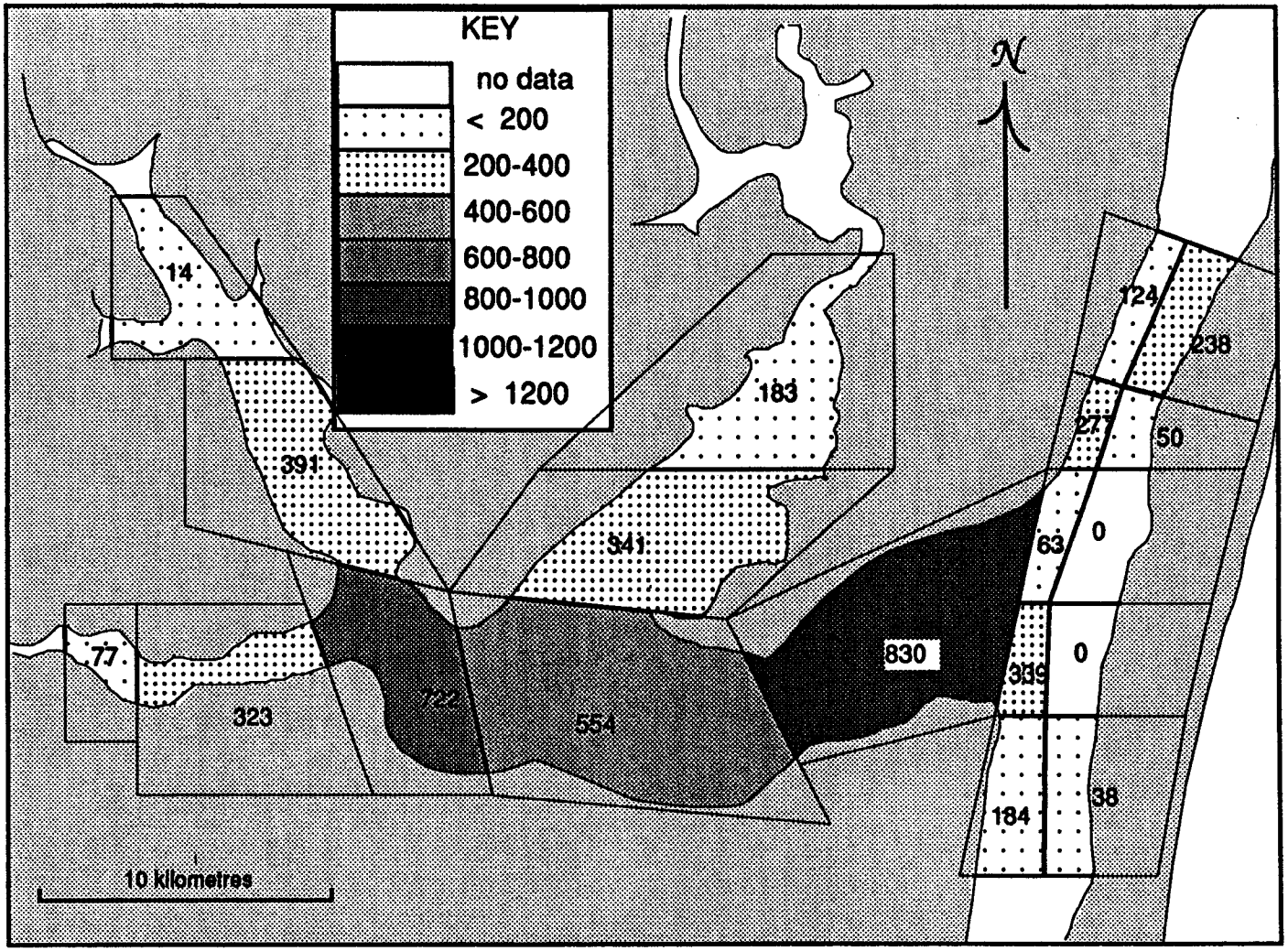


Figure 5-5. Sampling density (total number of measurements) of WQSAL for Baffin Bay system

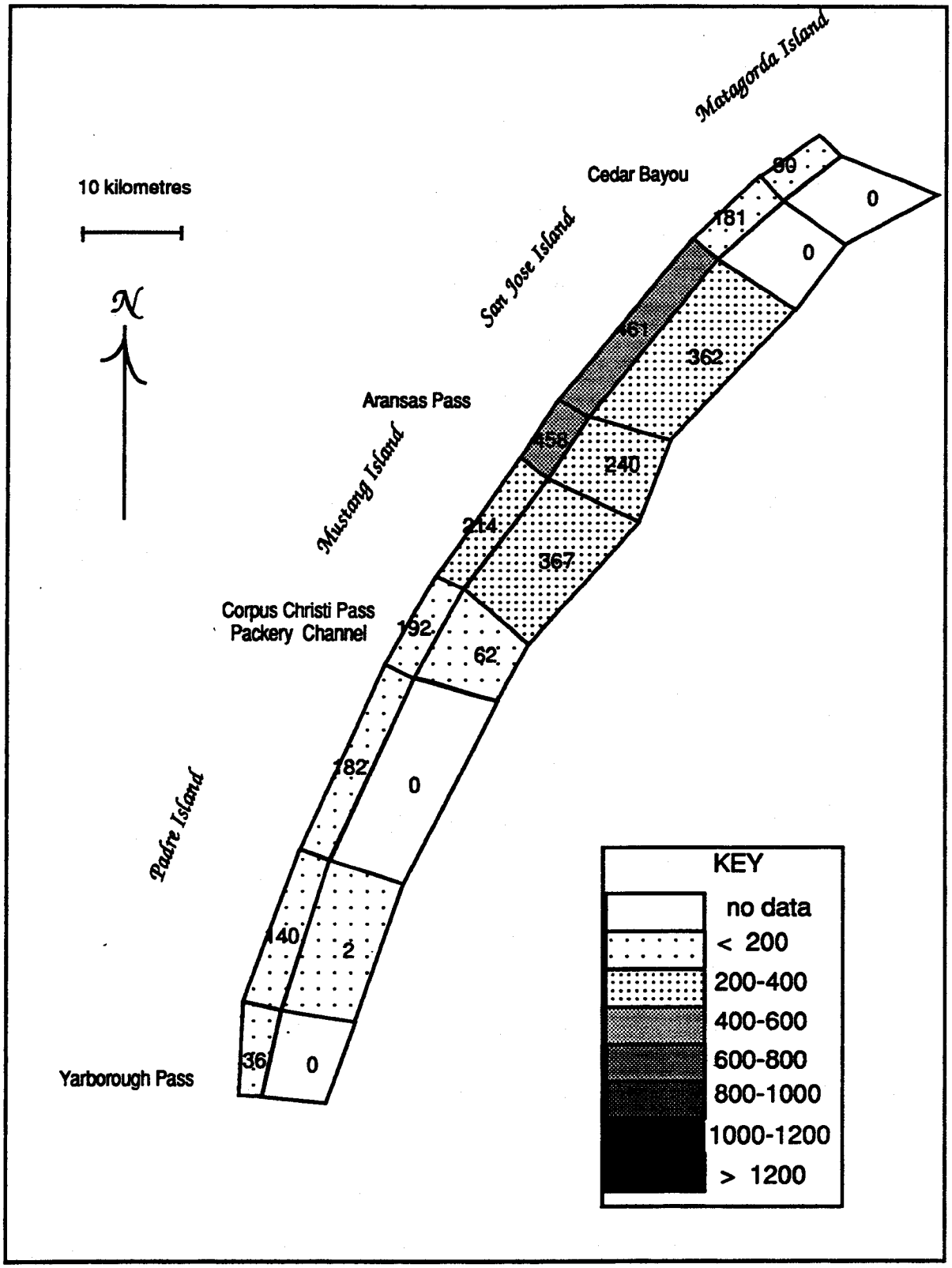


Figure 5-6. Sampling density of WQSAL for Gulf of Mexico

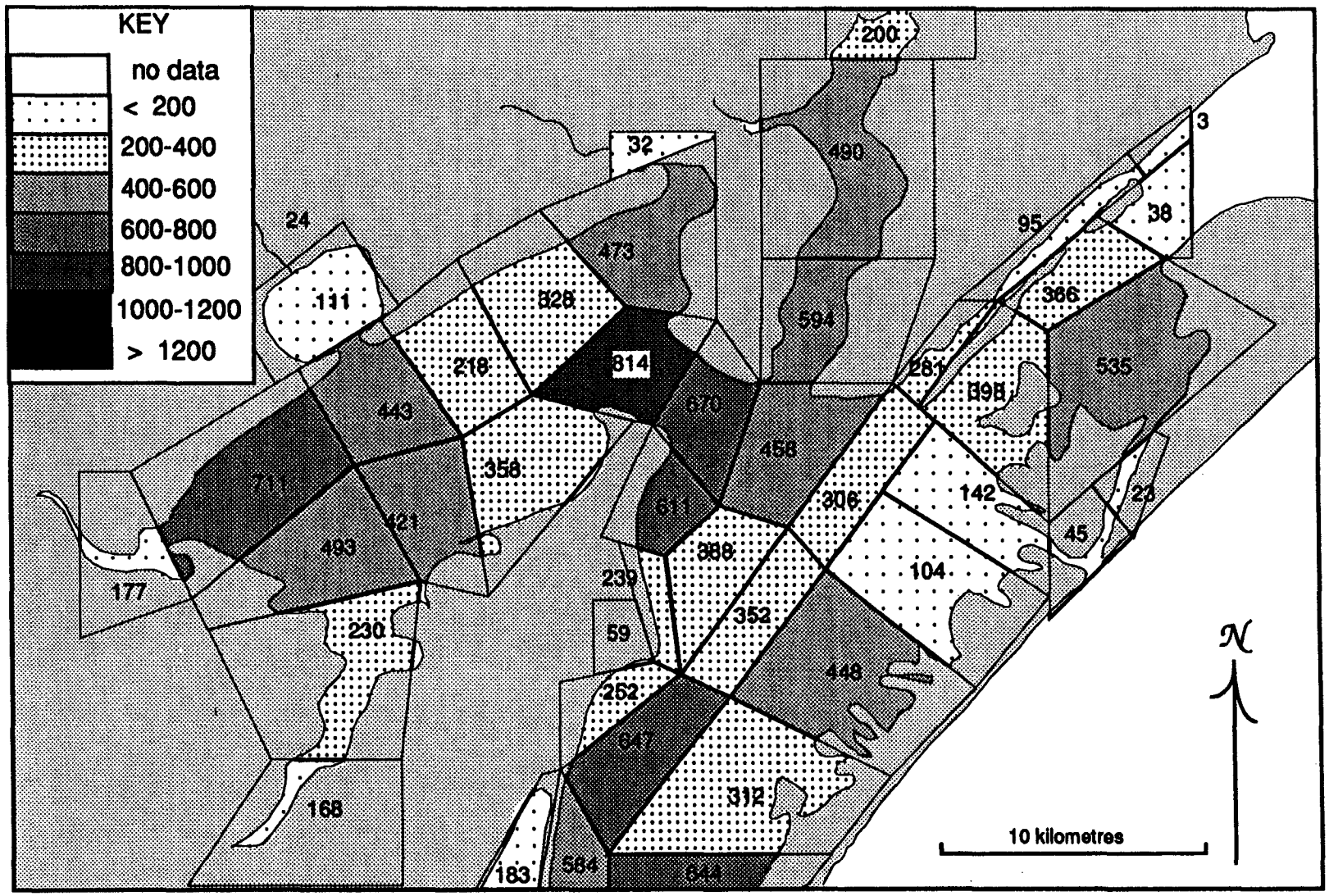


Figure 5-7. Sampling density (total number of measurements) of WQTEMP for Aransas-Copano system

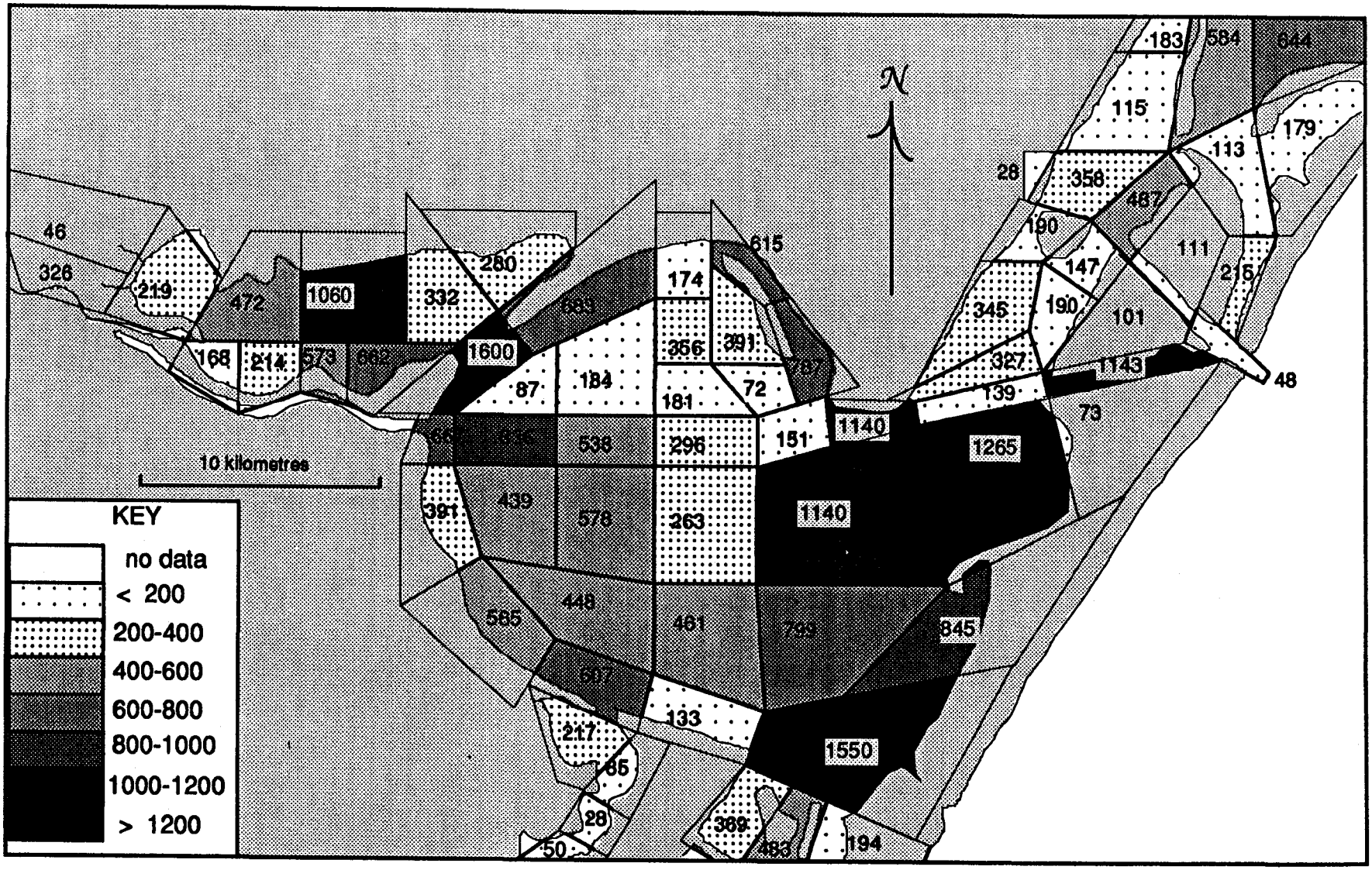


Figure 5-8. Sampling density (total number of measurements) of WQTEMP for Corpus Christi system

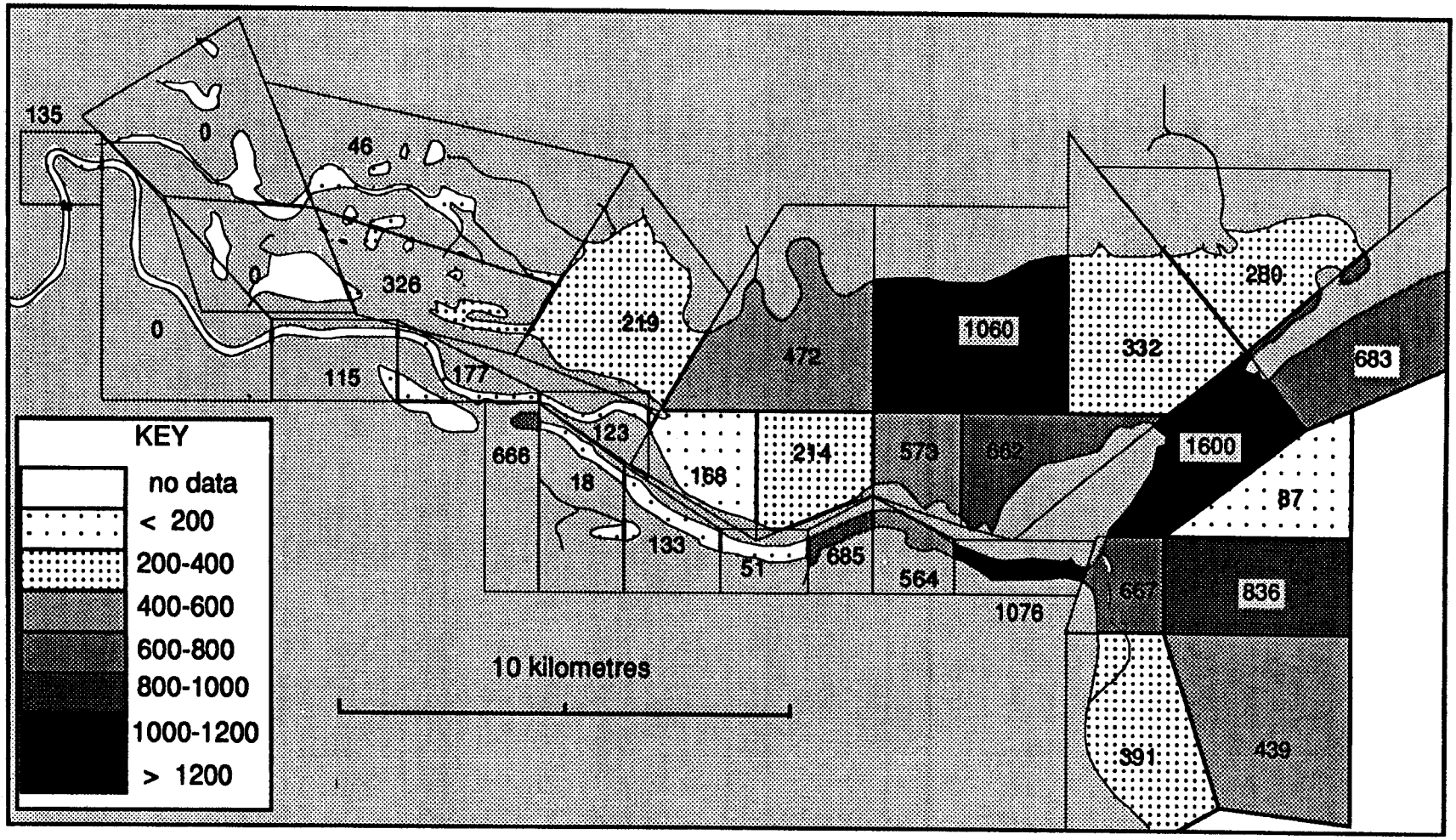


Figure 5-9. Sampling density (total number of measurements) of WQTEMP for Nueces system

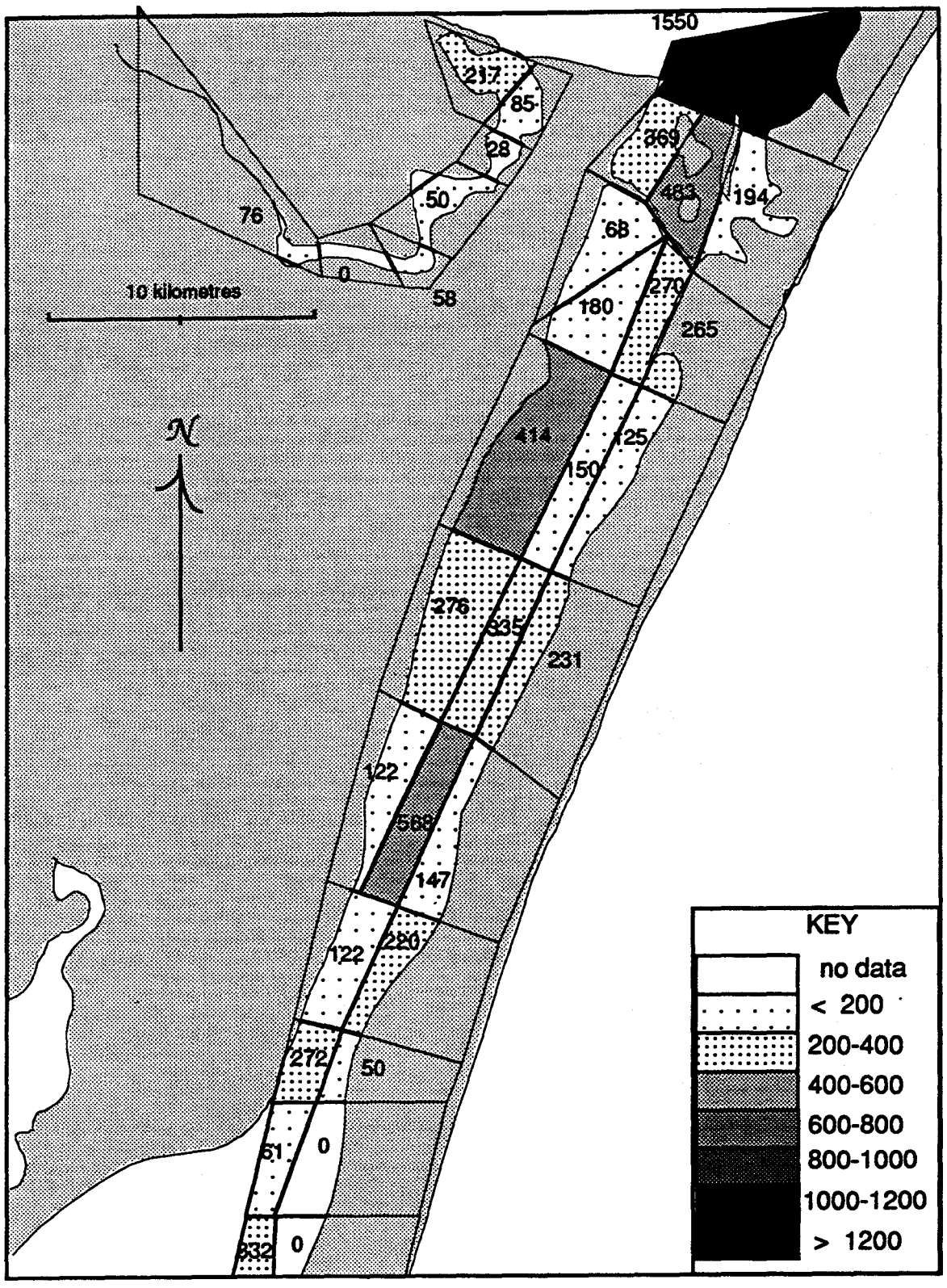


Figure 5-10. Sampling density of WQTEMP for Upper Laguna Madre

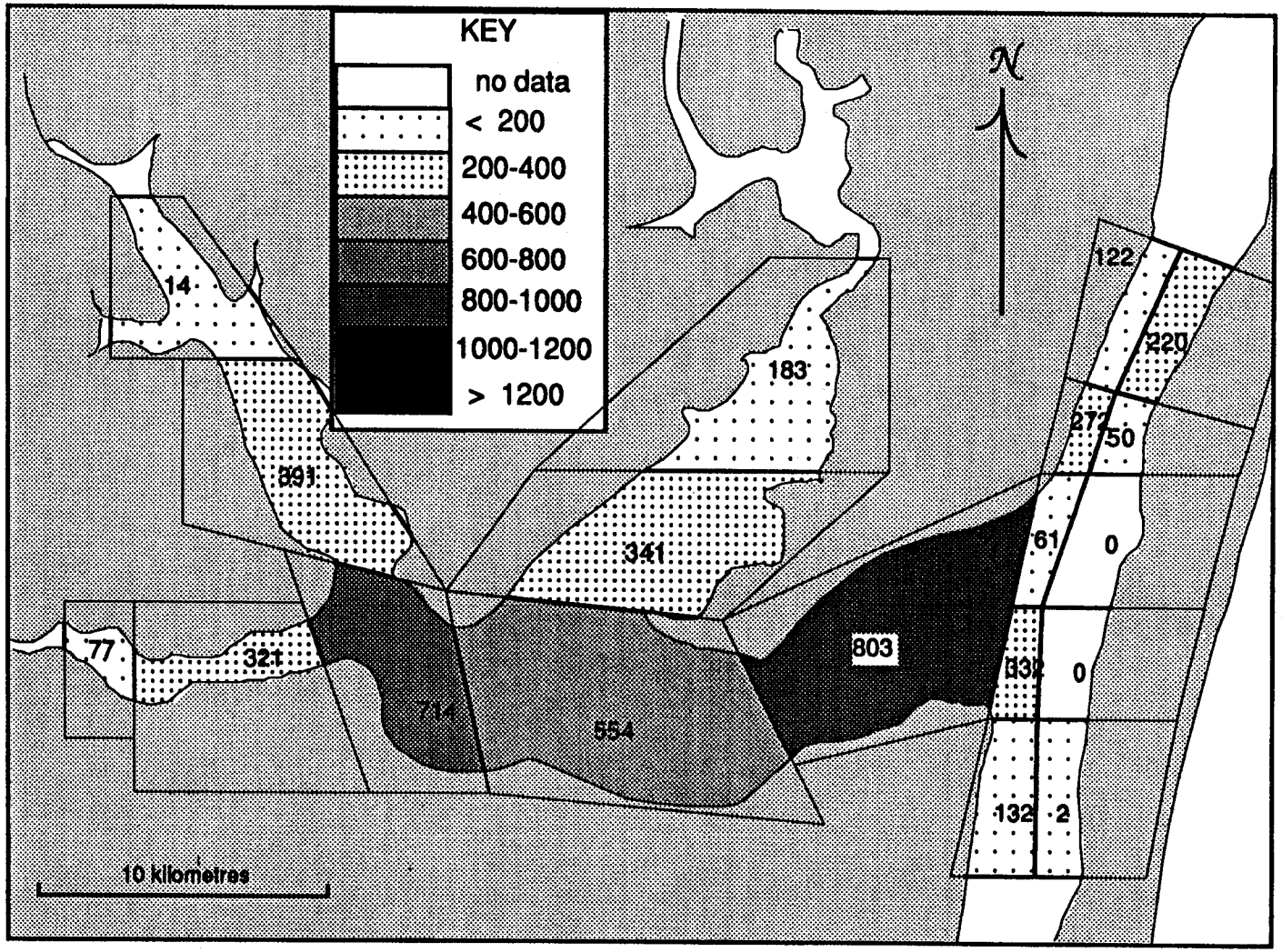


Figure 5-11. Sampling density (total number of measurements) of WQTEMP for Baffin Bay system

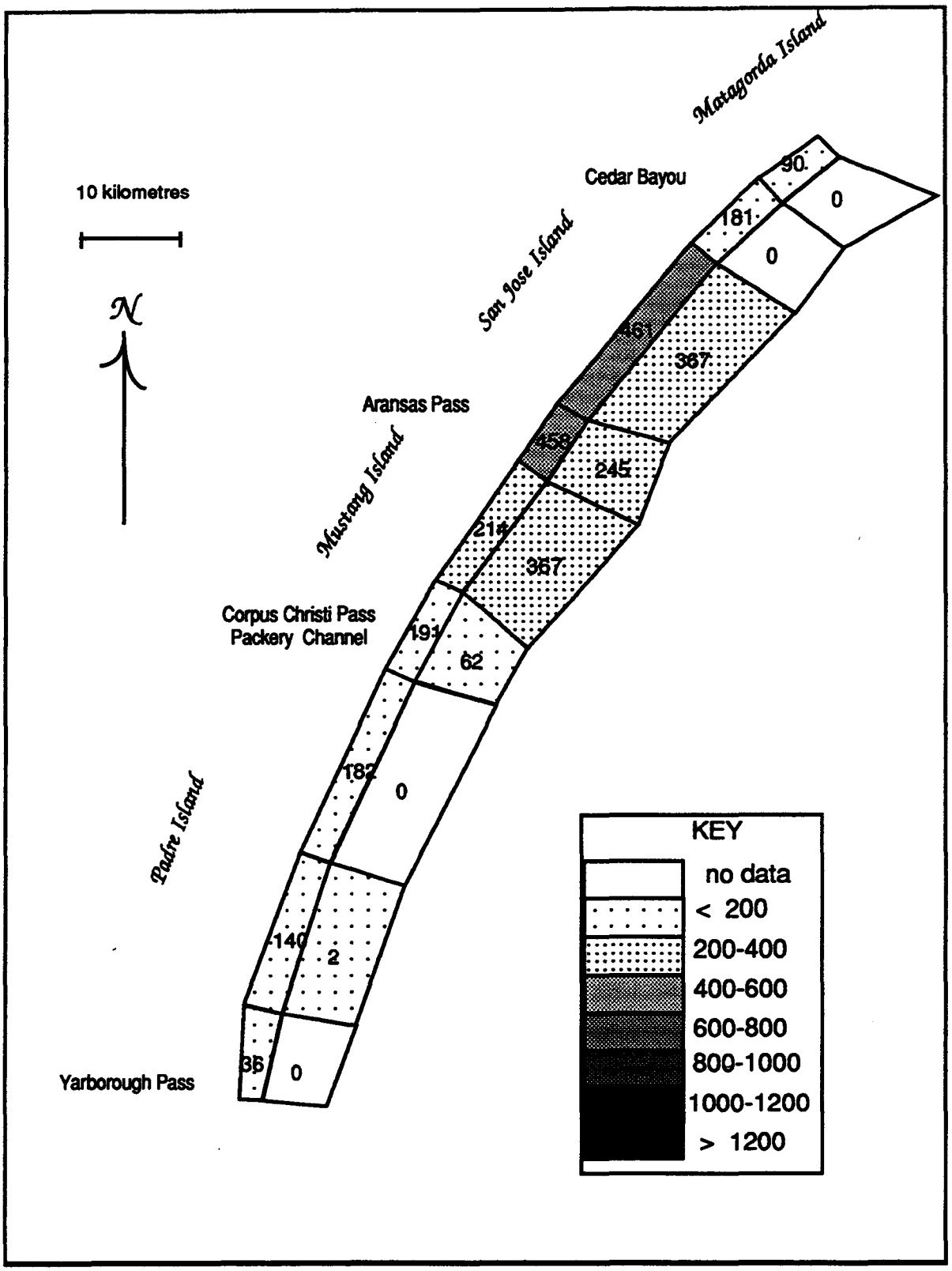


Figure 5-12. Sampling density of WQTEMP for Gulf of Mexico

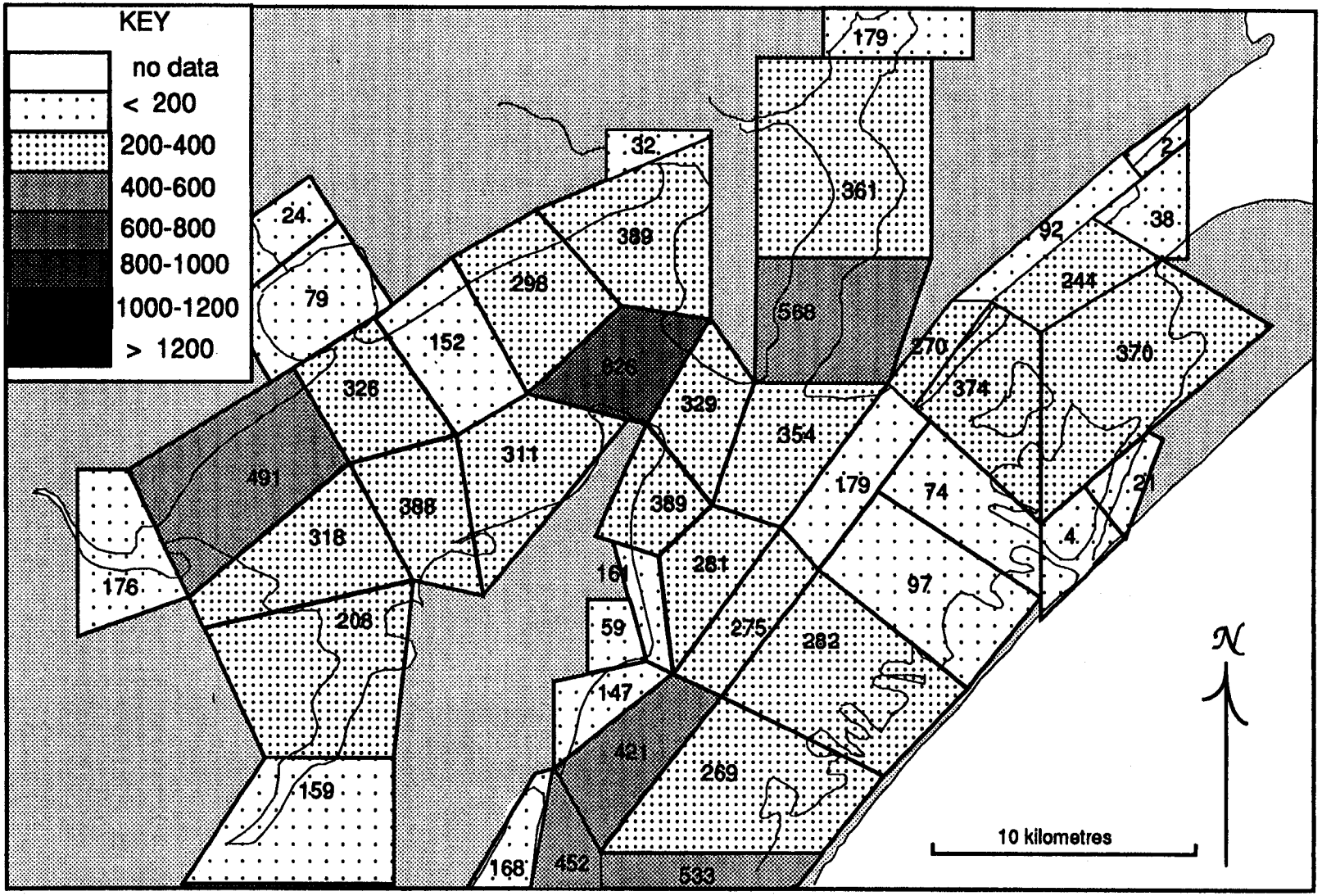


Figure 5-13. Sampling density of WQDO for Aransas-Copano system

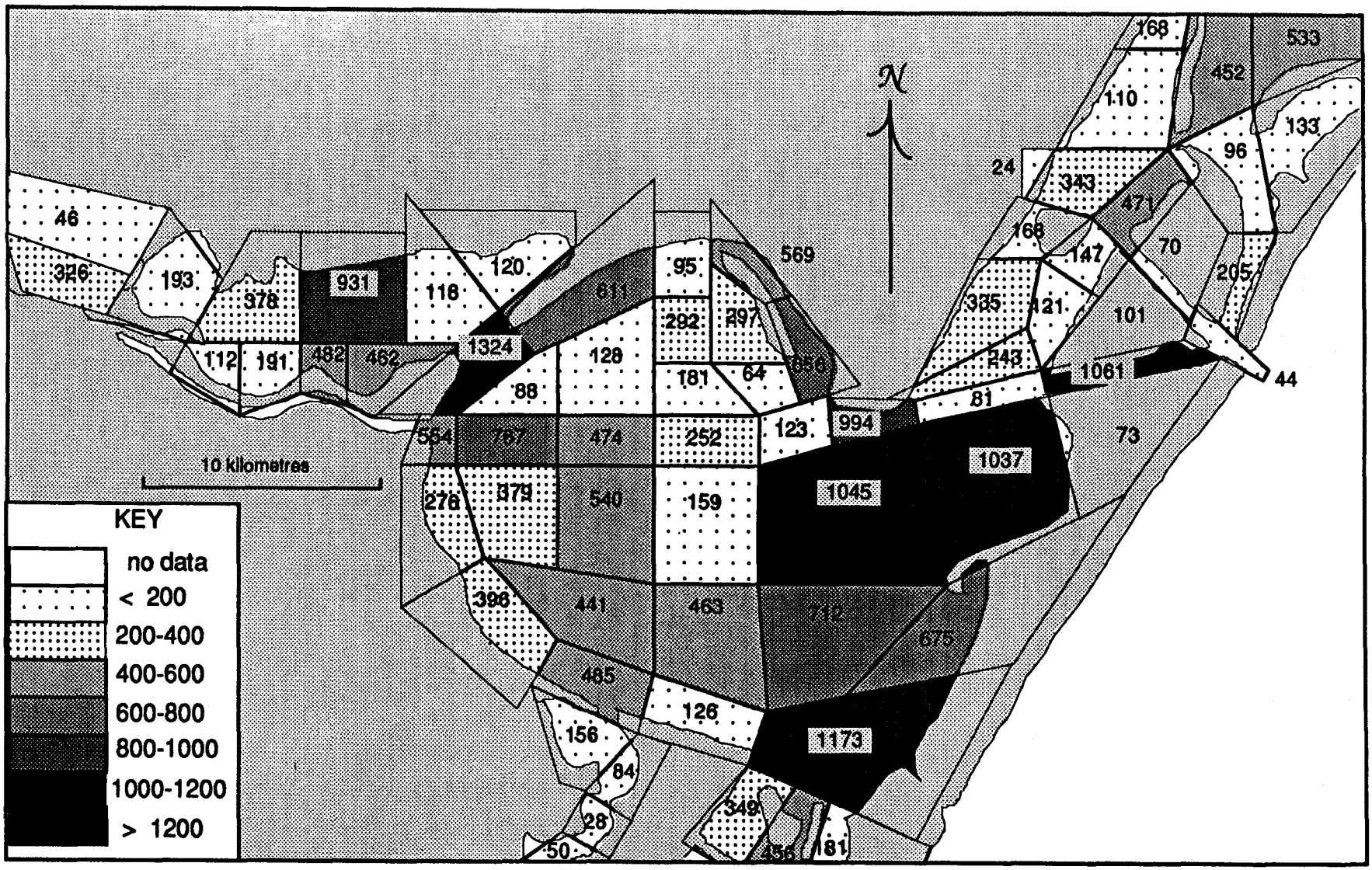


Figure 5-14. Sampling density of WQDO for Corpus Christi system

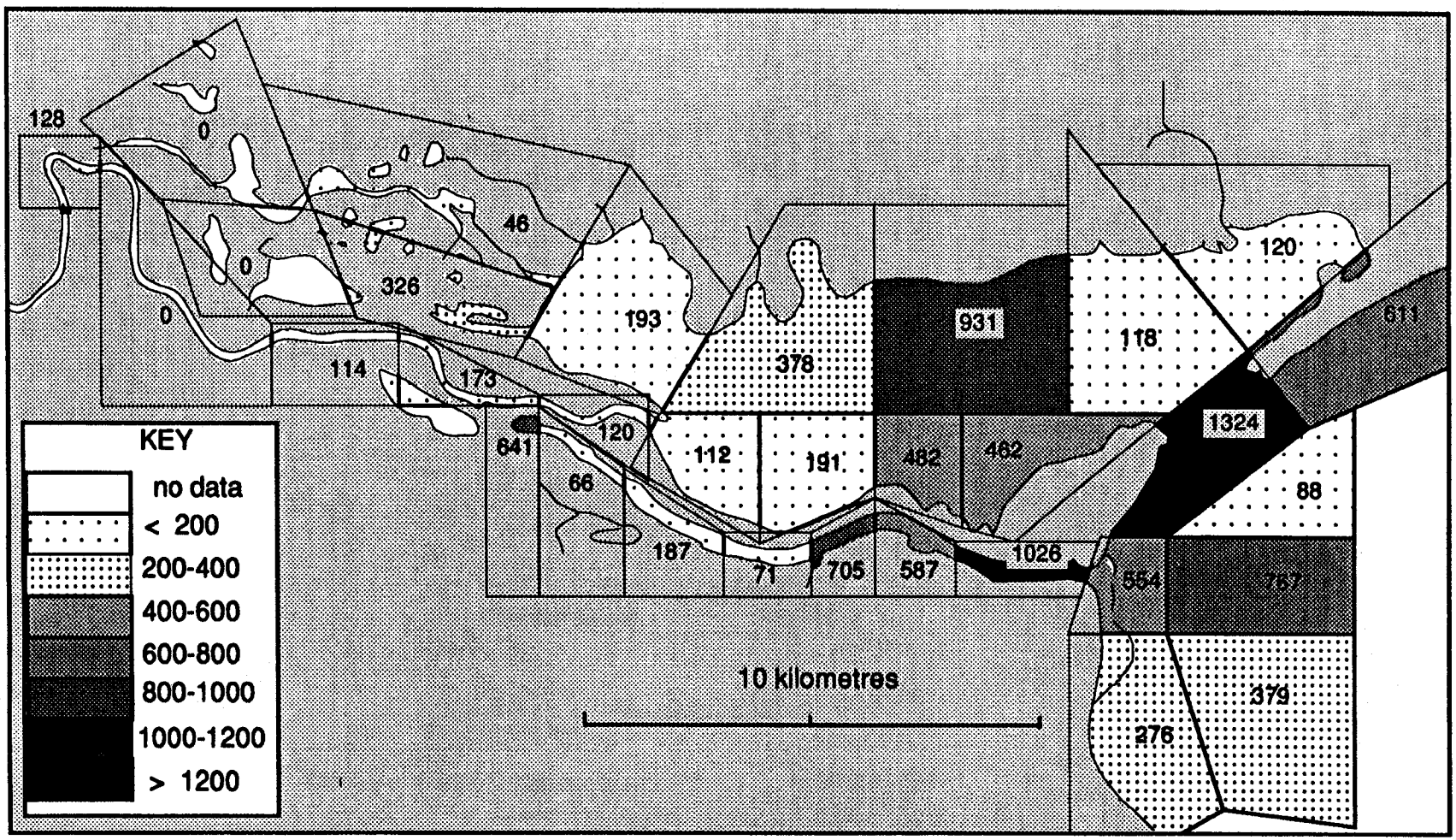


Figure 5-15. Sampling density of WQDO for Nueces Bay region, including Inner Harbor

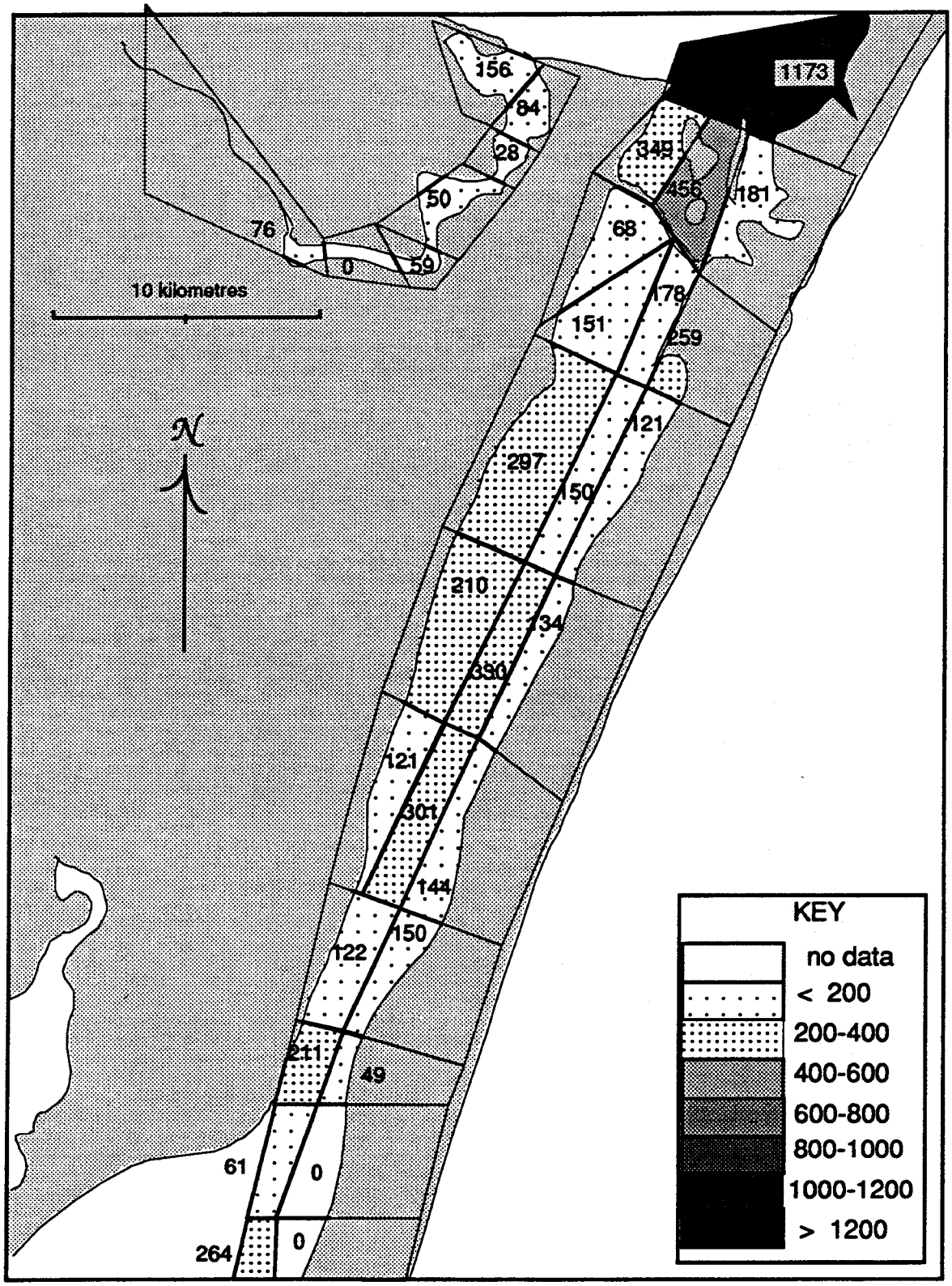


Figure 5-16. Sampling density of WQDO for Upper Laguna Madre and Oso Bay

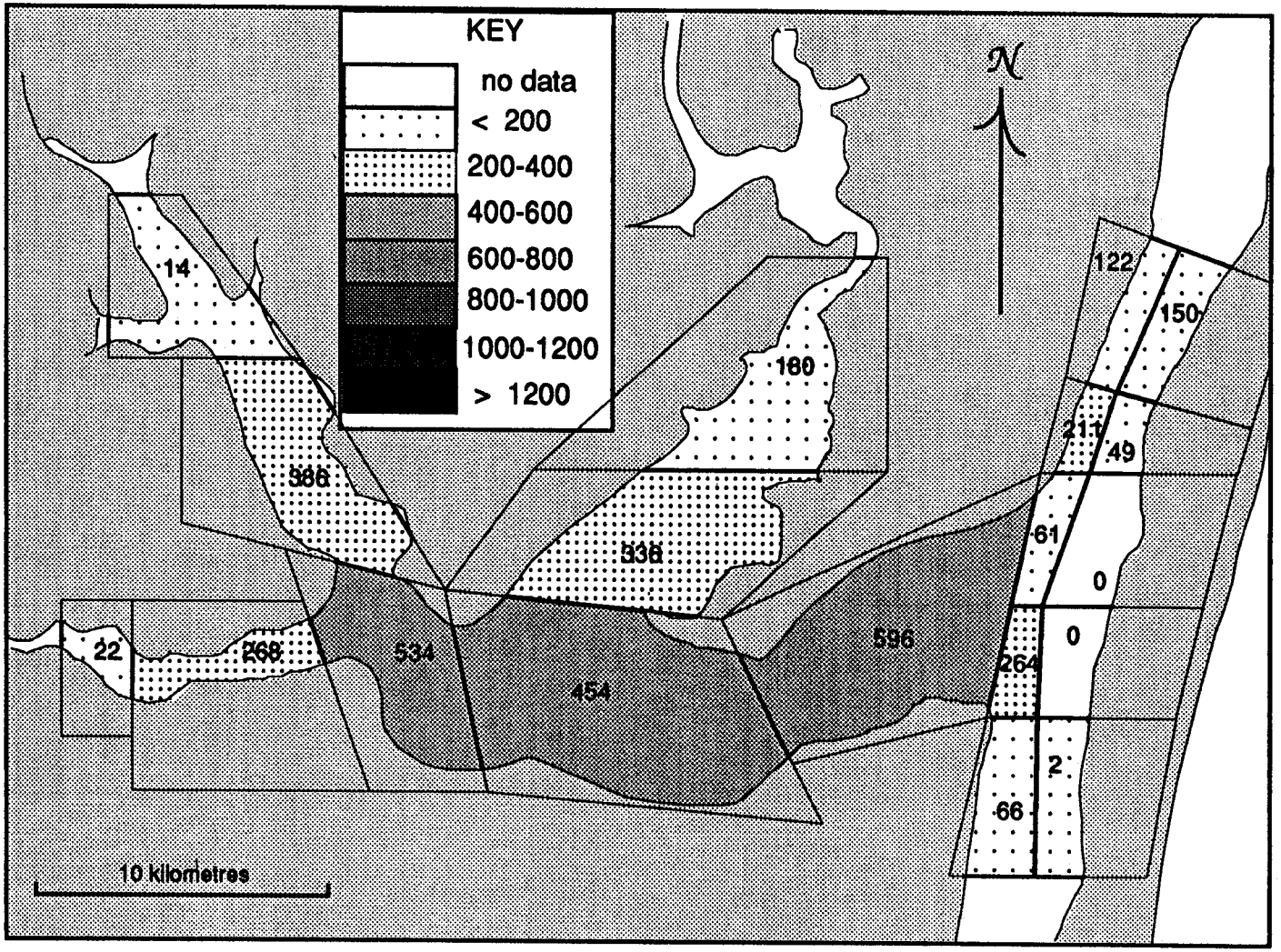


Figure 5-17. Sampling density of WQDO for Baffin Bay region

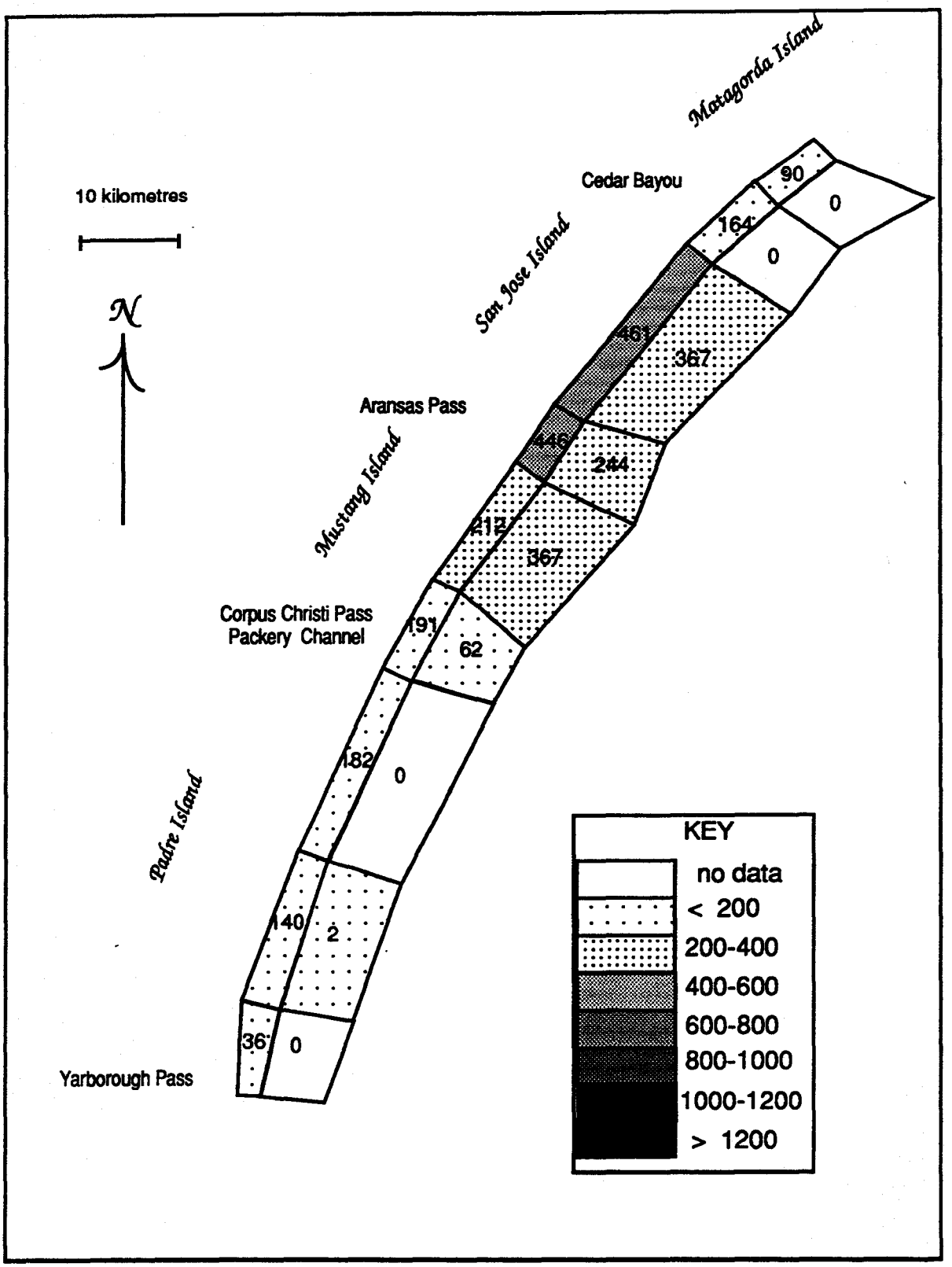


Figure 5-18. Sampling density of WQDO for Gulf of Mexico

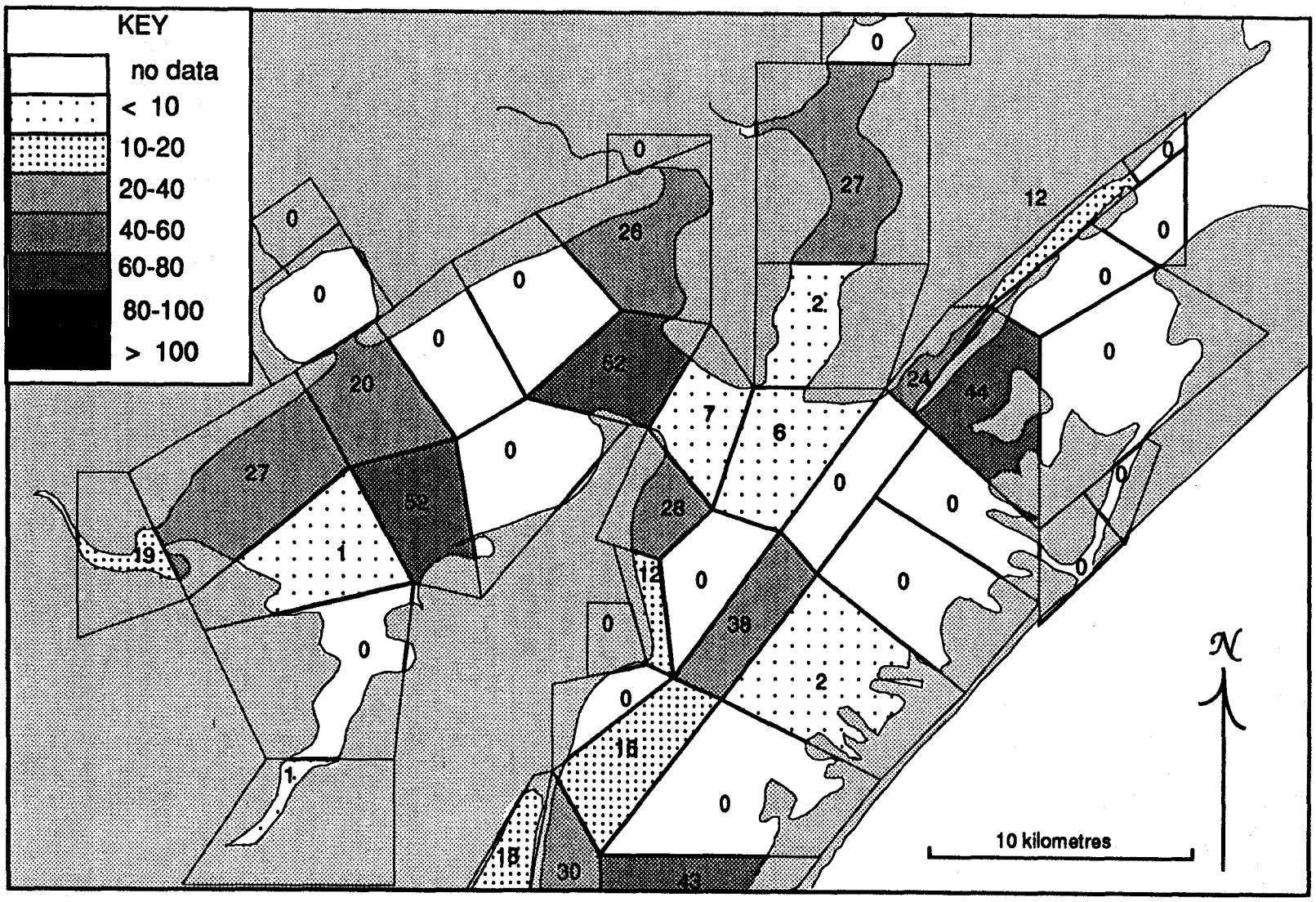


Figure 5-19. Sampling density of WQBOD5 for Aransas-Copano system

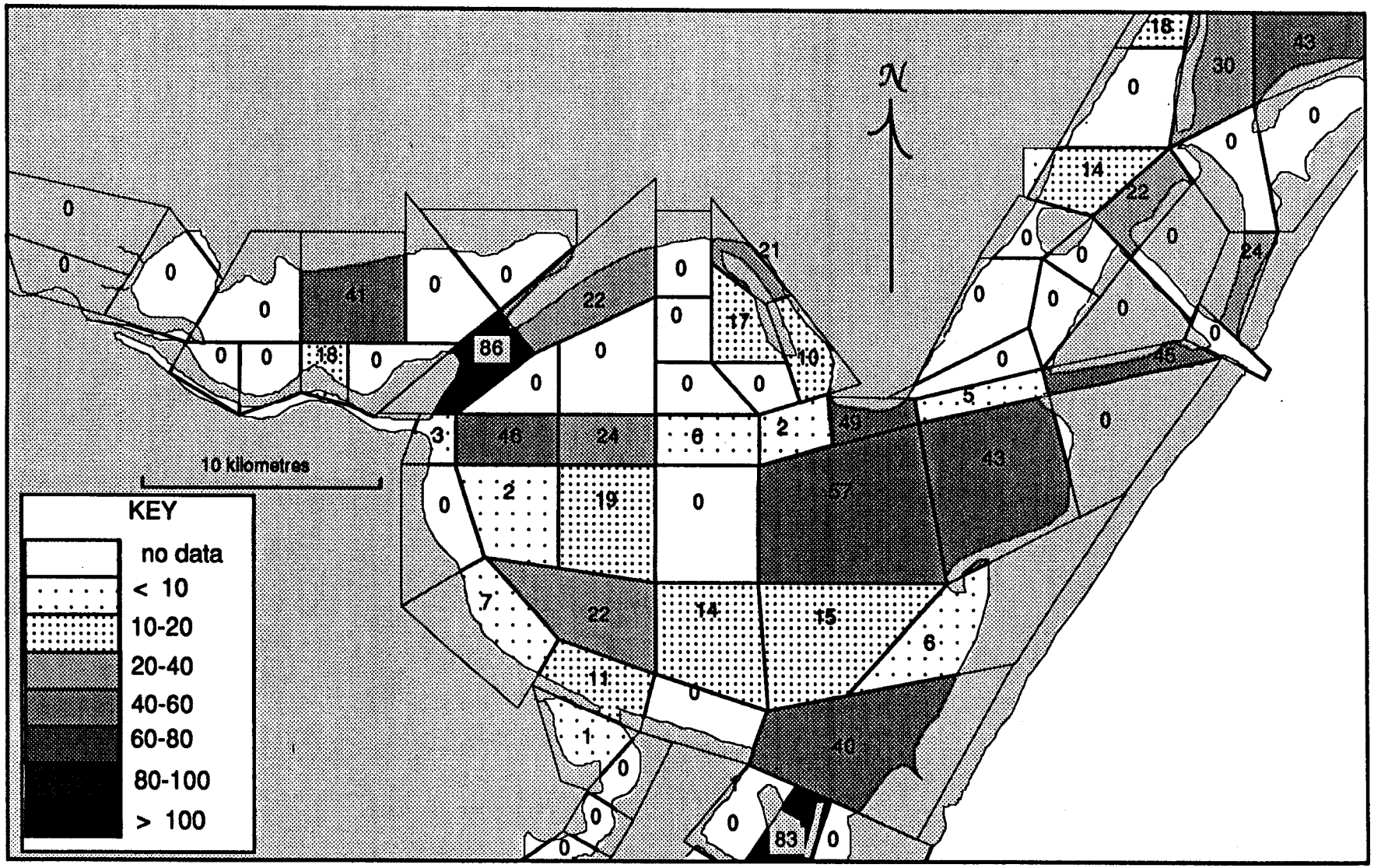


Figure 5-20. Sampling density of WQBOD5 for Corpus Christi system

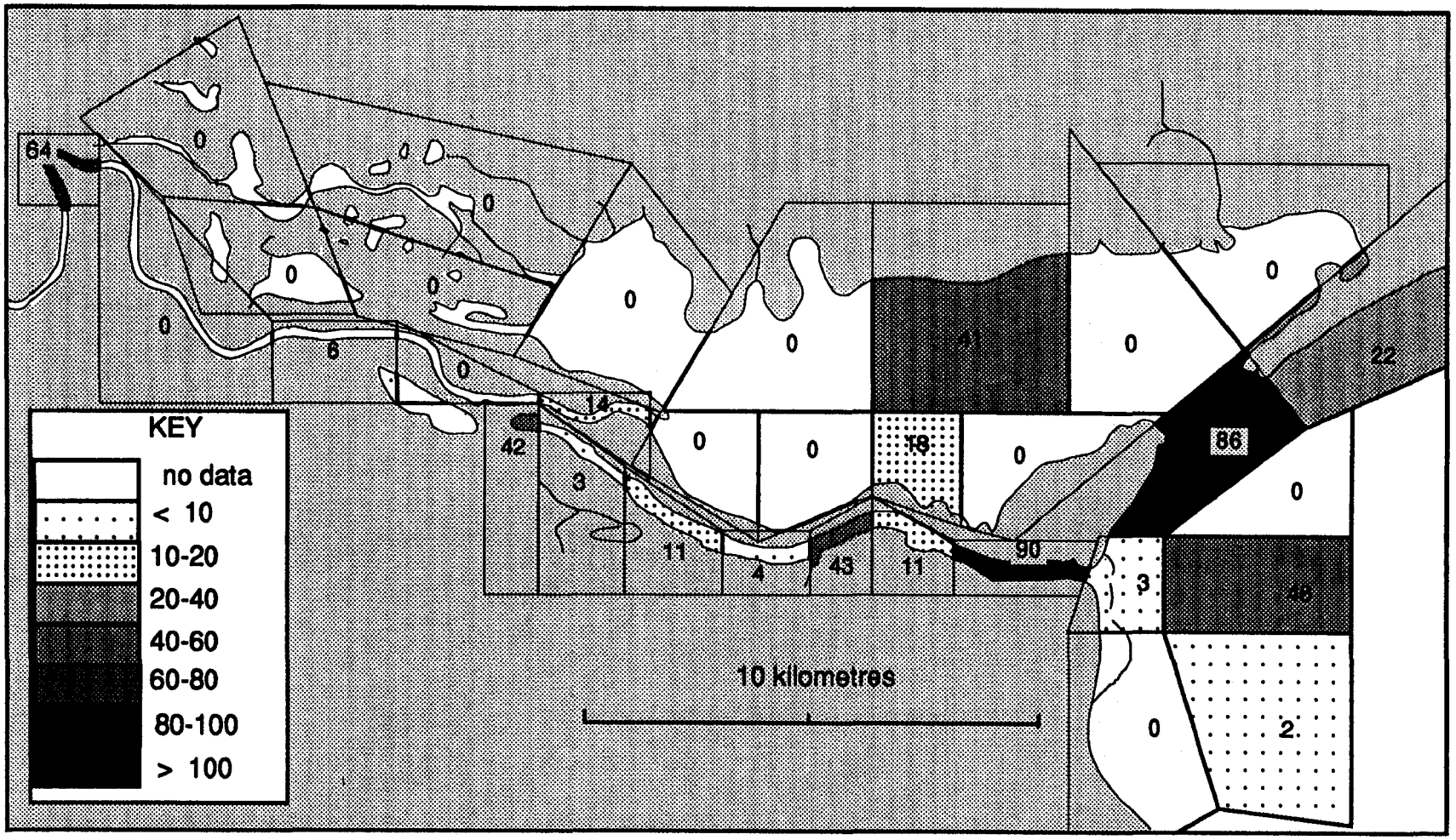


Figure 5-21. Sampling density of WQBOD5 for Nueces Bay region, including Inner Harbor

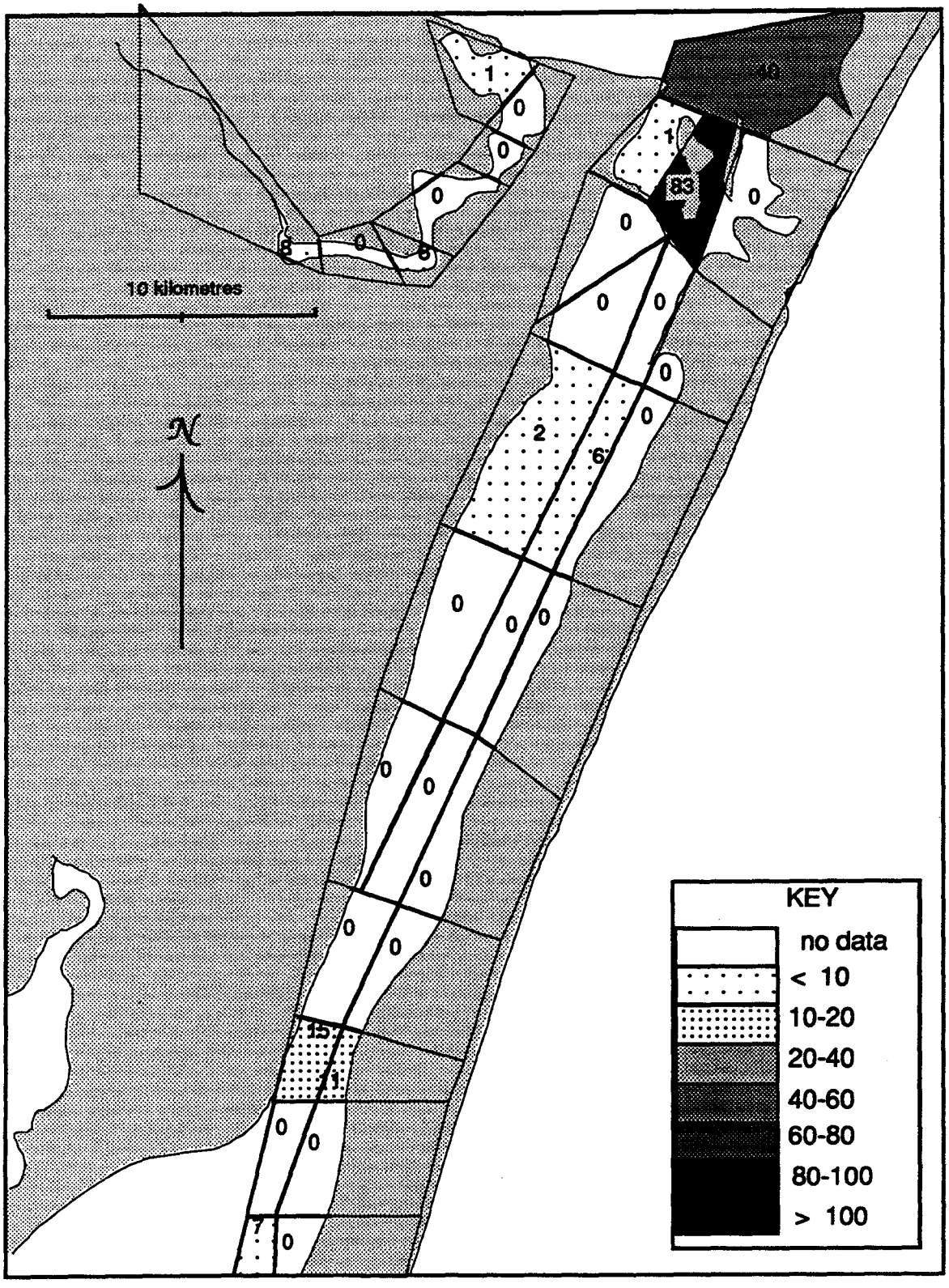


Figure 5-22. Sampling density of WQBOD5 for Upper Laguna Madre and Oso Bay

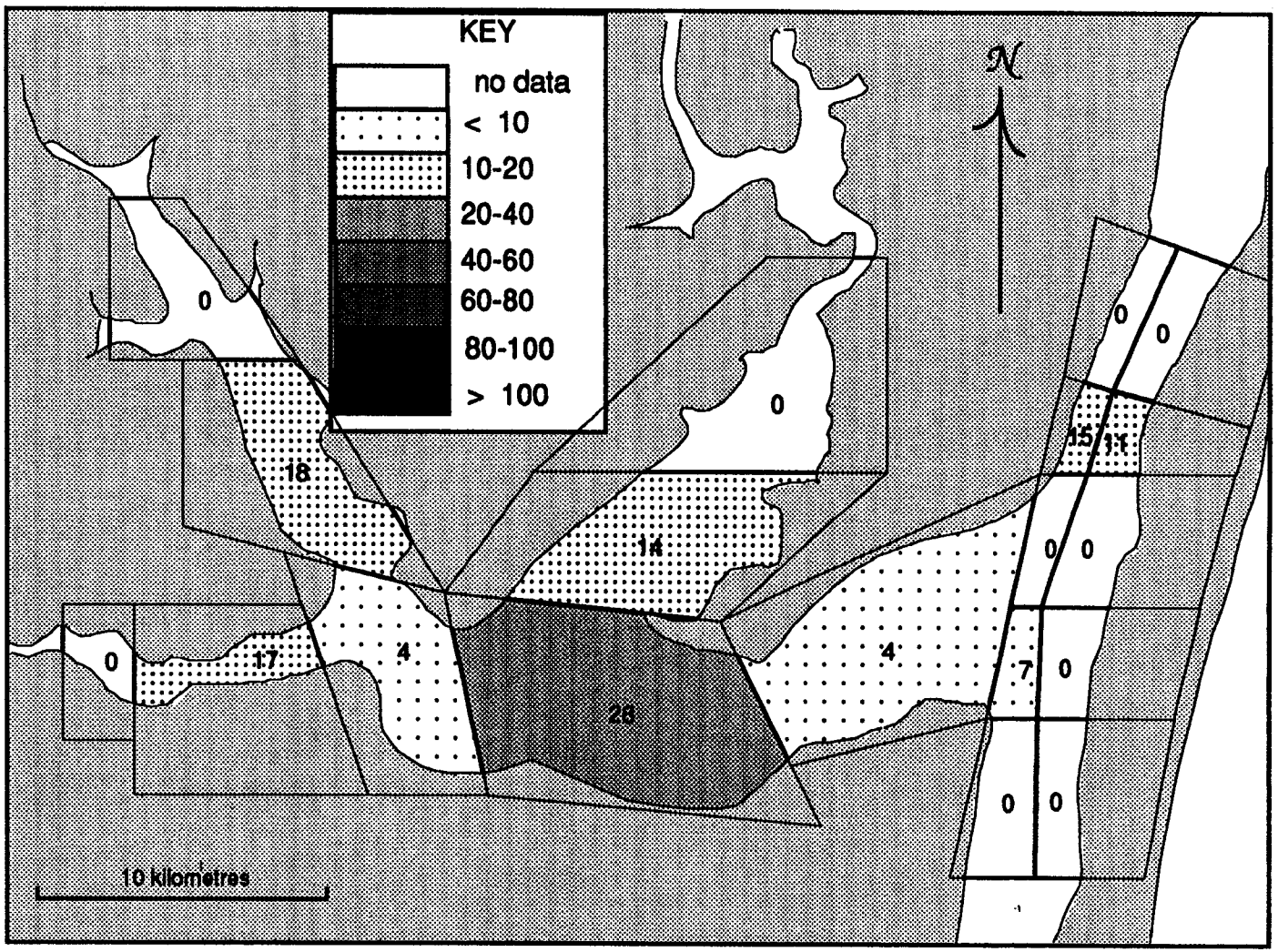


Figure 5-23. Sampling density of WQBOD5 for Baffin Bay region

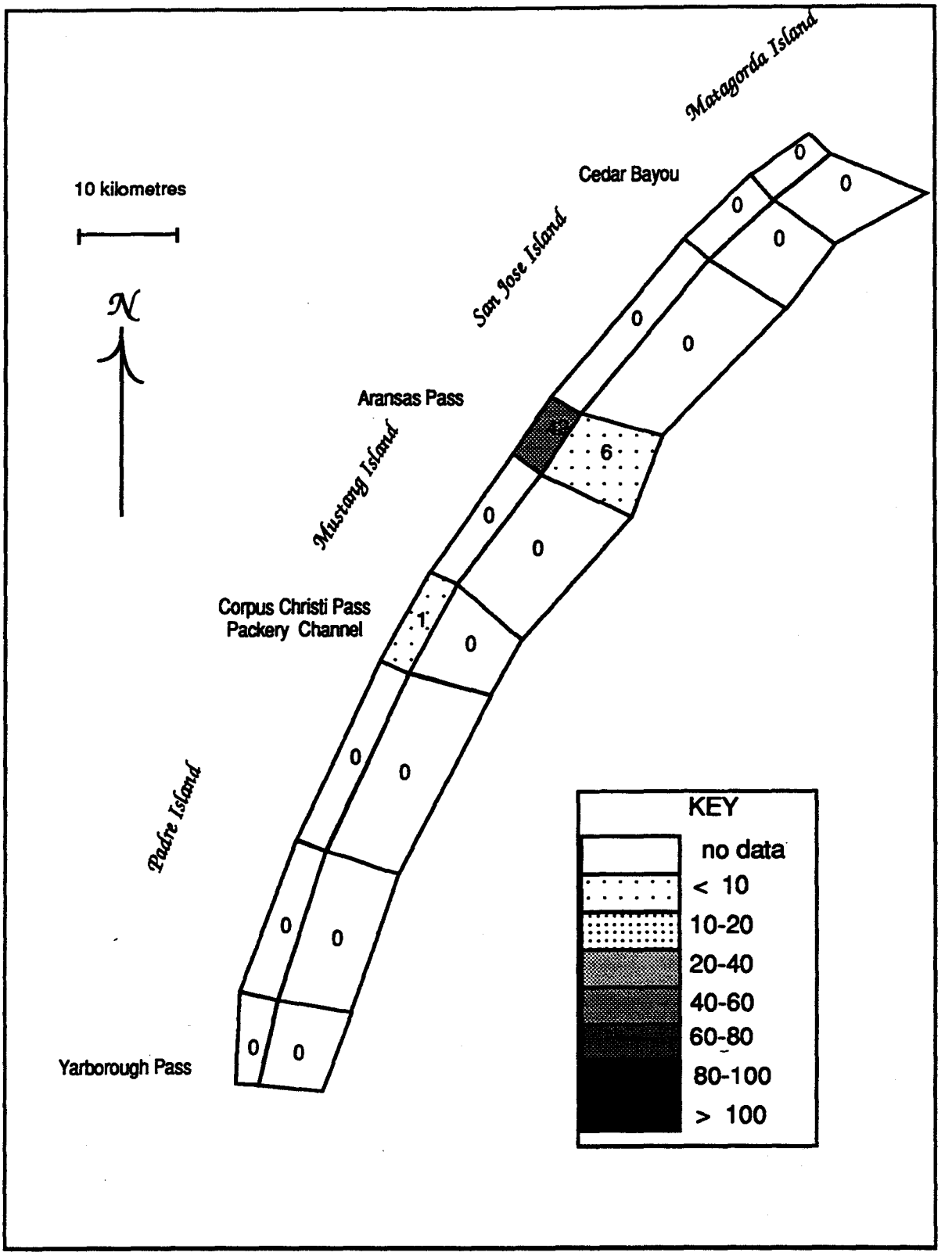


Figure 5-24. Sampling density of WQBOD5 for Gulf of Mexico

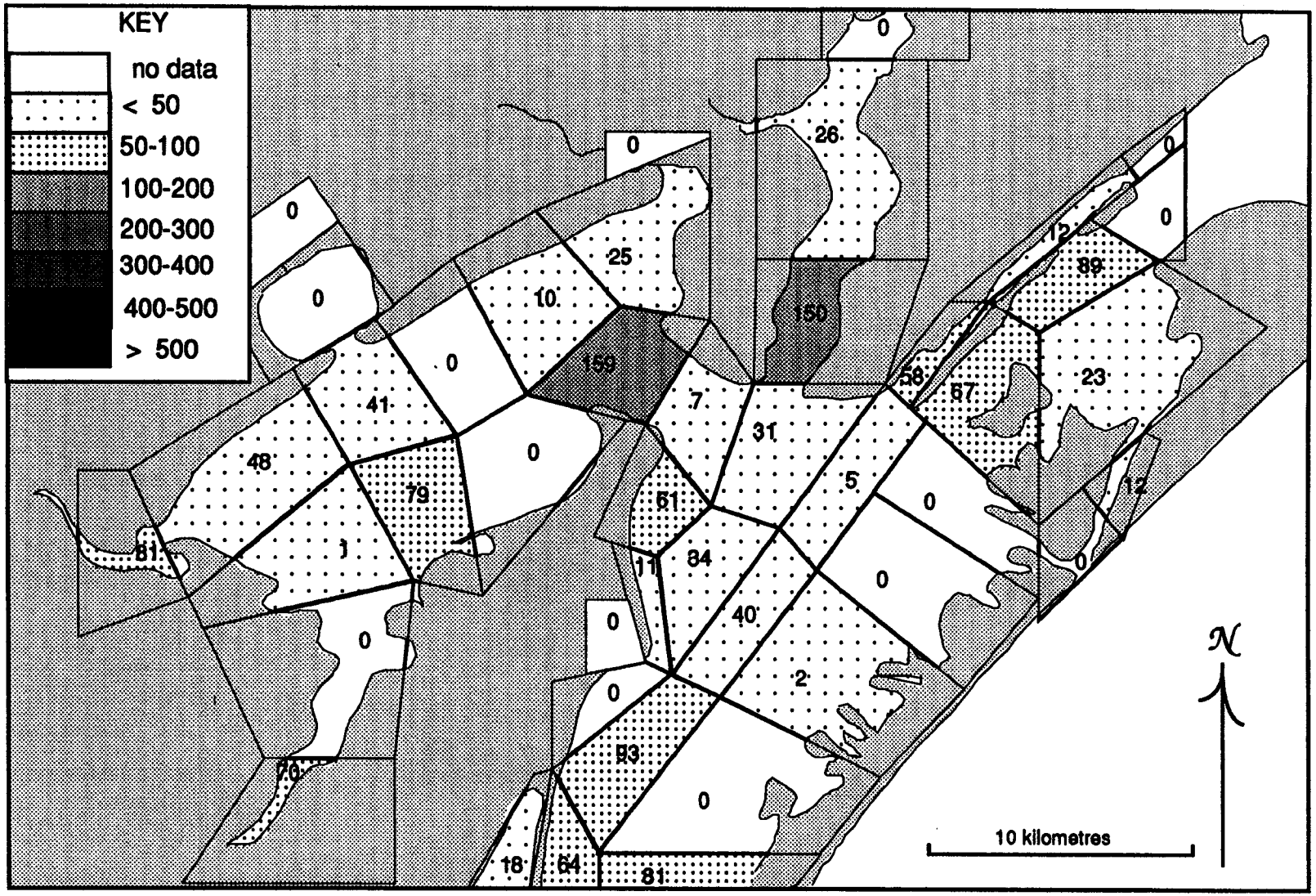


Figure 5-25. Sampling density of WQAMMN for Aransas-Copano system

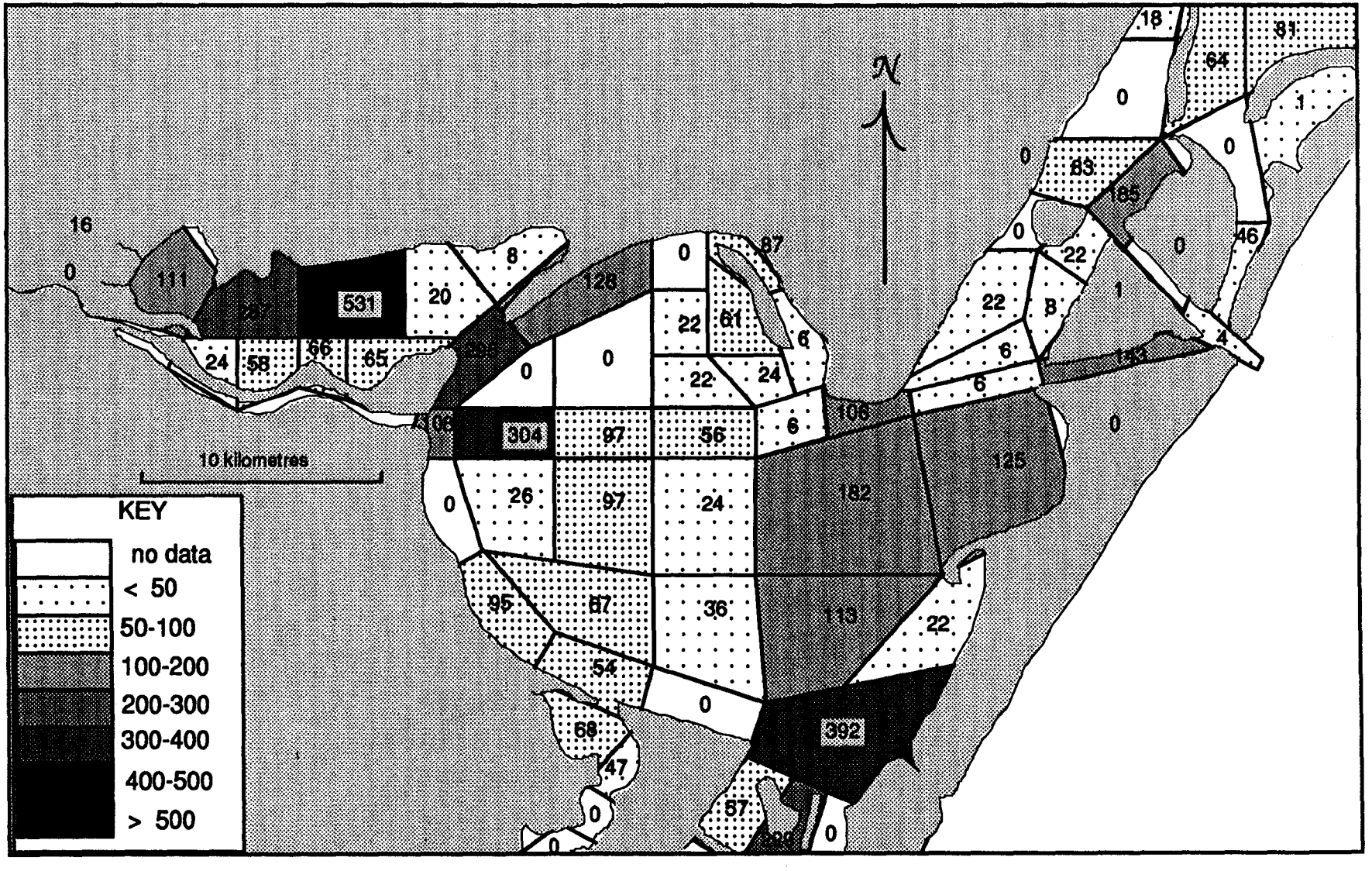


Figure 5-26. Sampling density of WQAMMN for Corpus Christi system

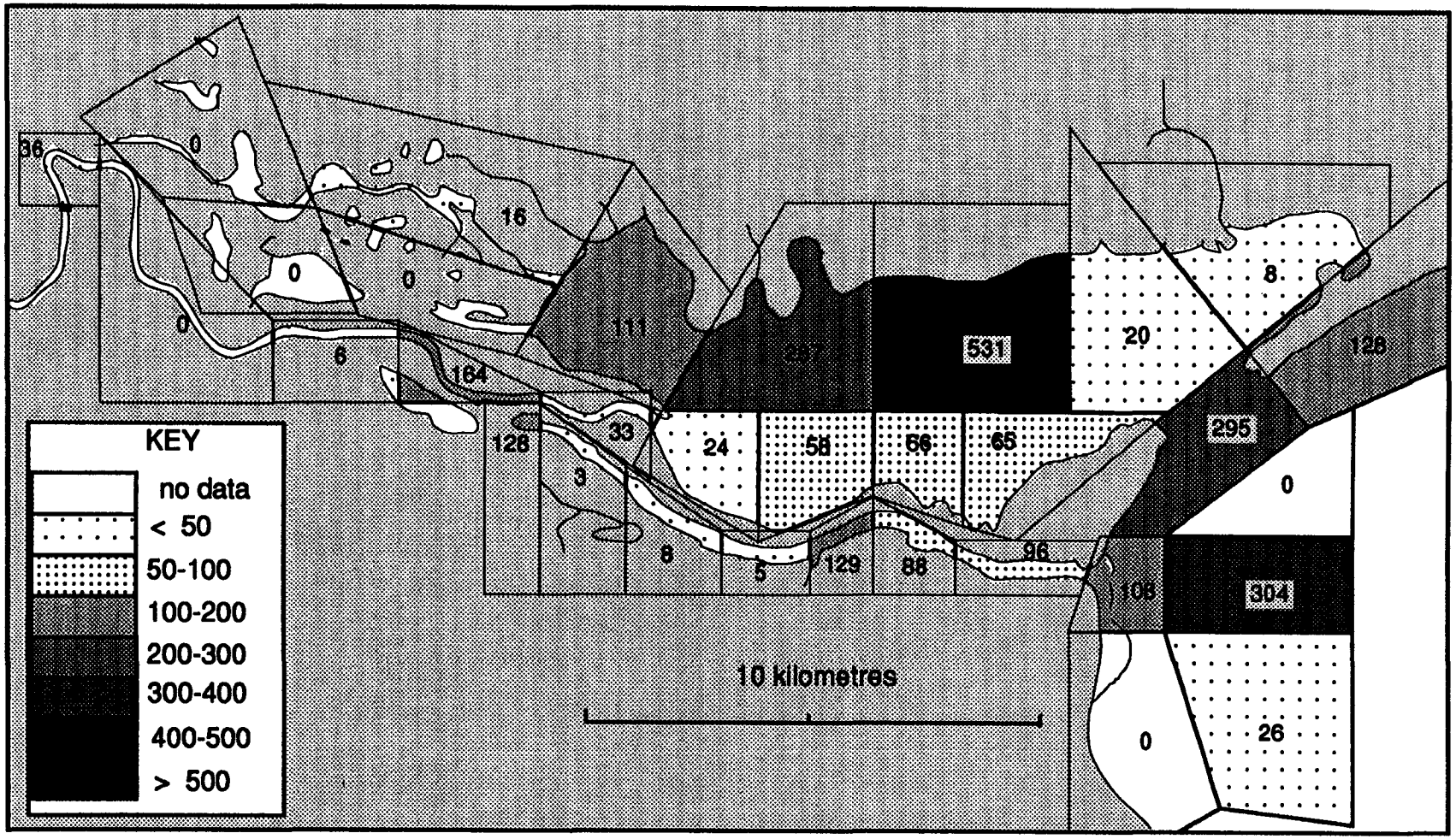


Figure 5-27. Sampling density of WQAMMN for Nueces Bay region, including Inner Harbor

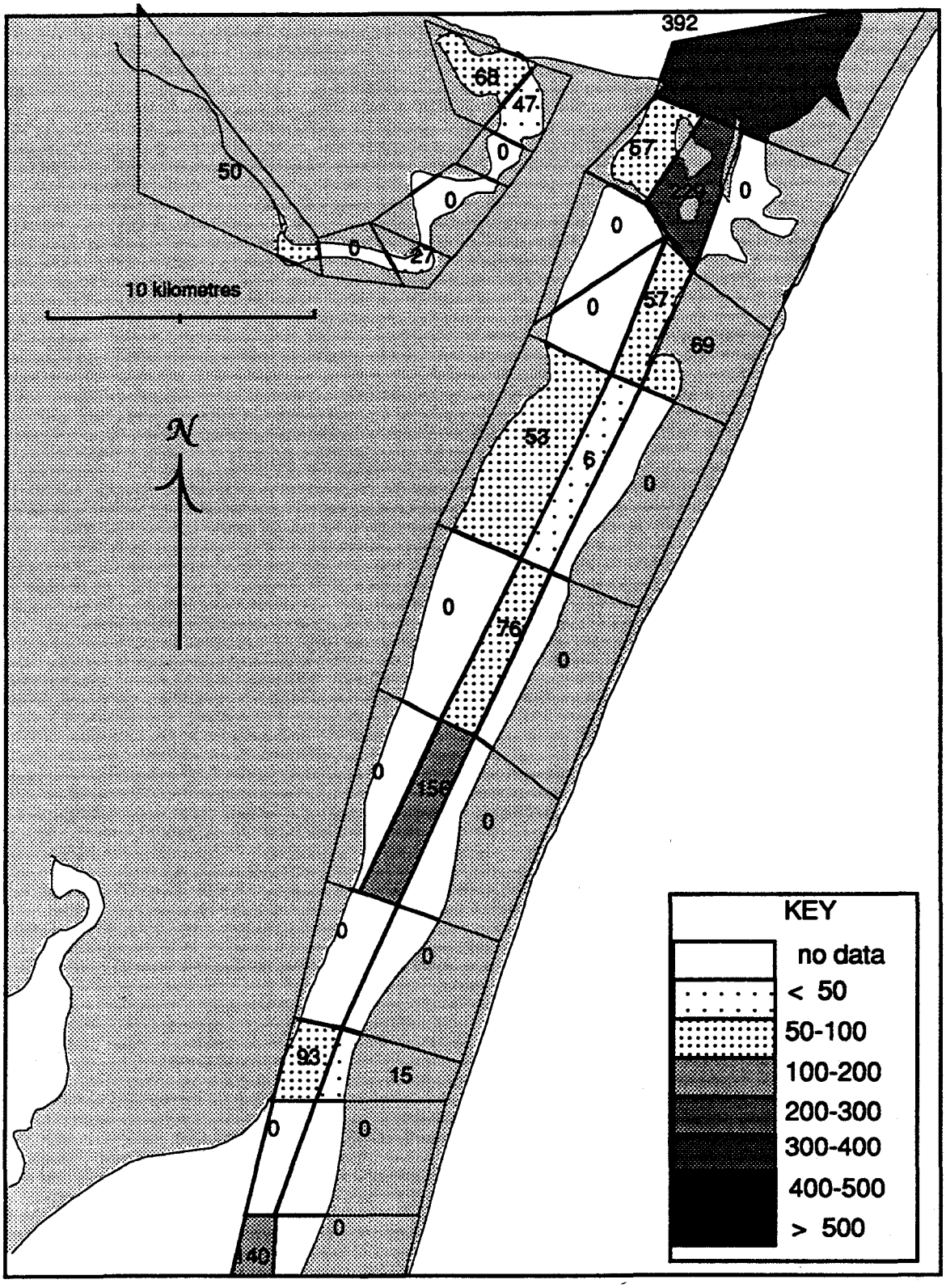


Figure 5-28. Sampling density of WQAMMN for Upper Laguna Madre and Oso Bay

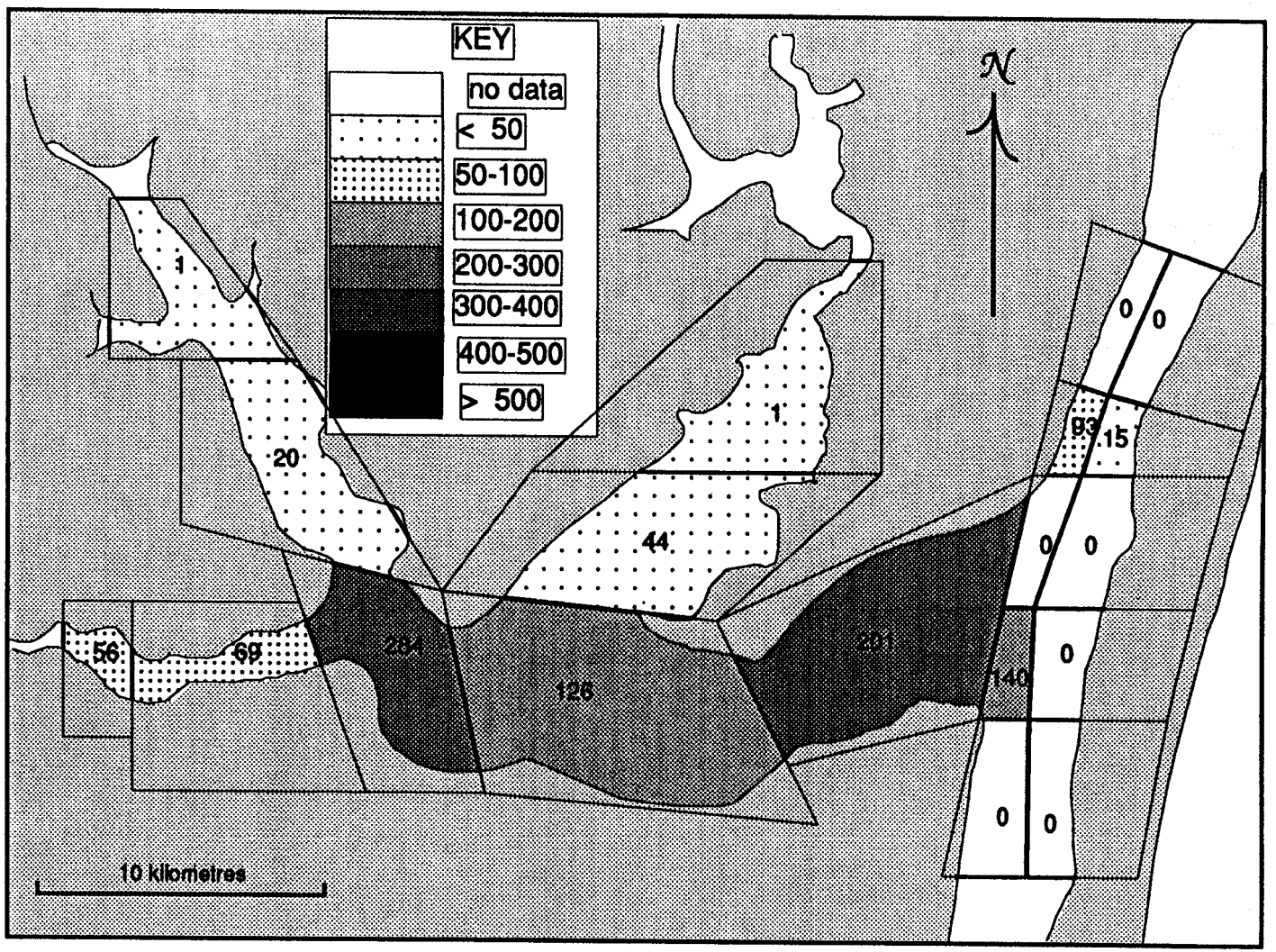


Figure 5-29. Sampling density of WQAMMN for Baffin Bay region

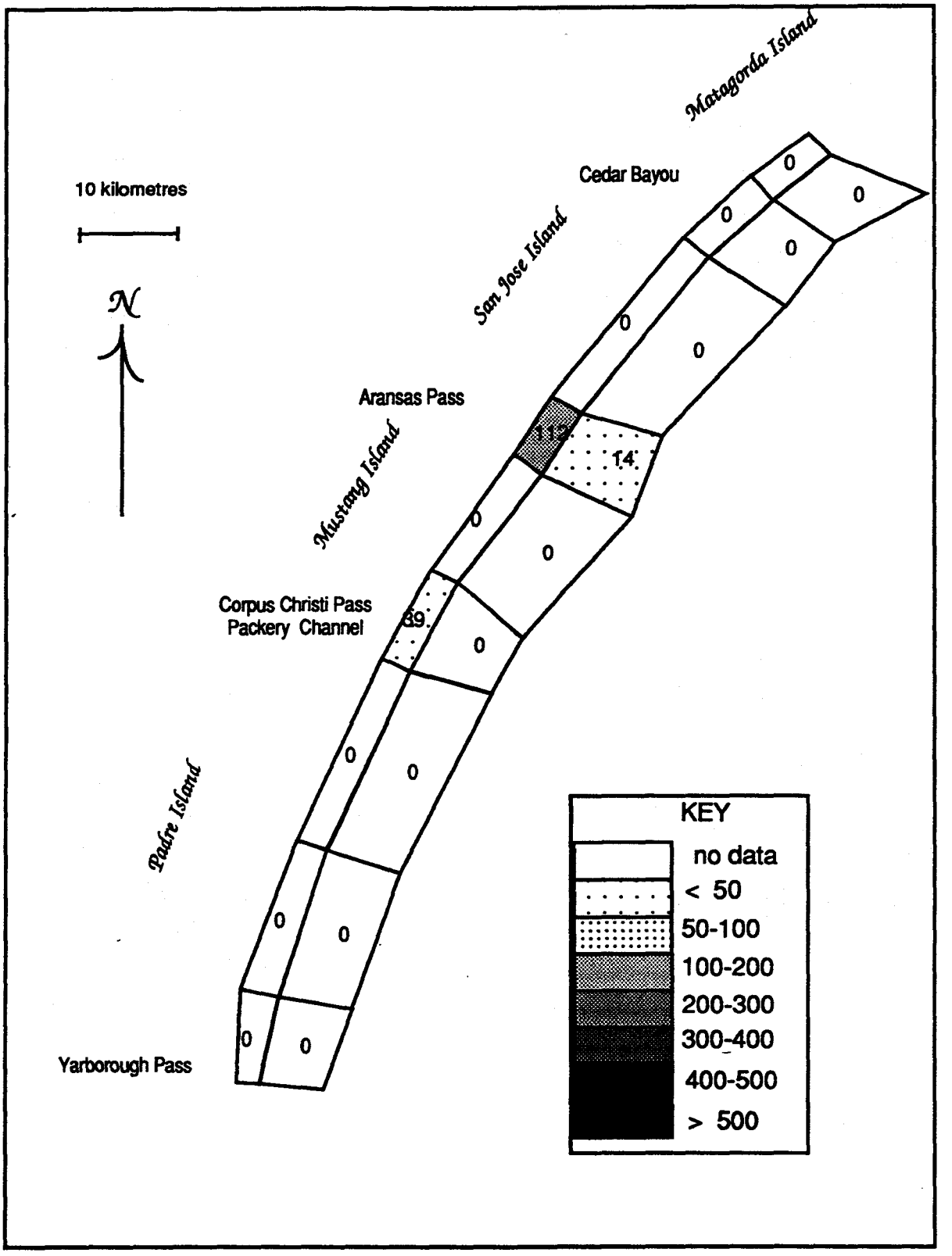


Figure 5-30. Sampling density of WQAMMN for Gulf of Mexico

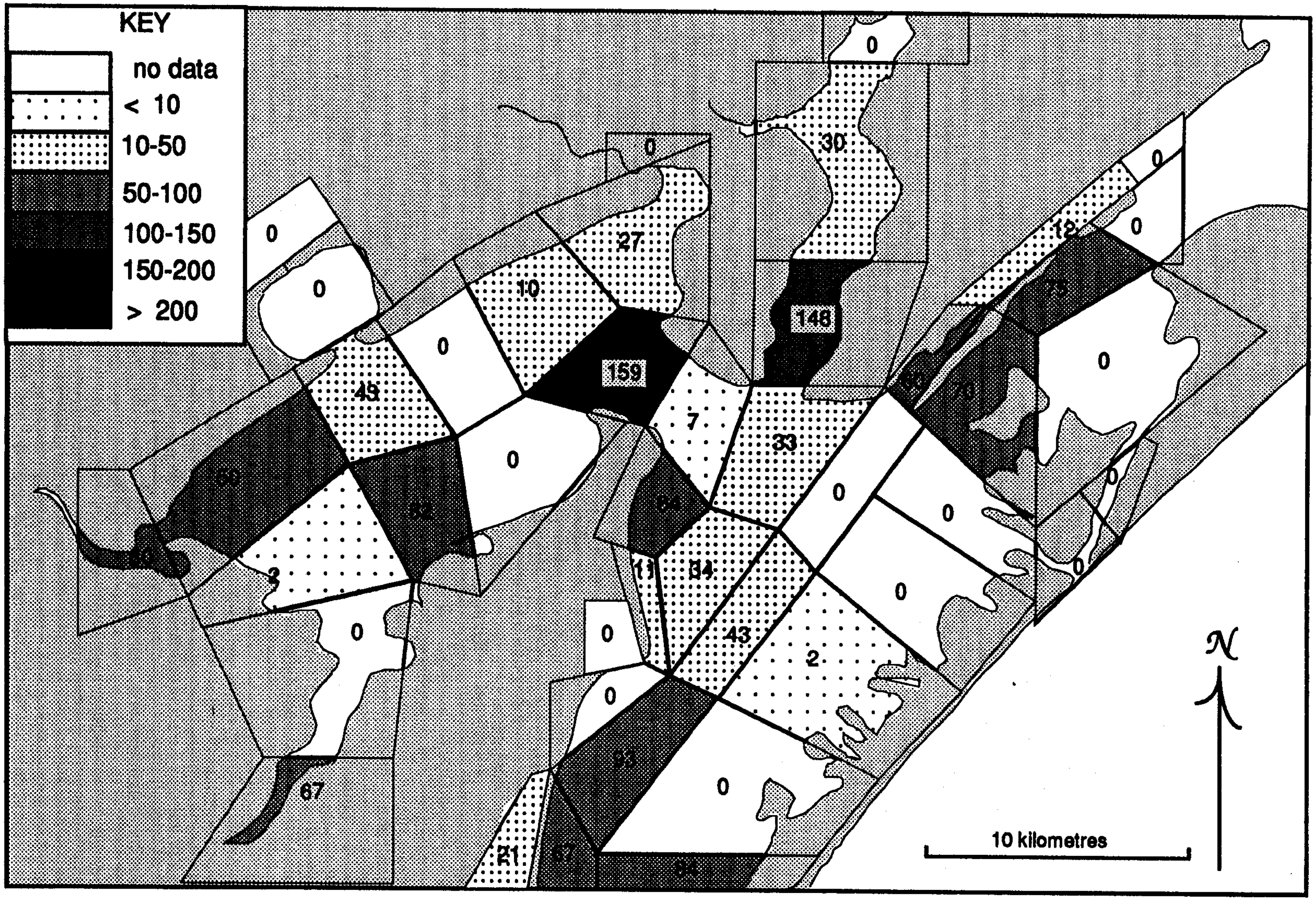


Figure 5-31. Sampling density of WQTOTP for Aransas-Copano system

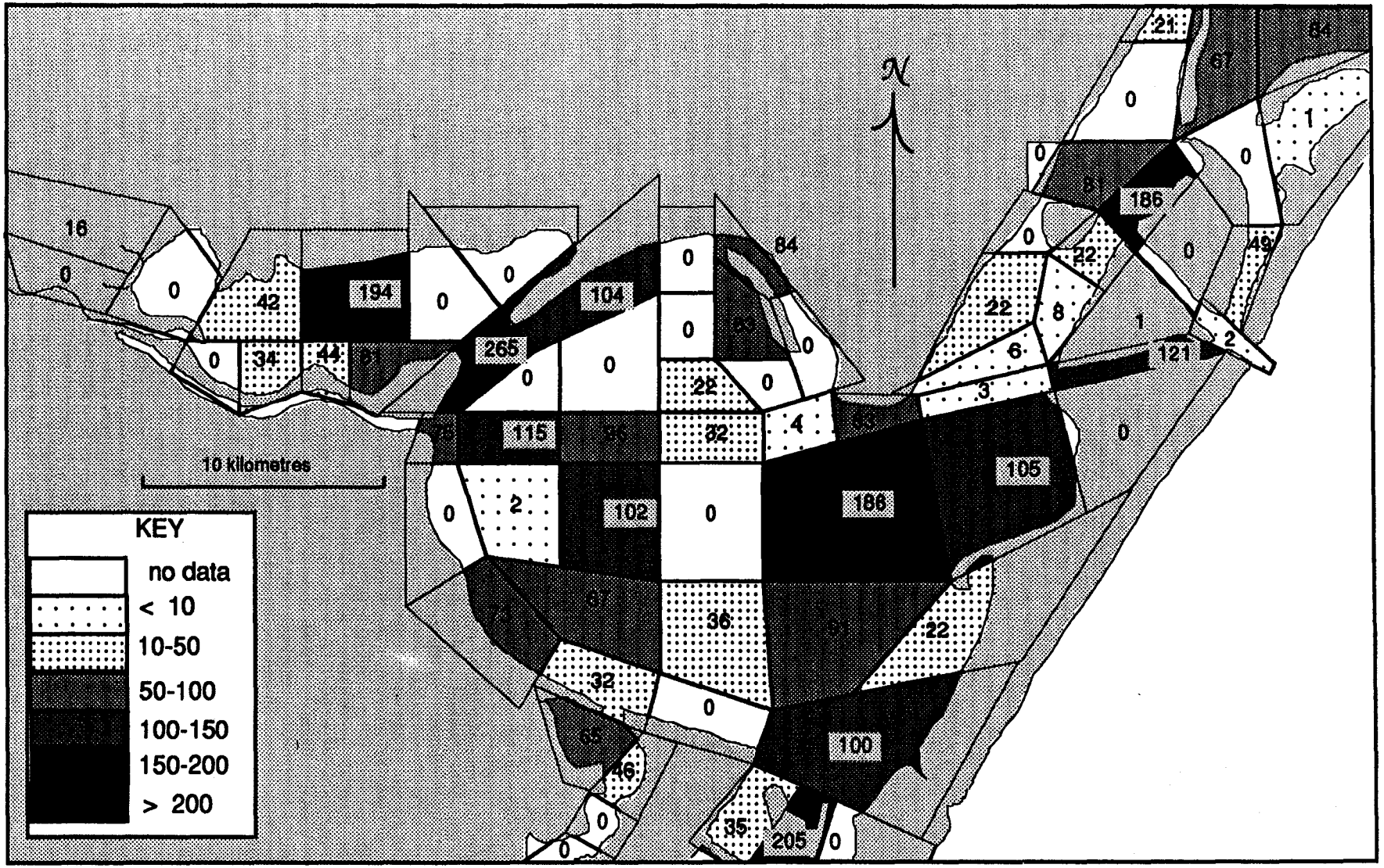


Figure 5-32. Sampling density of WQTOTP for Corpus Christi system

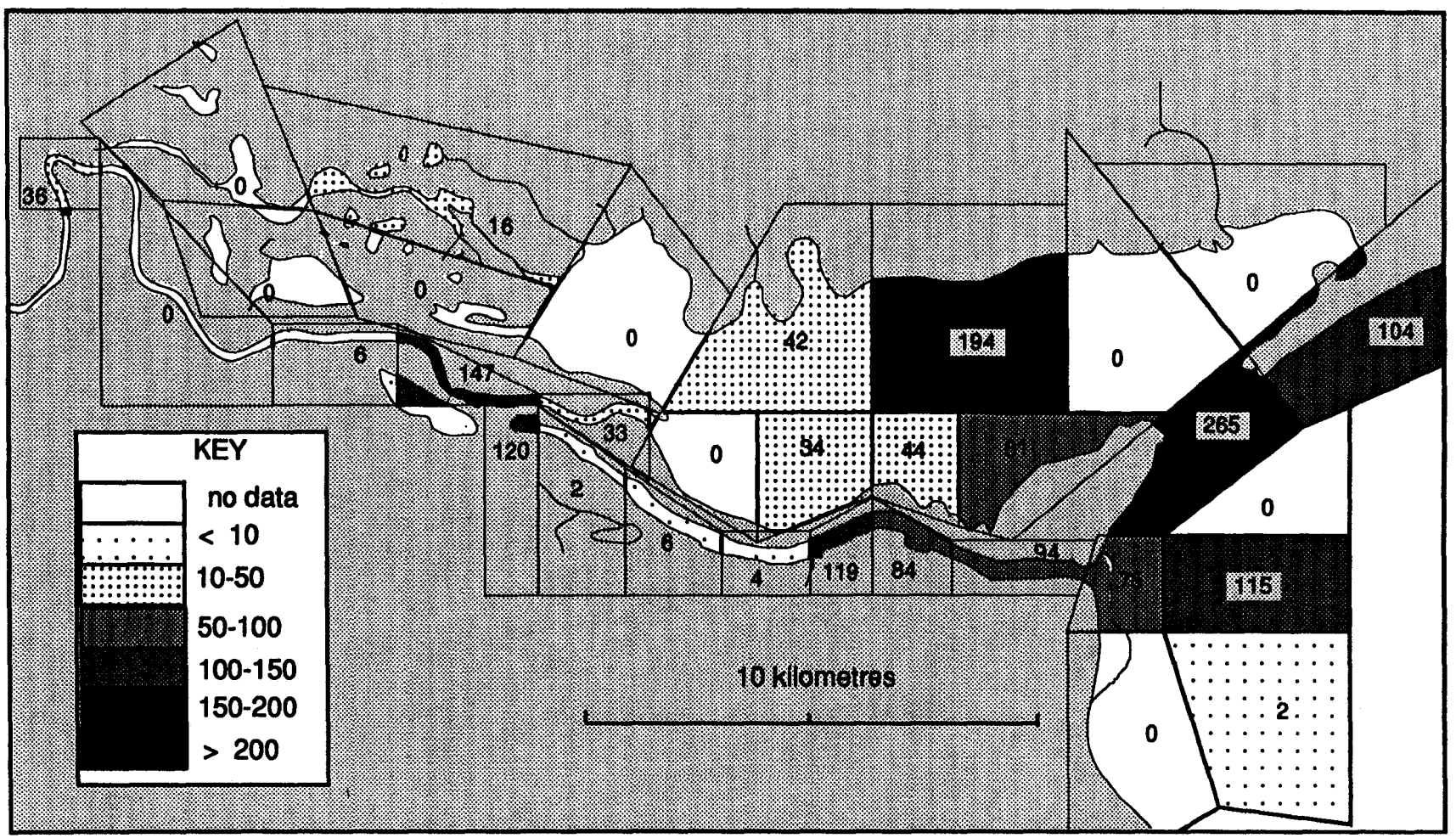


Figure 5-33. Sampling density of WQTOTP for Nueces Bay region, including Inner Harbor

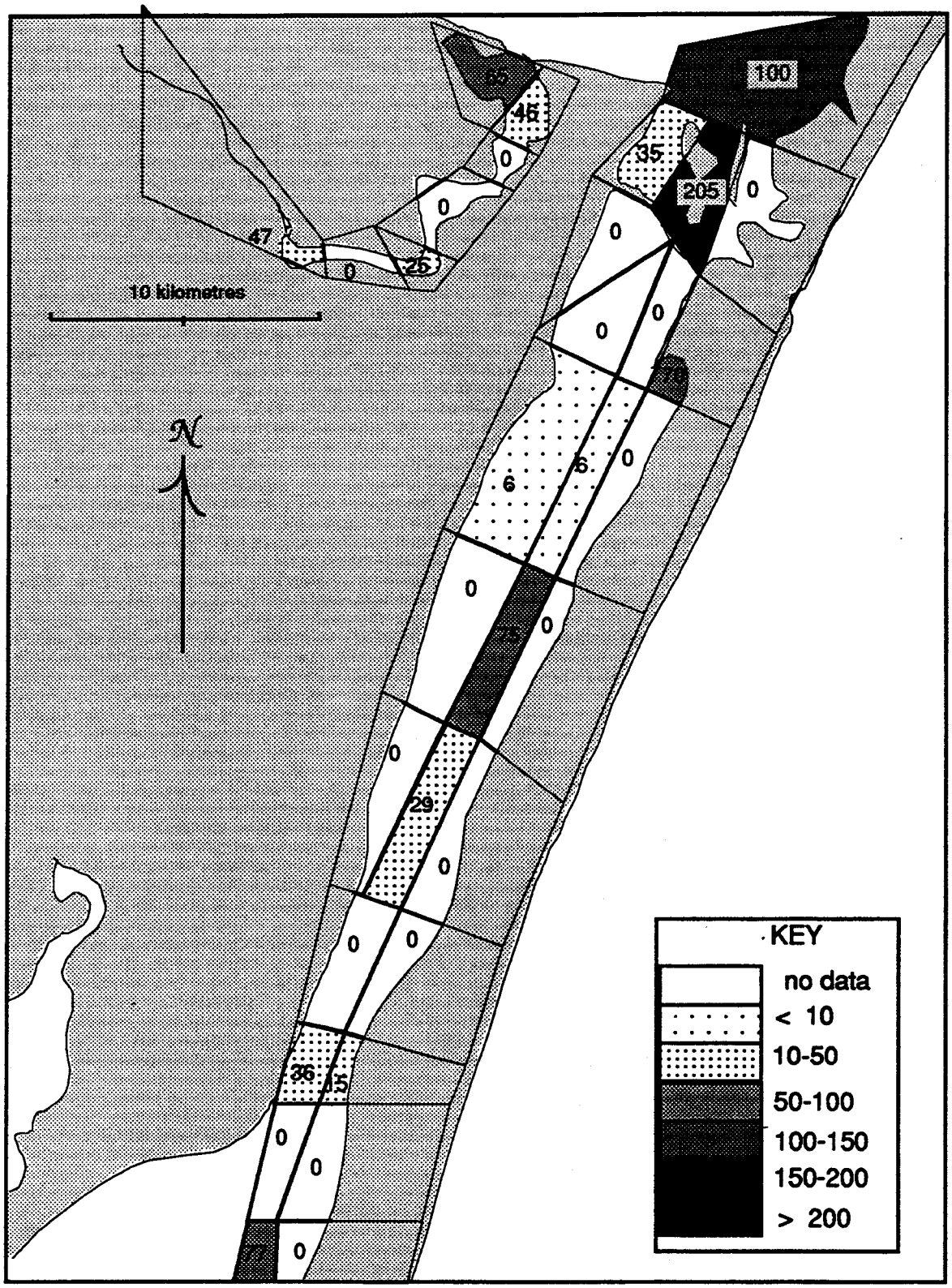


Figure 5-34. Sampling density of WQTOTP for Upper Laguna Madre and Oso Bay

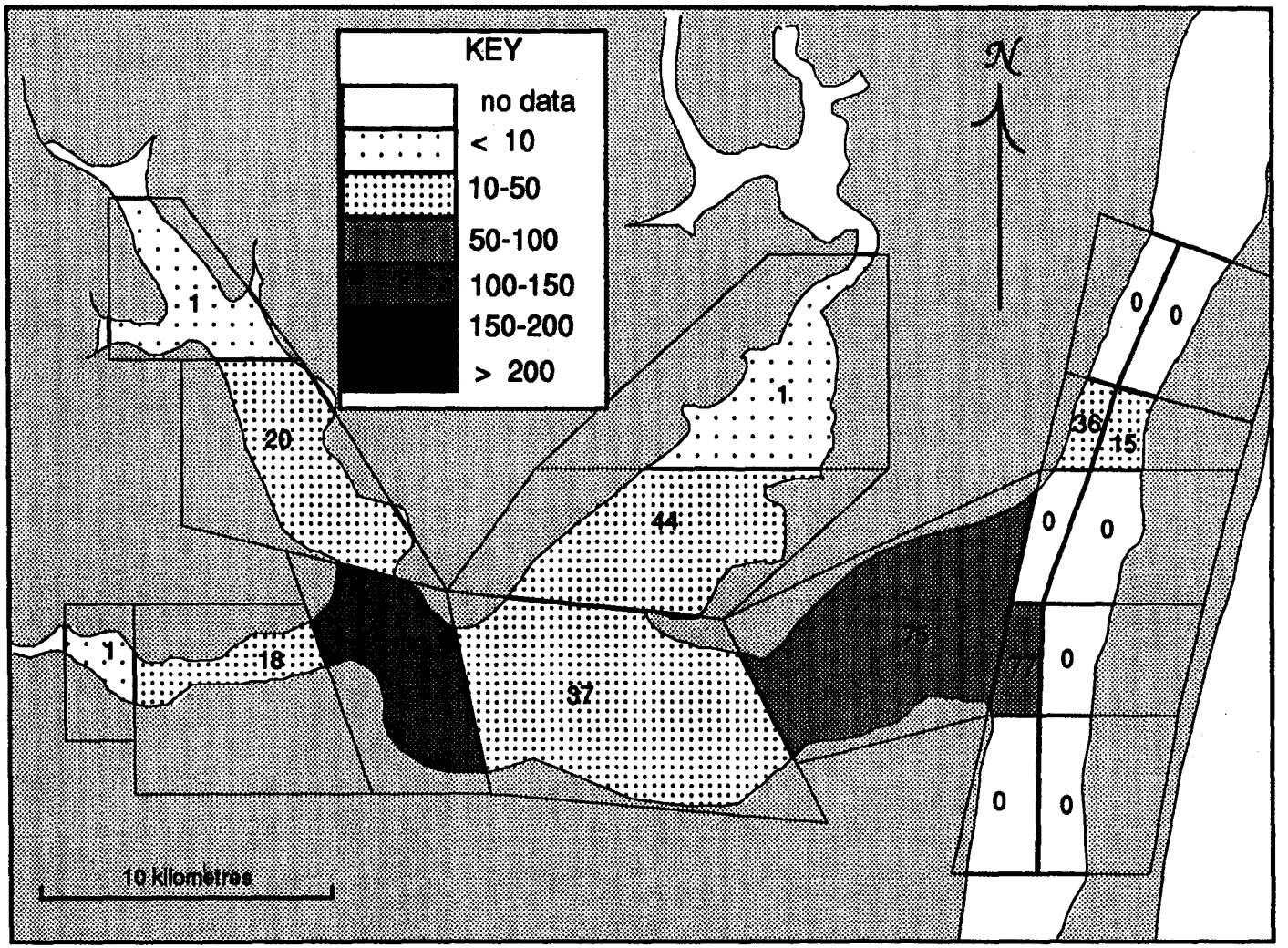


Figure 5-35. Sampling density of WQTOTP for Baffin Bay region

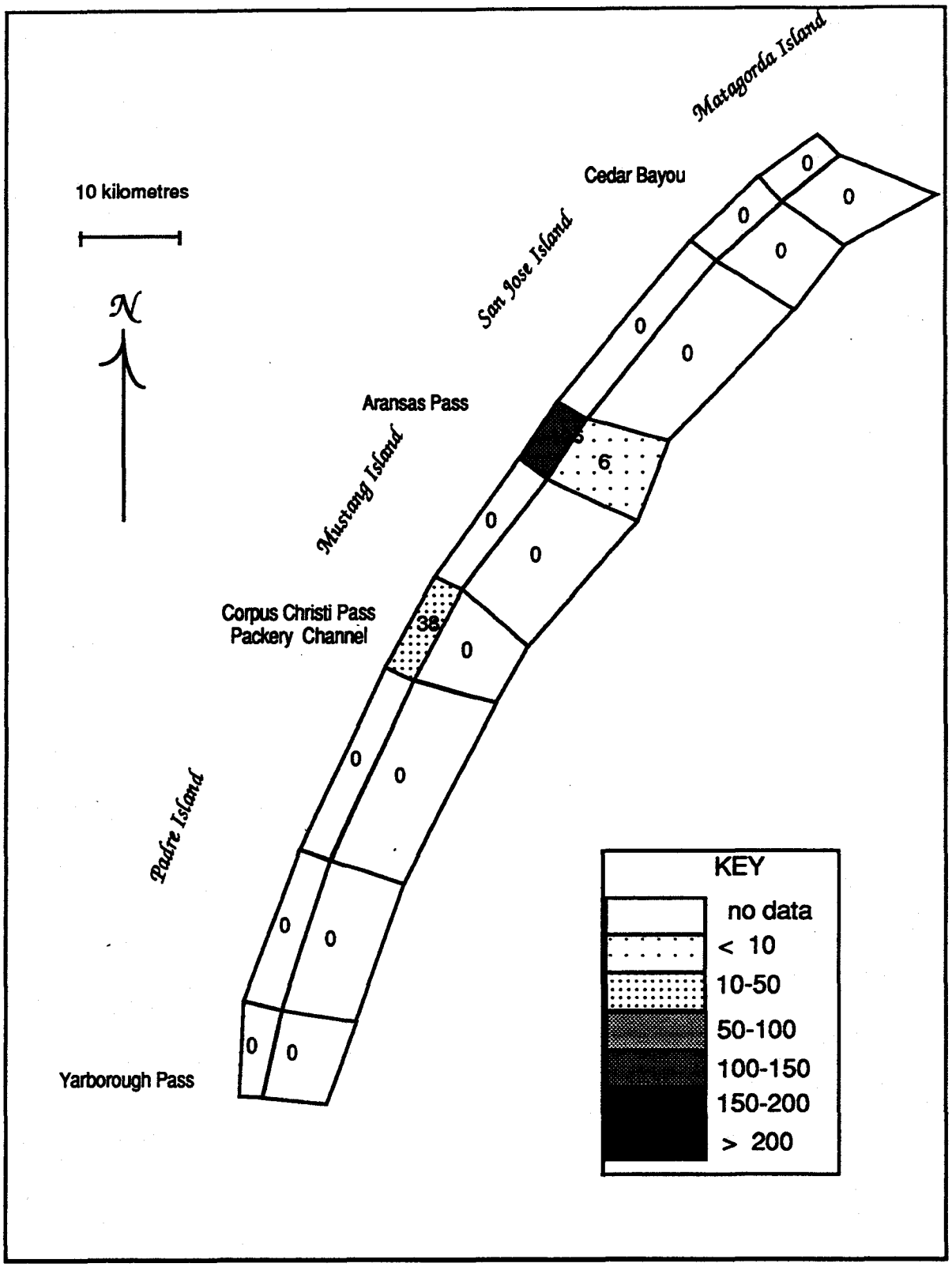


Figure 5-36. Sampling density of WQTOTP for Gulf of Mexico

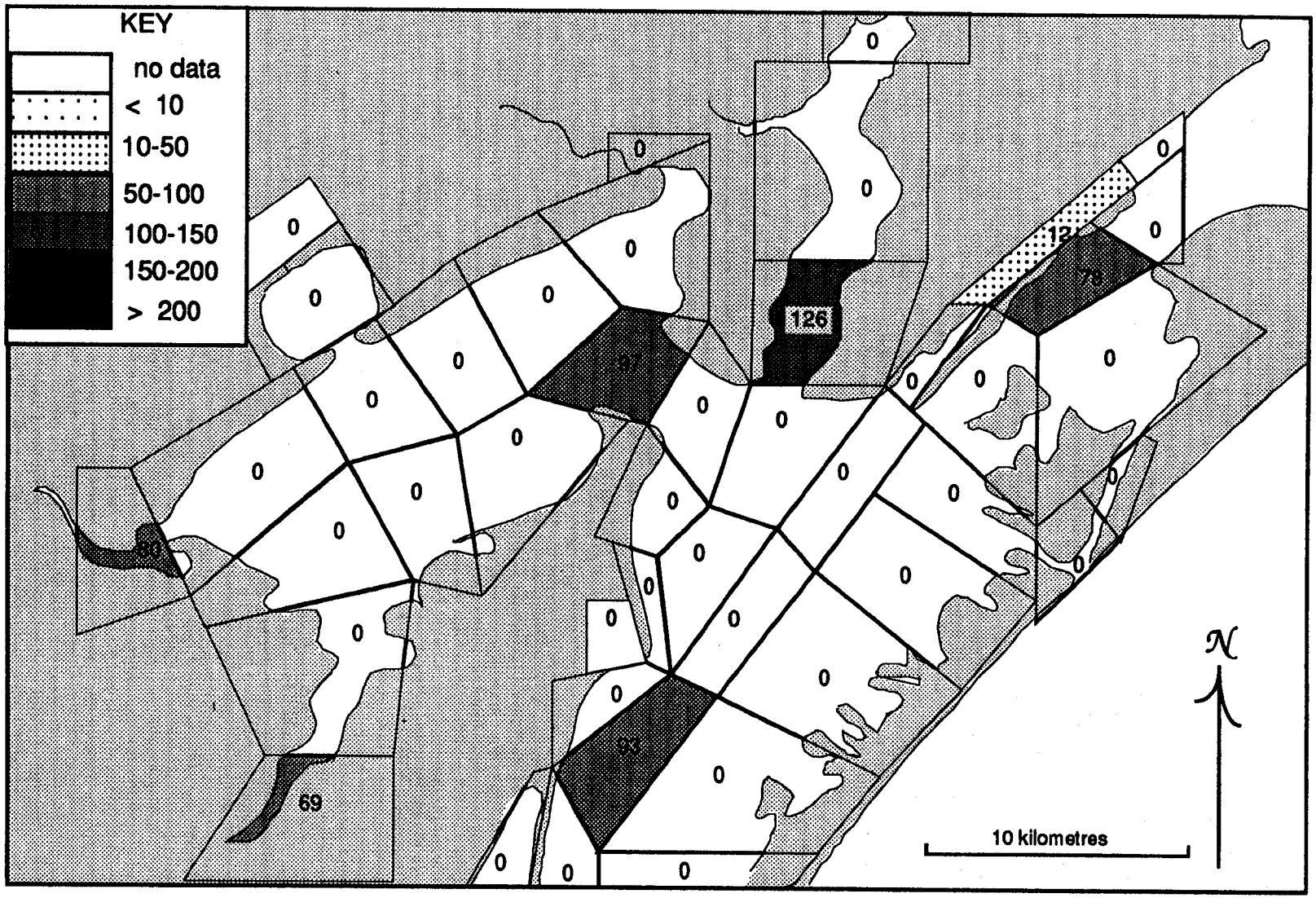


Figure 5-37. Sampling density of WQTSS for Aransas-Copano system

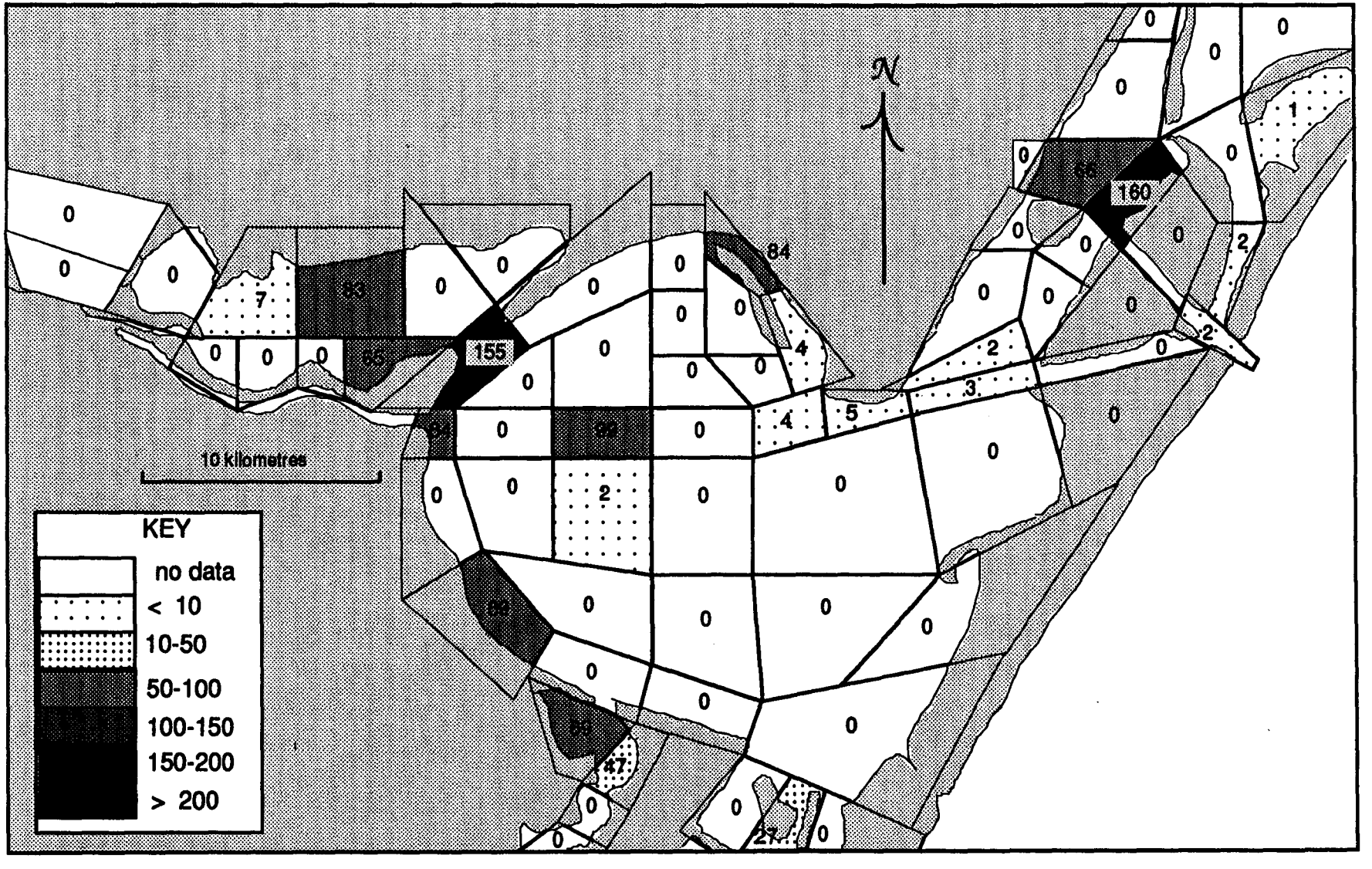


Figure 5-38. Sampling density of WQTSS for Corpus Christi system

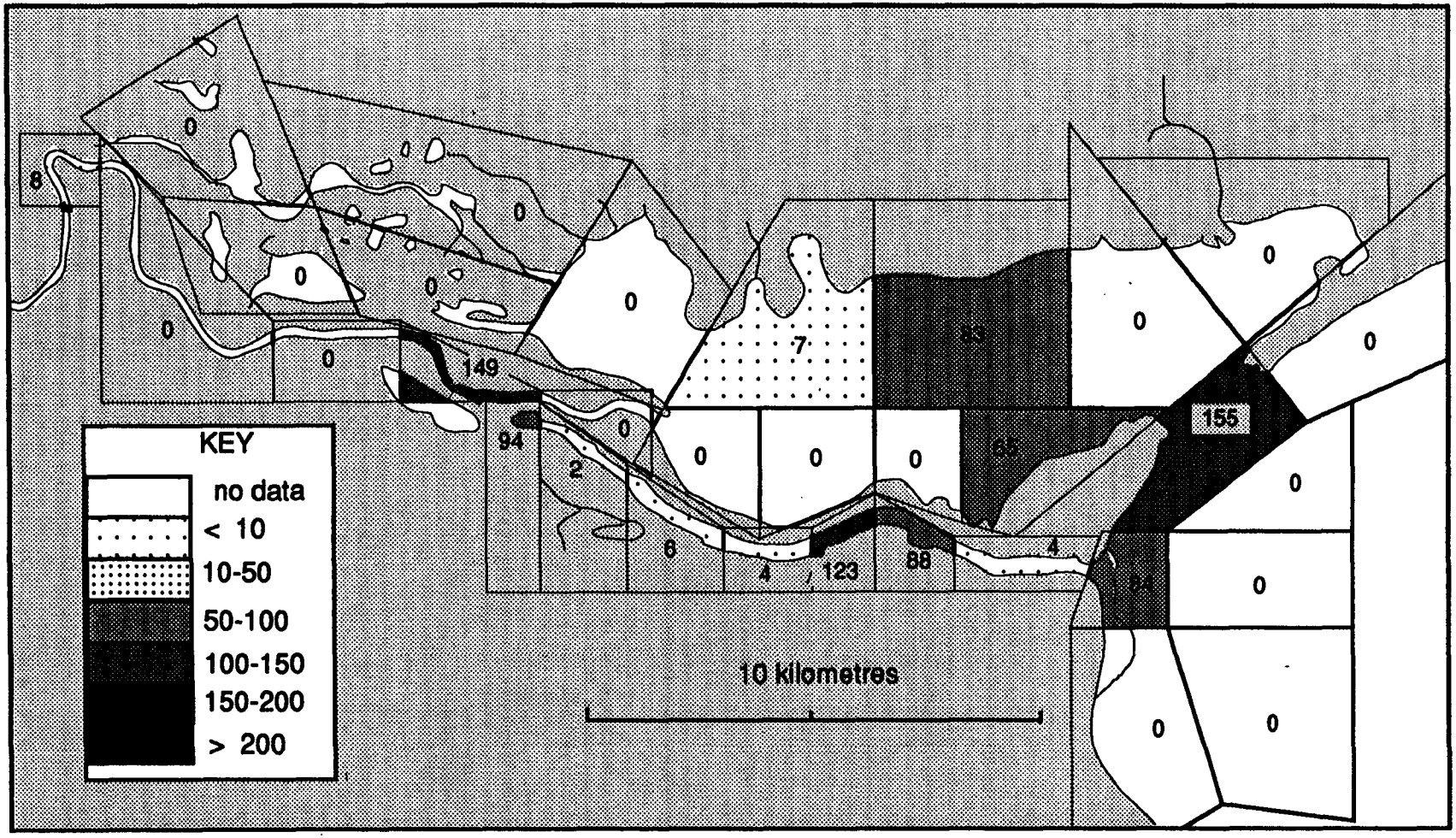


Figure 5-39. Sampling density of WQTSS for Nueces Bay region, including Inner Harbor

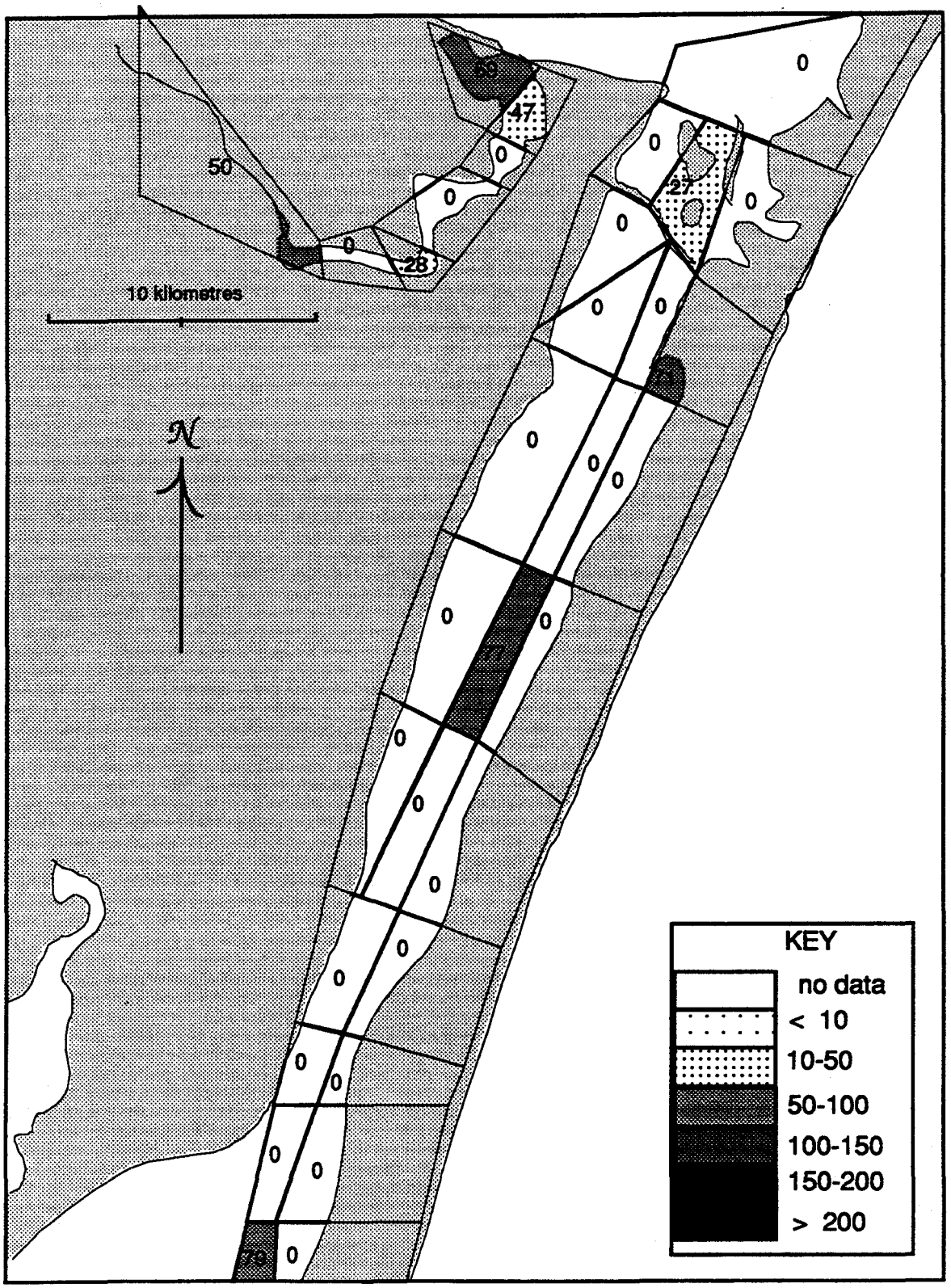


Figure 5-40. Sampling density of WQTSS for Upper Laguna Madre and Oso Bay

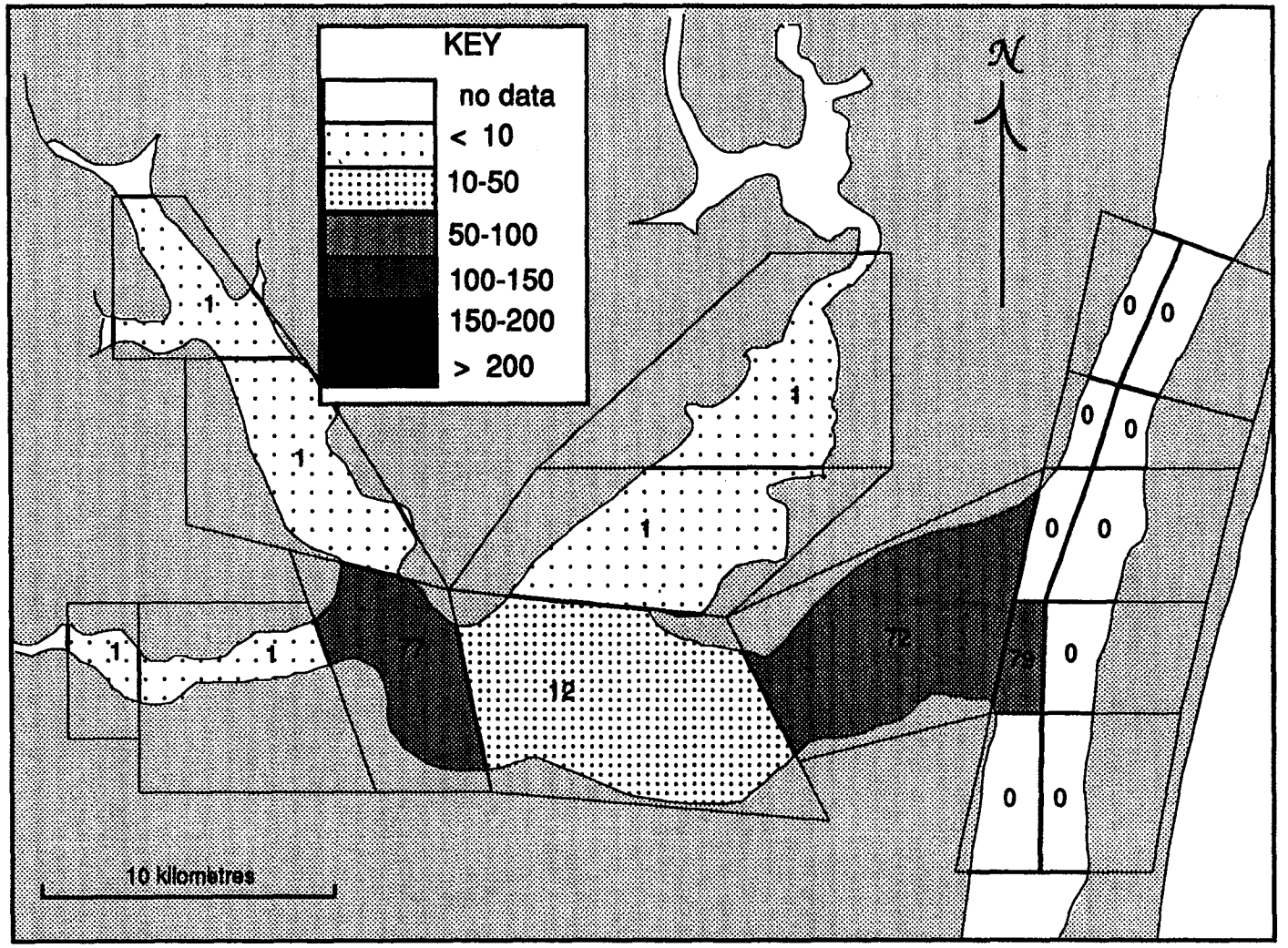


Figure 5-41. Sampling density of WQTSS for Baffin Bay region

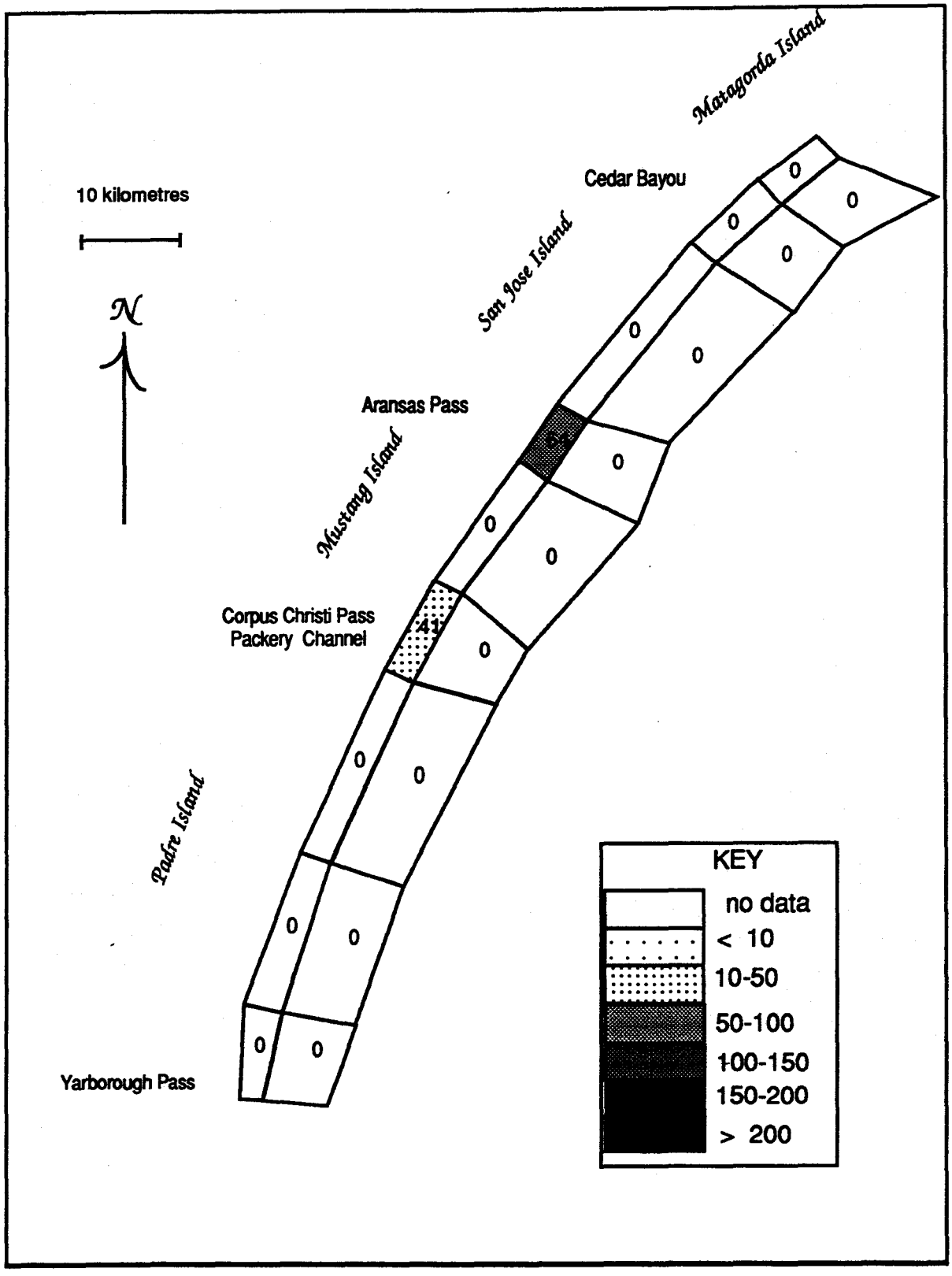


Figure 5-42. Sampling density of WQTSS for Gulf of Mexico

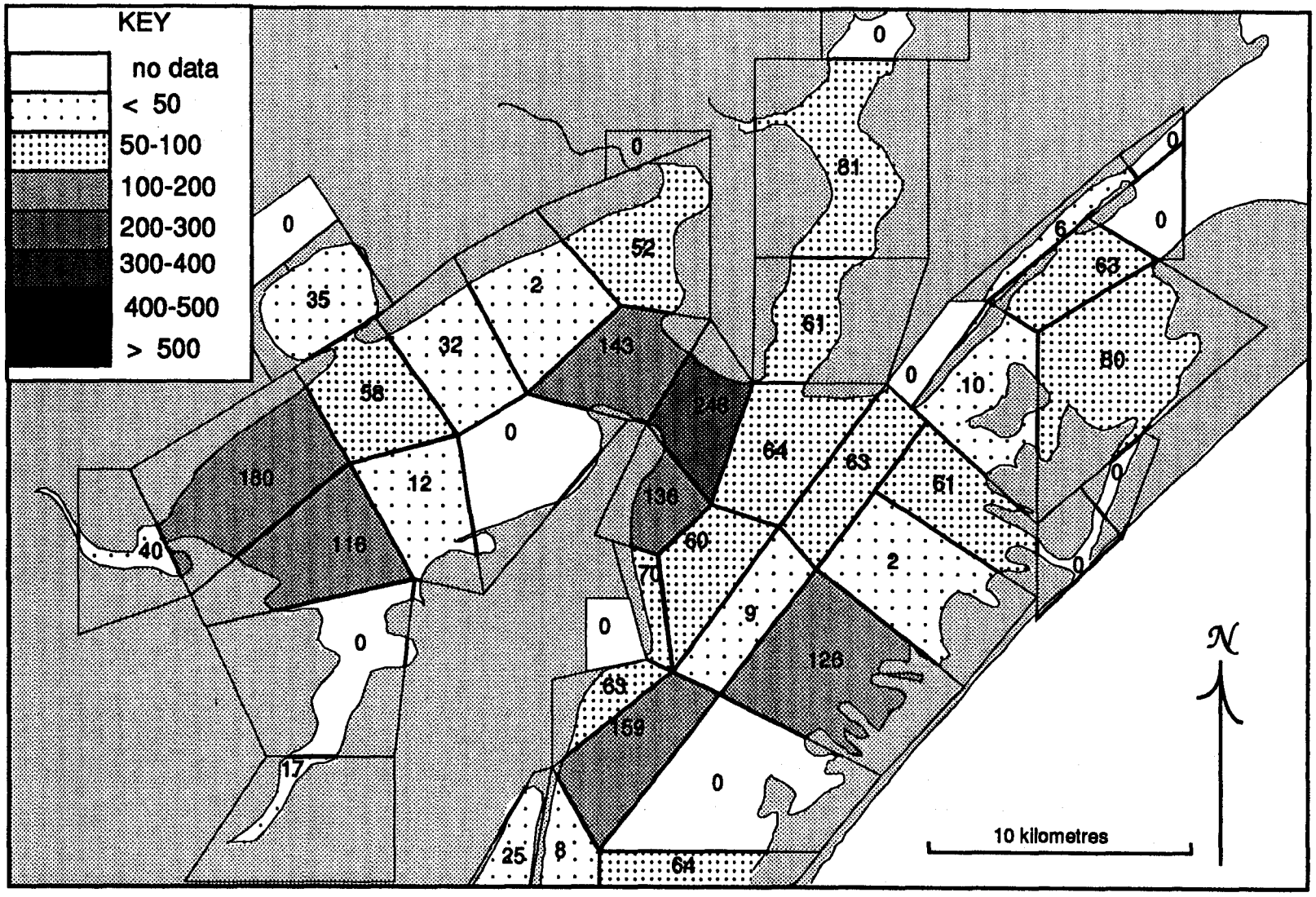


Figure 5-43. Sampling density of WQFCOLI for Aransas-Copano system

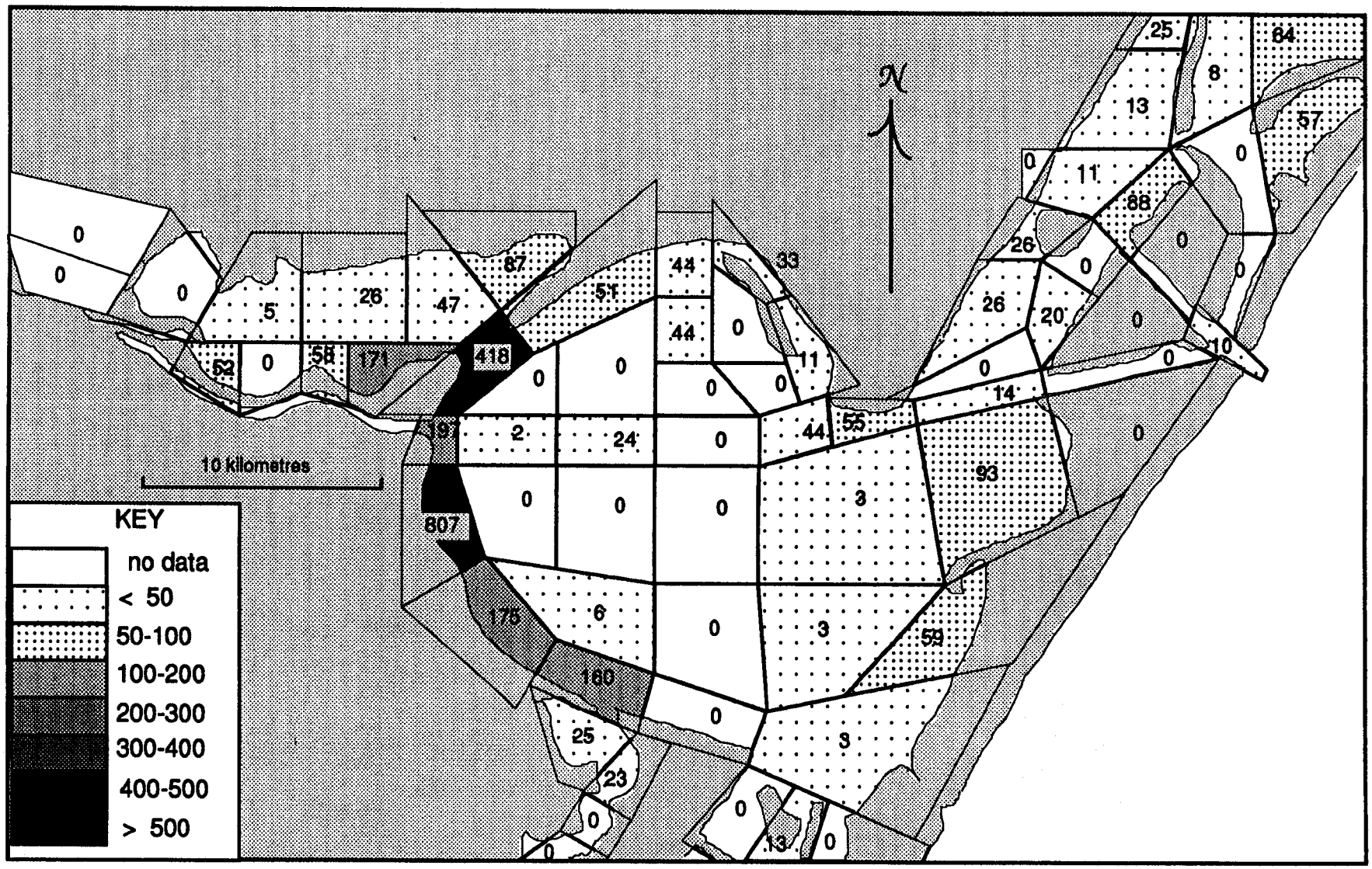


Figure 5-44. Sampling density of WQFCOLI for Corpus Christi system

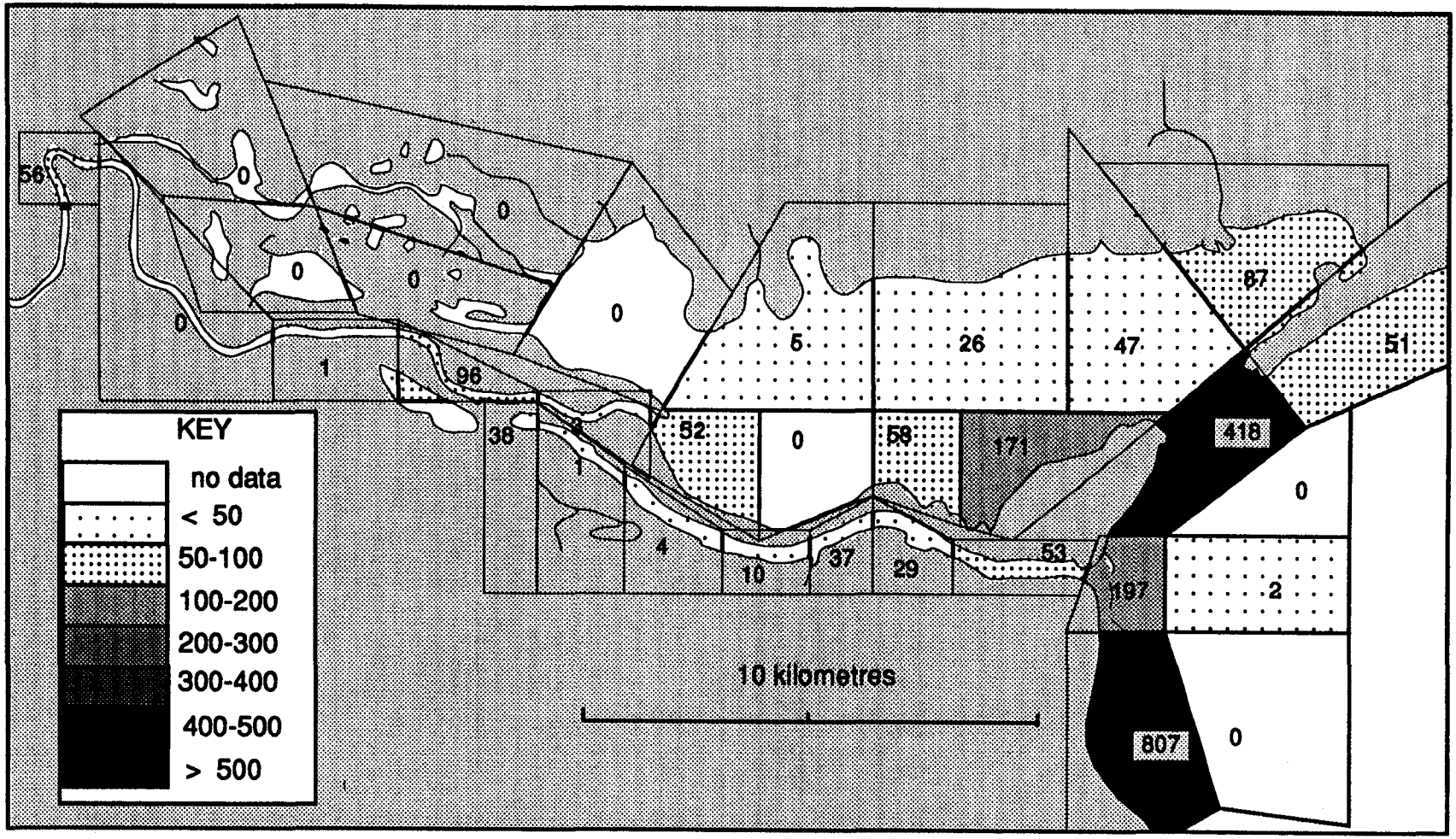


Figure 5-45. Sampling density of WQFCOLI for Nueces Bay region, including Inner Harbor

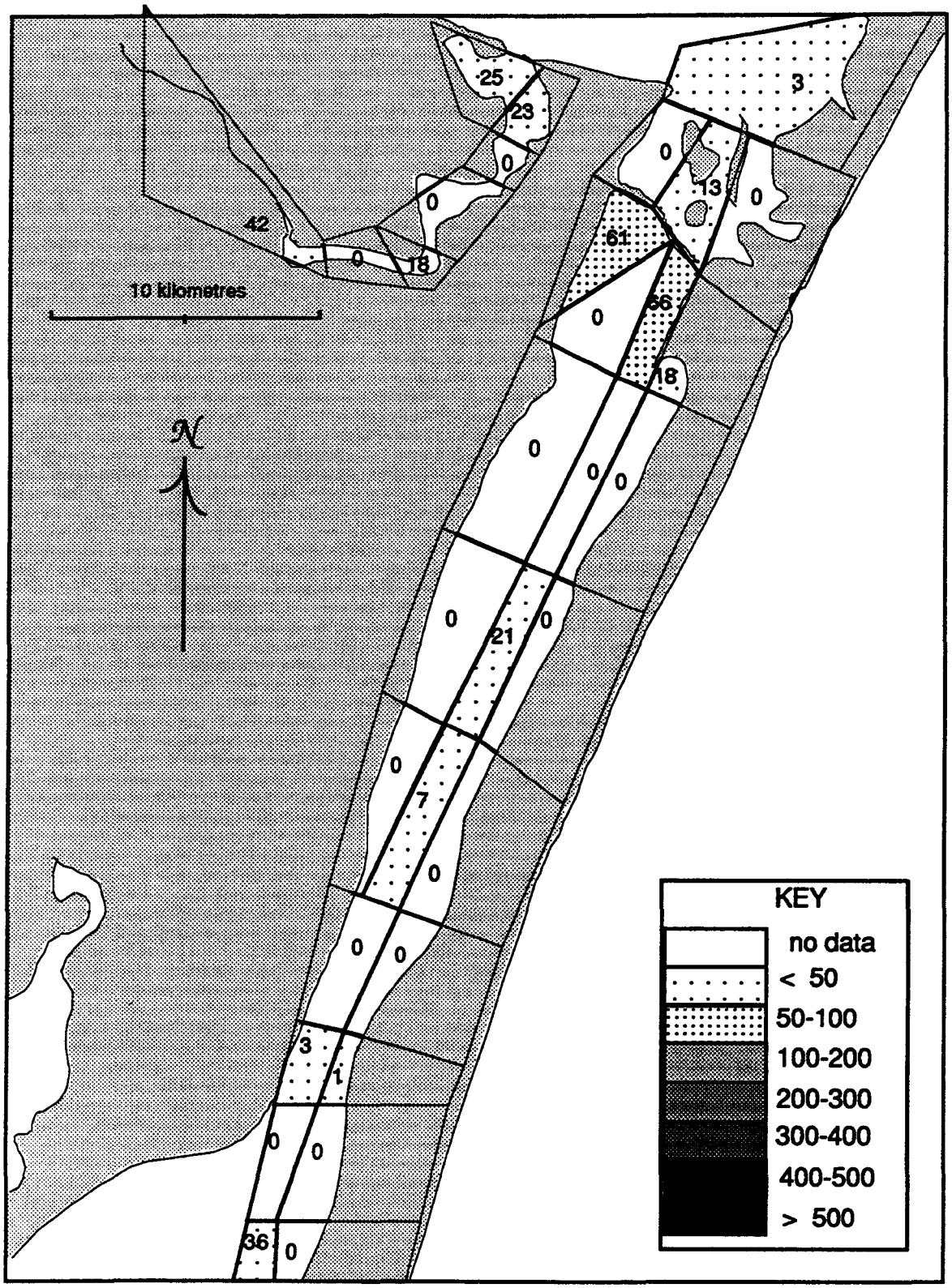


Figure 5-46. Sampling density of WQFCOLI for Upper Laguna Madre and Oso Bay

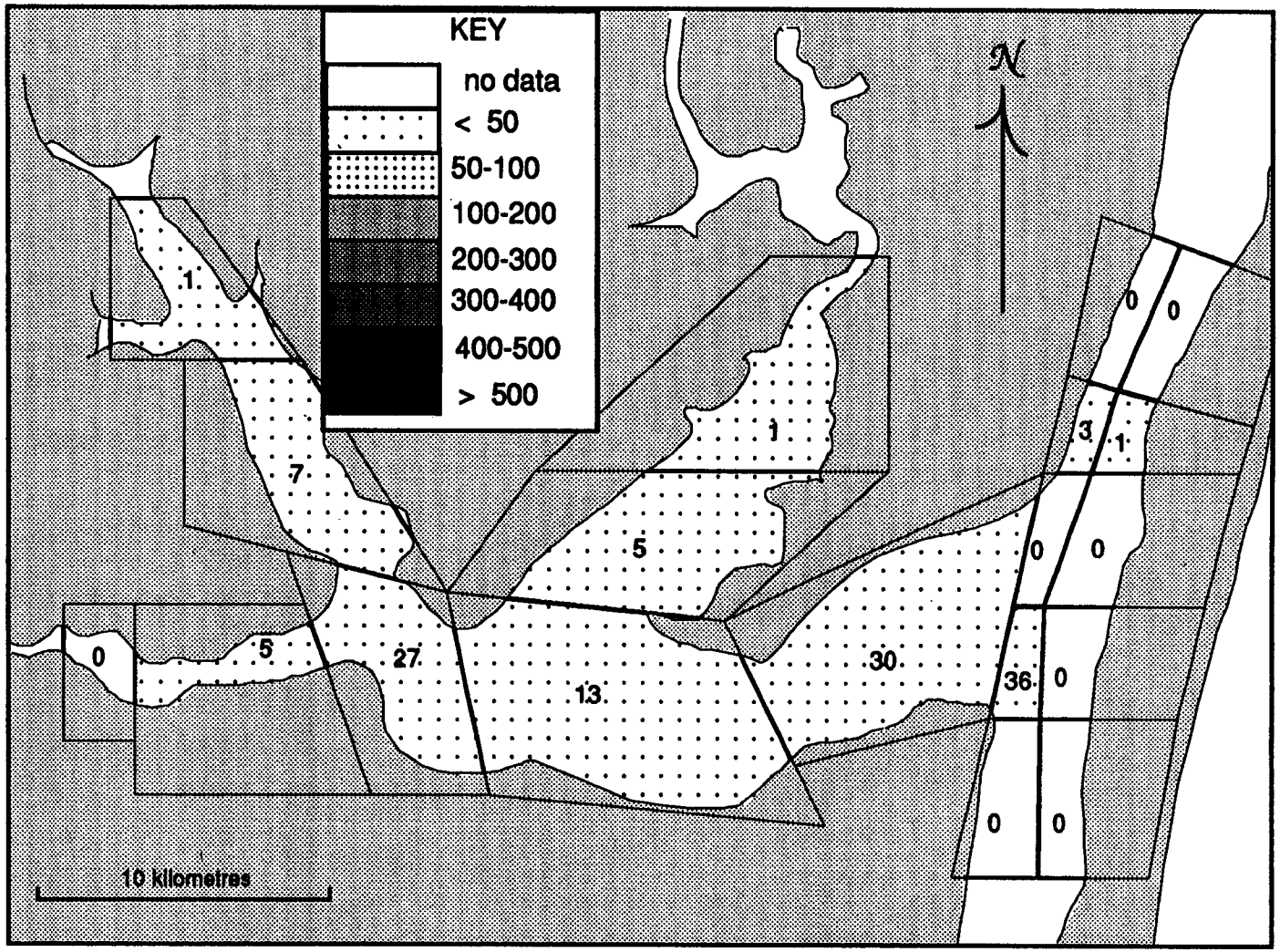


Figure 5-47. Sampling density of WQFCOLI for Baffin Bay region

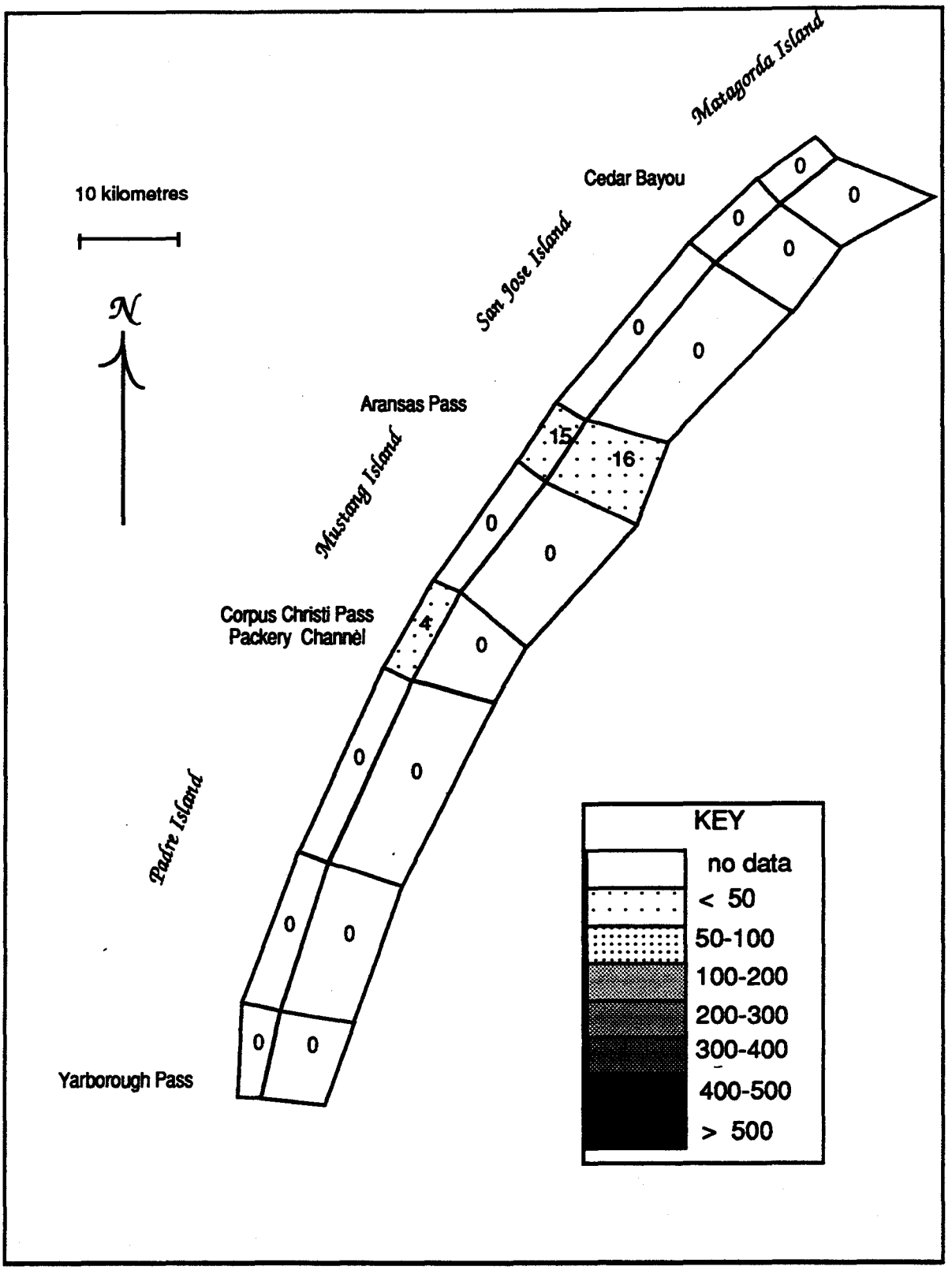


Figure 5-48. Sampling density of WQFCOLI for Gulf of Mexico

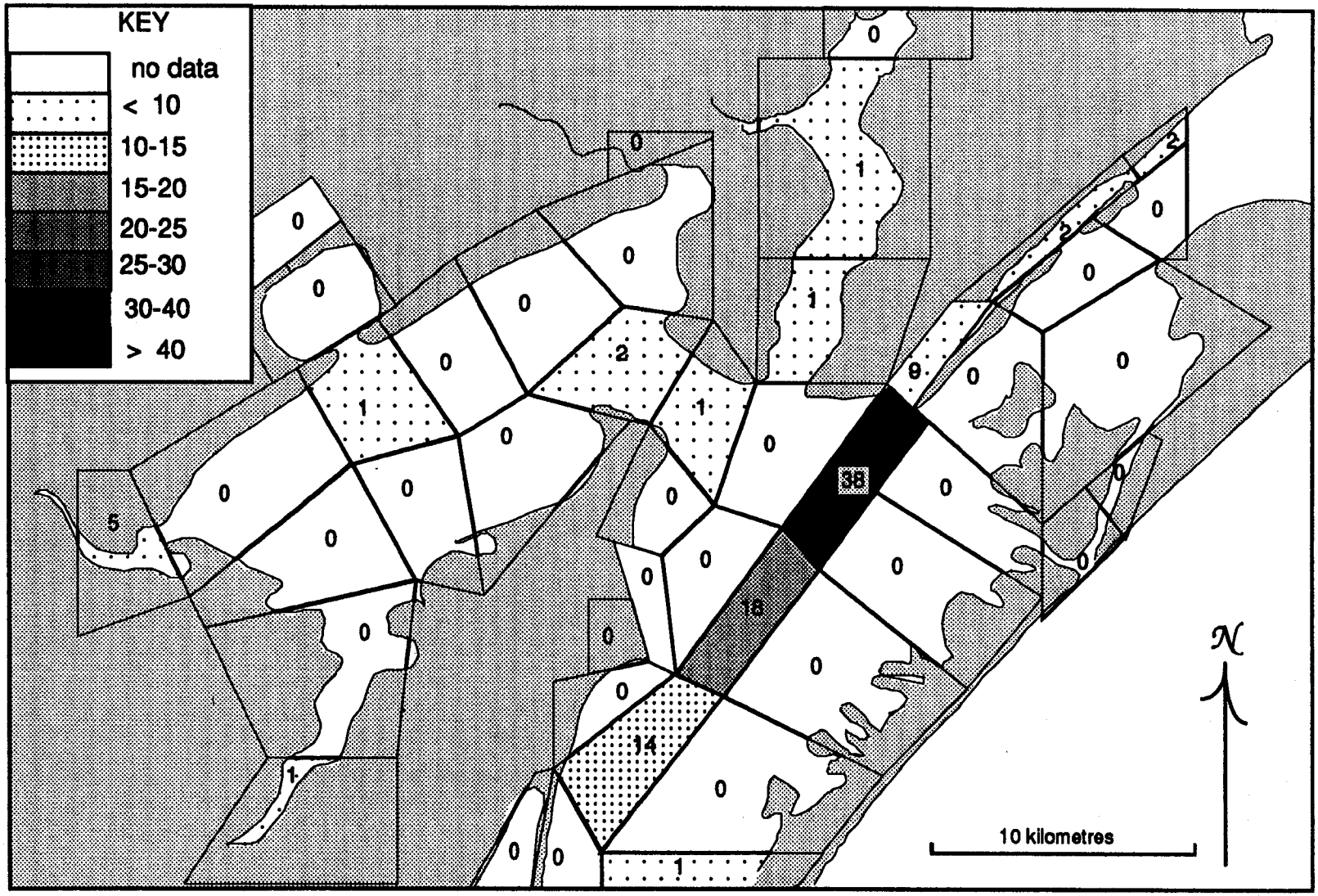


Figure 5-49. Sampling density of WQMETCDT for Aransas-Copano system

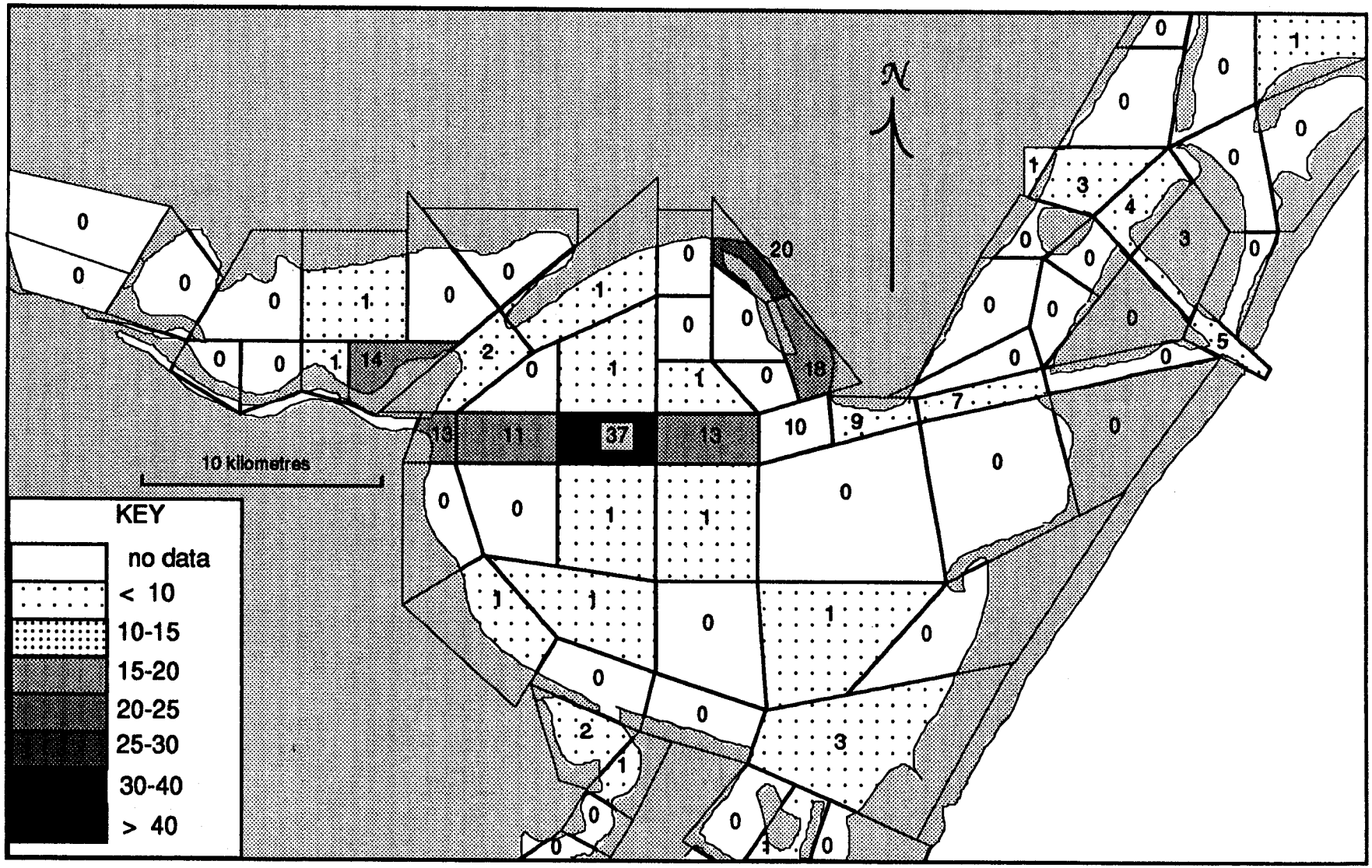


Figure 5-50. Sampling density of WQMETCDT for Corpus Christi system

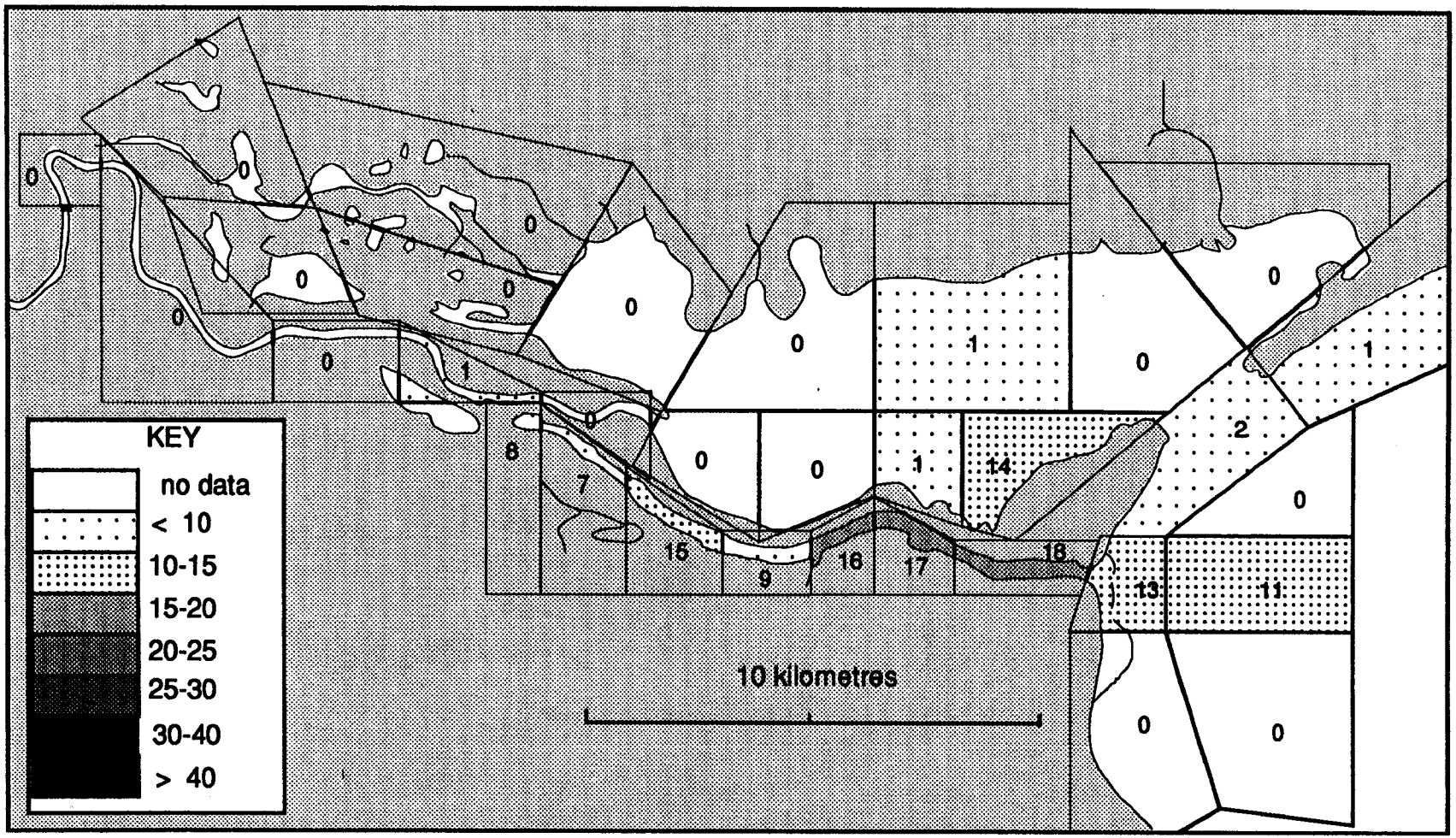


Figure 5-51. Sampling density of WQMETCDT for Nueces Bay region, including Inner Harbor

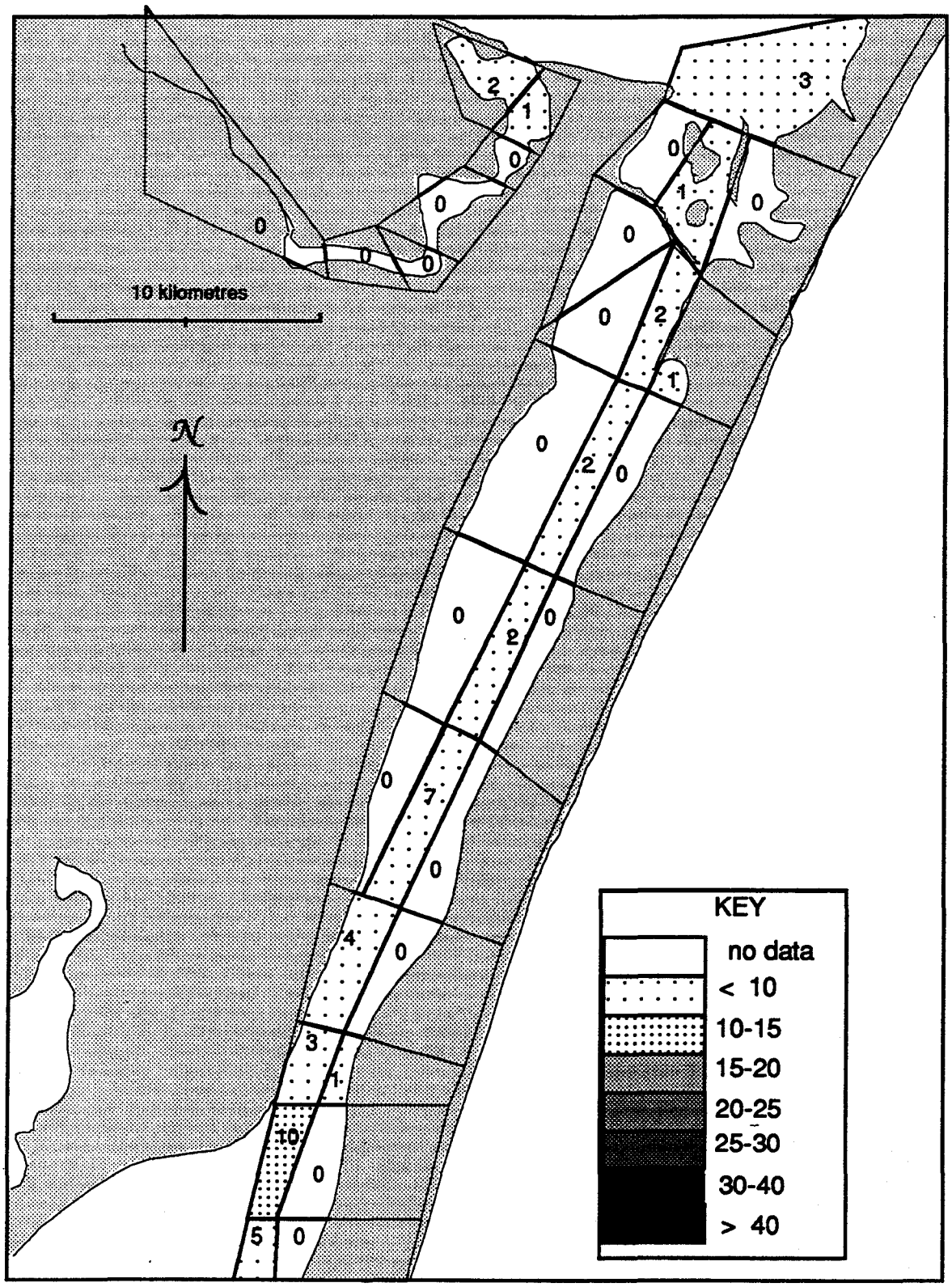


Figure 5-52. Sampling density of WQMETCDT for Upper Laguna Madre and Oso Bay

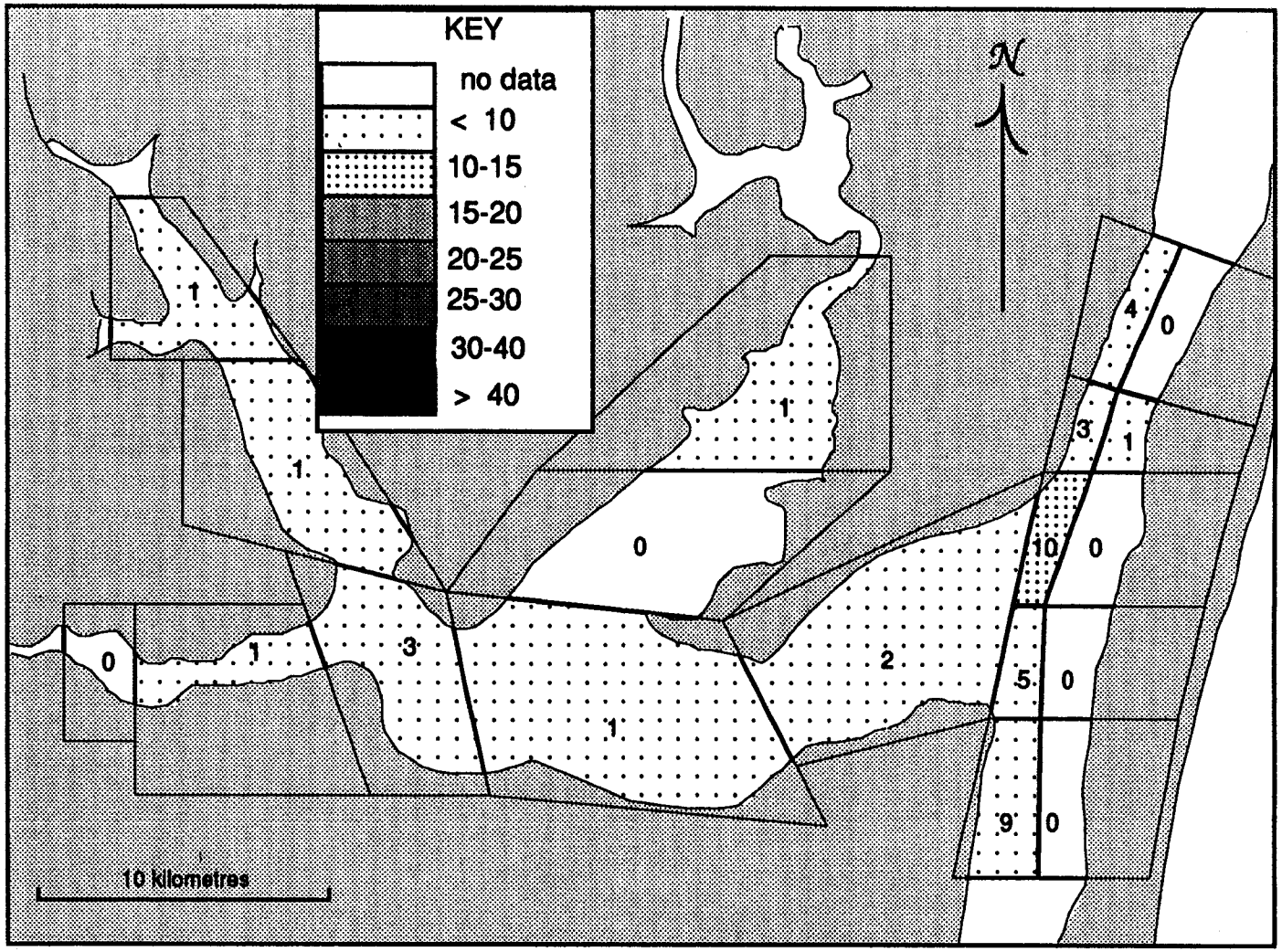


Figure 5-53. Sampling density of WQMETCDT for Baffin Bay region

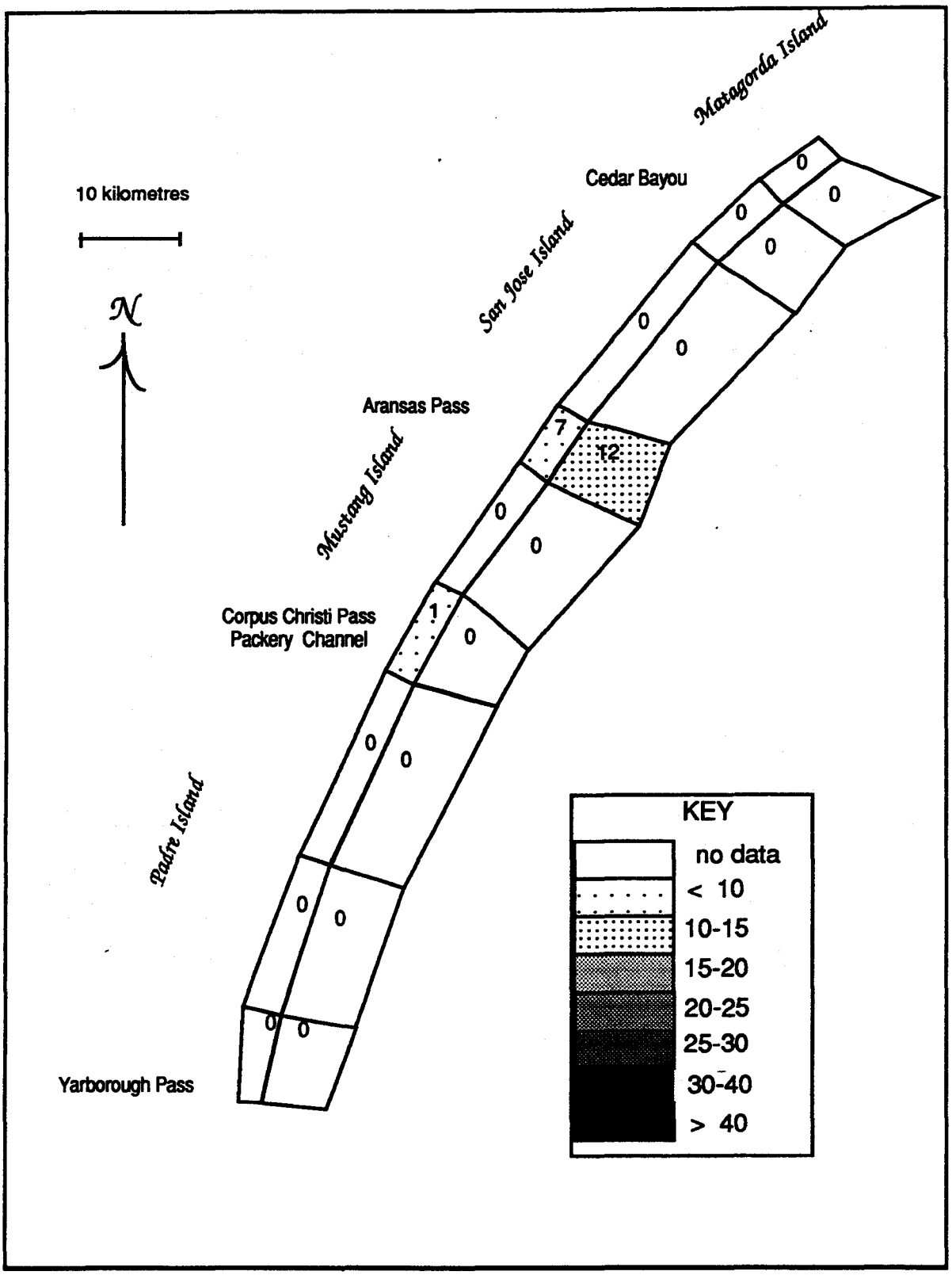


Figure 5-54. Sampling density of WQMETCDT for Gulf of Mexico

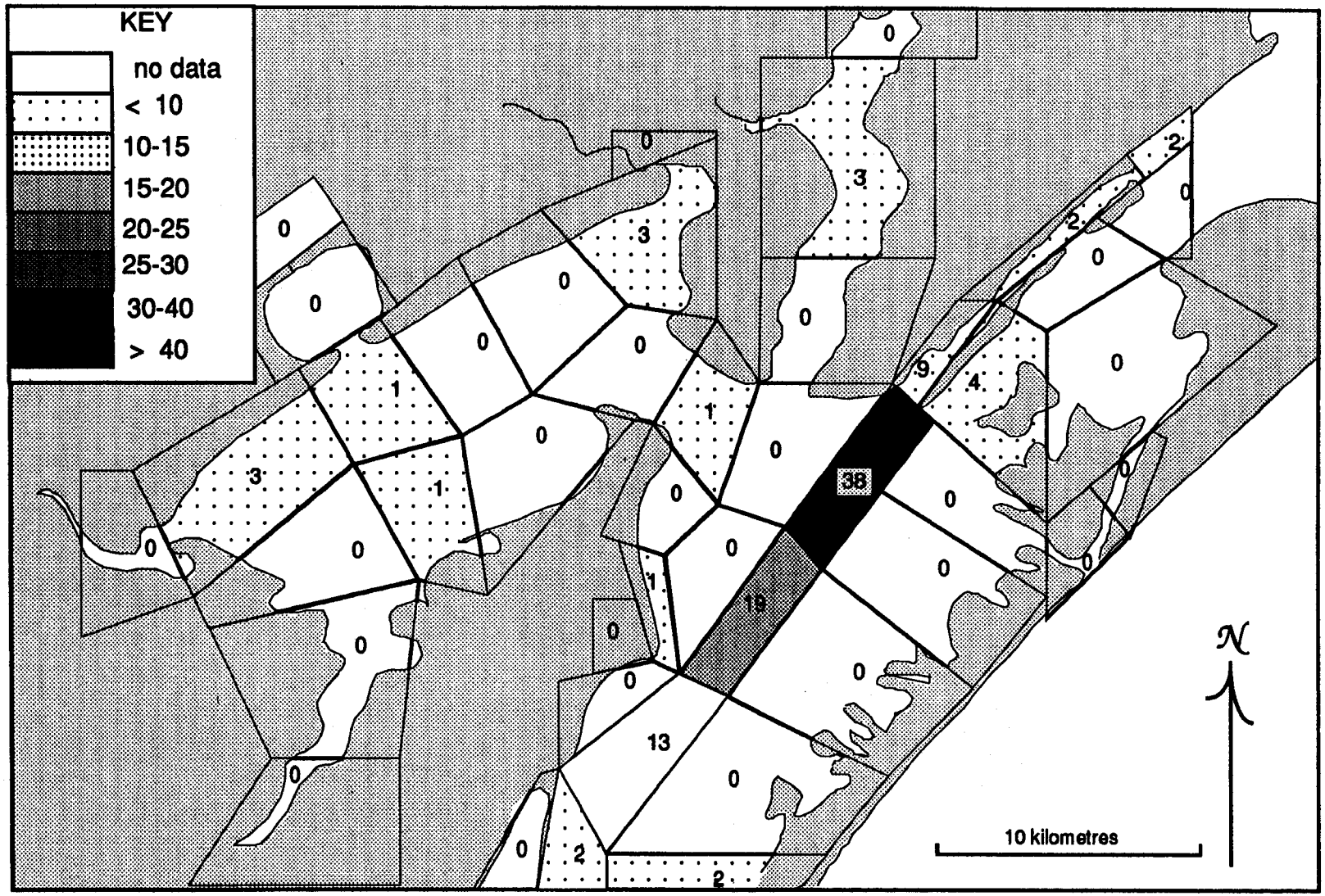


Figure 5-55. Sampling density of WQ-XDDT for Aransas-Copano system

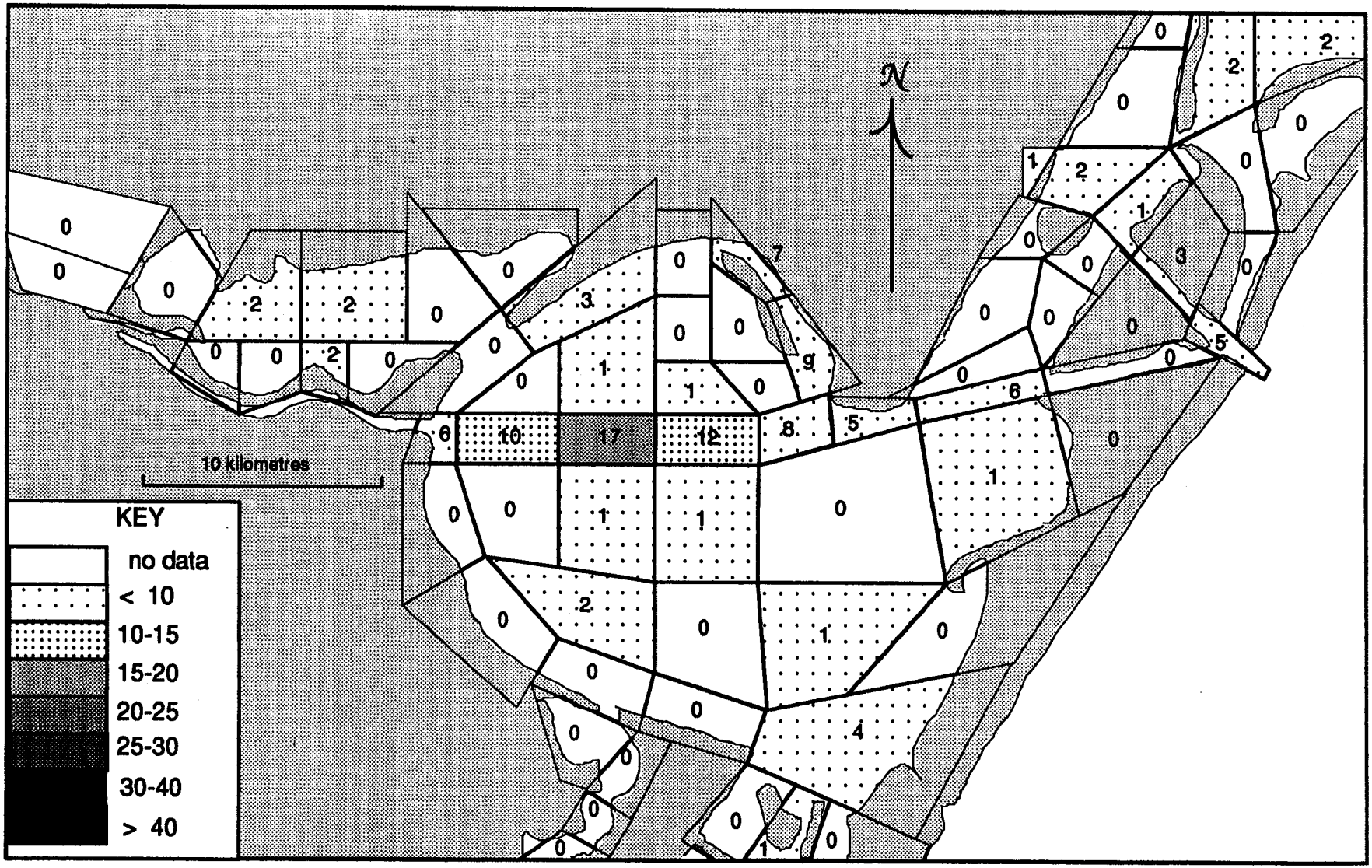


Figure 5-56. Sampling density of WQ-XDDT for Corpus Christi system

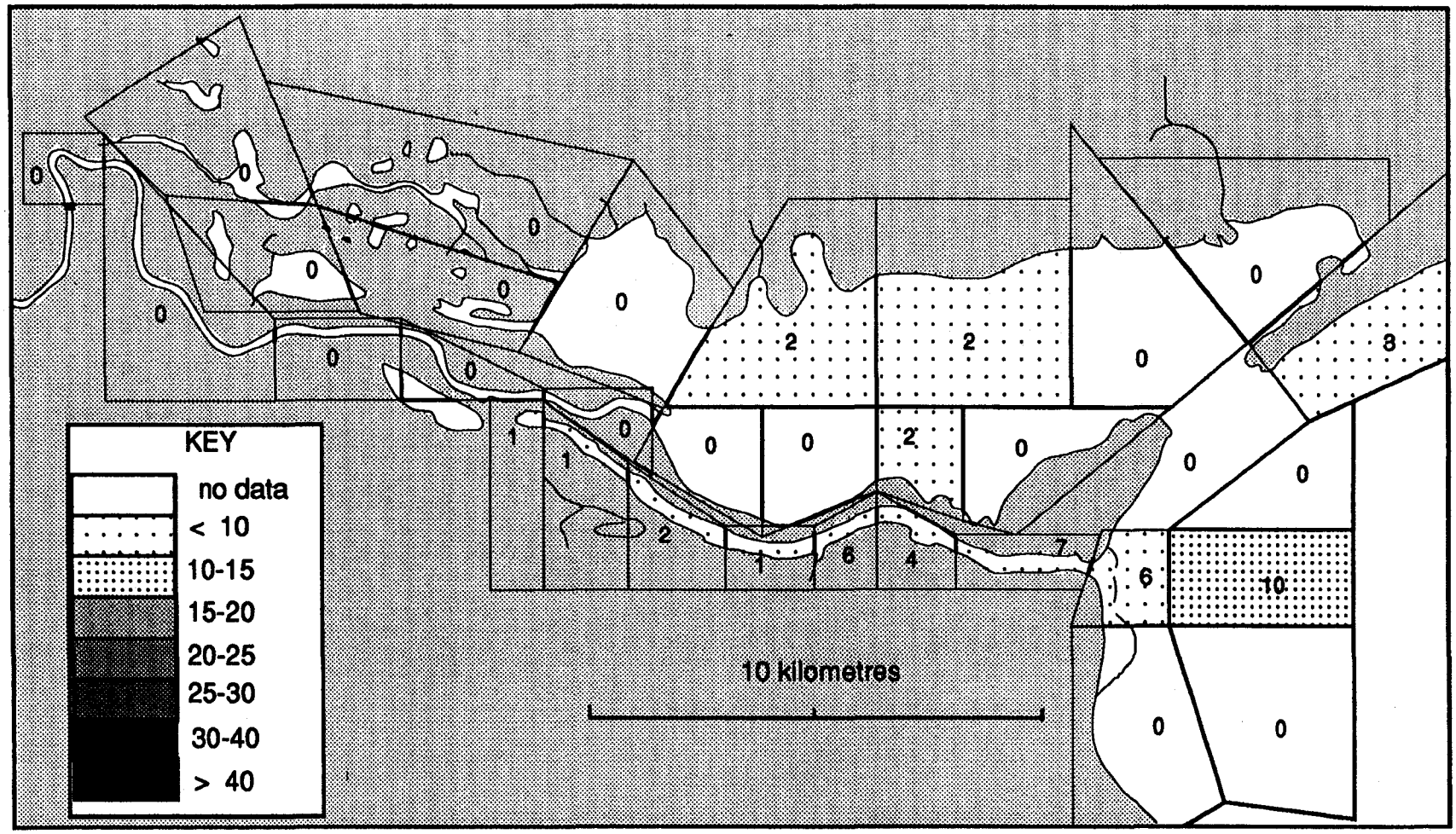


Figure 5-57. Sampling density of WQ-XDDT for Nueces Bay region, including Inner Harbor

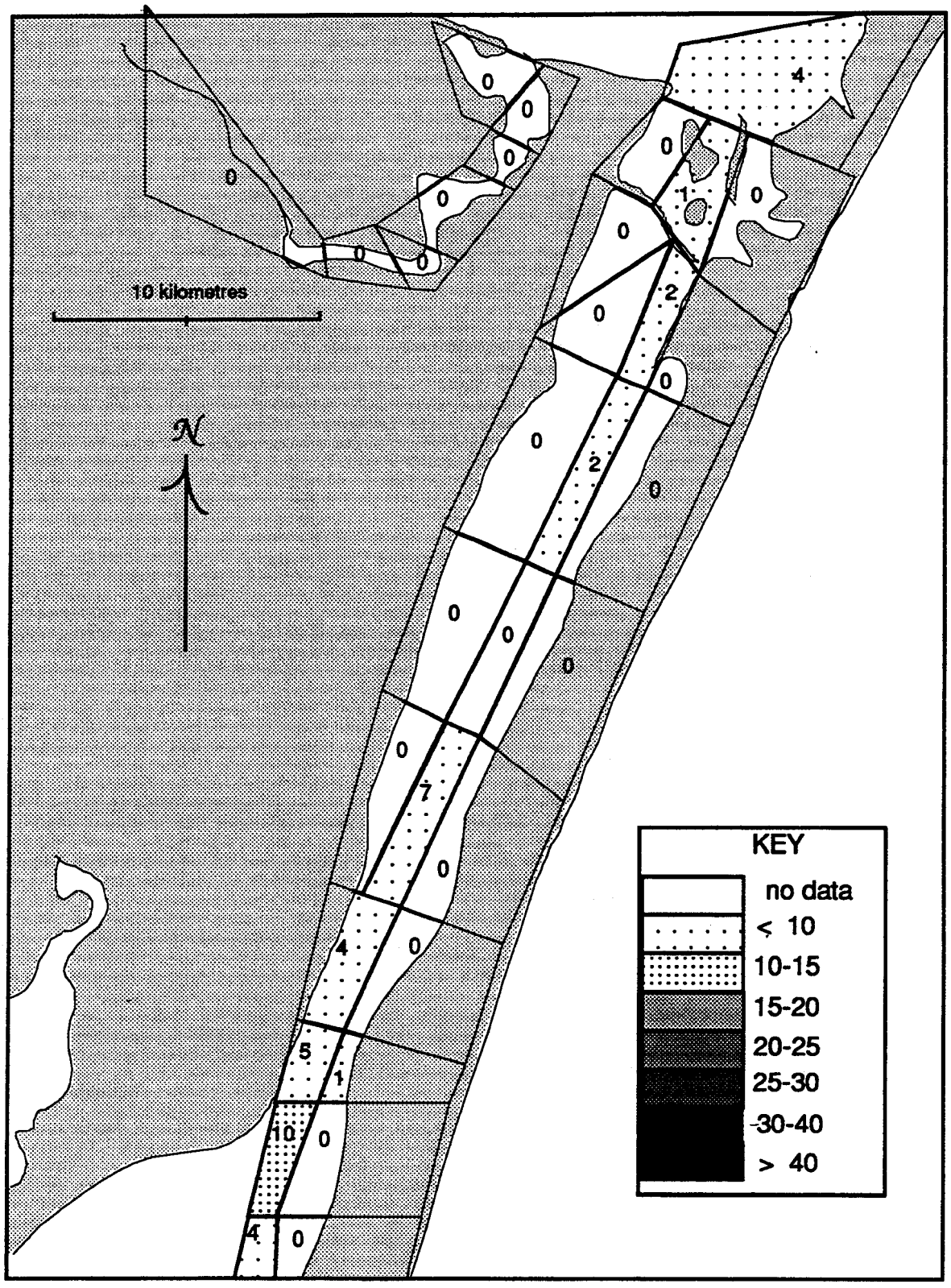


Figure 5-58. Sampling density of WQ-XDDT for Upper Laguna Madre and Oso Bay

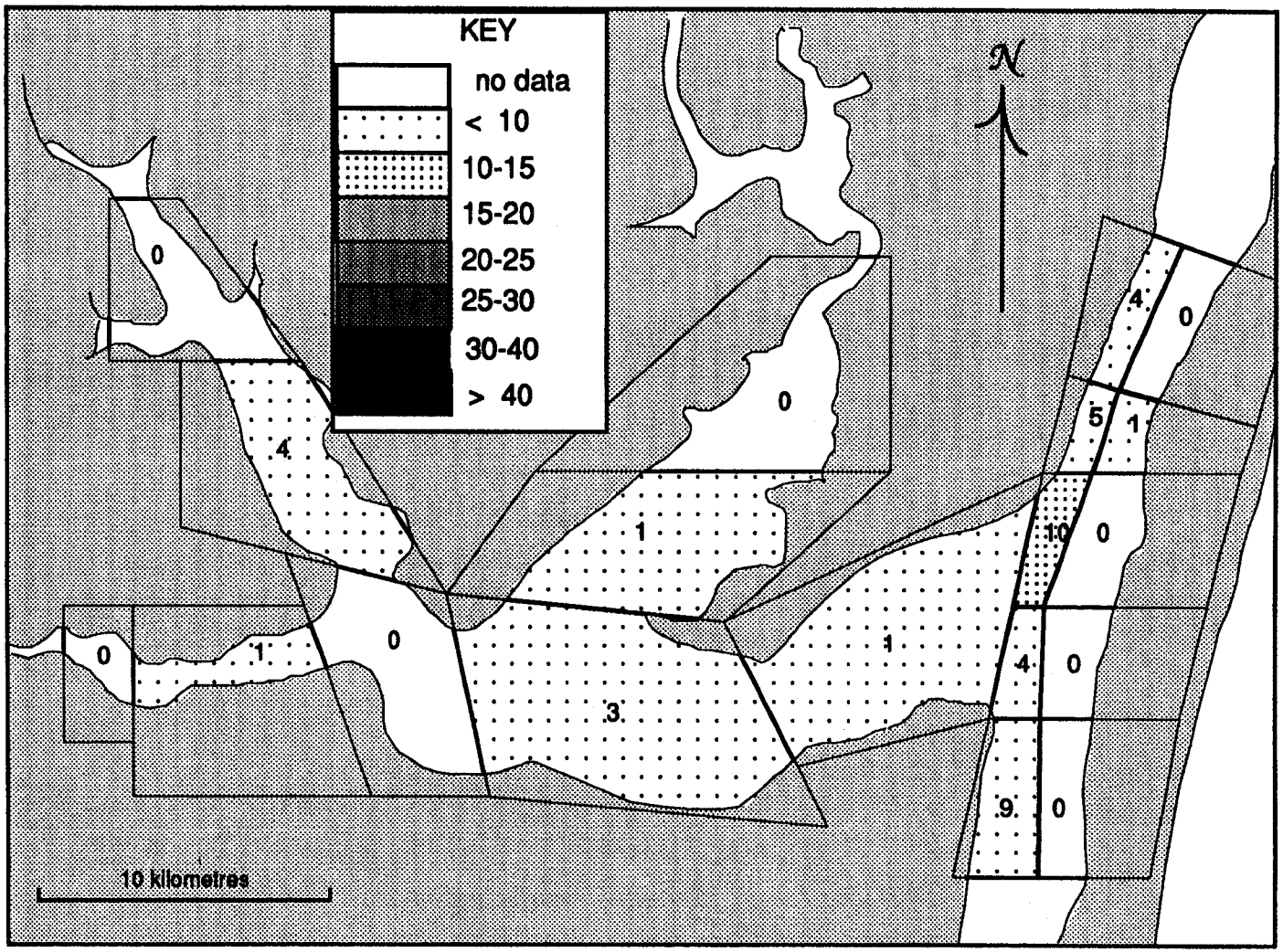


Figure 5-59. Sampling density of WQ-XDDT for Baffin Bay region

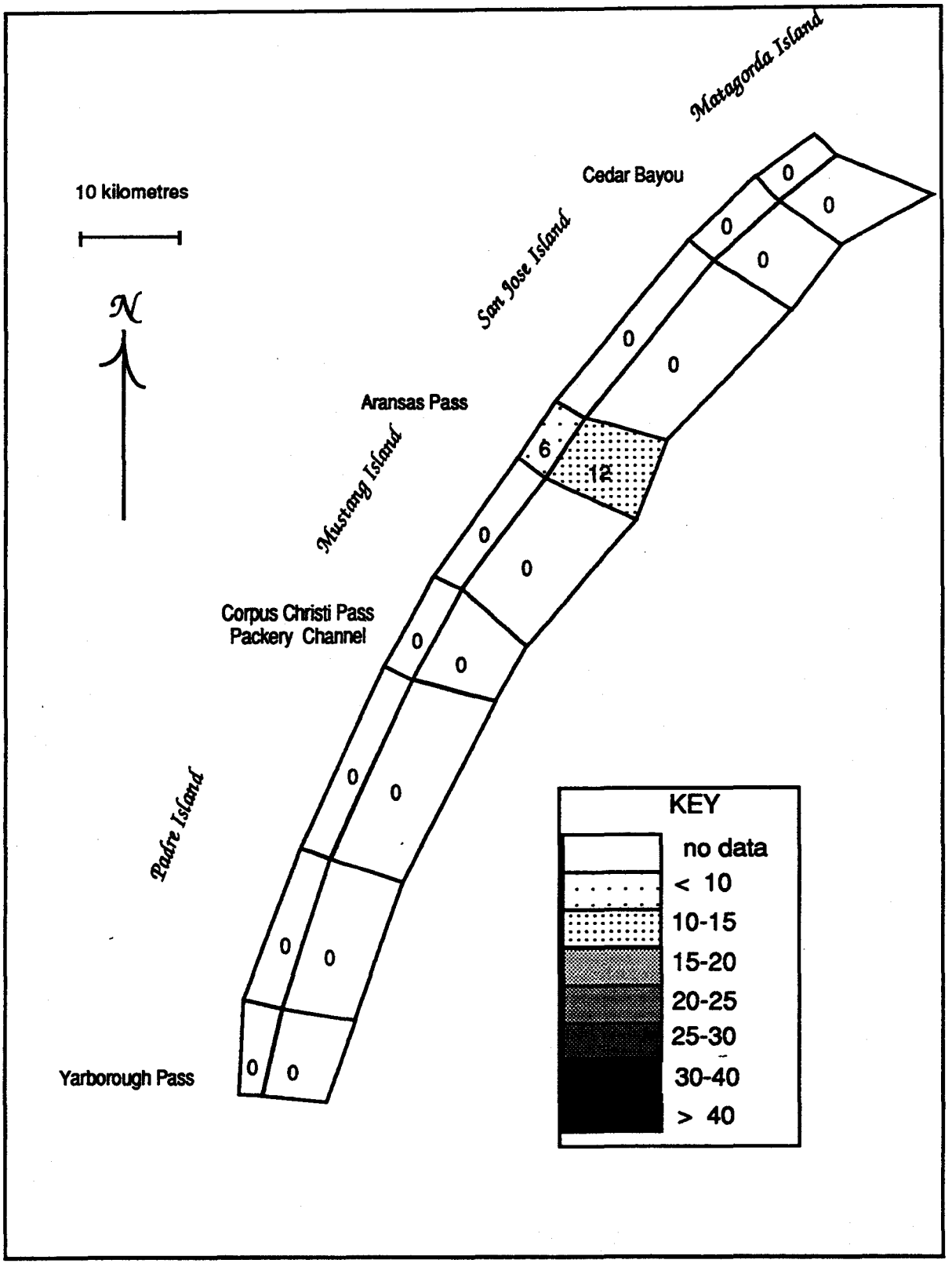


Figure 5-60. Sampling density of WQ-XDDT for Gulf of Mexico

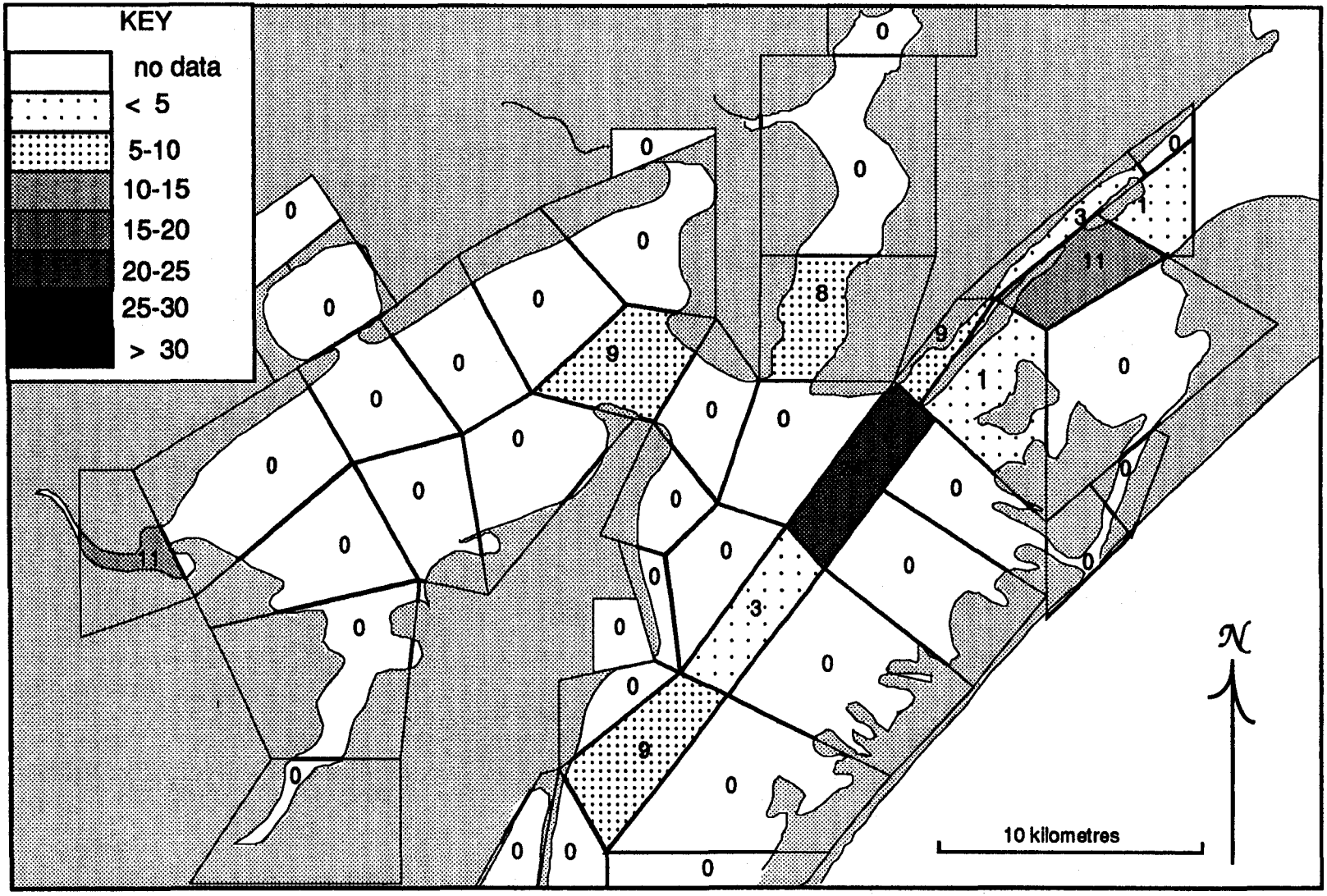


Figure 5-61. Sampling density of SEDO&G for Aransas-Copano system

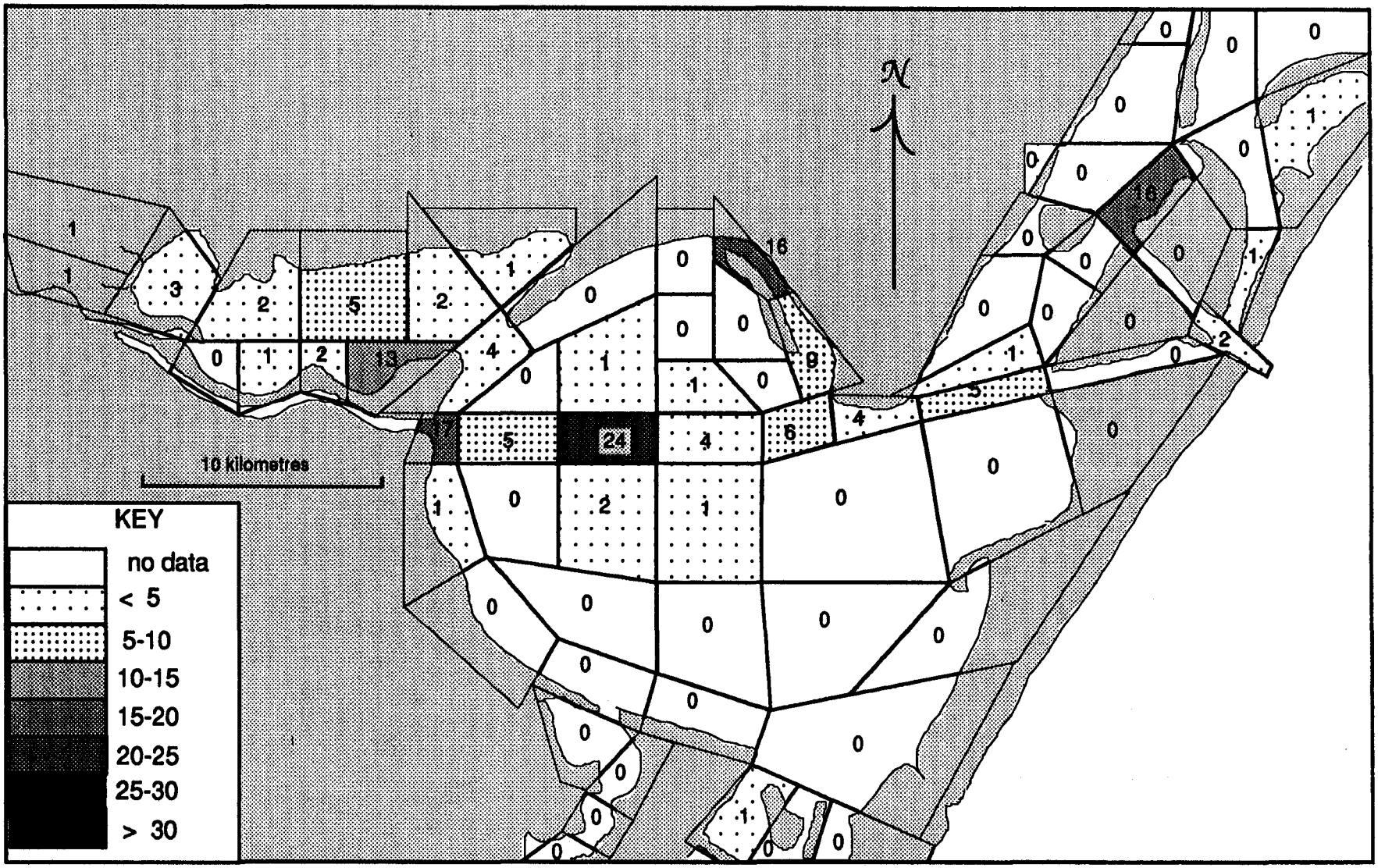


Figure 5-62. Sampling density of SEDO&G for Corpus Christi system

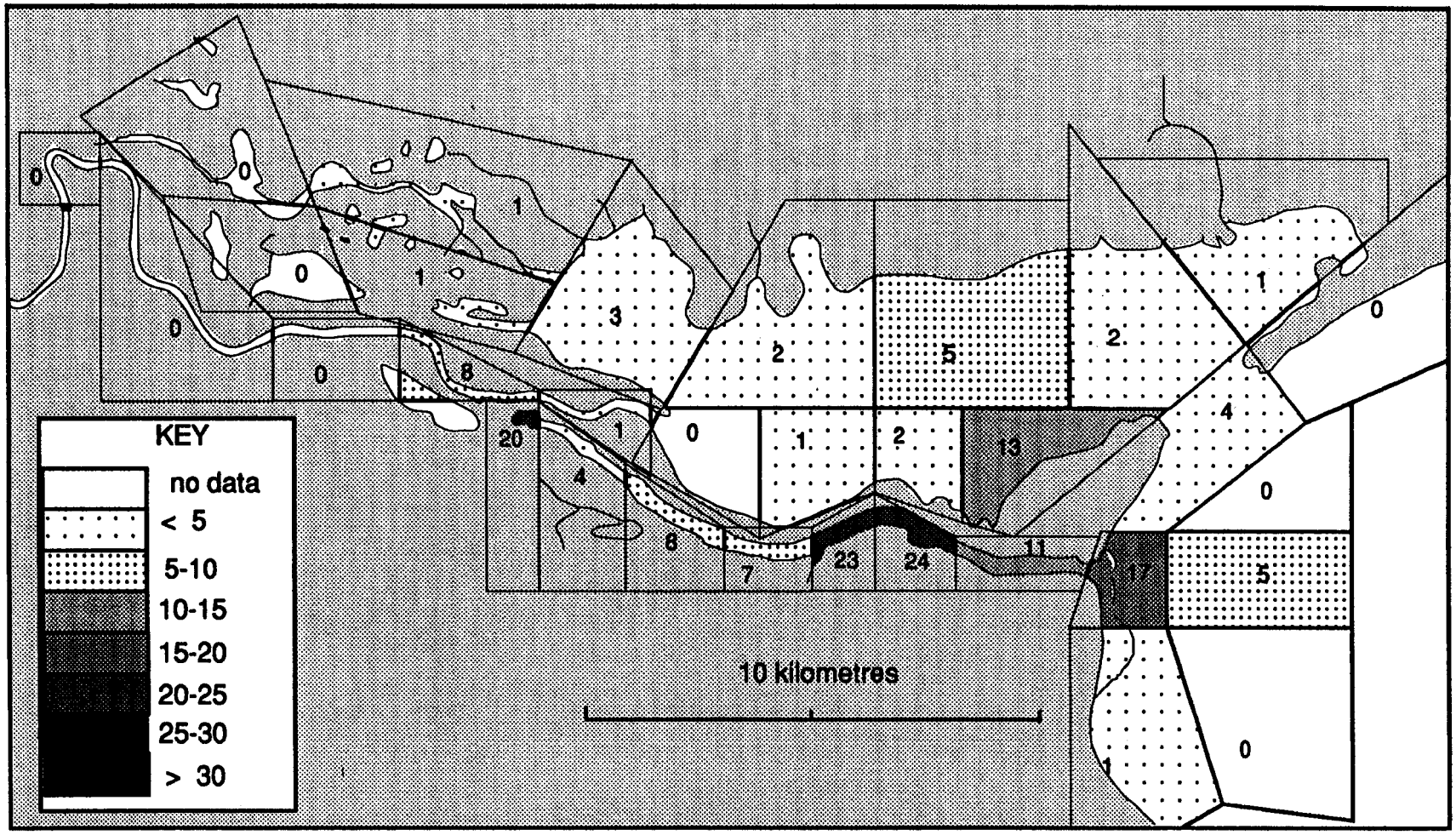


Figure 5-63. Sampling density of SEDO&G for Nueces Bay region, including Inner Harbor

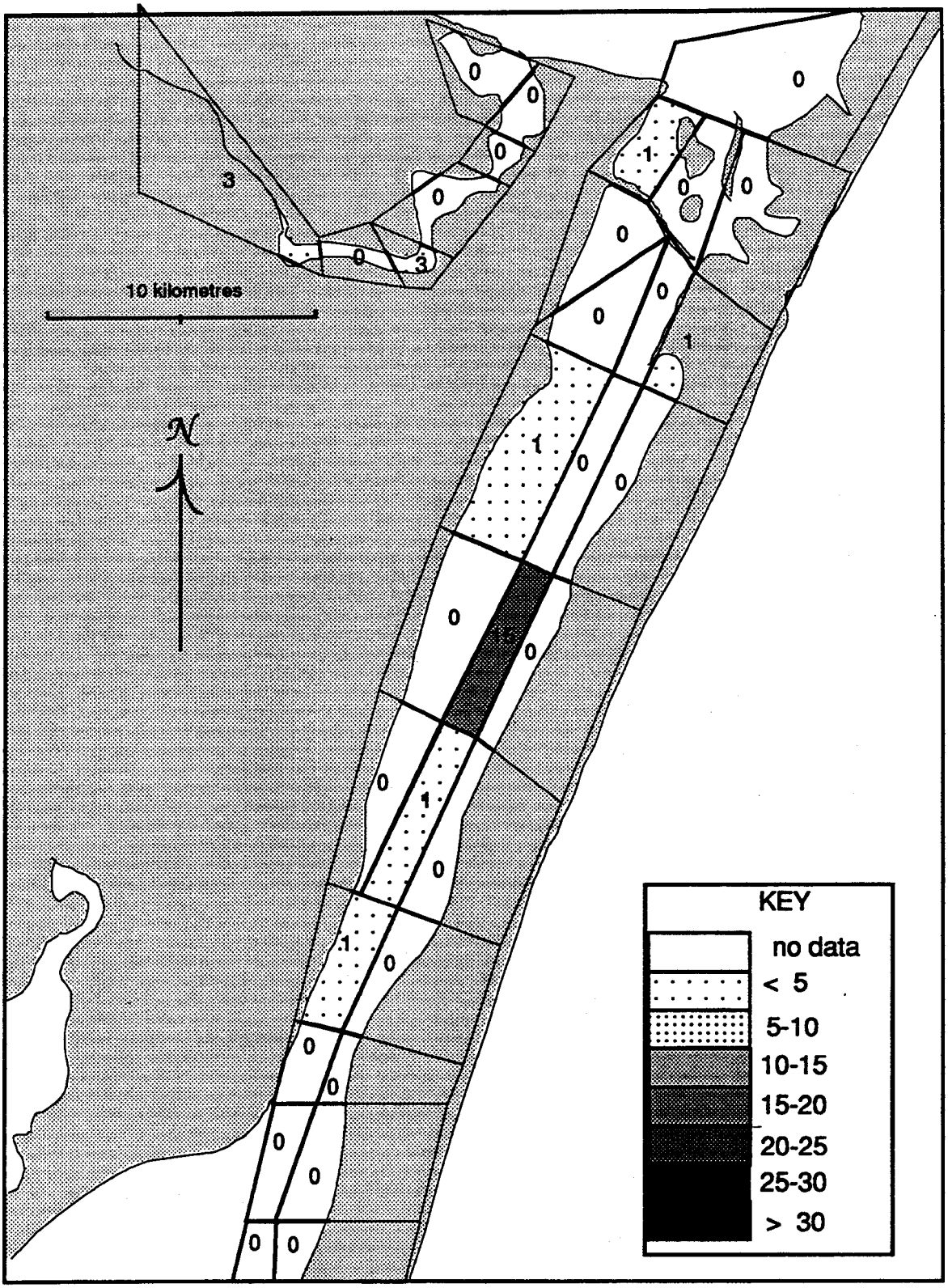


Figure 5-64. Sampling density of SEDO&G for Upper Laguna Madre and Oso Bay

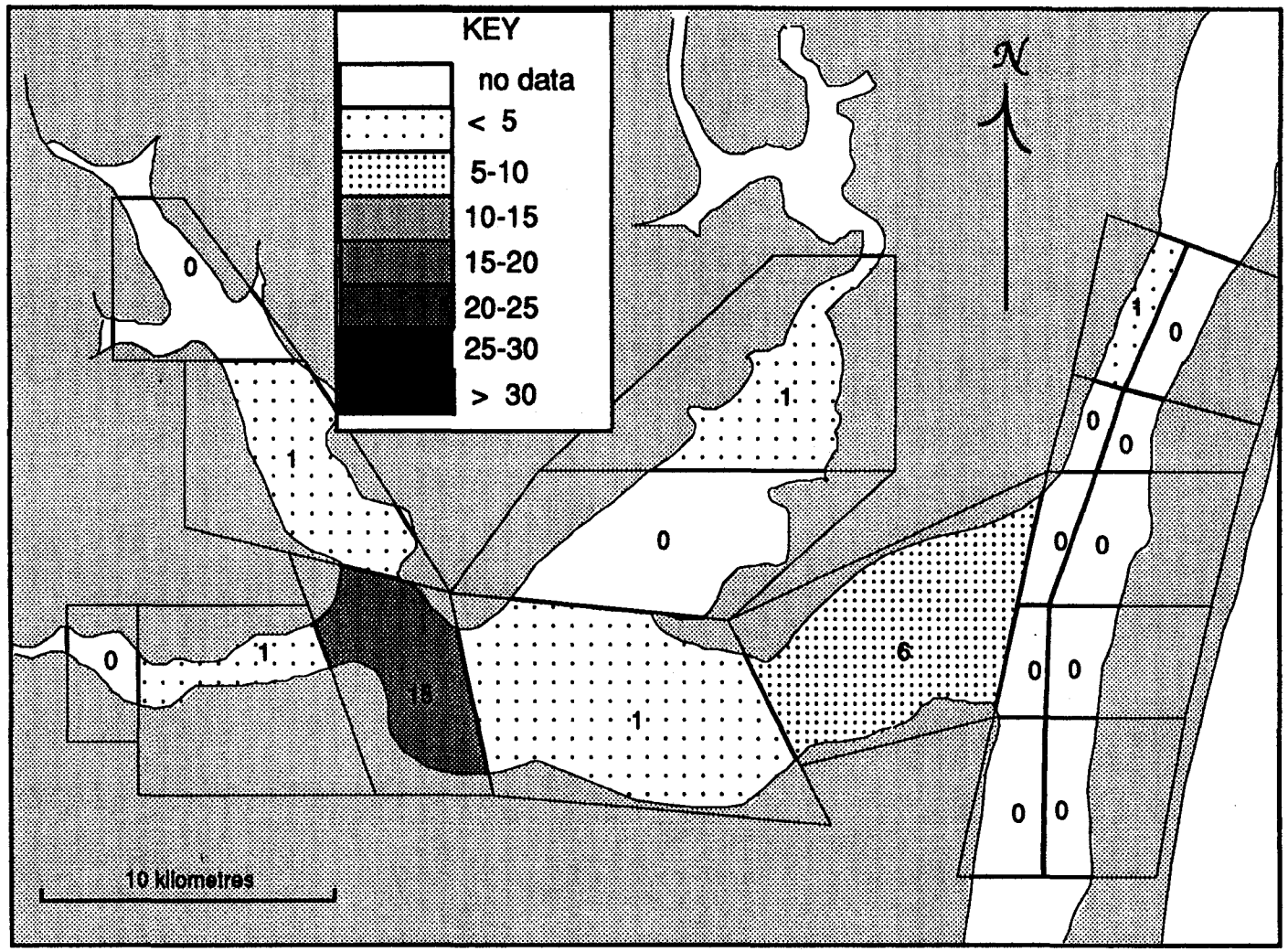


Figure 5-65. Sampling density of SEDO&G for Baffin Bay region

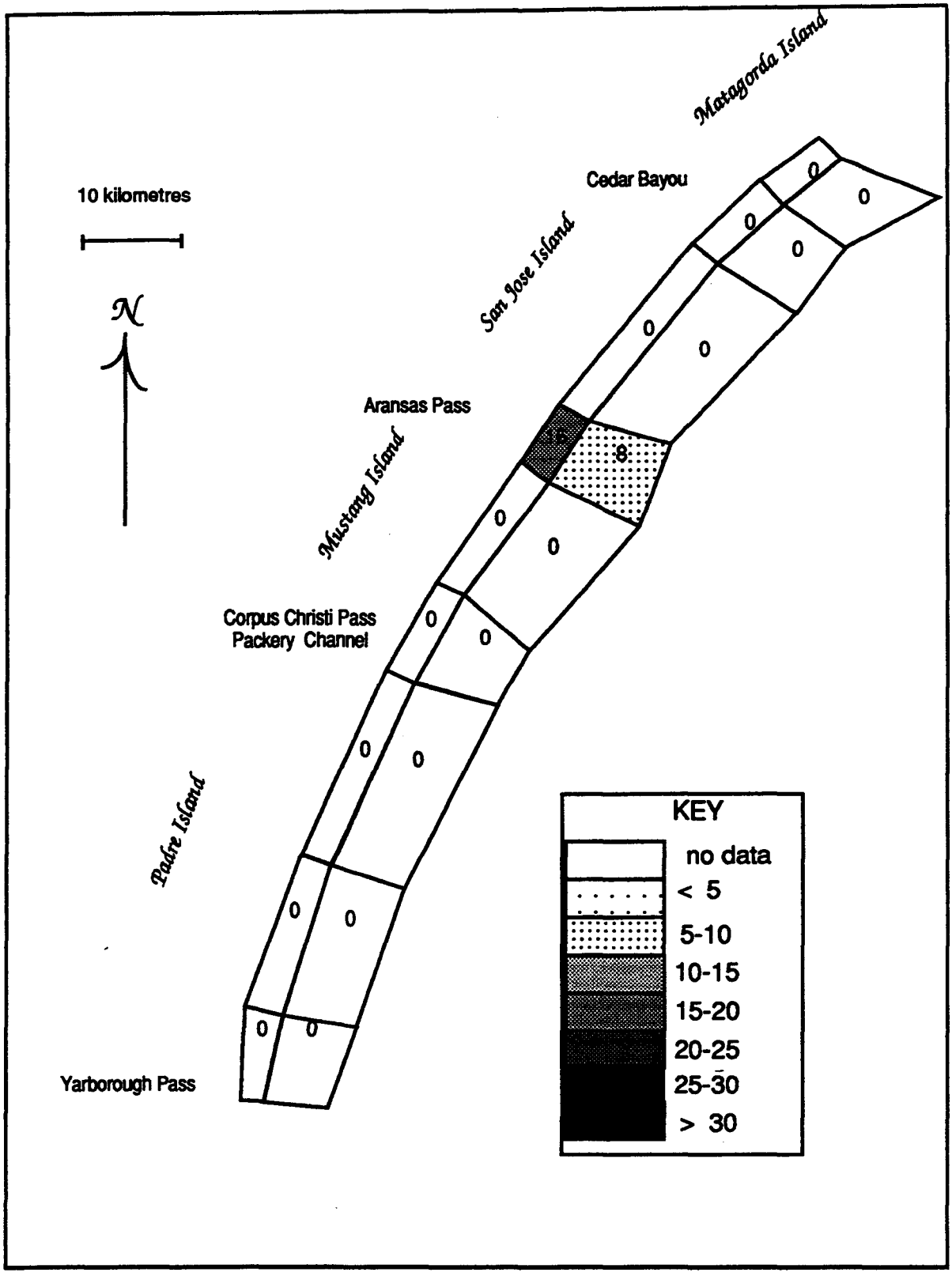


Figure 5-66. Sampling density of SEDO&G for Gulf of Mexico

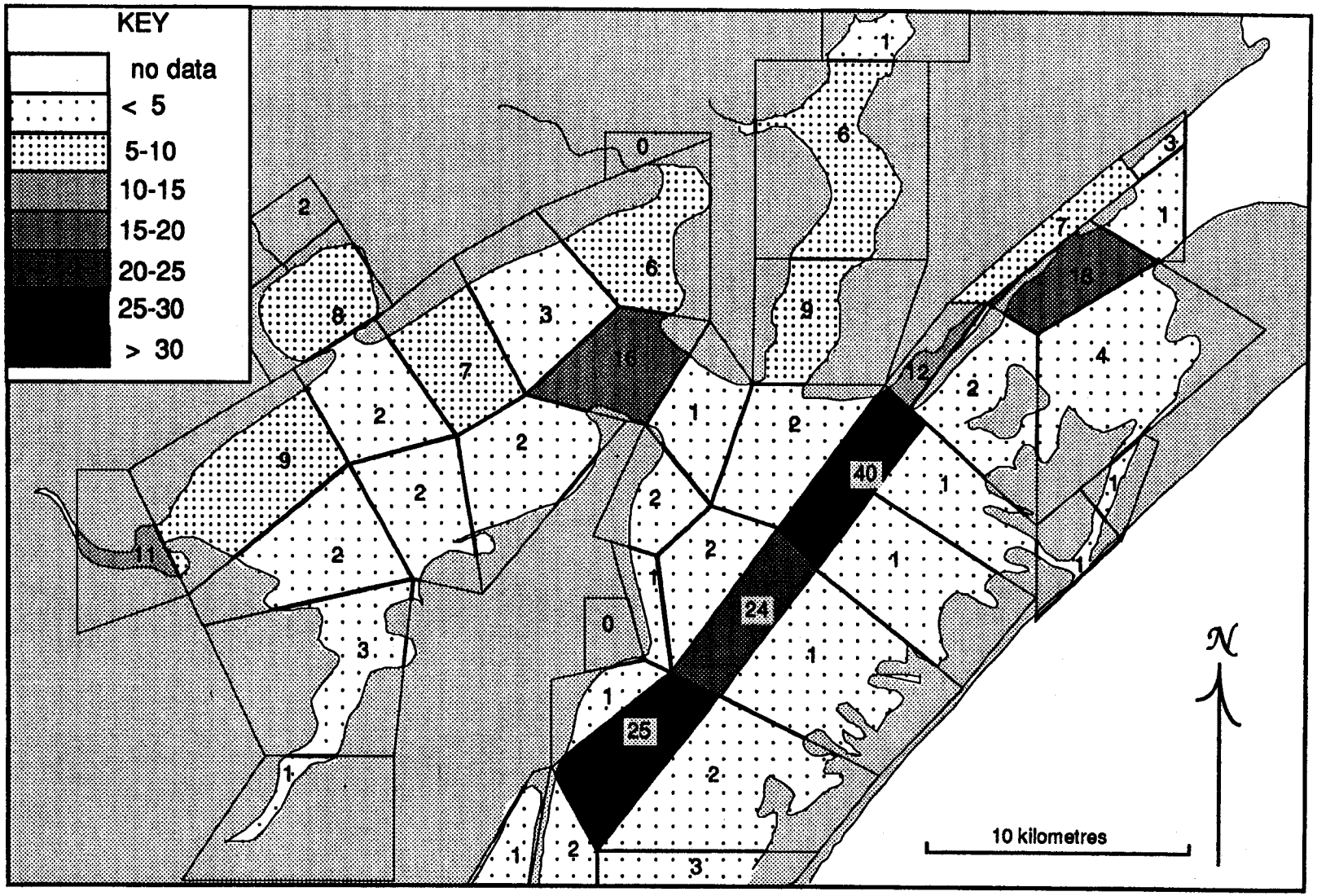


Figure 5-67. Sampling density of SEDMETZN for Aransas-Copano system

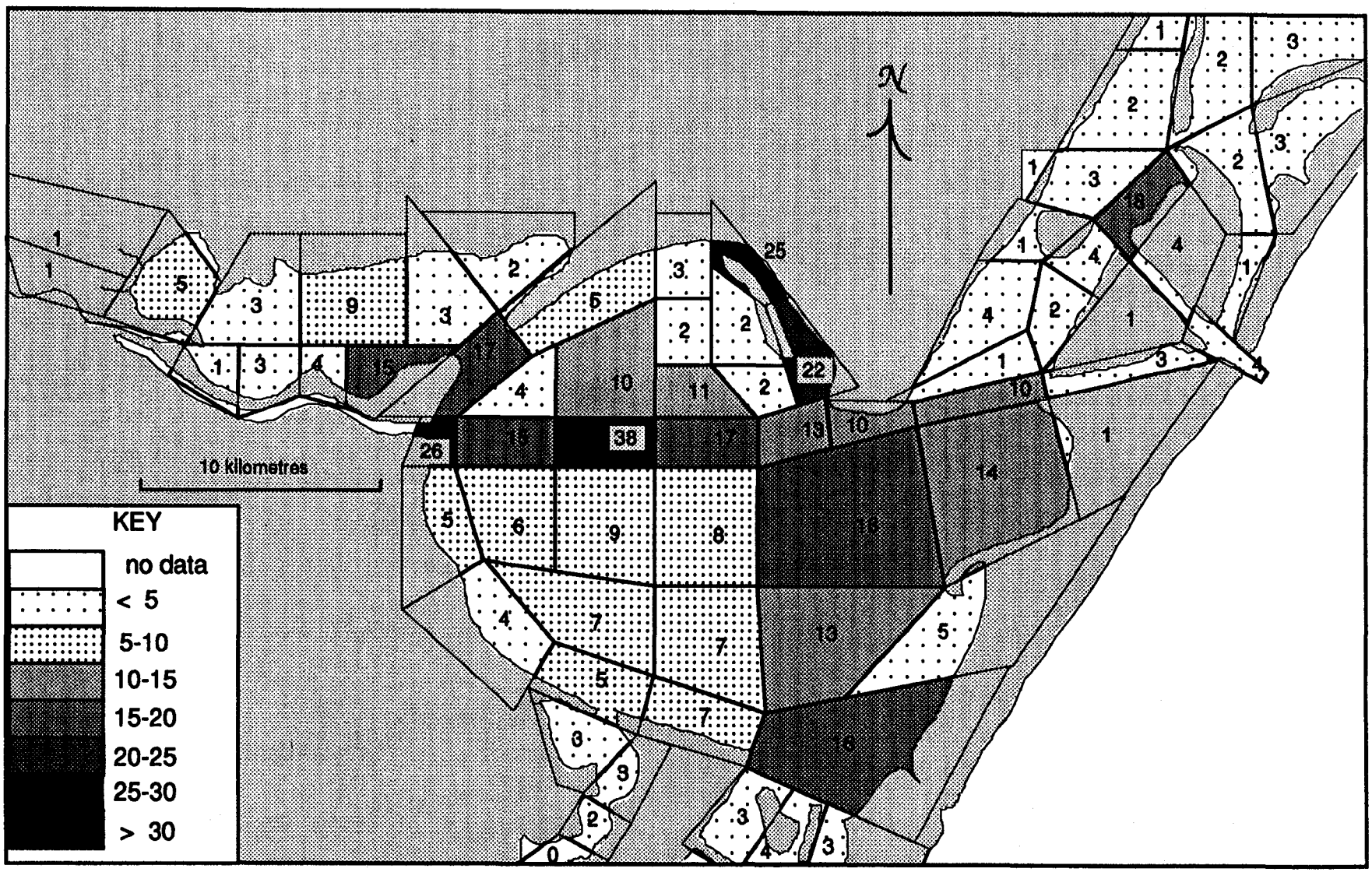


Figure 5-68. Sampling density of SEDMETZN for Corpus Christi system

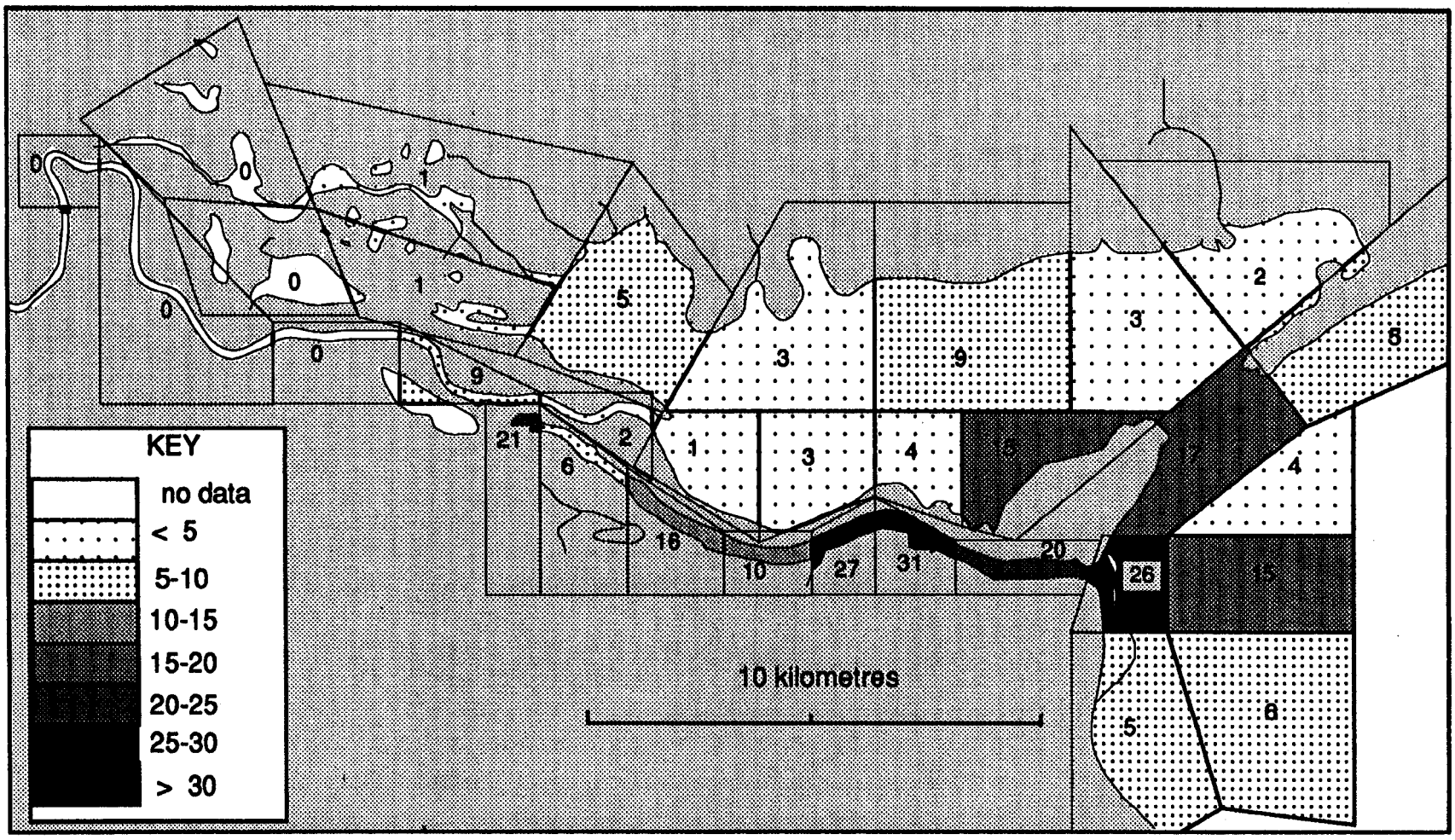


Figure 5-69. Sampling density of SEDMETZN for Nueces Bay region, including Inner Harbor

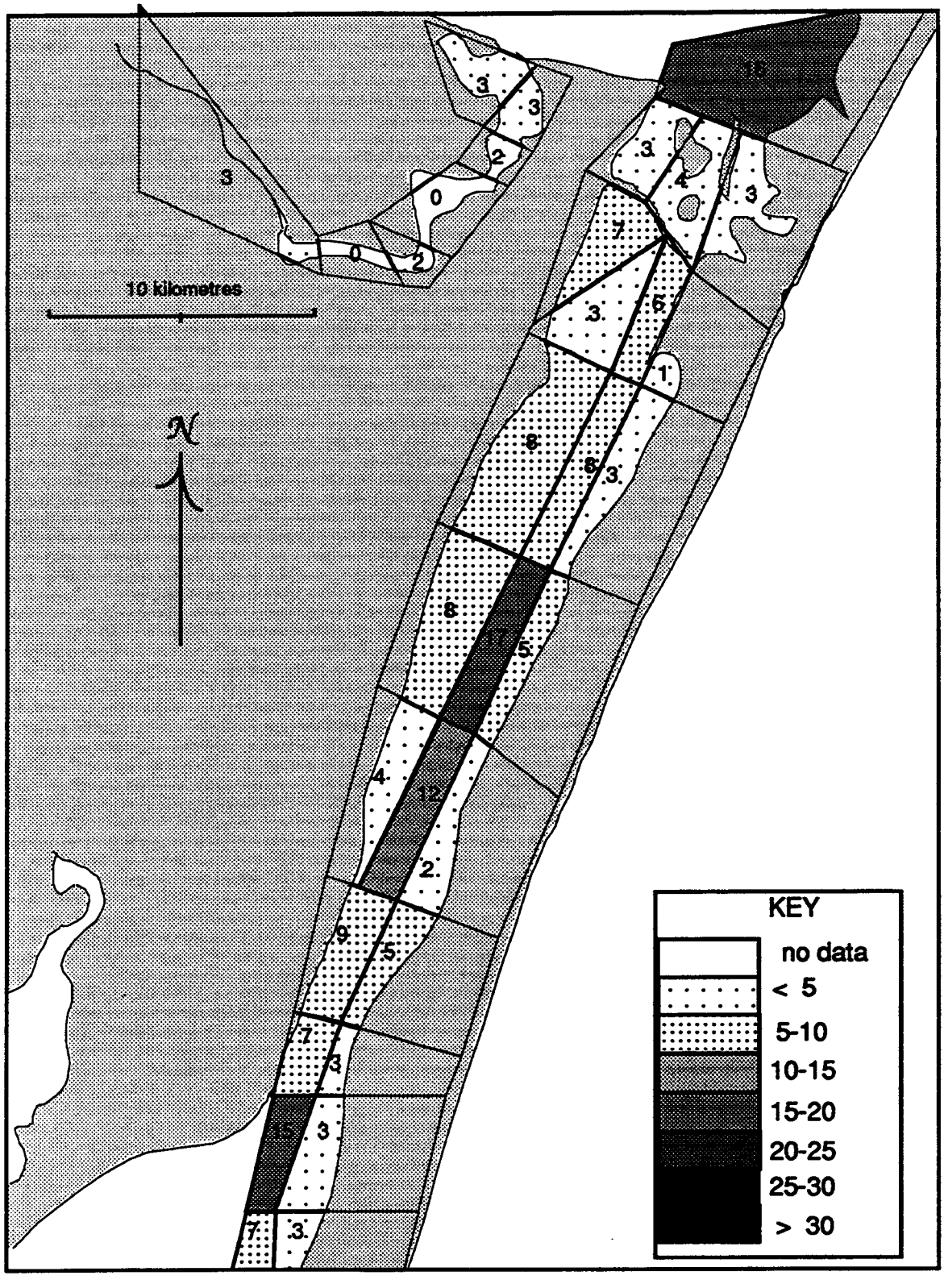


Figure 5-70. Sampling density of SEDMETZN for Upper Laguna Madre and Oso Bay

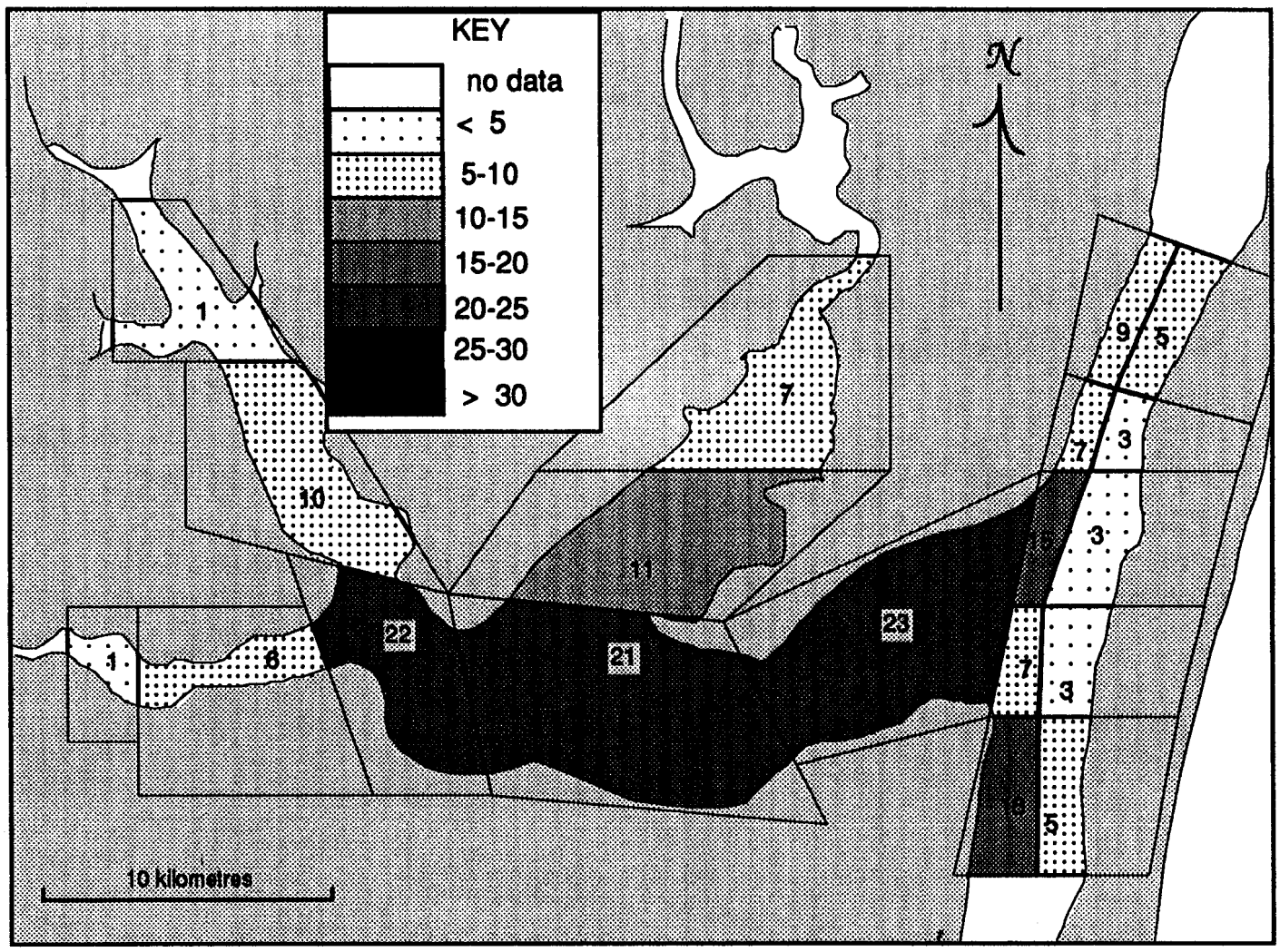


Figure 5-71. Sampling density of SEDMETZN for Baffin Bay region

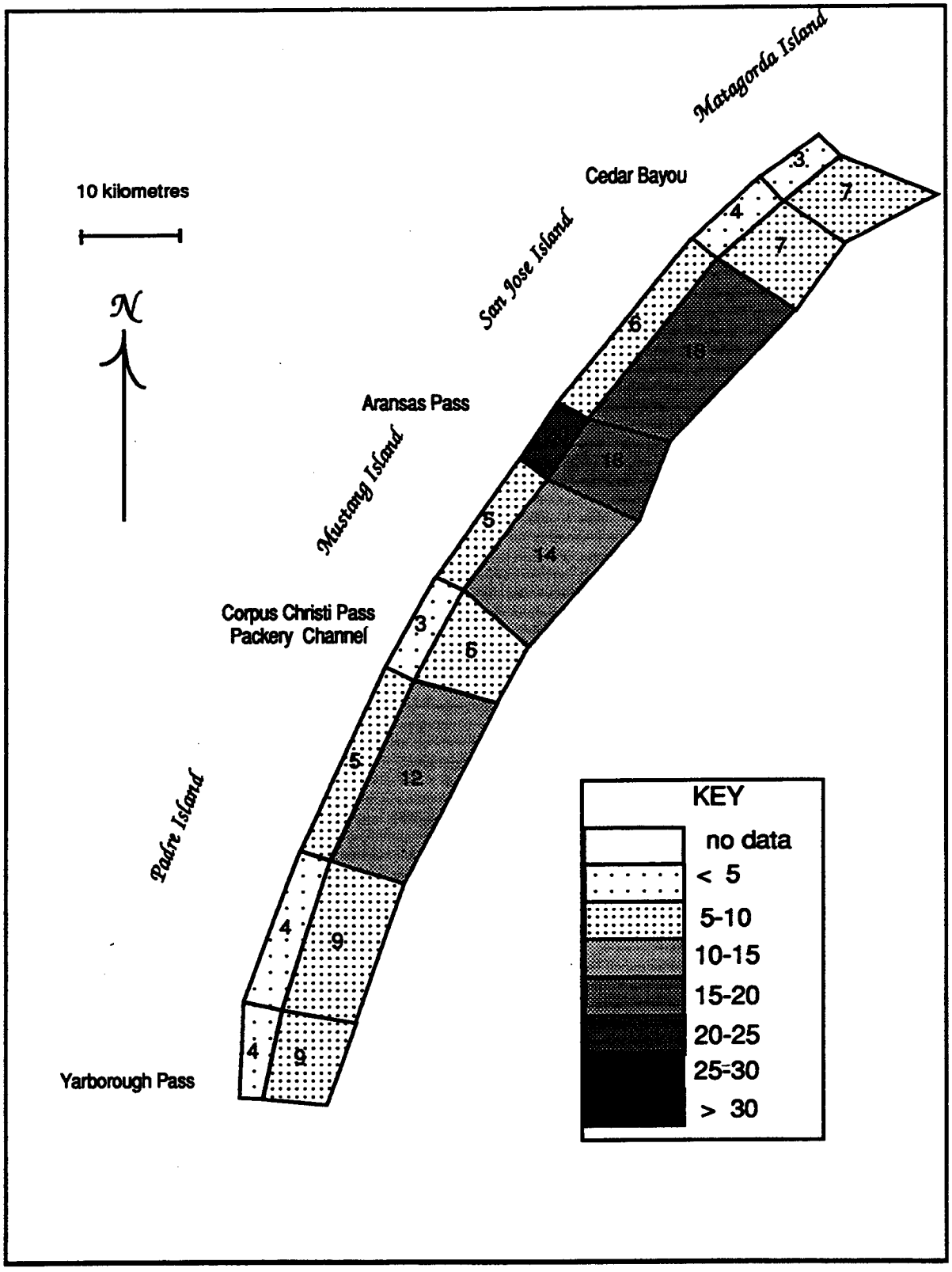


Figure 5-72. Sampling density of SEDMETZN for Gulf of Mexico

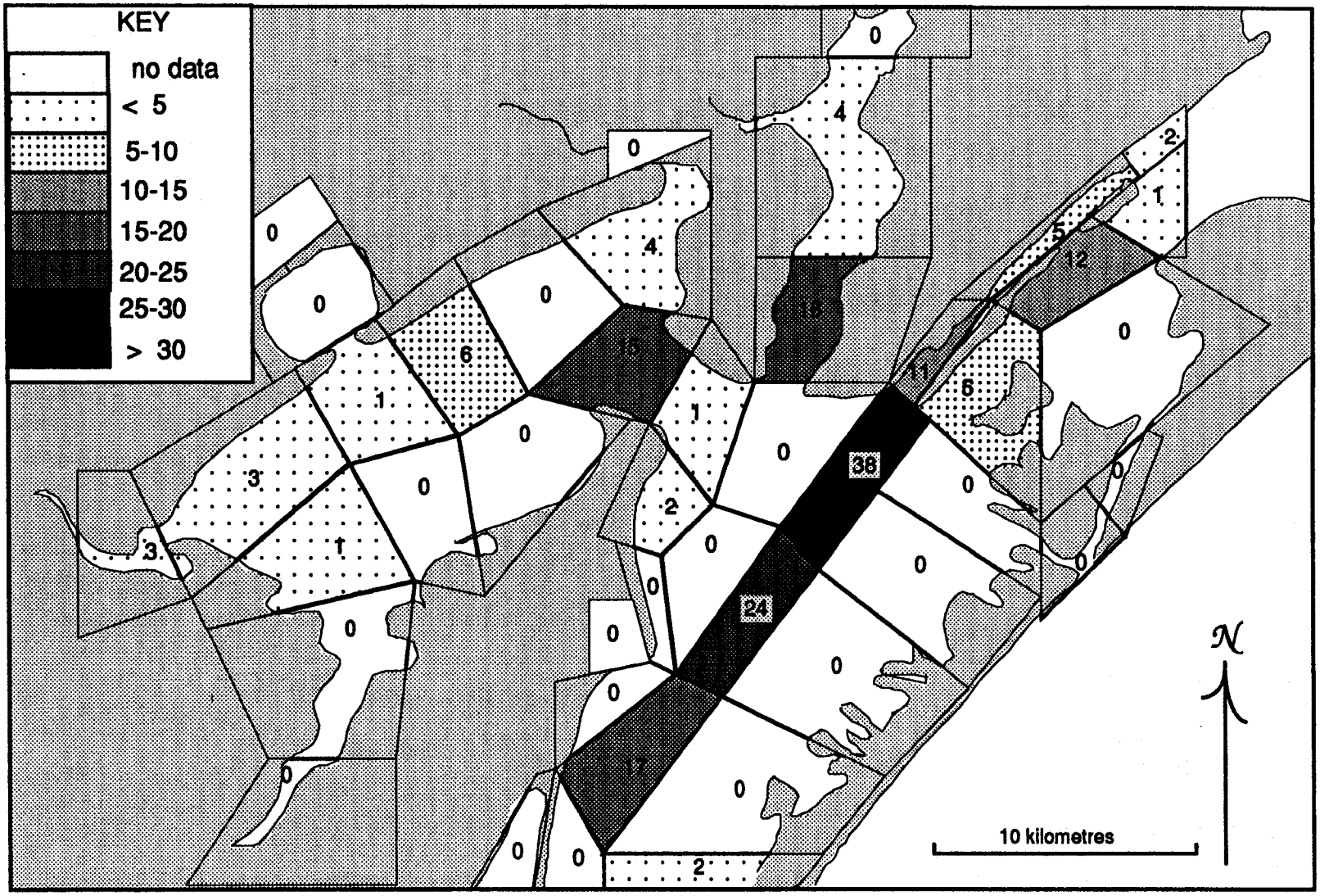


Figure 5-73. Sampling density of SED-XDDT for Aransas-Copano system

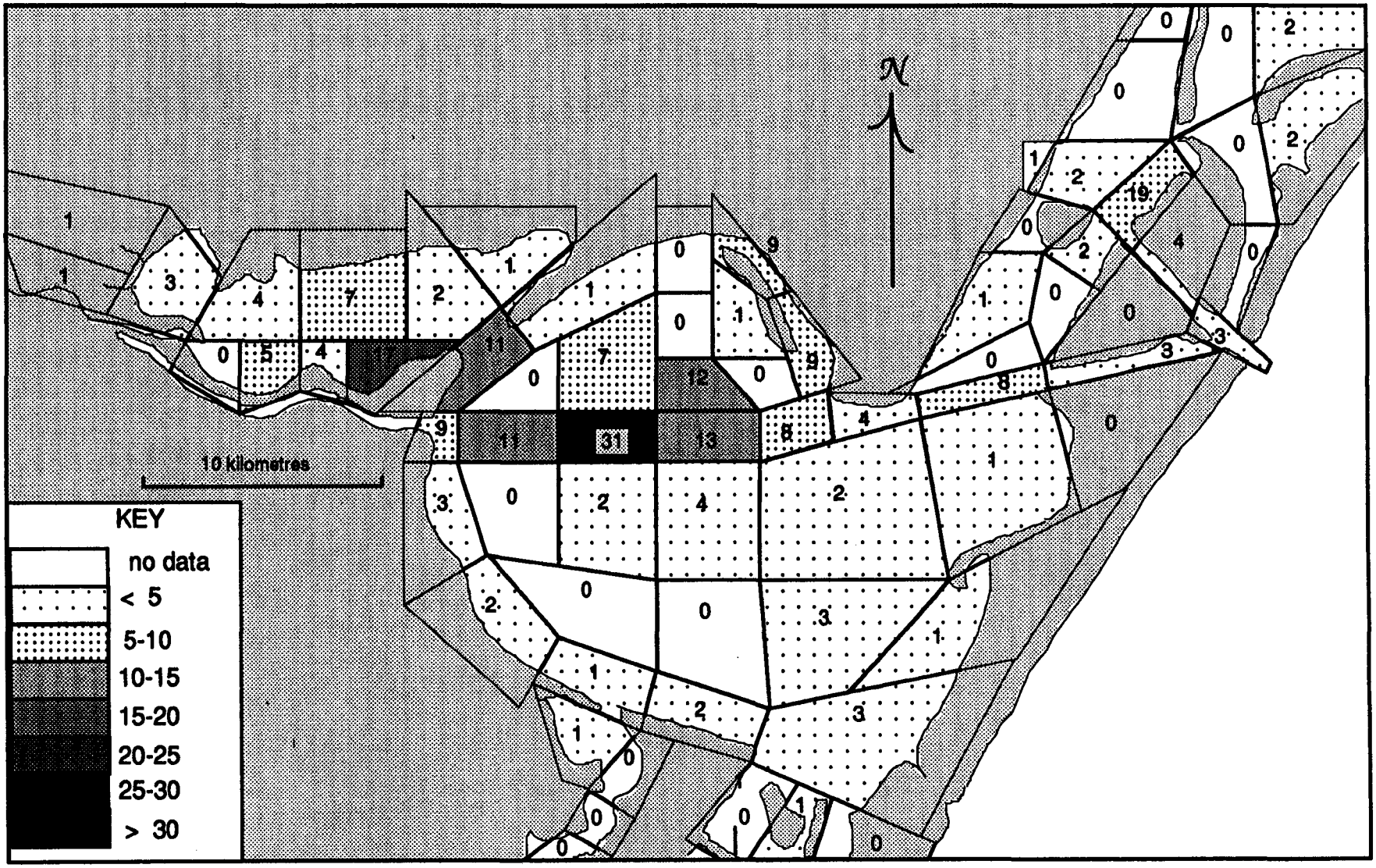


Figure 5-74. Sampling density of SED-XDDT for Corpus Christi system

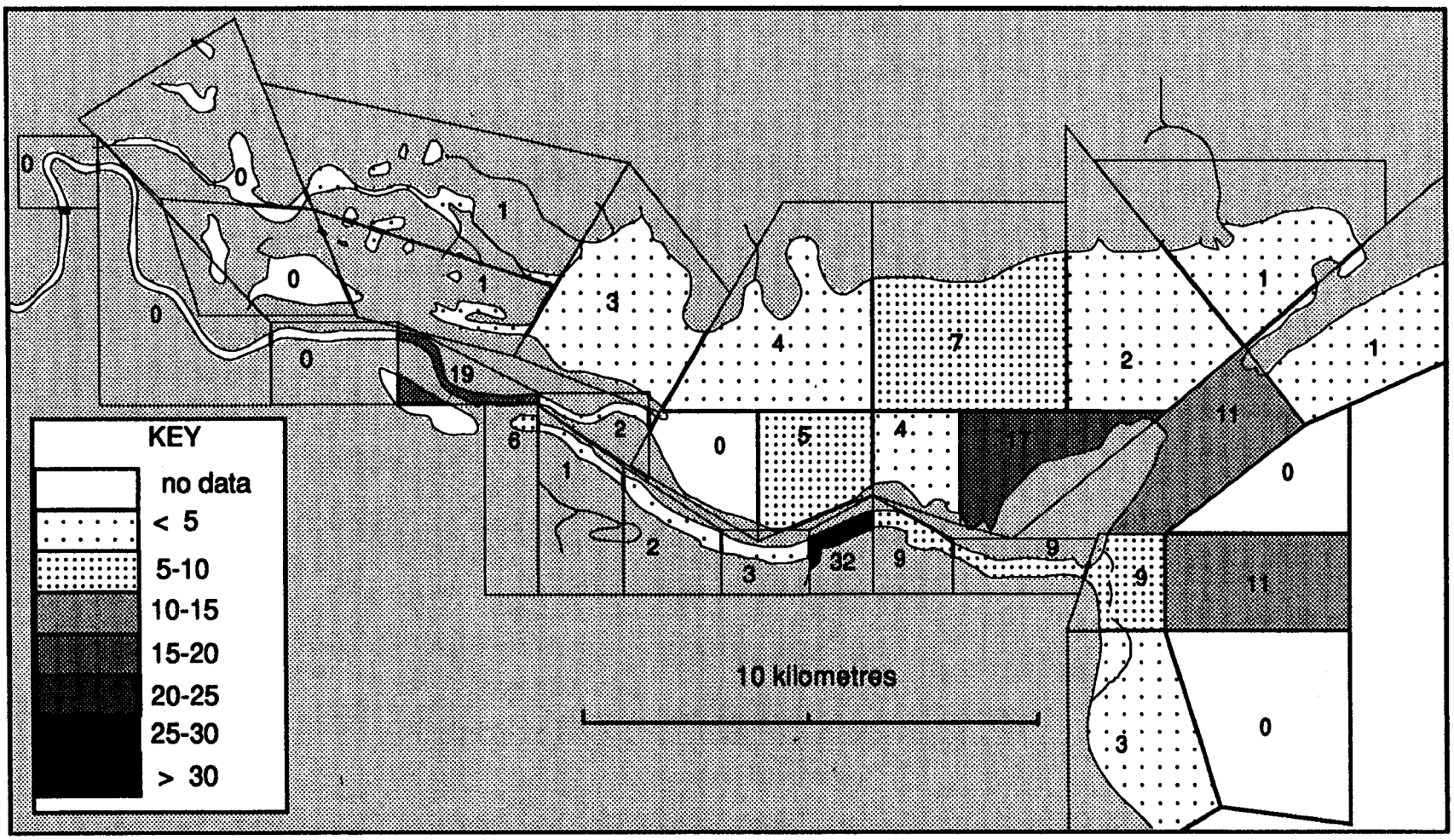


Figure 5-75. Sampling density of SED-XDDT for Nueces Bay region, including Inner Harbor

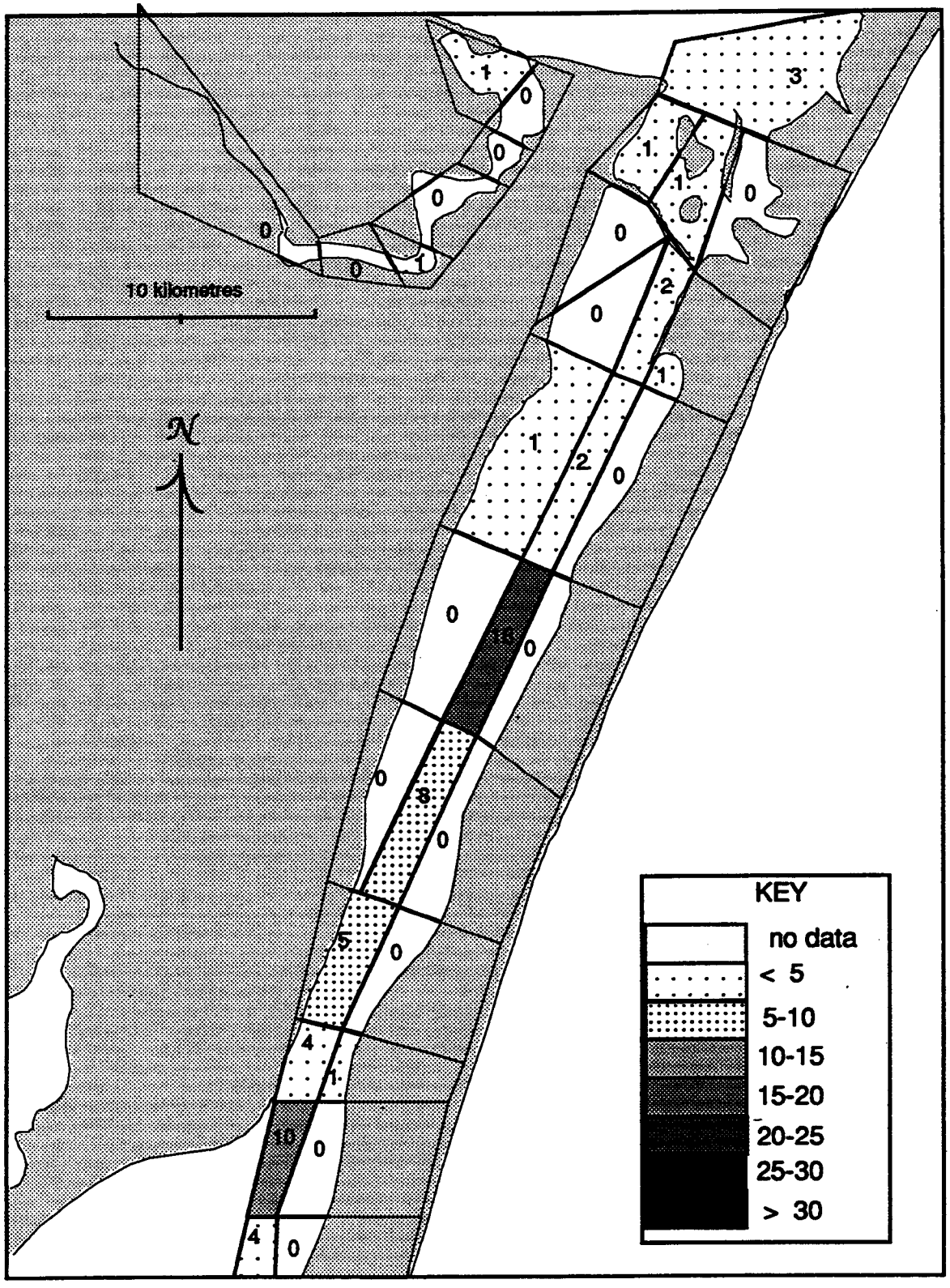


Figure 5-76. Sampling density of SED-XDDT for Upper Laguna Madre and Oso Bay

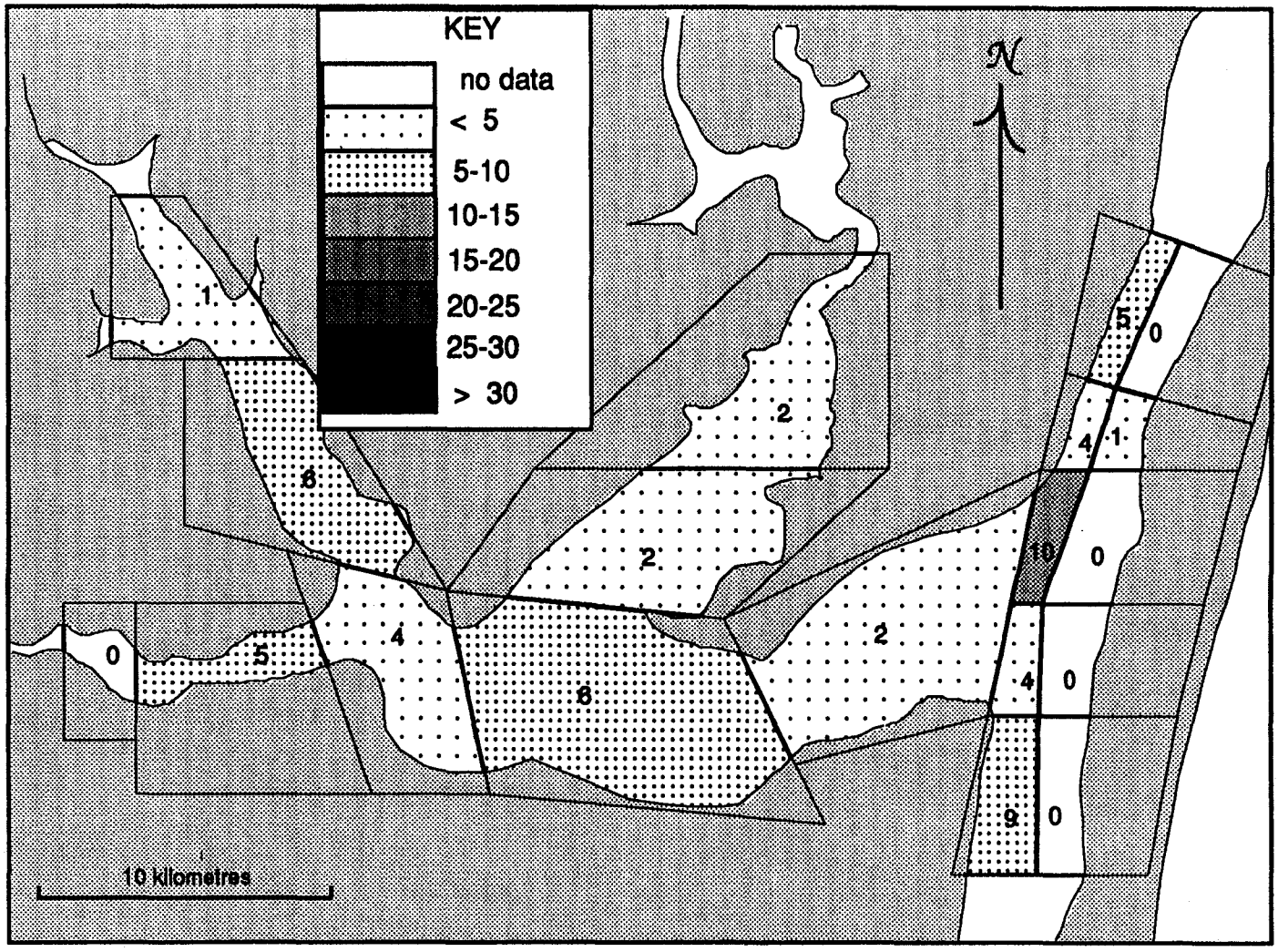


Figure 5-77. Sampling density of SED-XDDT for Baffin Bay region

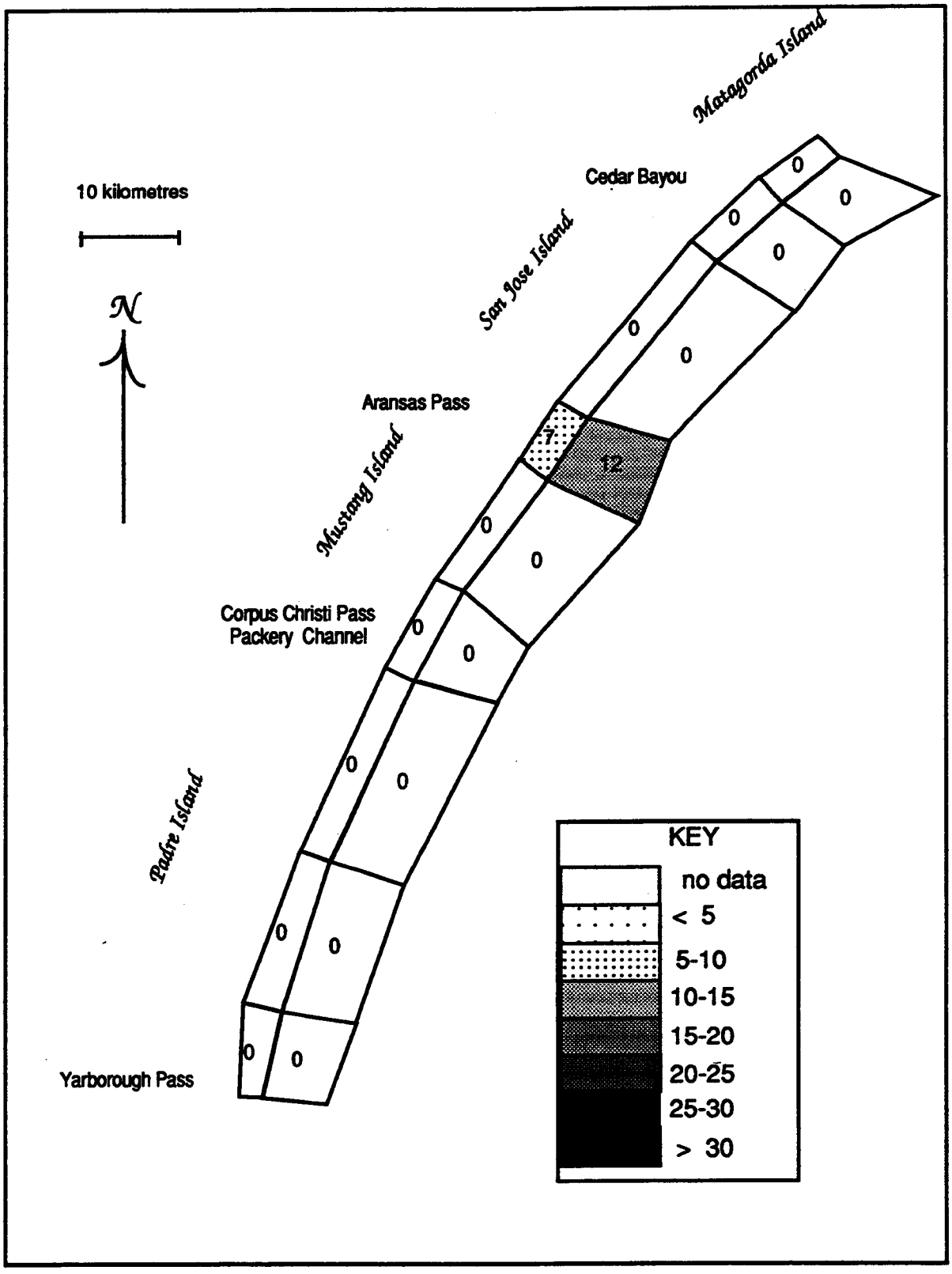


Figure 5-78. Sampling density of SED-XDDT for Gulf of Mexico

that should be theoretically available. Much of the historical data has been lost. Moreover, too many entries in the data record had to be excluded from the analyses presented here because the data were unreliable. It is our belief that this unreliability was not introduced in the original measurement but in the subsequent handling of the data. All of these problems are manifestations of deficiencies in data base management. We differentiate between the management of modern data bases, i.e. more-or-less contemporary data streams, discussed in Section 5.3.2, and the management of historical data bases, treated in Section 5.3.3.

Recommendations for both collection and management of data from Corpus Christi Bay are presented in Chapter 10.

5.3.1 Deficiencies in sampling strategy and data distribution

Because Corpus Christi Bay is a complex estuarine system, spatial gradients in concentration are the norm, created by circulation, intermixing of fresh water and seawater, and sources of pollutants. Positioning information is indispensable to properly interpreting measurements, the requisite accuracy being dictated by the region of the bay and the prevailing spatial gradients. Despite this, positioning information associated with water samples is frequently of inferior quality, and may be so erroneous that the data is unusable. For most sampling programs, positioning is a three-step process, each step of which is subject to errors:

(1) bringing the boat or sampling platform to its desired position
(2) rendering the sampling location on a map
(3) determining the geographical coordinates

For stations in a confined waterway with shore-based landmarks, or for stations on a well-marked navigation channel, positioning of the platform (1) can be carried out accurately in the field. When these landmarks, e.g. bridge structures or navigation aids, are *also* accurately located on a published map, Step (2) of rendering the locations on the map can be performed with equal accuracy. In the open waters of the bay, positioning in the field is more problematical, and placing the occupied position on a map is just as questionable. The traditional method of "eye-balling" is often used, relying upon distant landmarks, attempts to hold constant headings, estimating distance by speed (itself a judgment) and travel time, and similar exercises. The potential for error is considerable. The BEG (Project 12) and USF&WS (Project 27) both used this method, as did SWRI, USGS, TNRCC and many others.

Many of the data sources used in this study carried out only the first two steps. This project then performed the third step of reading the geographical coordinates from the map; the process and Q/A procedures are described in Sections 4.1 and 4.2.2. Some data sources, such as the Texas Parks and Wildlife Department (Project Code 3) and U.S. Geological Survey (Project Code 11), carried out Step (3) and provided only the final latitude/longitude coordinates. We of course have no

means of verifying these positions. Some of the TPWD stations plotted out in impossible positions, such as off North Africa, and one of the USGS stations plotted out in the middle of downtown Corpus Christi. Data from these stations had to be excluded from the compilation. But these raise the question of how many other stations are also mislocated, at positions that happen to lie within the study area so that the error cannot be detected.

In recent years, technology that would appear to eliminate all of these problems has become inexpensive enough that it is beginning to be used in sampling programs, *viz.* radionavigation systems, primarily LORAN, and geographical positioning systems (GPS). These systems include an onboard processor that provides immediate feedback to the operator, and effectively collapse all three of the above steps literally into a push of a button. It seems almost too good to be true.

LORAN (nee LORAN-C, before the original LORAN system was dismantled about a decade ago) is a hyperbolic radioposition system that operates in the LF band. It is subject to two primary sources of error: poor geometry (i.e., oblique crossing angles of the LORAN lines of position) and propagation noise, to which LF signals are particularly prone due to the variability of the ionospheric waveguide. Nominal accuracy cannot be expected to be better than 0.5 km, and may be 2-5 times this under poor atmospheric conditions (which are not obvious to the user). The internal processor for the onboard receiver does not provide the user with any measures of uncertainty, but produces latitude/ longitude coordinates to a meretricious 5 or 6 significant figures. LORAN-derived coordinates were provided for the MSI 1988-89 stations in Corpus and Nueces Bays (Project Code 17). In comparison to a hand-plotted map, these looked "about right" but upon closer verification, 12 out of 33 had to be mapped and their coordinates determined by hand because the LORAN positions were over a kilometre in error. One of these, in lower Nueces Bay, plotted out according to LORAN in a cow pasture near Odem. Another, in the Ship Channel near Harbor Island, plotted out in the surf off of Packery Channel.

GPS does not appear to be much more reliable, the vaunting of vendors notwithstanding. The signal is subject to error due to propagation between satellite and receiver. To realize the advertised accuracy, the receiver/processor must remain stationary for some time to integrate out the noise in the signal, which is often difficult to manage in a boat. ("Differential mode" using a fixed base station signal can considerably improve the performance.) Again, the black-box processor produces latitude/longitude coordinates to an impressive precision. The stations for one of the Laguna Madre data sets used in this compilation were determined by GPS: they plotted out 10 km in the Gulf of Mexico. (To be fair, though, it must be stated that the error in these positions may have been introduced in post-processing, and not from the GPS unit itself. We have too little information about the actual field and data-processing procedure to judge.)

Geographical distribution of sampling stations is frequently driven by the management objective of the agency, appropriately; but this also means that the data may not be placed most strategically for water-quality characterization. For

example, Nueces County Health Department monitors to ensure the quality of water for contact recreation, and therefore places its stations in areas where such recreation is concentrated, which happens to be mainly along the shoreline adjacent to the City of Corpus Christi. Similarly, TNRCC monitors pollution mainly in areas expected to be subjected to contaminants, such as the Inner Harbor and La Quinta Channel. Texas Department of Health monitors areas subject to shellfish harvesting. The Corps of Engineers concentrates its monitoring activities in the proximity of ship channels. The utility of any of these stations to a characterization of water quality is a matter of fortuity.

If one wishes to best determine properties of a water mass with a single station, it is apparent that one would monitor in the midpoint of the water mass. The reason, perhaps sensed intuitively, is that such placement will ensure that the measurement will be minimally subject to random spatial variation since here the water mass would be expected to be most uniform. In contrast, near the boundary of the water mass, measurements would be much more variable, and therefore less reliable, due to intermixing with waters from adjacent masses. This same principle ideally would be applied in placing sampling stations in an estuary for monitoring data to characterize water quality, i.e. placing the stations where water properties would be expected to be most homogeneous, and avoiding those areas where large spatial gradients would occur. For example, one would monitor near the center of a secondary bay, and would avoid monitoring at the inlet between this bay and the larger connected system. Yet an inspection of the sampling density of the data from Corpus Christi Bay shows that the inlets between systems, such as the entrance to Nueces Bay, the pass between Copano Bay and Aransas Bay, and the Upper Laguna Madre at the JFK Causeway, are most frequently monitored. This is an unfortunate manifestation of the fact that these areas are generally preferred because station location is much easier.

Of course, the optimum sampling distribution would be a dense, uniform distribution throughout the system. This is rarely possible, especially for a monitoring program, in contrast to a one-shot survey, therefore we have followed the strategy of collecting the data into hydrographic areas for spatial analysis. The sampling density figures given in the preceding section evidence a high degree of heterogeneity in sampling. As expected, Corpus Christi Bay *per se* is sampled most often, with the upper and lower systems of Aransas-Copano and Baffin being sampled much less frequently. The sediment samples are particularly poorly distributed, with the outer bays not being sampled for many parameters in years.

As noted in Chapter 1, the time history and temporal intensity of data collection in the bay are of central importance in assessing the data base, from two standpoints. First, a long period of data collection is necessary to encompass the range of variation of external conditions to which the bay is subject and which contribute to the variance in the parameters. Second, from the standpoint of determining time trends, a long period of record is absolutely indispensable. Moreover, a long period of record is much more important in improving statistical reliability than a reduction in the noise in the data.

The time history of sampling in the Corpus Christi Bay system since 1955 is roughly indicated in Figs. 5-79 through 5-89. These show total measurements per year in the entire study area including the adjacent Gulf of Mexico for the indicated parameters. Generally, data collection intensity peaked in the mid-1970's, in the sense of the maximum number of sampling programs being underway and the densest network of stations, and has been declining since. However, there have been notable increases in the collection frequency of hydrographic parameters and trace parameters. Figure 5-79 shows both the 1970's peak and the recent increase in salinity and DO (temperature and pH being almost identical). Figure 5-80 shows the collection intensity of the principal state monitoring programs that determine these hydrographic parameters, and clearly demonstrates that the increase since 1980 has been due to the intensified data-collection of the Texas Parks and Wildlife Coastal Fisheries program. The importance of this data collection enterprise, in terms of the raw numbers of observations made, cannot be overstated. The activity of the TWDB-sponsored Bays and Estuaries Program in the early 1970's should be especially noted. These data were collected largely by contractors to the TWDB, including U.S. Geological Survey, investigators at the Marine Science Institute, and various private consulting companies.

Conventional water contamination indicators are shown in Figs. 5-81 and 5-82. The decline of samples since 1993 is due in part to the pipeline problem of sample processing at TNRCC, which has a backlog of many months (see Section 5.3.2 below). The intensity of coliform data collection appears to have generally increased since the 1960's. This is in part due to the data collection by the state agencies, especially TDH, see Fig. 5-83, but in part to the loss of data from Nueces County Health Department taken prior to 1975. Also, fecal coliforms have replaced total coliforms, and while the coliform record encompasses nearly 40 years, it is really only half that good, since there is no proxy relation between the two coliform indicators. Nutrients are shown in Figs. 5-84 and 5-85. The peak in the 1970's is due primarily to the activities of TWDB Bays and Estuaries Program. Note the decline in the most recent five years. The most surprising aspect of the turbidity-related measurements, Fig. 5-86, is that the most important parameter TSS is measured on a long-term basis only by the TNRCC. Note also that NTU's have replaced JTU's in the historical record. (See Section 2.3 above.) The increase in the frequency of trace constituent analysis, noted above, was due to increased interest in a wide spectrum of metals and organic toxicants coupled with a quantum increase in analytical methodologies (e.g., mass spectrometry). This is exemplified by the parameters of Fig. 5-87, showing one metal, one pesticide, one PAH and total PCB's. Most of the parameters in the CCBNEP list were introduced by this same technological innovation, because the GC/MS methodologies permit a large generation of parameters from a single sample/procedure.

As salinity and temperature are the most easily measured variables, they represent the densest and longest data record. Even at this, past sampling practice does not generally permit analysis of time scales of variation shorter than a few days. Moreover, the extant measurements are nearly all for daytime hours, which must be considered a source of potential bias in the data. For salinity, in

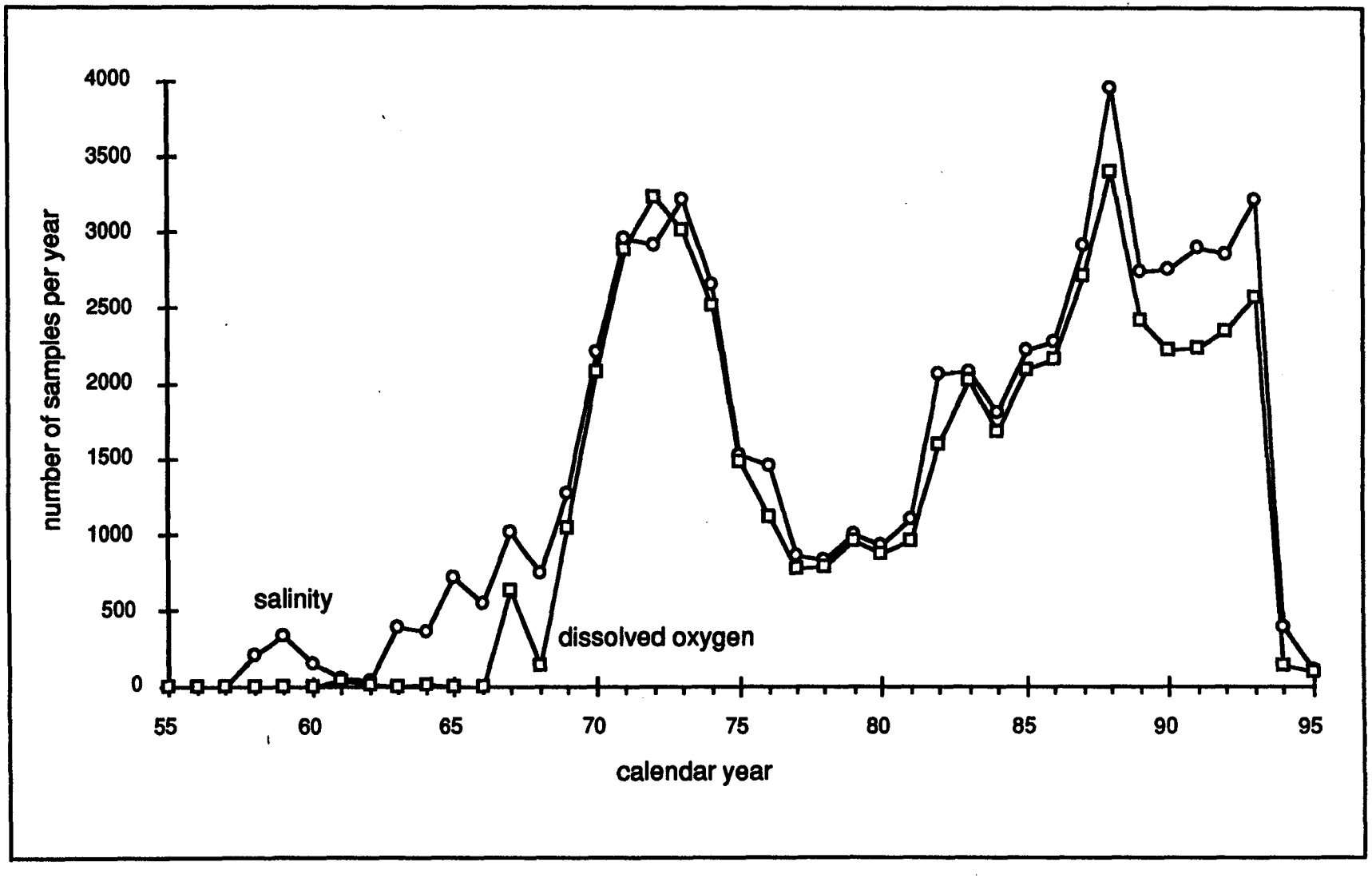


Figure 5-79. Data base annual measurements 1955-95, hydrographic parameters

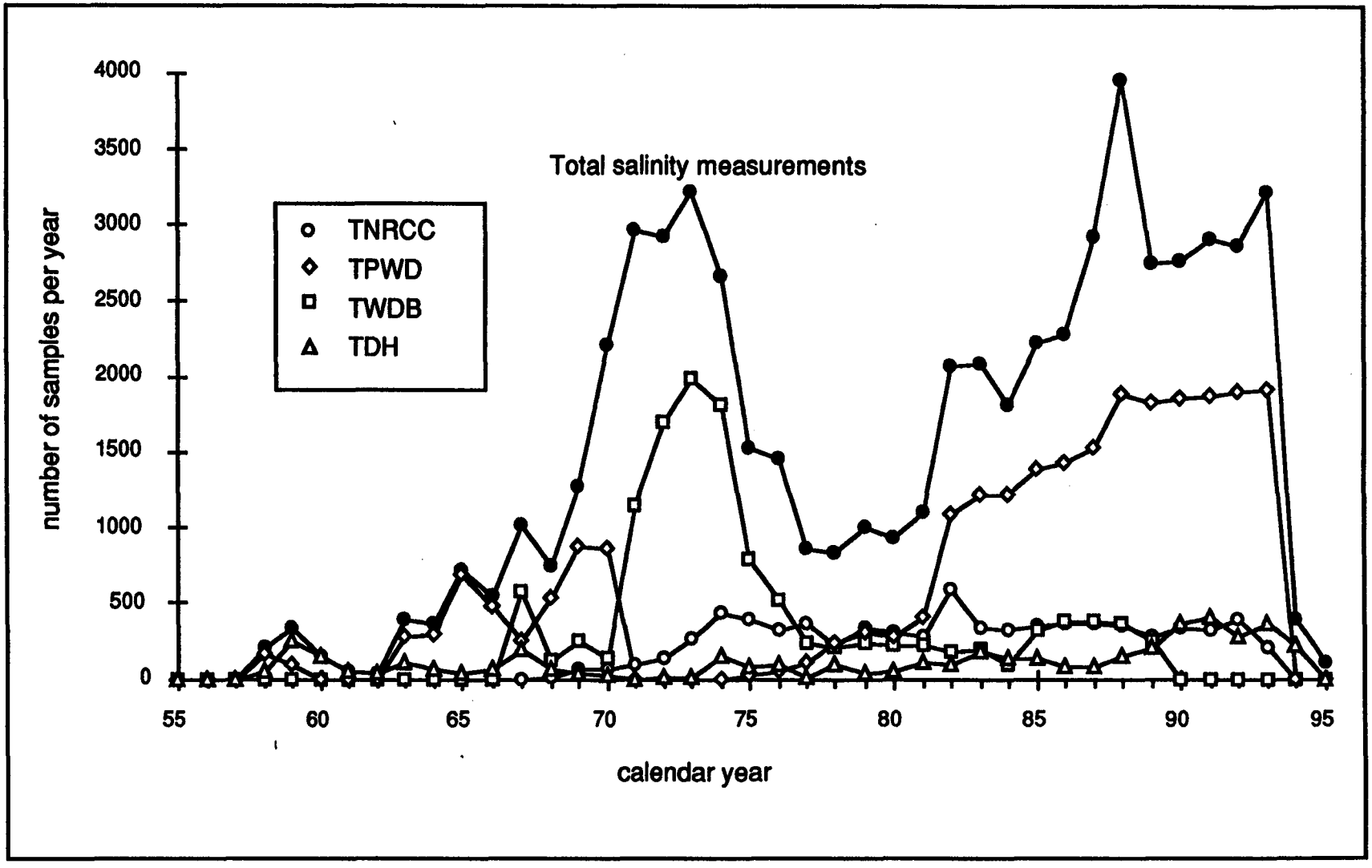


Figure 5-80. Data base annual measurements 1955-95, salinity by project

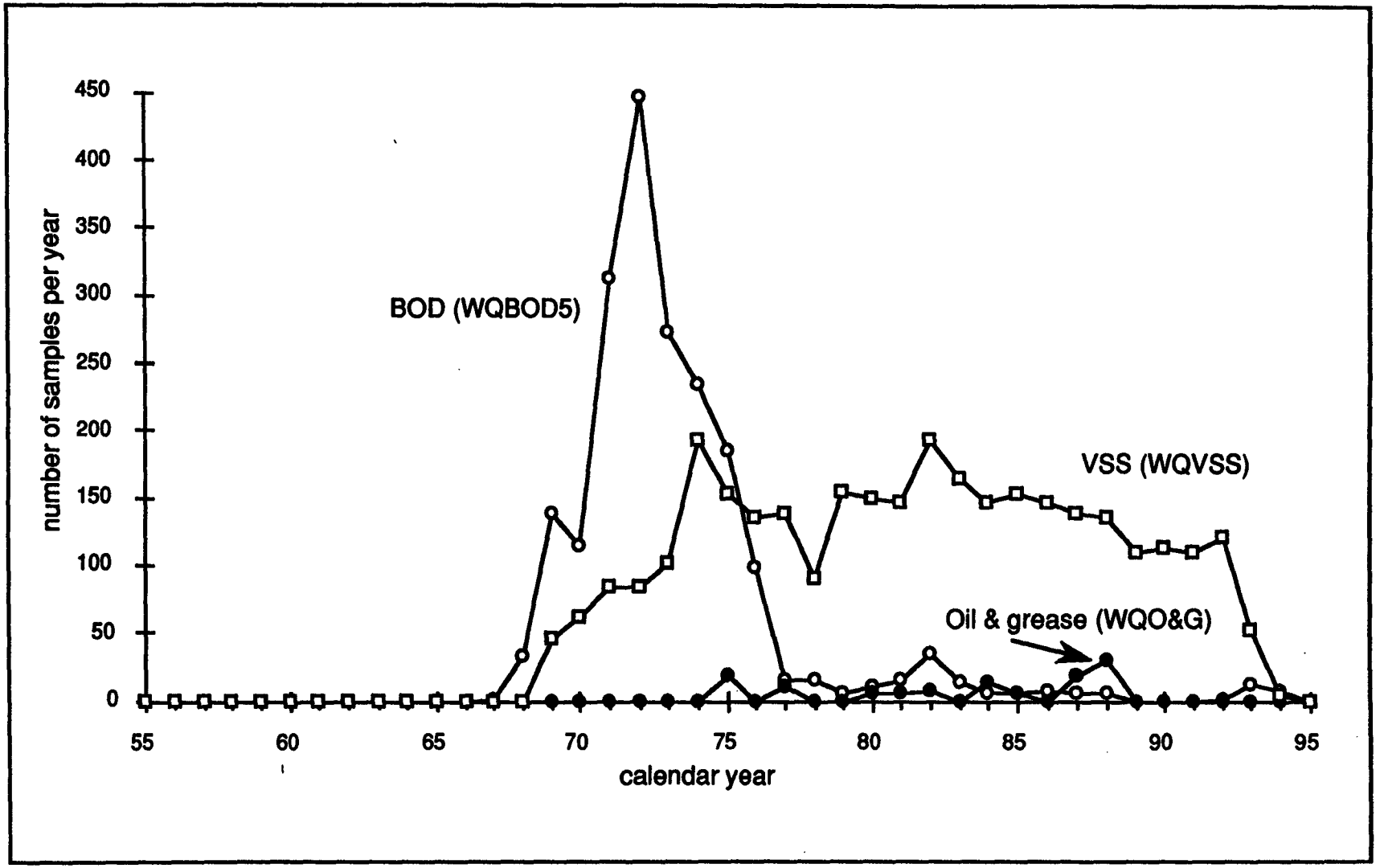


Figure 5-81. Data base annual measurements 1955-95, water-quality indicators

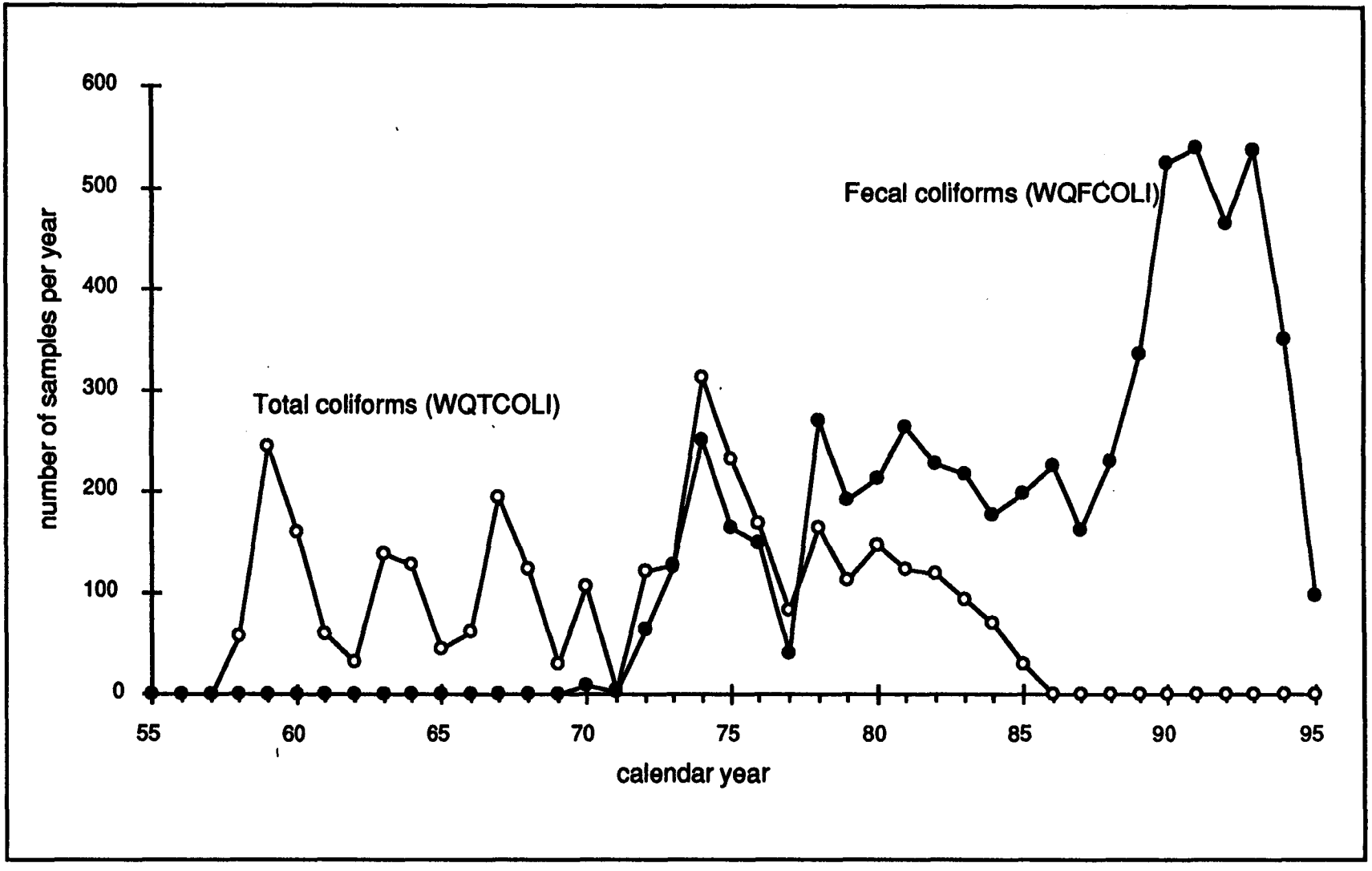


Figure 5-82. Data base annual measurements 1955-95, coliforms

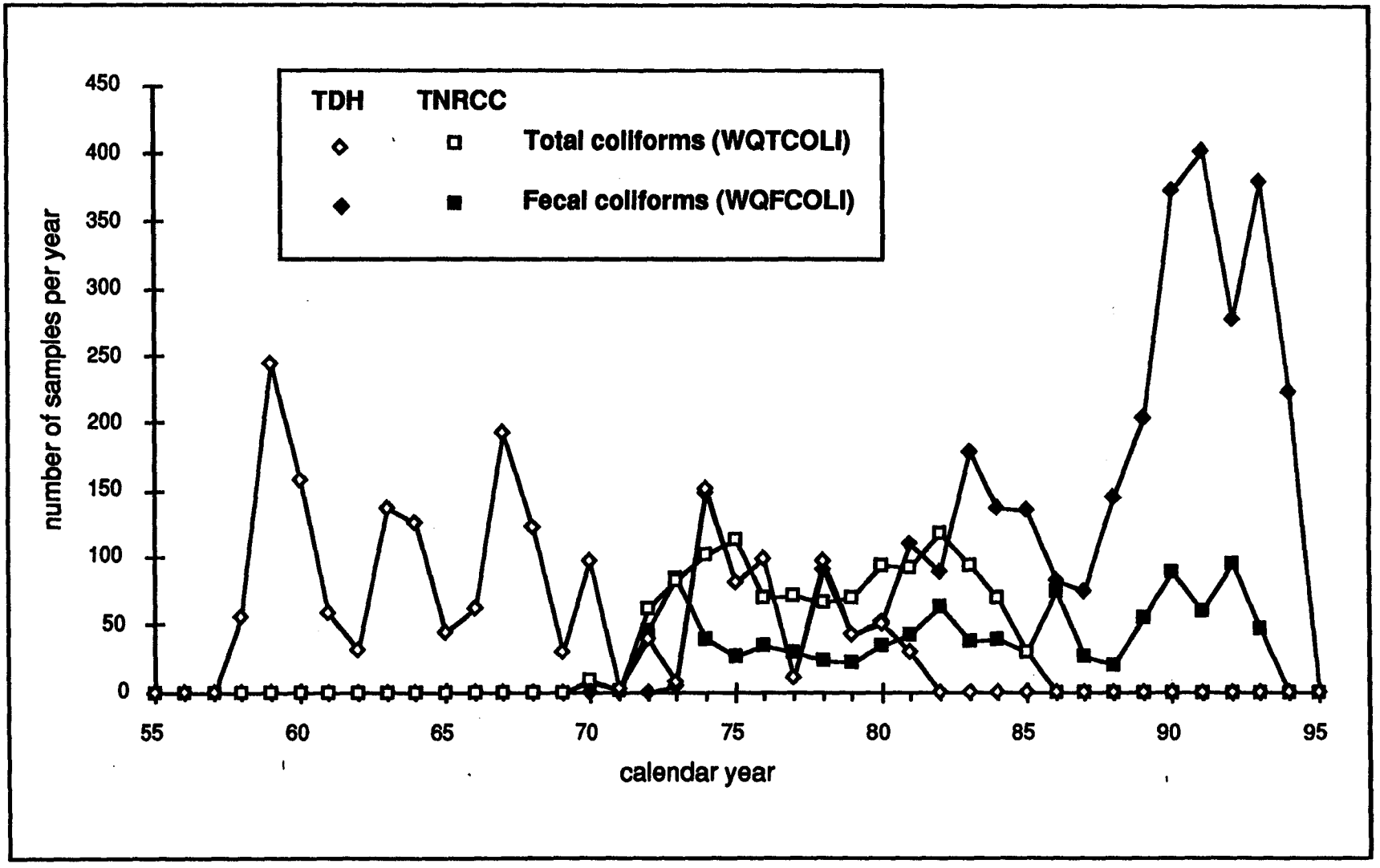


Figure 5-83. Data base annual measurements 1955-95, coliforms by state project

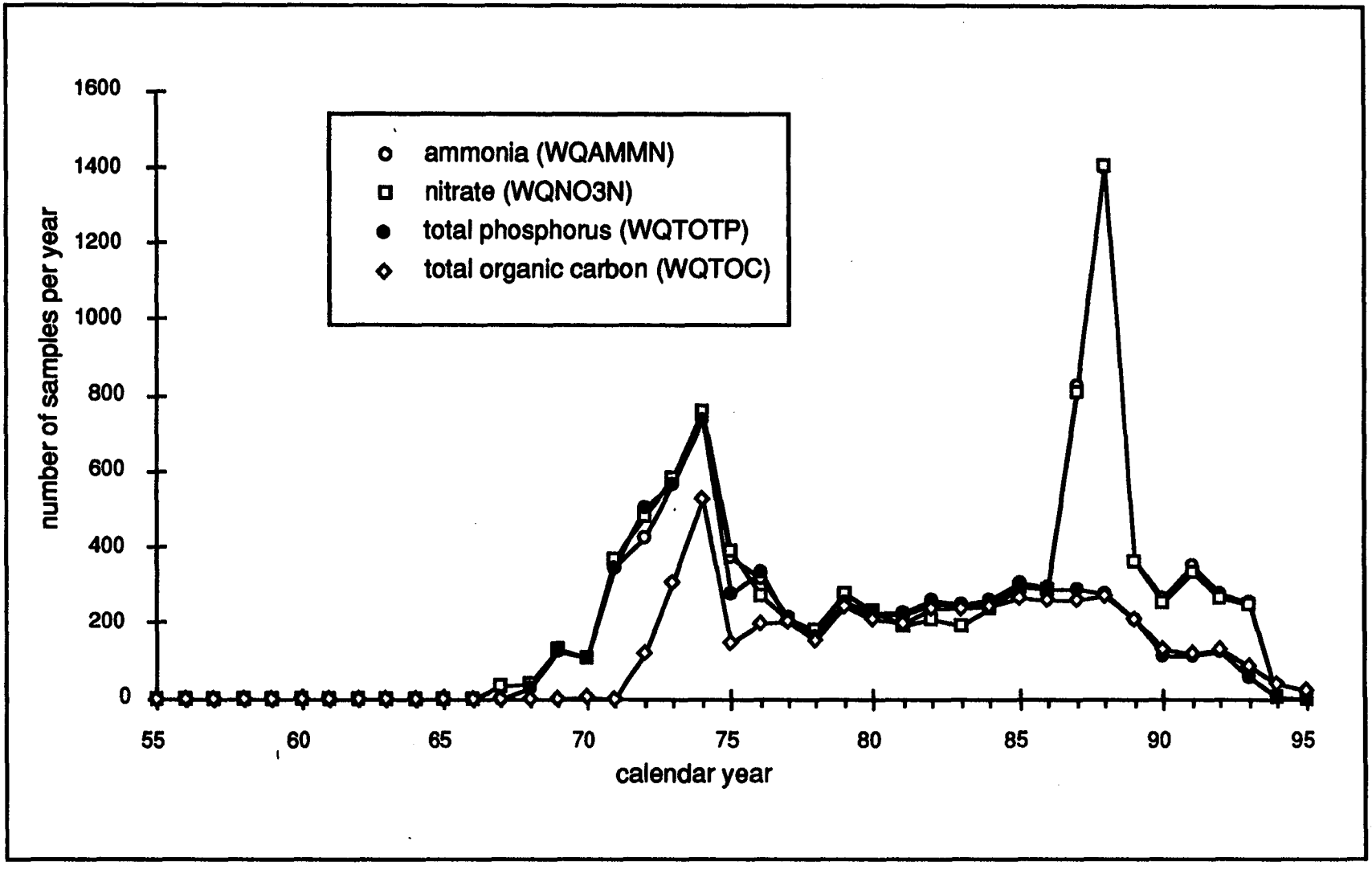


Figure 5-84. Data base annual measurements 1955-95, nutrients

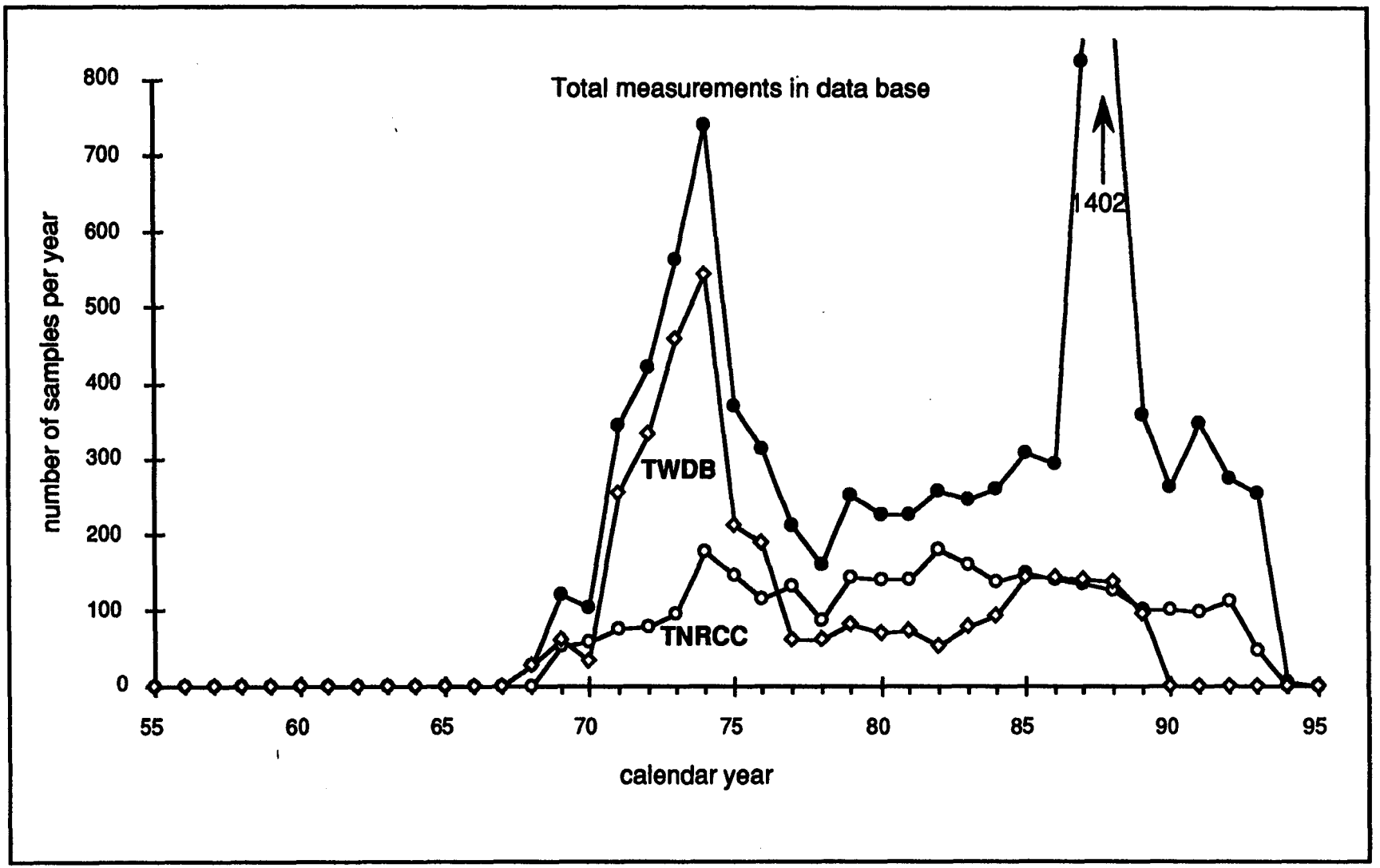


Figure 5-85. Data base annual measurements 1955-95, ammonia (WQAMMN) by state project

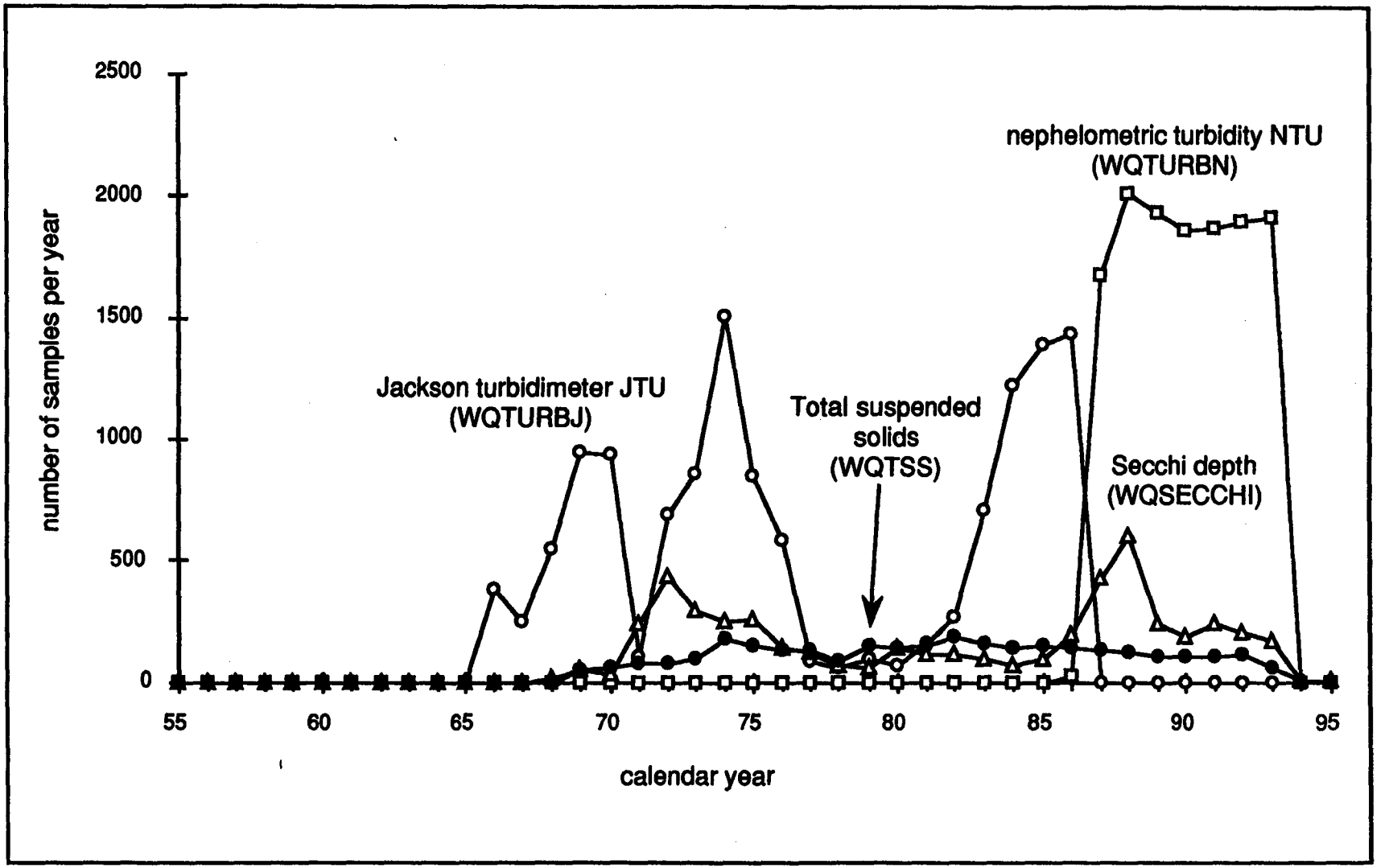


Figure 5-86. Data base annual measurements 1955-95, turbidity parameters

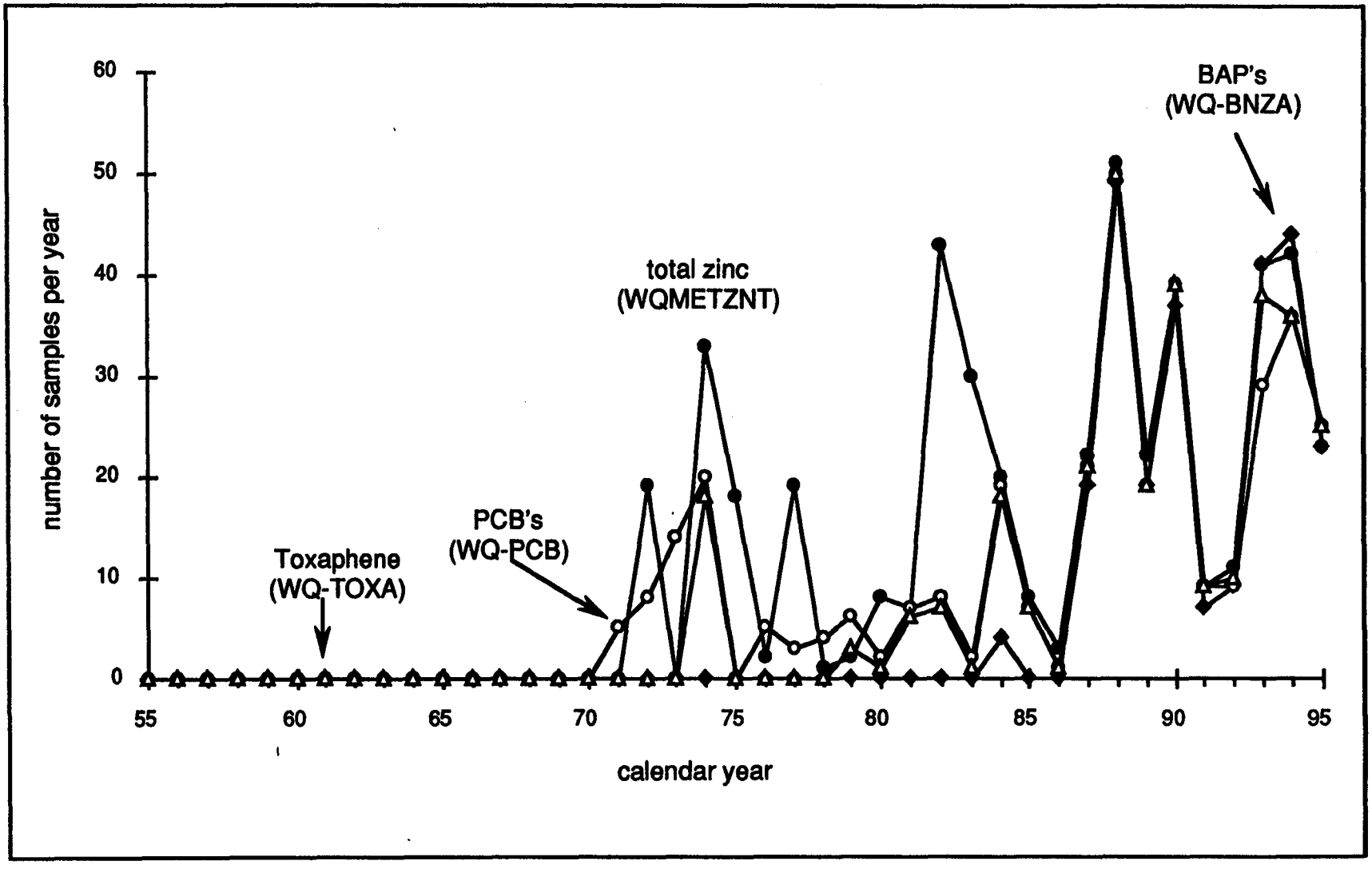


Figure 5-87. Data base annual measurements 1955-95, metals and toxics

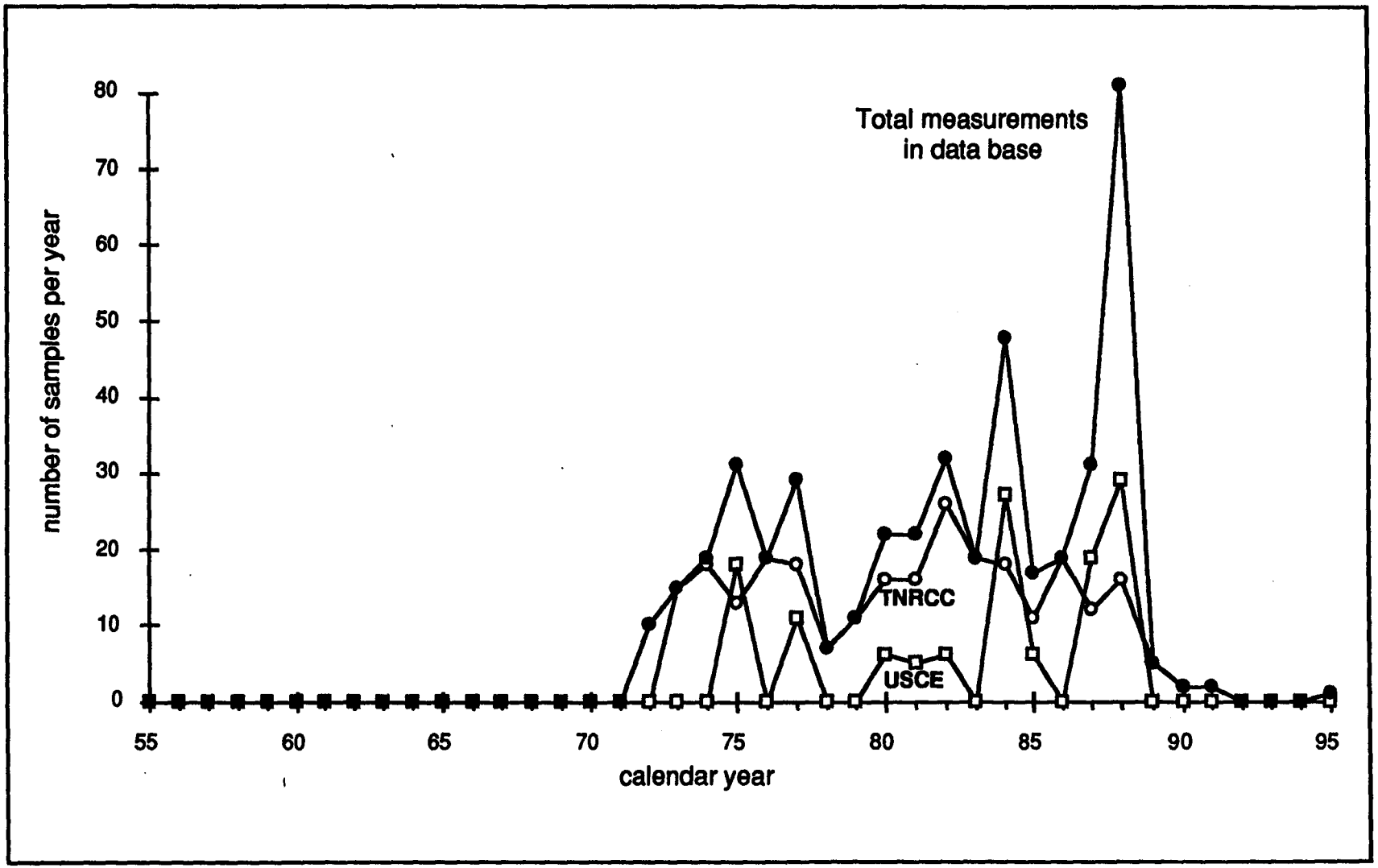


Figure 5-88. Data base annual measurements 1955-95, sediment oil & grease (SEDO&G)

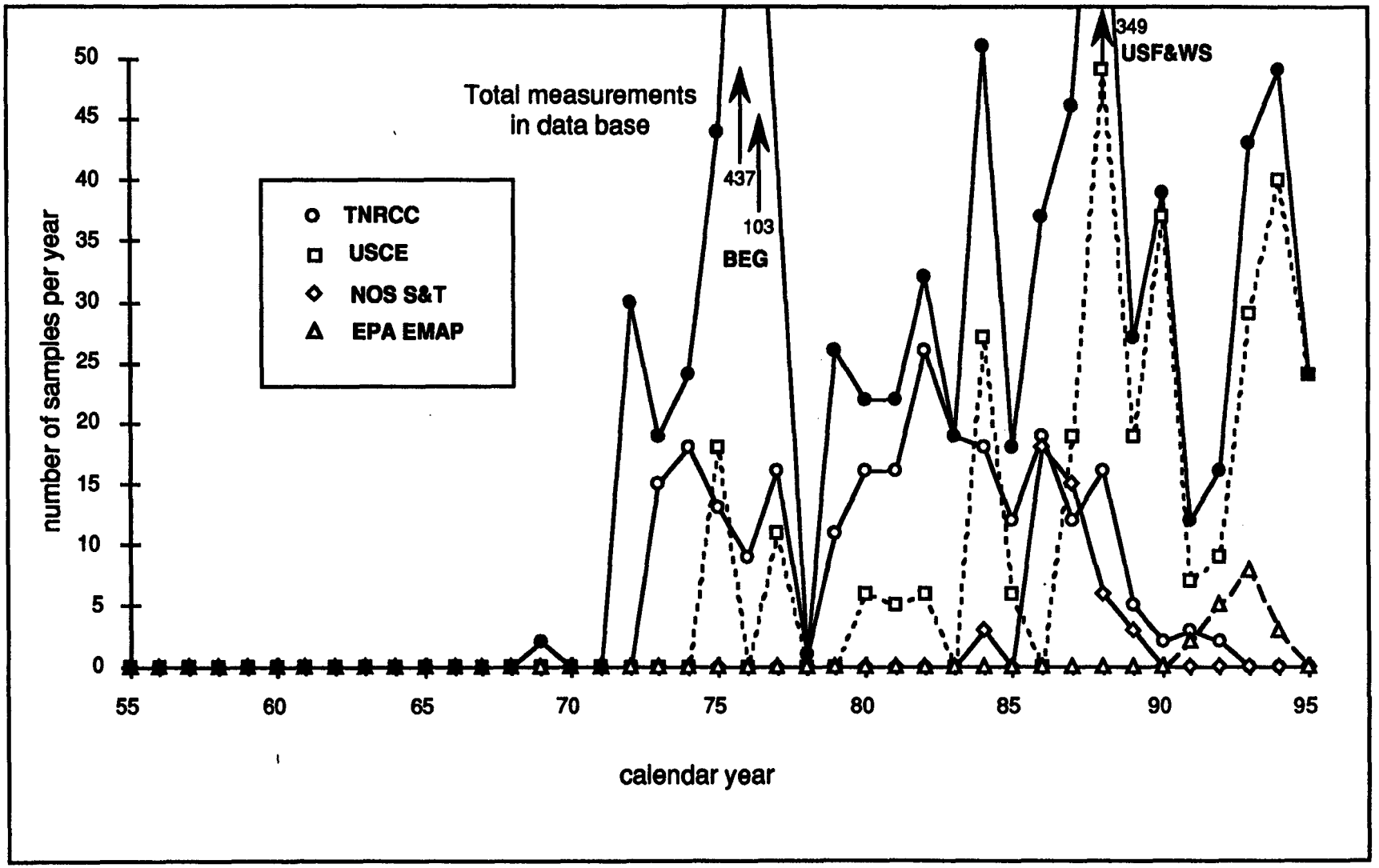


Figure 5-89. Data base annual measurements 1955-95, zinc in sediment (SEDMETZN)

some areas of the bay (depending upon the presence of steep gradients), there is a tidal oscillation that is generally unsampled, but certainly a source of variability. For temperature and dissolved oxygen, especially, there is a known diurnal variability which is virtually unsampled by routine observations in Corpus Christi Bay. The use of automatic data logging and electrometric sensing now permit the recovery of nearly continuous, fine-scale time signals of these parameters, and should be incorporated into routine monitoring of the bay. Their present use poses its own set of problems, discussed in 5.3.2 below. NB, such data acquisition does not replace routine sampling, since routine sampling provides far better spatial continuity and is not subject to vandalism and sensor degradation (see 5.3.2), which plague automatic monitors.

One of the central problems in constructing a sufficiently dense and long-term data base for analysis for the conventional parameters is the inconsistency in measurements and analytical methodologies from one program to another. Some programs emphasize COD and sulfides, say, while another examines phytoplankton and TOC, and a third may analyze BOD and chlorophyll-a. (Certainly, research demands that the utility of different indicator variables be explored, and the specific objectives of a given program may necessitate non-conventional analyses. On the other hand, the major investment is usually in acquiring the sample. Some consistency with other sampling programs could be reasonably attained at minor cost.) The PAH suite obtained by the Corps of Engineers is different from the PAH measurements of the TNRCC; the National Ocean Service Status & Trends Program obtain a different suite from either of these. And so it goes. The net effect is limited data coverage in a specific parameter that makes spatio-temporal analysis uncertain. Even for salinity, were it not for reliable proxy relationships, our ability to synthesize a comprehensive data set would be seriously truncated.

In recent years, there has been a shift of emphasis from rather gross and imprecise measurements to more precisely defined analytes. In most cases, this has involved a replacement of the old parameter with the new, so that the data record for the older parameter terminates, the data available for the new parameter is extremely limited, and there is no information as to the probable association between the two. Examples include the replacement of total coliforms with fecal coliforms, of Jackson turbidimeter measurements with those from nephelometers, and of oil & grease with total PAH's and then with specific PAH's such as napthalene, acenapthene and fluoranthene. (Further, in some programs, the specific PAH's vary from run to run.)

One of the principal properties of the water of Corpus Christi Bay is its turbidity. Suspended solids are particularly important in characterizing water quality because of the rôle particulates play in habitat quality, and in the sorption of nutrients and contaminants on the finer particulates. However, some programs do not obtain any measure of turbidity, and the only two that do obtain suspended solids (TNRCC and OxyChem) do not measure the grain-size distribution. Even a simple sequential filtration to determine partitioning of clays-and-finer would be of immense value in interpreting the data. The understanding of the behavior of

most nutrients, metals, pesticides and priority pollutants is limited by the lack of information on suspended solids in the water column.

Metals data are dominated by total (unfiltered) analyses. So little measurement has been made of the dissolved phase that no characterization or trends analyses are possible. This practice is perhaps not inappropriate because of the known affinity of trace metals for particulates, but underscores the problem of not having paired measurements of suspended solids to which the total concentrations could be related. Future sampling should include routine measurement of suspended solids with every metals sample. It would be even better to include a determination of grain-size distribution, as noted above. Much of the historical data for metals has been corrupted by inattention to detection limits. Frequently detection limits are reported in error (perhaps not determined as a part of the analysis) or, worse, zero values of concentration are reported.

Pesticides and other organic contaminants are a relatively recent addition to the suite of measurements, and the water-quality data base is presently inadequate for any detailed analyses. The best record is the extended DDT, obtained by combining reported "total" values with those estimated from the pp'-DDT isomer using the proxy relation (2-10). Even at this, there are only 315 observations of which only 6 are above detection limits in the entire bay (excluding the zero values discussed above). Interpretation of organic-contaminant data generally is based upon normalization to organic carbon (e.g., Karickhoff, 1981, Moore and Ramamoorthy, 1984a). For Corpus Christi Bay, there are practically no paired measurements of organic carbon and organic contaminants.

Sediment data is extremely limited for the bay. This is unfortunate because (1) the shallow nature of the bay would suggest that sediment interactions should be a signification factor in the quality of the overlying water and its habitat value, (2) sediment is considered to be a long-time-constant integrator of bay quality, compared to the variable and evanescent nature of the overlying water. While the number of observations given in Table 5-3 might appear to be large, for the conventional and metals parameters, the densest data sets, they reduce to on-the-order-of 50 observations (per parameter) per year over the period of record (and this is misleading, since the samples concentrate in a few specific years), see Figs. 5-88 and 5-89. If distributed uniformly over the study area (which they are not), this amounts to one sample per 50 square miles per year. For many metals and most organic pollutants, the data base is even smaller, and, moreover, only about 10% of the measurements are above detection limits (again, excluding the anomalous zero values).

By far, the Corpus Christi Bay component has the richest data base. For most of the sediment parameters, over half of the available data are taken from this bay. The Aransas-Copano system accounts for about a fourth of the data, and the remaining fourth is divided about equally between the Baffin system and the Upper Laguna Madre. For the objective of quantifying anthropogenic impacts, especially of industrial or urban origin, this is probably an appropriate distribution, since it is in rough proportion to the probable degree of human influence. For the purpose of characterizing natural sediment quality as a basis

for habitat assessments, the distribution is not appropriate. Neither Copano nor Baffin have been sampled anywhere fore anything in over five years.

The spatial distribution of data in these systems is dominated by two survey projects. The first was the Submerged Lands project of the Bureau of Economic Geology in the mid-1970's (Project 12 in Table 5-1). This collected sediment samples at approximately one-mile centers throughout the Gulf nearshore and estuarine coastal zone. At each of these stations TOC was determined, and at about one-third of them a suite of metals was analyzed. The second project was the contaminants study of the U.S. Fish and Wildlife Service (Project 27 in Table 5-1), which obtained metals and (at a subset of the stations) organics data at stations at one-mile centers throughout the system, except for Aransas-Copano.

The most important monitoring project that routinely collects sediment quality data throughout the system is that of the TNRCC, see Fig. 5-89. USCE collects data at irregular intervals near its navigation projects. Both the NOS Status & Trends Project (18 in Table 5-1) and the EPA EMAP/REMAP Project have limited periods of record and there is considerable doubt about their continuation.

A major deficiency of the sediment data base is that there are almost no measurements of sediment texture (i.e. grain-size distribution). Many of the parameters of concern, such as heavy metals and pesticides, have an affinity for fine-grained sediment, and moreover probably enter the system through run-off, also the source for most of the fine-grain fraction of sediment. Therefore, analysis of the variability of these quality parameters in the sediment must consider the grain-size fractions. Considering that sediment texture is an inexpensive measurement, especially compared to gas-liquid chromatography and mass spectrometry, it is inexplicable that texture data has not been routinely obtained for sediment samples. The BEG Submerged Lands Project and the EMAP programs are the only instance in which texture and metals data were both obtained. Only the BEG collected a respectable spatial density of samples, but even in this program only a minority of the samples were *paired*, i.e. chemical and textural analysis run on aliquots of the same sample.

Finally, we must note that maintenance of a monitoring project within a limited budget and resources represents a compromise between station density, temporal frequency, and the extent of the suite of analytes. Cost for all three have been increasing, the last due to more precise and expensive laboratory methodologies. Within recent years there has been a concomitant decline in all of these, especially in the spatial and temporal intensity of sampling. This is exemplified by Fig. 5-90, showing the historical discontinued stations of TNRCC and TDH, as well as the current (1994) stations.

5.3.2 Deficiencies in management of modern data

Data management is generally a shambles. Reference is made to the conclusions of Ward and Armstrong (1991) concerning data management practices and data loss in general. While these were presented with respect to the data inventory for

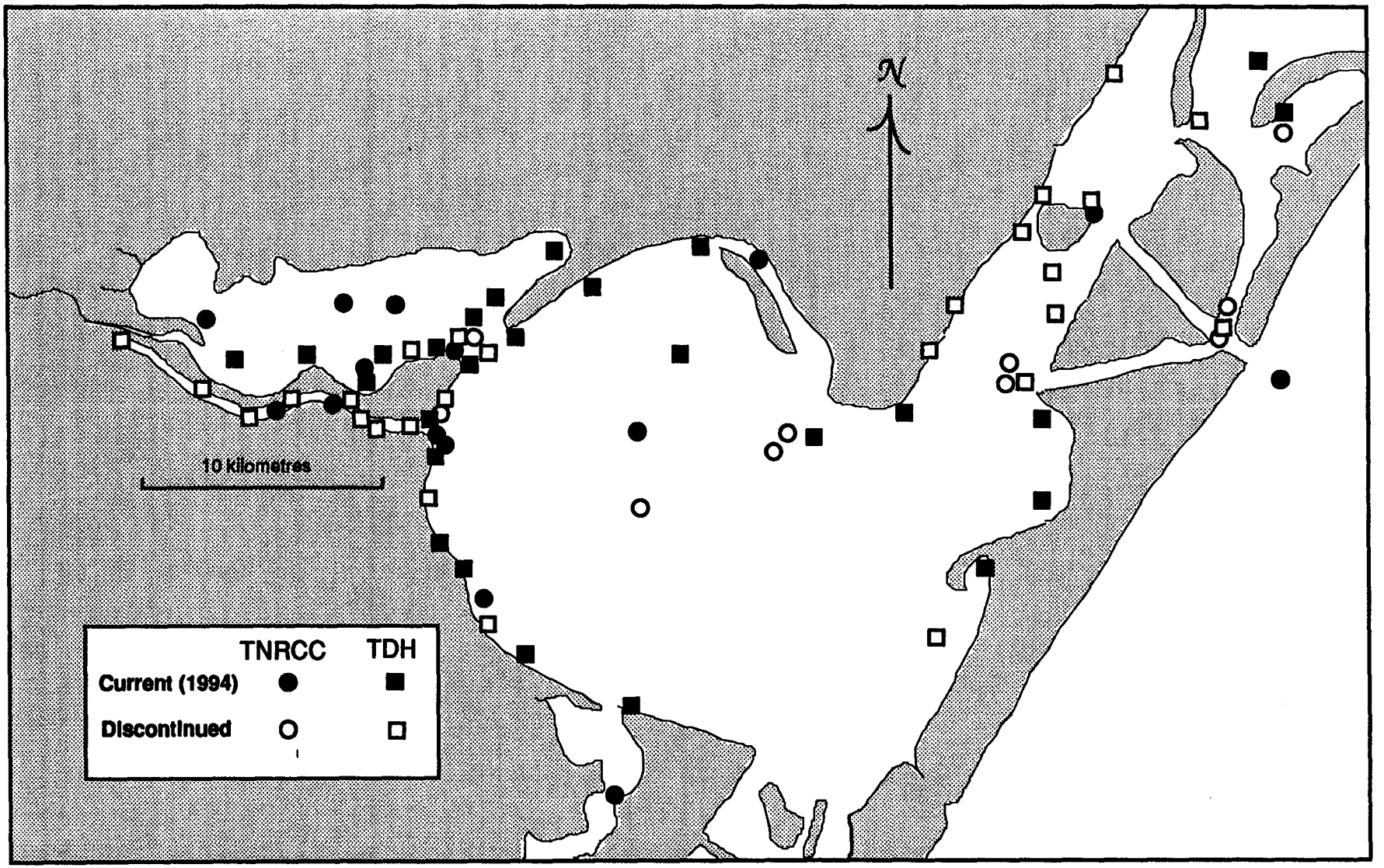


Figure 5-90. Sampling stations of TNRCC and TDH in Corpus Christi Bay

Galveston Bay, most of them apply as well to the Texas coast in general and to Corpus Christi Bay in particular. Also, while the GBNEP study was carried out over five years ago, the same problems were encountered in this study. And, as will be seen, some new ones have been added. In the present study, we identified four principal causative factors compromising the integrity of *modern* data bases. These are enumerated below with discussion and examples drawn from the present study.

1. Poor data recovery procedures, including an unwarranted trust in technology.

By "recovery" is meant all data manipulation procedures after the basic measurement has been documented by field sheet, laboratory report, or records from a data logger. These include application of necessary calibration or conversion factors, date entry (or downloading), post-processing and re-formatting. Data recovery problems arise from data-entry and data-corruption errors, and inadequate review of digitized data to detect these errors when they are capable of correction. These also include data-entry backlogs, which, though not a source of data-entry error *per se*, exacerbate the problems of detecting and correcting errors. All data recovery problems originate in neglect. From an economic viewpoint, their existence is mystifying, given the great investment of money and effort in the acquisition of the measurement itself. The necessary post-processing, checking and verification procedures to ensure that measurement has been properly entered in the data base are comparatively modest and would seem to be prudent to protect the investment already made in collecting the data.

In view of the Galveston Bay experience (Ward and Armstrong, 1992a, 1992b), it is not surprising to have identified major data management problems in the TNRCC SMN data base. We must point out that the procedures of this agency in verifying data entry and in retaining hard-copy field records, as well as the development of a new data management system, have greatly improved the situation. The problems experienced in this CCBNEP data compilation originated with the older data, for which there is probably no feasible solution at this stage. These problems include data entry errors, position errors, and incorporation of "BOGAS" measurements (see below) into the data base together with real measurements. This data program is also the prime example of data backlog. Except for the freshwater stations, virtually no data was available to this study from the SMN stations later than 1993. We were advised that this data was still in the processing "pipeline." Much of the ability to detect and correct aberrant values depends upon their timely detection. Two years is surely too long. The same backlog problem is experienced with the EPA EMAP/REMAP program in the Gulf of Mexico, for which 1994 (!) data is still being processed and Q/A'd, therefore very little could be made available to this project.

An example of the problems attending to the unwarranted trust in technology is the U.S. Fish & Wildlife Service sediment contaminants program of the late 1980's (Barrera, et al., 1995). From the standpoint of data preservation and dissemination, the USF&WS did everything right in this project–a rare accomplishment–including the inclusion of a diskette in the endcover of the

report containing all of the raw data in spreadsheet format. Unfortunately there was no review of the final spreadsheet data files. We discovered that about half of the aromatic hydrocarbons from the sediment analyses and *all* of the organic analyses for the tissue samples were absent from these files. It is noteworthy that the missing data records begin at pagebreak positions in the spreadsheet. Apparently, due to a bug in the software or an incorrect print-range specification, these data were simply not transferred to diskette. The computer used for the master data file has since been purged and there were no hard copies or digital backups retained. USF&WS advises that the only way to recover the lost data would be to go back to the raw lab sheets and completely re-keyboard them. Unfortunately, this is not a lone example, but a constant frustration in the preservation of digital data bases, see Section 5.3.3.

Another instance of data-recovery problems involves automatic data-collection equipment. Experiments have been underway since the mid-1980's in the collection of time-intense water-quality data by automatic recorders equipped with electrometric sensors. The Bays and Estuaries Program of TWDB was the first agency in the Corpus Christi Bay study area to employ such robot observation systems, referred to generically as "sondes." The Marine Science Institute of the University of Texas and the Conrad Blucher Institute of Texas A&M–Corpus Christi have also experimented with robots, CBI incorporating sondes into its program of tide gauging (the TCOON system). These data sets are valuable in providing insight into a element of variation of Corpus Christi Bay that is virtually unsampled, and the surface has only been scratched in the analysis of the data. However, no sonde data have been included in the present Status & Trends data compilation. The reason is that the data is either uncorrected or untrustworthy.

The electrometric probes are prone to fouling and degradation, especially in the saline environment. Even salinity (i.e. conductivity) and temperature, the simplest of the sensors, can exhibit substantial drift in time due to these effects. Dissolved oxygen is even less reliable. Some sondes are self-contained with a built-in data logger. Sampling is activated by an internal timer, whose accuracy can degrade over time. If care is not taken in operation of the sonde, the time part of the data measurement can drift, accumulating an error of as much as several days after a one-month service period. (Many of the CBI sondes, e.g. those of CBI, are remotely interrogated and the data is directly telemetered to a permanent facility from the sonde, so time drift is eliminated.) The keys to developing a reliable record of data from a robot sonde are frequent maintenance, careful pre-deployment and post-deployment calibration, and diligent data scrubbing (i.e., review of the sonde records and detection of aberrancies).

Despite the effort that has been invested in capital equipment, mooring and retrieval, and downloading procedures, none of the data records available to this project could be considered reliable. In some cases, the information potentially exists to validate the sonde data, but the data logs have not been corrected. The TWDB performs measurements with a separate instrument when the sonde is deployed and when it is retrieved. These measurements can be used to "calibrate" the raw data, thus correcting for sensor drift. (This assumes the drift rate is linear, but that is another matter.) Only 14% of the TWDB sonde data files have

been corrected in this manner. One might reason that since the sondes are checked and calibrated before deployment, at least the first few days of the record could be expected to be accurate. However, this calibration apparently does not include adjustment of the instrument to agree with the standard, and comparison of the TWDB-corrected records versus the raw data quickly dispels this hope, see, e.g. Fig. 5-91. Moreover, an examination of the "corrected" files that are available shows that other sorts of problems, such as aberrant values, have not been removed. Fig. 5-92 shows one "corrected" record from Nueces Bay with obviously incorrect values. The CBI data does not appear to be in any better shape. While calibration data are noted by CBI staff, none of the records have been corrected; also, what may be major calibration problems have been discovered recently and are presently being investigated (N. Krause, CBI, pers. comm., 1996). A comparison of the raw records for TWDB and CBI sondes located in proximity at the JFK Causeway is shown in Fig. 5-93. Not only do the raw values differ substantially (which is to be expected), but the time responses of the two are uncomfortably dissimilar.

2. Failure to differentiate between the archival functions and the analytical functions of a data base.

In Section 2.1 was displayed the presence of BOGAS data in the older salinity data from TNRCC SMN. The reader may infer that the laboratory involved in those years, Texas Department of Health, has now been exposed in some sort of fraudulent practice. This would be an unfair and inappropriate judgment. Rather this is a prime example of a conflict arising from forcing a data base to serve both an *archival* and an *analytical* function (see Section 5.2 above). On the one hand, the SMN is a permanent digital archive for all water-quality measurements performed by the TNRCC and predecessor agencies. On the other hand, this data base is the foundation for various analyses of water quality, including statistics and model validation, carried out by the same agency. To satisfy the archival objective, the actual measurements must be preserved, without any modification, even conversion of units (which can distort the precision of the original measurement), certainly without the supply of BOGAS data. To satisfy the analytical objective, continuity in the suite of measurements in both space and time is necessary to maximize the available data base, which requires consistency in variables reported and their units. So long as the same variables are measured in the same units, there is no conflict between these objectives. Once the suite and/or units are altered, then the conflict arises.

Over the past three decades, there have been many modifications to both the suite and units in water-quality surveys, and the TNRCC in trying to have its SMN data base satisfy both objectives has compromised its archival integrity. In the early period of data collection, the lab conductivity was almost always available, so it is easy to see that it would be desirable to maintain a continuity of record by supplying a "lab conductivity" when the actual measurement was chlorides or field conductivity. In all likelihood this would have been done by hand calculation either in the lab report or at the data-entry stage. The problem with the SMN practice is not this entry of BOGAS data *per se*, but failures to flag BOGAS data and to check the calculation. While this practice is no longer observed in the

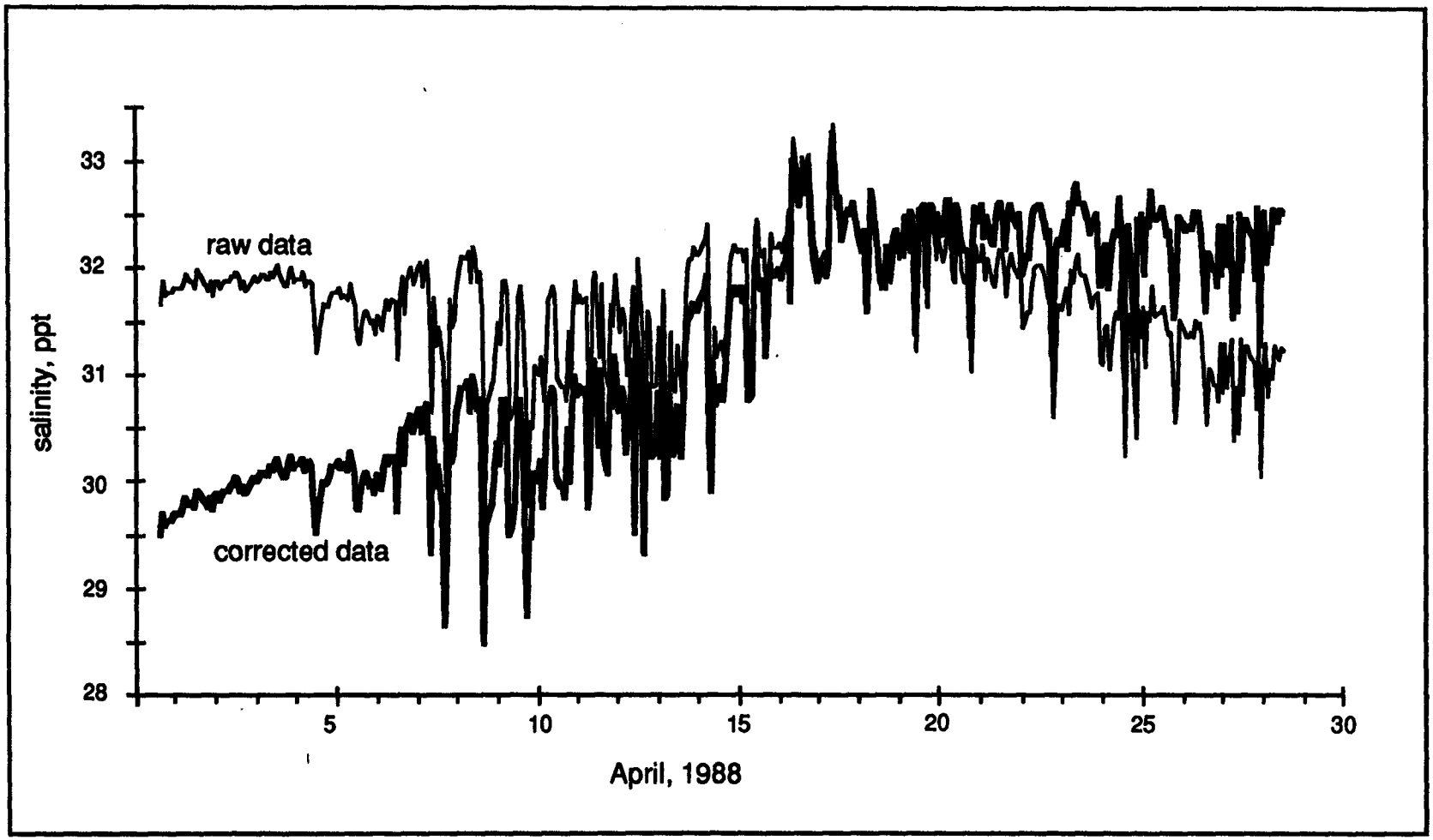


Figure 5-91. Salinity record from hydrosonde in Corpus Christi Bay near Ingleside, raw data and corrected

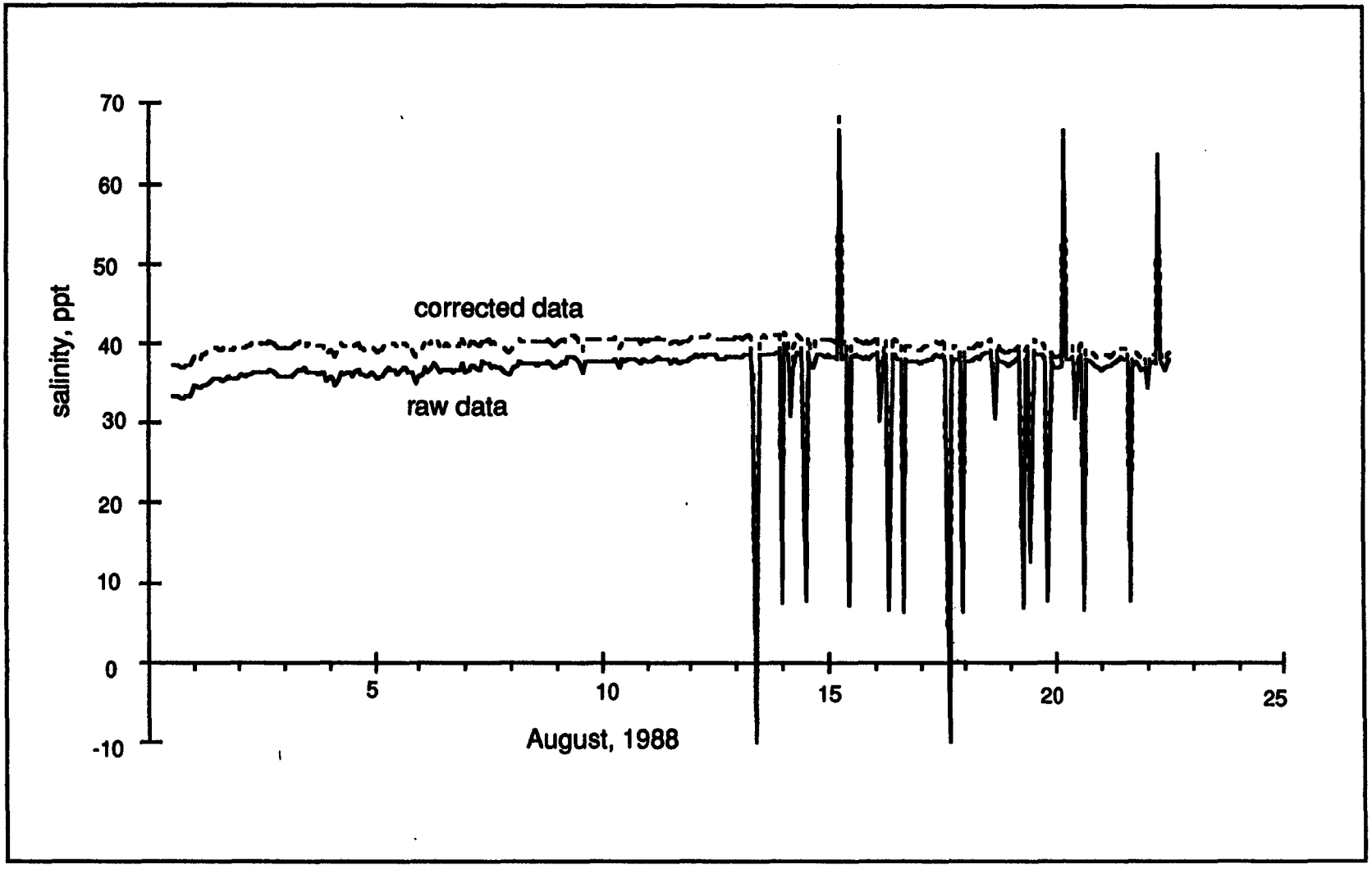


Figure 5-92. Salinity record from hydrosonde in Nueces Bay, raw data and corrected

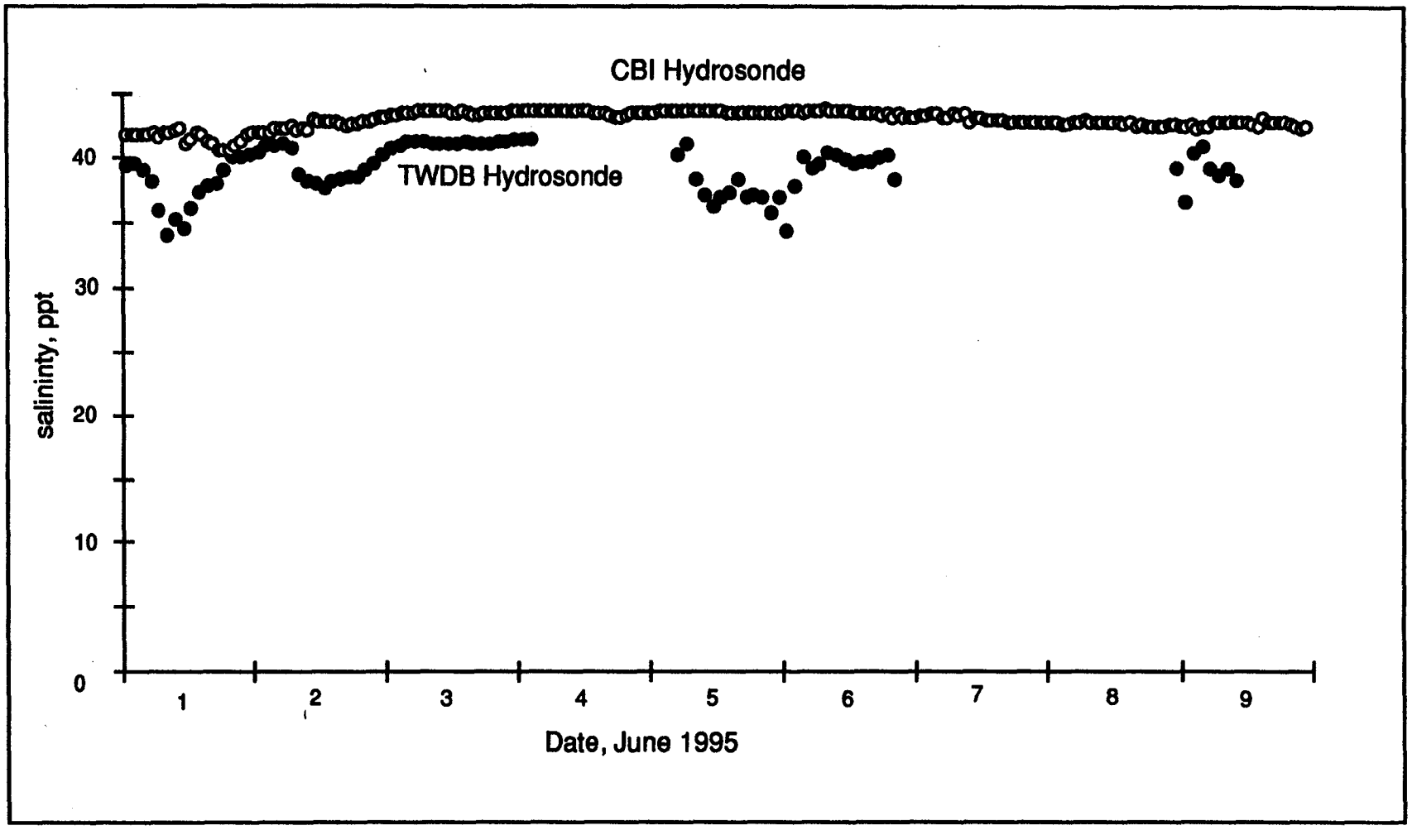


Figure 5-93. Salinity records from hydrosondes moored in GIWW at JFK Causeway

present TNRCC procedures, it is instructive to note them here to document some of the screening and data-rejection decisions that were made in the analyses for this project, and to caution against such practices in other endeavors.

Another example of the same problem is the frequent occurrence of zero concentrations for organic analytes in both the TNRCC SMN and the TWDB Coastal Data System, probably due to the replacement of censored (BDL) data by a zero value, which is indeed one of the most common means of treating censored data of this sort for *analytical* purposes. While this practice has stopped since the mid-1970's, it nevertheless illustrates the practice of altering the archived measurements to achieve an analytical objective. Still another example is the incorporation of data from other agencies into the TWDB CDS to support the *analytical* function of that data base. Each of these measurements is assigned a station location using the TWDB line-site system that is nearest the originating agency's station location. Once this "re-located" non-TWDB measurement is added to the system, there is no means for identifying it as having originated from another agency. We suspect that some of the data in the CCBNEP compilation may in fact be duplicated measurements, from both the TWDB and another agency, but because their geographical positions differ by as much as a mile, we cannot be justified in removing them.

3. Lack of a suitable archival structure for a data base.

This includes *ad hoc* filing procedures, changes in software basis without updating, and failure to provide for data preservation. Two examples from the Corpus Christi Bay compilation will be given (though there are others). The Corps of Engineers presently maintains its O&M data in three different formats. The older data are in hard-copy format only. Data from the late 1980's are in LOTUS spreadsheets (but in many cases only hard-copy printouts have survived). More recent data are maintained in yet a different data base manager. Much effort was required in this project to re-format and reconcile the data in these different formats. The second example is the Coastal Data System of TWDB. This was originally housed on the TNRCC mainframe, but with the impending demise of that system, the CDS has degenerated to a lengthy catalog of files maintained on various platforms, the files corresponding to older surveys of the Bays & Estuaries Program, to data from past contractors, and to data from cooperative studies of several state agencies. Moreover, no single individual seems to have control or management authority. We had to make repeated, increasingly specific requests over a sustained period to obtain all holdings for the Corpus Christi Bay study area, and discovered, too late, that these did not include the intensive inflow studies because these were in the possession and use of yet other members of the TWDB staff.

This is a common problem for those agencies for whom data collection is not the primary responsibility of the agency, but rather is a supporting function. This unfortunately describes all academic research, all local and regional agencies, and most state and federal agencies. To design and implement a digital archival system for data requires not only foresight, but an initial investment in effort that is usually viewed as unwarranted by the agency. Only after various data files are

accumulated in differing formats is the need for a basic archival structure perceived, and then the effort of retrofitting the accumulated data would represent a diversion from other, more important responsibilities. The situation is therefore self-perpetuating. It has been exacerbated by the recent proliferation of software products, and the promotional device of American software purveyors of issuing updates and new releases at a diarrhoetic rate, which has created widespread incompatibility and non-transportability of data files.

4. Poor data dissemination protocols.

In many respects this is a corollary to the previous problem of an inadequate archival data-base structure, since one can argue that a suitable data dissemination procedure is one of the requirements of such an archive. We list this as a separate problem, however, because (1) there are archival systems that are satisfactory in all other respects except they lack a means for a non-agency user to receive and/or easily manipulate a data file; (2) because most agency use of the data is internal, the lack of a suitable dissemination protocol may go unnoticed. One example from this study is the EPA-sponsored EMAP/REMAP program. Data dissemination is performed on a case-by-case basis, in which the program data manager in Gulf Breeze routes the request to the contractor in Lafayette, who performs an *ad hoc* download to diskettes for transmittal. The formats are inefficient (e.g., station location, sampling date/time, and sample depth must be searched from separate files) and vary depending upon the calendar period for the data requested.

The National Status & Trends Project of the NOAA National Ocean Service has sought to facilitate user access to the data by having a download site on the Internet. We discovered that the only way to be sure of trapping all of the data from the project area would be to download the entirety of the Gulf of Mexico holdings. The structure of this massive data file could be charitably described as quasi-random, and required manual searching and copying to synthesize the necessary information. Then the detection limits have to be separately downloaded for each data record depending upon the code identifying the laboratory. The entire process required nearly two weeks of intensive data manipulation and reformatting before we had structured files that could be worked with.

The current fad of Internet operations is beginning to improve access to large-scale data holdings. This is welcome technology. On the federal level, much of the data holdings of USGS, and some of NOAA are now available for download via the Internet. TWDB has recently began making its data files available for direct ftp access. Formatting can still be a problem, as exemplified by the NOS S&T example above. However, one must contrast this to the situation with this same NOS data system in the Galveston Bay Status & Trends Project, five years ago. The GBNEP PI's were advised then by NOS that, although the data did reside in a digital form on the NOS mainframe, it would be easier far all concerned if GBNEP keyboarded the data from the published data reports, because weeks of special-purpose programming would be needed to produce a digital copy of the Galveston Bay data set (Ward and Armstrong, 1992b). Progress is being made.

5.3.3 Deficiencies in management of historical data

Ward and Armstrong (1991) quantified data accessibility in Galveston Bay for salinity/temperature, chemistry and biological data, as a function of the age of the data, disclosing an appalling rate of data "inaccessibility" (which includes both data that is lost and whose use is prohibited) that approaches 100% for data older than the 1960's, with for practical purposes almost everything prior to 1950 being lost. Our intuition is that a similar situation obtains for Corpus Christi Bay. While in the GBNEP Data Inventory work, six major historical data sets were rescued from "the edge of the abyss" and digitized, in the present project, three such major projects were rescued:

- the TAMU program of the 1950's sponsored by Reynolds Metals
- the SWRI monitoring program of the early 1970's
- the USF&WS-sponsored study of the system in the late 1970's

We were too late for others. Ward and Armstrong (1991) identified seven principal factors that contributed to this data loss. These were found to be operating in the Corpus Christi setting as well, and are repeated here, with appropriate examples from the present study:

1. Low priority assigned to archiving and preservation of older data.

This is a reflection of human psychology. Once a project or survey is completed, there is a tendency to stack the results out of the way and move on to the next challenge. Many agencies operate under a pressure of time, which conspires against good archival practices. Some agencies have some form of data management currently in place. While this is encouraging, it is also precarious, in that these programs are sensitive to shifts in organizational emphasis. An office purge is forever.

2. Mission-specific agency operation: perception of old data as "obsolete" and archiving as an unwarranted expense.

The Corps collects hydrographic or water quality data to support, e.g., navigation projects in place or in planning. Once a condition survey has been used to determine the need for dredging, once a decision on spoil disposal is made, once a project design is completed, the data sets employed in those activities are no longer needed. The mission of Texas Parks and Wildlife is to monitor the state of the coastal fisheries. The present condition is always primary. The Texas Natural Resource Conservation Commission and EPA are concerned with the present loadings of contaminants and the enforcement of water quality standards. The level of loadings a decade ago, or even last year, are rarely pertinent to that mission. And so it goes. The value of data diminishes quickly with age in these kinds of problem-specific operations. Yet it is these agencies that are largely responsible for the bulk of data collection within the Corpus Christi Bay system.

Among historical data collection programs in Corpus Christi Bay whose data are now lost include:

- City-County Health Department (Corpus Christi-Nueces County Department of Public Health): salinity, temperature, DO, pH, coliforms, monthly 1961-1969

- City-County Health Department: miscellaneous hydrographic and chemistry data, 1940?-1975

- Pittsburg Plate Glass: Inner Harbor stations, salinity, temperature, DO, pH, monthly 1944-47

- Corps of Engineers: Inner Harbor stations, hydrography (specific parameters unknown), monthly 1963

- Corpus Christi Sewer Department, parameters unknown, 1960?-1965

- Texas Game, Fish & Oyster Commission surveys, 1950?-1970

The loss of the early City-County Health Department Surveys is particularly frustrating, as these would have extended the record back in time substantially. It is noteworthy to observe that more recent coliform data taken by CC-NCHD have also been discarded, including those of 1976, 1977, 1983, and 1984.

Loss of the above data sets could be described as resulting from "benign neglect." In recent years, a much more malevolent entity has entered the scene, in the person of the new administrative function of Records Management, especially in fashion in the state agency headquarters. These "records managers," who are typically nontechnical and have little knowledge or appreciation of the functions of their agency, adopt a ruthless philosophy toward older information: seek out all older files, and summarily destroy those for which there is no apparent use. Massive paper purges have already been rendered at the TNRCC, among other state agencies. Holdings of district offices and storage in state warehouses have been targeted. While knowledgeable local staff have resisted thus far, it is probably only a matter of time.

3. Personnel turnover, combined with little or no documentation.

Only a handful of people in an agency generally has immediate familiarity with a data base. If the data base is not currently in use, this number will decline due to turnovers. When the last of these leave, the institutional memory goes with them. This problem is most acutely manifested in the case of a single principal investigator at a university. Most of the rare data sets we succeeded in locating for this project resulted from contacting (finally) the one or two persons remaining in the agency (or in the area) that knew something about the data.

The most extreme instance of this is when the entire data-collection entity is terminated. An example is the operation of the Southwest Research Institute Ocean Science and Engineering Laboratory in the early 1970's. This agency acquired a large amount of field data during its existence, as well as obtaining

copies–perhaps originals–of data from other entities in the Corpus Christi area including some of those listed above. Nothing is known as to the fate of the holdings of this lab, which was closed down by SWRI around 1975. The data search by the present project was stonewalled by the SWRI San Antonio headquarters. Fortunately, a few individuals in the Corpus Christi area recognize the value of older data. One is Mr. John Buckner of the Coastal Bend Council of Governments, to whom the SWRI Ocean Science lab provided copies of their reports and some of their holdings. Mr. Buckner has diligently preserved this information for the past two decades and made his holdings available to the present project, from which SWRI routine data (Projects 5 and 13, Table 5-1) were keyboarded.

Another instance is the Corpus Christi field office of U.S. Geological Survey, which operated throughout the 1970's, collecting sediment chemistry data and hydrographic data (including circulation studies), but then was closed by USGS around 1980 and the personnel scattered. What holdings of this office survived are in the possession of Dr. Charles Holmes of the Denver USGS office, and appear to be only a fraction of the data actually collected by this office over the years.

4. Agency instability, i.e. dissolution, merging, reorganization, displacement & relocation.

Some data sets have survived by dint of being undisturbed. With an office move, as parcels, files and boxes are shifted about, the exposure to loss or discard is greatly increased. The disarray and haste usually typifying such moves contribute to a "clean-the-house" mentality, exacerbated by snap judgements on the part of personnel in no position to appraise the value of information. The decision is forced to consider data sets whose retention is already tenuous. Clearly, any sort of instability that leads to such shifting of materiel increases the probability of data loss.

5. Natural calamities (fires, floods, hurricanes) in poorly protected housing.

This problem speaks for itself. We have had a surprisingly large number of losses to such events on the Texas coast. Ironically, it is the large, centralized, difficult-to-duplicate sets that are most exposed. The usual problems of water leakage, faulty wiring, and deterioration operate everywhere, but the Texas coastal zone is exposed to extraordinary hazards. The human tendency is to disregard the risk of extreme hazard.

6. Changes in data management technology, without upgrading of historical files.

This is a surprising factor, at least to these authors. There are several forms of this technological hazard. The first is simple technological obsolescence. At the time of data entry, punched cards and 8-track formats seemed to be fixed technology. Now, they are virtually unreadable. There is a transition period, of course, when newer technologies replace the old, but the task of upgrading

formats of large, rarely used data files is onerous and of low priority. Then, with the same apparent suddenness of the demise of the LP and the Magcard, the technological hardware support is no longer available. At this writing, many data sets which were "stored" on floppy disks are becoming as unreadable as 8-inch floppies.

A second variety of this hazard is software obsolescence, in which the encoding is no longer readable. This ranges from discontinuation of a proprietary software, to loss of the description of coding formats. The prominent example of the former is System-2000 data bases. There are several examples of the latter, in which there exist tapes containing numerical data which can be read but whose meaning is no longer documented. (We suspect one of these may be the reason that SWRI could not produce any data from its longtime study from the early 1970's.) In recent years, the proliferation of various "data-base managers" and "spreadsheet" softwares, combined with the increasing numbers of DOS and UNIX platforms, has greatly aggravated the problem, because most of these products are cross-platform and downward incompatible.

The third form of this hazard is due to the increasing information density of digital storage. As large data bases are compressed into smaller physical dimensions, the possibility of physical loss is increased: an errant electromagnetic field, small fire, or simple mislaying can wipe out the equivalent of reams of data. Probably the most prevalent form of this hazard is the acquisition of parity errors on an archival tape, and data garbling by stray magnetic fields. As new high-density media begin to appear, e.g. the Bernoulli box, the possibility of simple physical loss becomes greater. The key to minimizing this hazard is to create multiple copies. Technology is assisting in this, in that the cost for production of tapes and CD's is continuing to drop.

7. Proprietary attitude toward data by individual PI's.

This has been an endemic problem in academia, but it is also too frequently manifested in federal and state agencies. We will not propose to analyze the causes of this mentality, which may be rooted in the publish-or-perish environment, the paranoia of being "scooped" in some great insight gleaned from data analysis, the notion that "information is power," the view that one's data is valuable, and the view that one's data is worthless. We will observe that we did not encounter nearly as many cases of overt resistance in the Corpus Christi data search as in the Galveston Bay area. Most of the principal-investigators and agency personnel were cooperative (and a lack of cooperation being due more to limits of time than intransigence). Perhaps this is because the problems in the Galveston Bay work have been widely publicized and corrective administrative actions have been taken. We are inclined to believe otherwise, that this is due instead to a basic cultural change presently underway, driven primarily by large-scale networking, *viz.* the Internet, which is fostering a more communal view of data resources.

6. WATER QUALITY OF CORPUS CHRISTI BAY

The derivative data bases developed according to the procedures of Section 4.3 for each of the study parameters formed the basis for characterization of water quality in Corpus Christi Bay, presented in this chapter. By "characterization" is meant the water-quality "climate" of Corpus Christi Bay, as evidenced in objective statistical analysis of the historical data base. This characterization entails both the spatial dimension and the temporal, the latter including the analysis of trends in time. The word "climate" is well-chosen, because of its analog with individual experience, *viz.* the weather-climate dichotomy, serving to remind oneself that this characterization is the "average" or "representative" behavior of a suite of parameters that individually exhibit a high degree of variability. Moreover, it cautions one to avoid attaching too much significance to isolated measurements.

One must realize that Corpus Christi Bay is under-sampled, relative to the time and space scales of natural variability. Therefore, any partitioning of the data in space or time involves trade-offs in statistical confidence. The more spatial segments that are defined (i.e., the smaller their spatial extent), the fewer data points that will be placed in each segment. Similarly, the coarser a variable is sampled in time, the greater the "noise" induced by randomly encountering smaller scales of variation, e.g. tides. If gross temporal cycles, such as seasonal variation, are extracted by partitioning the data in time, a similar trade-off occurs between detail of time variation that can be resolved and fewer data points per time segment. An additional source of noise is the fact that the period of record will vary between space/time segments, due to the differing operations of the various historical sampling projects from which data were obtained.

Thus, even if the individual quality parameters were measured with absolute precision, the sampling strategies and the aggregation and analysis of data would introduce statistical variation. But, of course, the individual measurements themselves are subject to analytical error. As a preliminary to analysis, Table 6-1 summarizes the principal water quality parameters and a nominal estimate of the uncertainty of measurement of each. These were developed from the data of Ward and Armstrong (1992a), in turn compiled from their study of historical laboratory procedural accuracy and precision data. Reference is made to the discussion of uncertainty in Section 4.2.3. The nominal uncertainty is given in Table 6-1 as a standard deviation, expressed as a fraction of the measurement (based upon typical values in Texas coastal waters when the standard deviation does not vary directly with parameter value). While establishment of the uncertainty for most of the parameters of Table 6-1 is based upon a relatively small sampling of lab intercomparisons, and is therefore subject to considerable uncertainty itself, the important conclusion from the data of this table is that most parameters are not measured with a high level of accuracy. For a high probability the associated confidence bounds are two or three times the standard deviation, the latter corresponding to the intuitive notion of tolerance. Thus, for ammonia the 98%-probable value lies nominally within ±60% of the measurement. This translates to an additional, and in many cases considerable, source of variation in the data.

TABLE 6-1

NOMINAL UNCERTAINTY IN MEASUREMENT OF
WATER QUALITY PARAMETERS
(See Table 2-1 for definition of abbreviations)

abbreviation	*units*	*nominal standard deviation (as percentage of value)*
	Conventional Parameters	
WQTEMP	degrees Celsius	1
WQSAL	parts per thousand	1
WQDO	mg/L	2
WQDODEF	mg/L	5
WQPH	pH units	5
WQTURB	NTU, JTU	10
WQXTSS	mg/L	10
WQAMMN	mg/L	20
WQORGN	mg/L	20
WQKJLN	mg/L	20
WQNO3N	mg/L	25
WQTOTP	mg/L	15
WQVOLS	mg/L	10
WQVSS	mg/L	20
WQO&G	mg/L	10
WQTOC	mg/L	10
WQXBOD5	mg/L	20
WQCHLA	µg/L	20
WQTCOLI	org/100 mL	200
WQFCOLI	org/100 mL	200
	Metals	
WQMETAST	µg/L	35
WQMETASD	µg/L	35
WQMETBAT	µg/L	15
WQMETBAD	µg/L	25
WQMETB	µg/L	25
WQMETCDT	µg/L	15
WQMETCDD	µg/L	20
WQMETCRT	µg/L	100
WQMETCRD	µg/L	100
WQMETCUT	µg/L	25
WQMETCUD	µg/L	100
WQMETFET	µg/L	20
WQMETFED	µg/L	100
WQMETPBT	µg/L	10
WQMETPBD	µg/L	20

(continued)

TABLE 6-1
(continued)

abbreviation	*units*	*nominal standard deviation (as percentage of value)*
	Metals (continued)	
WQMETMNT	µg/L	100
WQMETMND	µg/L	35
WQMETHGT	µg/L	40
WQMETHGD	µg/L	40
WQMETNIT	µg/L	20
WQMETNID	µg/L	30
WQMETSET	µg/L	50
WQMETSED	µg/L	50
WQMETAGT	µg/L	50
WQMETAGD	µg/L	50
WQMETZNT	µg/L	15
WQMETZND	µg/L	100
	Organics	
WQ-ABHC	µg/L	10
WQ-LIND	µg/L	10
WQ-XDDT	µg/L	10
WQ-ALDR	µg/L	5
WQ-CHLR	µg/L	15
WQ-DIEL	µg/L	5
WQ-ENDO	µg/L	25
WQ-ENDR	µg/L	5
WQ-TOXA	µg/L	30
WQ-HEPT	µg/L	5
WQ-MTHX	µg/L	5
WQ-PCB	µg/L	25
WQ-MALA	µg/L	35
WQ-PARA	µg/L	10
WQ-DIAZ	µg/L	20
WQ-MTHP	µg/L	10
WQ-24D	µg/L	10
WQ-245T	µg/L	10
WQ-PAH	µg/L	20

6.1 Spatial Variation in Water Quality

Table 5-2 summarized the data record for water analytes in Corpus Christi Bay, presenting summary statistics for the bay as a whole. These statistics, which were based upon unscreened data apart from the limits on bounds given in Table 4-1 (and therefore may be of eroded accuracy due to spurious entries), take no account of the considerable variation within the bay. In order to better delineate the spatial variation of water quality parameters, it is necessary to aggregate the data according to position. The data record for each parameter was sorted into two different segmentations of the bay: the Texas Natural Resource Conservation Commission (TNRCC) Water Quality segments, and the hydrographic segments developed for this project. Both segmentation systems are described in Chapter 3, and the specific defining quadrilaterals are given in the Appendix, Tables A-4 and A-5. As emphasized in Section 3.1, any such segmentation is based upon the assumption that each segment is homogeneous, within an allowable scatter in the data (i.e., within a certain statistical confidence), and therefore data from that segment can be considered independent measurements of the same variate. Such an approach, i.e. of aggregating data from stations that do not coincide but are within a "neighborhood" of each other, is necessary because of the sparsity of the data record in Corpus Christi Bay, as discussed in Chapter 5.

To reiterate the discussion of Chapter 3, the differences between the TNRCC and hydrographic-area segmentations are: (1) the TNRCC segments tend to be larger in space, especially within the open bay, and may have arbitrary or political boundaries; (2) the hydrographic-area segments are smaller in spatial extent and are defined by principal geomorphic controls on flow and/or known predominant flow patterns; (3) the TNRCC segments include tributaries of the principal inflows; (4) the hydrographic-area segments focus upon the bay system *per se*, its immediate periphery, and the nearshore Gulf of Mexico, but do not encompass the upper reaches of the tributaries. Analysis by TNRCC segments, which was specified by the CCBNEP Management Conference as a requirement of this study, has the advantages of: (a) treating a smaller number of segments, (b) corresponding to the administrative framework for Corpus Christi Bay, and therefore allowing direct comparison with standards and past surveys. On the other hand, analysis by hydrographic segments allows: (a) better spatial definition of variability, especially in the open bay, and (b) more realistic definition of areas that are nearly homogeneous, i.e., based upon hydrographic controls rather than political boundaries or convenience of access, therefore greater precision in the analyzed data.

While spatial variability is better delineated by using smaller spatial segments, the statistical confidence in the values at each segment is reduced because of the fewer number of data points. To improve the number of data points by aggregating into larger segments is to introduce more "noise" in the data due to spatial variability; the ultimate extreme of this strategy is the baywide analysis given in Tables 5-2 and 5-3, in which all available data are used to compute the statistics, but the high variance renders the computed statistics practically useless. The hydrographic segmentation developed in this study, in which the bay system and periphery are subdivided into 178 segments, represents our best

compromise between a sufficient data record in each segment for meaningful analyses and a sufficiently small and well-defined segment domain so as to reduce the spatially-induced "noise." Even at this, as shown by the sampling density maps of Figs. 5-1 *et seq.*, a majority of the segments are so undersampled for most parameters as to be indeterminate.

The segmentation philosophy followed in this project is to require that any location in the bay lies within exactly one segment. While this is not rigorously necessary for water-quality analysis purposes, it greatly facilitates the census aspects of this status-and-trends project. However, we make one exception to this philosophy. Recall (Section 3.3.3) that the Gulf of Mexico segments and those defined for the estuarine areas overlap in areas within the tidal inlets to the system. Therefore sampling stations located within the inlets will be captured in both the estuarine segment and the Gulf of Mexico segment. This is deliberate. These transitional stations are considered to be indicative of both the nearshore Gulf of Mexico environment as well as that within the inlet itself, and therefore need to be included in both data subsets. However, in the overall census of data from the system presented in Chapter 5 and the water-quality analyses in this chapter, the Gulf of Mexico data sets are segregated from the estuarine data sets, to provide a better depiction of the data base for each region.

The historical statistics for each of the study parameters, for each of the TNRCC segments and each of the hydrographic segments, are presented in Appendix B. For each parameter there is a pair of tables, the first, the Period of Record Statistics, presenting basic data on magnitude and variance of the measurements, and the second, the Time Trend Analysis, presenting data on the time history dimension of the parameter's variation. These tables, and their companions on sediment quality, are the central product of this study and warrant examination far beyond the comments offered here. However, because of the considerable volume of the tables and the fact that most readers will not wish to delve into the details of the analyses, these results are relegated to the appendix.

Tables 6-2 and 6-3 present two examples of the first of the pairs of tables from these analyses, for the hydrographic-area segmentation. (The companion tables showing time-trend results are presented as Tables 6-36 and 6-37 in the next section.) The same table format is observed for the TNRCC segments, except of course there are fewer such segments, and generally more data per segment.

In these tables the first key entry is in the second column, *viz.* number of observations. This number obviously circumscribes the confidence of the remainder of the analyses for that segment: for many segments this number is zero, or is so small as to provide little useful information. To conserve paper, segments with zero data are omitted from the hydrographic-segmentation tables in the Appendix in order to conserve space. (For the TNRCC-segment tables, all segments are given, even if there are zero data points.) Figures 5-1 *et seq.* depicted the distribution of sampling intensity in Corpus Christi Bay (by hydrographic segment) for key study parameters. Particular note should be made of the paucity of measurements of metals and organics.

It will be recalled (Section 3.3.1) that we have elected to treat measurements below detection limits (BDL) in three different ways. First, all such data are ignored. This is done in all computations of *variability*, including standard deviations and regressions, as well as in the first average (column three) of Tables 6-2 and 6-3. Second, all BDL's are assigned a value of zero, the more optimistic extreme, assuming a BDL is equivalent to nonpresence of the analyte. Third, all BDL's are assigned the value of the corresponding detection limits, the more pessimistic extreme, assuming a BDL variate is present to the maximum concentration that remains undetectable. The separate averages using these latter two conventions are given in the final two columns of the Period of Record Statistics tables (e.g., Table 6-2 and 6-3). These represent upper and lower bounds on the actual mean concentration. Because many of the data records contain a high frequency of BDL values, and (worse) reported values of 0 instead of a detection limit, a census of BDL's, minimum values, and non-zero minima is also given in the Period of Record Statistics tables.

The general spatial variation of key water quality parameters is depicted in Figs. 6-1 through 6-54, for the subsections of the study area with the most important, distinctive or interesting gradients. These mapped values are based upon the average values for each segment computed with BDL values taken as 0. These figures should be employed together with the corresponding sampling intensity figure of Chapter 5 or the corresponding table of Appendix B, because the number of data points available in a given segment is an indication of the validity of that average. Only selected metals are shown in these figures, to provide some indications of spatial variation supported by the data base for the respective parameters. No toxic organics are shown in this type of display because the spatial distribution of samples above detection limits is so sparse that these displays prove to be virtually useless. The complete statistical tables in Appendix B should be consulted for specific organics of interest. While some data exist in virtually every segment for the frequently measured parameters of salinity, temperature and dissolved oxygen, for most of the parameters data is totally absent from some or many segments. These are shown as white on Figures 6-1 et seq. The user is advised to cultivate the practice of reading these white areas as a screen, as though that portion of the map is covered, because for these areas we have no information as to the historical behavior of the plotted constituent.

Temperature, salinity, and dissolved oxygen warrant special treatment because of the nature of the external controls (to anticipate somewhat the discussion of Chapter 9) and because of how they are sampled. With respect to the former, one of the primary controls is surface processes so these parameters are particularly influenced by the depth of measurement and the annual march of climate. With respect to the latter, these are measured either at a single point in the vertical (usually near the surface) or as a vertical profile, but no discrimination by depth is made in the construction of the statistics tables. To depict the horizontal variation in these parameters requires eliminating potential bias due to varying proximity of the measurement to the surface, and eliminating any spurious weighting of stations where profile data were taken. Therefore, these parameters were also separately analyzed for near-surface values only. This was taken to be the upper 1 meter (3.3 feet) of the water column. The results of all of these

statistics are given in Tables 6-4 through 6-7 for the hydrographic-area segments (in a more compressed format than that of Table 6-2 since BDL's do not have to be addressed). Both dissolved oxygen and dissolved oxygen deficit are analyzed in these tables (see Section 2.2). In Figs. 6-1 through 6-18, the depicted distributions are of the values in the upper 1 meter.

Many of the water quality parameters exhibit annual variations, due to direct climate effects such as surface forcing, due to indirect effects from dependence upon variables like temperature and salinity that have seasonal variation, and due to seasonal variation in transport processes or mass loadings. The long-term statistical analyses represented by Tables 6-2 and 6-3 do not differentiate by date, and therefore any seasonal variation in the parameter is incorporated into the computed variance. To determine the existence and nature of systematic annual variation, each parameter was subjected to separate statistical analyses after being sorted by month of measurement. In this analysis, because the data are sorted both by hydrographic area and by month of measurement, we are somewhat more discriminating in our requirement for a minimal analyzable data set, requiring a minimum of three measurements in the period of record for a specific month to compute that monthly mean. These results are presented in Tables 6-8 through 6-25. Only the hydrographic-area segments for which available data permit at least one monthly average to be computed are given in these tables.

These same analyses are a useful vehicle for displaying the general variation of the indicated parameter through the study area. To facilitate this, principal components ("bays") of the Corpus Christi Bay system were defined as follows:

principal component bay	*hydrographic segments*
Aransas	A1-A4, A8-A12, I4-I7
Copano	CP02-CP10
St. Charles	SC2-SC3
Mesquite*	MB1, MB2, AYB, CB
Redfish Bay	RB2-RB9
Corpus Christi	C01-C08, C10, C11, C13, C14, C16-C23
CCSC (open bay)	CCC3-CCC7
Inner Harbor	IH1-IH7
Nueces Bay	NB2-NB5, NB8
Causeway N	C24, C25, I9
Causeway S	UL01, UL02, UL04, I10
Laguna (King Ranch)	UL03, UL05-UL11, I11-I15
Laguna (Baffin)	UL12-UL14, I16-I18
Baffin	BF1-BF3, AL2, GR2
Aransas Pass area	INL, LAC, CCC1, HI1
GOM inlet	GMI5-GMI7, GMO5-GMO7

*including Carlos and Ayres Bays

The philosophy underlying these designations is to identify and group segments characteristic of the open waters of the component indicated, excluding regions

that are biased by probable external factors. For example, in the Corpus Christi group, C15 at the entrance of Nueces Bay and C12 at East Flats are excluded. Similarly, in Nueces Bay, the segments along the southern shore, which could be affected by the CP&L Nueces steam-electric station discharge, are excluded. The Upper Laguna is subdivided into two reaches, the northern reach (but not including the region in immediate proximity to the JFK Causeway, which is considered separately as Causeway S) being designated as the King Ranch reach, and the southern reach as the Baffin reach. GOM Inlet designates the Gulf of Mexico in proximity to Aransas Pass. A comparison of the above groupings to the maps of hydrographic areas of Figs. 3-8 *et seq.* will make readily evident the motivation for inclusion or exclusion of various segments in this grouping. The monthly averages for each of these "principal bays" are presented at the end of each of Tables 6-8 *et seq.* These were computed by averaging the monthly means for each of the component hydrographic areas, so each hydrographic area is weighed equally. The seasonal variation of the most important of the water-quality parameters is shown graphically for selected "principal bays" in Figures 6-55 through 6-68.

Figures 6-58 through 6-61 provide an excellent demonstration for the utility of DO deficit as an indicator parameter. The plots of dissolved oxygen show a substantial seasonal variation, of 4-5 ppm, almost entirely due to the variation of solubility because of the annual march of temperature and, to a lesser extent, of salinity, cf. Fig. 2-5. Deficit, in contrast, has little systematic seasonal variation (note the small range of the axes of Figs. 6-60 and 6-61), but significant differences between various component sections of the estuary.

For many of the parameters, especially the metals and organics, there is insufficient data in the record to discriminate real month-to-month variability from sample-to-sample variation, due both to the sparsity of data and to the fact that most measurements are reported as below detection limits. The sparsity of the record for metals is apparent from the many blank entries in Table 6-21 *et seq.* The data is so sparse for organics that no monthly statistics are presented. While monthly variation in metals cannot be reliably extracted from the available data base, there is apparent a significant spatial distribution. This is evident in the maps of Figs. 6-47 through 6-54. It is also evident in the long-term averages (with BDL=0) further averaged into the groupings of "principal bays" presented above. These averages are shown in Table 6-26, with the highest three occurrences of each metal marked in boldface.

The extent of vertical stratification in a parameter is frequently of concern in water-quality analysis. The intensity of vertical mixing in the Texas bays, and the resulting vertical homogeneity of the water column has been frequently remarked, e.g. Ward (1980). With the data base assembled here, the extent of vertical stratification could be analyzed for key variables for which coincident measurements at two depths were available. Variables for which stratification was analyzed were: temperature, salinity, dissolved oxygen deficit, and to a lesser extent ammonia, nitrate, suspended solids, extended proxy suspended solids, total phosphorus and chlorophyll-a. Vertical stratification VS was computed as

the vertical gradient in concentration between the two most widely separated measurements in the vertical for a specific sample station and date:

$$VS = \Delta c/\Delta z \qquad (6\text{-}1)$$

where Δc is the upper-to-lower difference in concentration, and Δz is the difference in elevation of the two measurements with z positive upwards. It must be emphasized that *stratification* is treated in its fluid dynamics sense, and does not imply any "layering" of the water (which entails quantum changes in parameter values at an interface, which we would refer to in our present usage as "singularities" in stratification). Such "layering" and associated concepts, such as the notorious "salt wedge," are rare and evanescent phenomena in Corpus Christi Bay. We note, from (6-1), that the units of stratification are parameter units per unit depth, e.g. ppm per meter, and VS is positive if concentration increases upward. Therefore, the normal stable density stratification would imply a positive stratification in temperature and a negative stratification in salinity.

The vertical stratification in water-quality parameters is tabulated in Tables 6-27 through 6-34. Because stratification is a divided difference, it is even noisier than the concentration data upon which it is based. Therefore, at least three values in a given segment was required to include that average value in these tables. This data is presented in two ways: the arithmetic average stratification in each segment, with the associated standard deviation, and the percentage of the data exhibiting positive stratification. The predominance of stratification is manifested by a large value of gradient compared to the normal magnitude of concentration, and/or a predominance of sign. Since predominance of sign is based upon positive values of stratification, this excludes the occurrence of zero stratification. Therefore, one cannot infer that if positive stratification occurs r % of the time then negative stratification will occur (100 - r) % of the time, but rather that negative *or zero* stratification will occur (100 - r) % of the time. The general negative stratification in salinity and suspended solids, and the general positive stratification in temperature and dissolved oxygen are consistent with the physical processes controlling each of these (to anticipate, again, the discussions of Chapter 9). At the end of each of Tables 6-27 *et seq.* is a summary by principal component bay, based upon the above-specified hydrographic segments,

TABLE 6-2
Period of record statistics for CCBNEP Hydrographic Segments
WQAMMN

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
A1	7	0.001	0.004	7	100	0.000	741017	0.01	741017	0.01	741017	0.00143	0.00143
A2	31	0.101	0.078	31	100	0.000	730419	0.02	730220	0.47	720330	0.101	0.101
A3	61	0.077	0.073	61	100	0.000	710608	0.01	740418	0.44	720330	0.0766	0.0766
A4	34	0.024	0.015	34	100	0.010	850506	0.01	850506	0.1	860511	0.0238	0.0238
A5	11	0.008	0.008	11	100	0.000	750416	0.01	710608	0.03	710608	0.00818	0.00818
A6	0												
A8	0												
A9	0												
A10	2	0.030	0.010	2	100	0.020	710608	0.02	710608	0.04	710608	0.03	0.03
A11	0												
A12	81	0.064	0.066	81	100	0.000	711111	0.01	720724	0.41	801022	0.0637	0.0637
A13	1	0.100	0.000	1	100	0.100	740723	0.1	740723	0.1	740723	0.1	0.1
AL1	1	0.000	0.000	0	0	0.000	0	0	0	0	0	0	0.05
AL2	44	0.052	0.050	43	97.73	0.000	720928	0.02	750604	0.2	731017	0.0511	0.0523
AR1	81	0.106	0.093	43	53.09	0.020	750729	0.02	750729	0.43	700106	0.0561	0.0984
AYB	0												
BF1	284	0.066	0.210	256	90.14	0.000	690915	0.00014	890415	2.7	750409	0.0597	0.064
BF2	126	0.061	0.093	126	100	0.000	920415	0.002	911215	0.55	711215	0.0614	0.0614
BF3	201	0.046	0.071	175	87.06	0.000	690915	0.0021	890415	0.5	920407	0.04	0.0456
C01	0												
C02	95	0.070	0.077	68	71.58	0.008	880510	0.008	880510	0.47	880714	0.0499	0.0614
C03	54	0.134	0.130	54	100	0.000	720328	0.0048	880510	0.6	760109	0.134	0.134
C04	26	0.074	0.071	26	100	0.009	871020	0.0088	871020	0.26	880714	0.0743	0.0743
C05	67	0.080	0.100	67	100	0.000	720920	0.01	741024	0.82	801021	0.0804	0.0804
C06	36	0.073	0.040	36	100	0.000	701013	0.01	730517	0.11	740611	0.0731	0.0731
C07	97	0.077	0.100	97	100	0.000	720328	0.02	831128	1	721219	0.0767	0.0767
C08	24	0.091	0.083	24	100	0.010	880810	0.0095	880810	0.28	880714	0.0906	0.0906

(continued)

TABLE 6-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
C09	22	0.078	0.170	22	100	0.000	750130	0.01	770210	0.84	801021	0.0777	0.0777
C10	113	0.066	0.069	113	100	0.000	690326	0.0055	880510	0.57	880714	0.0661	0.0661
C11	182	0.070	0.086	182	100	0.000	690917	0.01	710506	1	731115	0.0703	0.0703
C12	125	0.066	0.110	125	100	0.000	711111	0.01	720725	1	740114	0.0655	0.0655
C13	0												
C14	392	0.048	0.053	392	100	0.000	690326	0.00014	930415	0.4	720126	0.0476	0.0476
C15	295	0.107	0.170	253	85.76	0.000	680530	0.0036	880413	1.4	700922	0.0914	0.0979
C16	0												
C17	128	0.064	0.097	128	100	0.000	720920	0.0063	880510	0.95	801021	0.0643	0.0643
C18	0												
C19	0												
C20	22	0.071	0.053	22	100	0.009	880810	0.0094	880810	0.19	880714	0.0713	0.0713
C21	61	0.089	0.041	61	100	0.000	720328	0.01	720328	0.21	711105	0.0887	0.0887
C22	22	0.114	0.046	22	100	0.100	721219	0.1	721219	0.3	730312	0.114	0.114
C23	24	0.085	0.092	24	100	0.010	880510	0.01	880510	0.32	880714	0.0854	0.0854
C24	57	0.051	0.072	57	100	0.000	690916	0.0076	880510	0.32	871208	0.0513	0.0513
C25	0												
CB	67	0.081	0.092	67	100	0.000	721115	0.01	720330	0.51	731010	0.0813	0.0813
CBH	0												
CBY1	12	0.025	0.020	12	100	0.004	870126	0.0041	870126	0.062	870602	0.0245	0.0245
CBY2	0												
CCC1	143	0.046	0.042	143	100	0.000	690326	0.0095	880810	0.19	880714	0.0463	0.0463
CCC2	6	0.230	0.210	5	83.33	0.080	810507	0.08	810507	0.63	810507	0.192	0.2
CCC3	106	0.058	0.060	105	99.06	0.000	680326	0.0074	880510	0.24	880714	0.0573	0.0578
CCC4	6	0.100	0.000	5	83.33	0.100	740723	0.1	740723	0.1	740723	0.0833	0.0917
CCC5	56	0.059	0.075	56	100	0.000	711111	0.0081	880510	0.3	871208	0.0586	0.0586
CCC6	97	0.094	0.087	60	61.86	0.010	860528	0.01	860528	0.48	691208	0.0578	0.0738
CCC7	304	0.049	0.062	304	100	0.000	690325	0.0025	871019	0.48	710903	0.0488	0.0488
CCC8	108	0.212	0.670	93	86.11	0.010	760115	0.01	760115	6.3	760406	0.183	0.189
CP01	0												

(continued)

TABLE 6-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
CP02	25	0.027	0.036	25	100	0.000	711111	0.01	720724	0.16	720330	0.0268	0.0268
CP03	48	0.093	0.120	48	100	0.000	711111	0.01	720330	0.8	730311	0.0931	0.0931
CP04	1	0.040	0.000	1	100	0.040	710915	0.04	710915	0.04	710915	0.04	0.04
CP05	41	0.078	0.062	41	100	0.000	711111	0.01	720724	0.31	720330	0.0776	0.0776
CP06	0												
CP07	79	0.065	0.075	79	100	0.000	711111	0.01	740531	0.42	720330	0.0652	0.0652
CP08	0												
CP09	10	0.066	0.110	10	100	0.000	770210	0.01	770629	0.37	801022	0.066	0.066
CP10	159	0.103	0.150	127	79.87	0.000	711108	0.01	750318	1	690521	0.0825	0.0923
EF	0												
GR1	1	0.000	0.000	0	0	0.000	0	0	0	0	0	0	0.05
GR2	20	0.100	0.110	19	95	0.000	690915	0.01	741023	0.3	751029	0.0945	0.097
HI1	0												
HI2	1	0.020	0.000	1	100	0.020	770210	0.02	770210	0.02	770210	0.02	0.02
I1	0												
I2	12	0.196	0.300	12	100	0.100	700827	0.1	700827	1.2	700218	0.196	0.196
I3	58	0.095	0.110	55	94.83	0.000	720330	0.01	710608	0.64	720330	0.0903	0.0929
I4	5	0.170	0.000	1	20	0.170	840823	0.17	840823	0.17	840823	0.034	0.074
I5	40	0.046	0.041	39	97.5	0.000	711111	0.01	710608	0.12	720530	0.0448	0.046
I6	93	0.124	0.170	60	64.52	0.020	750721	0.02	750721	1.1	750423	0.0801	0.0948
I7	64	0.047	0.110	64	100	0.000	711111	0.01	710608	0.9	840530	0.0473	0.0473
I8	0												
I9	229	0.086	0.140	229	100	0.000	690916	0.0099	880510	1	690522	0.0863	0.0863
I10	57	0.015	0.015	57	100	0.000	930415	0.00014	930415	0.076	890315	0.0147	0.0147
I11	6	0.160	0.230	6	100	0.000	690916	0.02	701008	0.6	680828	0.16	0.16
I12	76	0.137	0.190	48	63.16	0.020	821122	0.02	821122	1.1	750707	0.0865	0.102
I13	156	0.024	0.034	156	100	0.001	911215	0.00098	911215	0.22	930715	0.024	0.024
I14	0												
I15	93	0.041	0.079	93	100	0.000	690916	0.0018	911215	0.67	680827	0.0411	0.0411
I16	0												

(continued)

TABLE 6-2
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
I17	140	0.082	0.160	115	82.14	0.004	911115	0.0042	911115	1.3	900412	0.0677	0.075
I18	0												
IH1	128	0.490	0.740	115	89.84	0.000	690325	0.02	910710	4.4	760406	0.44	0.445
IH2	3	0.203	0.074	3	100	0.120	820810	0.12	820810	0.3	770621	0.203	0.203
IH3	8	0.209	0.069	8	100	0.120	820810	0.12	820810	0.3	770621	0.209	0.209
IH4	5	0.166	0.046	5	100	0.110	820810	0.11	820810	0.21	820810	0.166	0.166
IH5	129	0.460	0.670	124	96.12	0.000	680530	0.02	900808	5.4	760406	0.443	0.444
IH6	88	0.285	0.460	80	90.91	0.010	920728	0.01	920728	3.4	760406	0.259	0.263
IH7	96	0.226	0.190	95	98.96	0.000	680530	0.02	721116	1	800409	0.224	0.225
INL	4	0.333	0.330	3	75	0.100	740723	0.1	740723	0.8	820317	0.25	0.263
LAC	46	0.059	0.084	46	100	0.000	711108	0.01	721115	0.51	801022	0.0589	0.0589
LB	0												
LQ1	6	0.117	0.009	3	50	0.110	801203	0.11	801203	0.13	801203	0.0583	0.0833
LQ2	87	0.145	0.470	48	55.17	0.000	741024	0.01	750130	3	750423	0.0797	0.0996
LS1	56	0.036	0.061	55	98.21	0.003	890415	0.0031	890415	0.32	920215	0.0348	0.0357
LS2	69	0.026	0.038	68	98.55	0.000	690915	0.0014	890415	0.19	740424	0.0255	0.0262
M1	0												
M2	0												
MB1	89	0.092	0.150	54	60.67	0.000	750924	0.0035	870126	0.87	780206	0.0559	0.0727
MB2	23	0.030	0.030	23	100	0.004	870126	0.0039	870126	0.09	870602	0.0304	0.0304
NB1	111	0.098	0.085	111	100	0.017	871119	0.017	871119	0.59	880121	0.0982	0.0982
NB2	24	0.094	0.073	24	100	0.016	871119	0.016	871119	0.27	871209	0.094	0.094
NB3	58	0.060	0.058	58	100	0.016	880811	0.016	880811	0.23	871209	0.0599	0.0599
NB4	287	0.119	0.091	287	100	0.009	880811	0.0094	880811	0.83	920107	0.119	0.119
NB5	531	0.088	0.079	502	94.54	0.000	690326	0.0041	880412	0.74	920107	0.0835	0.086
NB6	66	0.113	0.120	66	100	0.000	690326	0.01	750417	0.8	720125	0.113	0.113
NB7	65	0.135	0.190	40	61.54	0.010	860826	0.01	860826	1.2	920107	0.083	0.0991
NB8	20	0.069	0.063	20	100	0.003	880413	0.0025	880413	0.22	871209	0.069	0.069
NB9	8	0.055	0.069	8	100	0.005	880413	0.005	880413	0.2	880712	0.0547	0.0547
ND1	0												

(continued)

TABLE 6-2
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
ND2	16	0.096	0.054	16	100	0.045	781204	0.045	781204	0.2	790209	0.0956	0.0956
ND3	0												
ND4	0												
NR1	36	0.072	0.140	29	80.56	0.000	680530	0.01	730517	0.72	701012	0.0578	0.102
NR2	0												
NR3	6	0.208	0.310	6	100	0.000	731016	0.04	720725	0.86	701012	0.208	0.208
NR4	164	0.237	0.300	114	69.51	0.020	760908	0.02	760908	1.8	751209	0.164	0.179
NR5	33	0.132	0.120	33	100	0.000	680530	0.02	760608	0.46	750417	0.132	0.132
OS1	50	6.500	6.700	49	98	0.050	920928	0.05	920928	30	750422	6.37	6.38
OS2	0												
OS3	27	0.545	0.690	19	70.37	0.059	760419	0.059	760419	2.7	750701	0.384	0.407
OS4	0												
OS5	0												
OS6	47	0.187	0.460	33	70.21	0.010	930427	0.01	930427	2.7	890209	0.131	0.144
OS7	68	0.784	3.100	55	80.88	0.010	860826	0.01	860826	23	820505	0.634	0.643
PB1	70	0.112	0.220	50	71.43	0.010	870121	0.01	870121	1.6	750422	0.0797	0.0926
PB2	0												
RB1	18	0.043	0.037	18	100	0.000	711111	0.01	720724	0.12	711105	0.0433	0.0433
RB2	0												
RB3	83	0.113	0.220	56	67.47	0.000	690326	0.01	710506	1.6	870212	0.0759	0.0909
RB4	0												
RB5	22	0.100	0.000	22	100	0.100	721220	0.1	721220	0.1	721220	0.1	0.1
RB6	22	0.100	0.000	22	100	0.100	721215	0.1	721215	0.1	721215	0.1	0.1
RB7	8	0.044	0.030	8	100	0.010	790608	0.01	790608	0.1	790209	0.0444	0.0444
RB8	185	0.077	0.110	98	52.97	0.000	710506	0.01	740425	0.8	801021	0.0409	0.0613
RB9	6	0.047	0.038	6	100	0.020	890122	0.02	890122	0.1	740723	0.0467	0.0467
SC1	0												
SC2	26	0.084	0.250	26	100	0.000	720724	0.01	721115	1.3	711111	0.0838	0.0838
SC3	150	0.119	0.300	87	58	0.010	710608	0.01	710608	2.9	750422	0.0687	0.0879
UL01	0												

(continued)

TABLE 6-2
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
UL02	0												
UL03	53	0.026	0.043	53	100	0.000	690916	0.00084	920815	0.19	930715	0.0257	0.0257
UL04	69	0.094	0.076	43	62.32	0.010	821122	0.01	821122	0.3	750707	0.0584	0.0735
UL05	0												
UL06	0												
UL07	0												
UL08	0												
UL09	0												
UL10	0												
UL11	15	0.076	0.100	15	100	0.000	690916	0.01	780301	0.4	820330	0.076	0.076
UL12	0												
UL13	0												
UL14	0												
GMI1	0												
GMI2	0												
GMI3	0												
GMI4	39	0.179	0.34	25	64.1	0.04	770124	0.04	770124	1.8	750422	0.115	0.132
GMI5	0												
GMI6	112	0.115	0.21	90	80.36	0	690326	0.01	711111	1.5	700305	0.0924	0.102
GMI7	0												
GMI8	0												
GMI9	0												
GMO1	0												
GMO2	0												
GMO3	0												
GMO4	0												
GMO5	0												
GMO6	14	0.339	0.31	11	78.57	0	730516	0.03	730516	0.8	820317	0.266	0.277
GMO7	0												
GMO8	0												
GMO9	0												

TABLE 6-3
Period of record statistics for CCBNEP Hydrographic Segments
WQXTSS

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
A1	269	39.6	35	263	98	0	740612	1.7	901019	210	760819	38.7	39.3
A2	240	49	58	240	100	0	750129	1.7	870603	420	740531	49	49
A3	275	35.6	39	271	99	0	720918	1.7	871118	300	751103	35	35.4
A4	184	37.4	44	184	100	0	720724	0.93	720724	340	840329	37.4	37.4
A5	124	29.3	29	124	100	0	720724	4.7	740418	230	850306	29.3	29.3
A6	132	28.5	21	130	98	1.7	870421	1.7	870421	140	830614	28.1	28.5
A8	59	35.5	40	59	100	1.7	870924	1.7	870924	240	890905	35.5	35.5
A9	78	28.5	22	78	100	1.7	870603	1.7	870603	150	830920	28.5	28.5
A10	232	38.1	74	232	100	0	720724	1.7	870603	930	830503	38.1	38.1
A11	253	33.7	39	253	100	1.7	870318	1.7	870318	330	930902	33.7	33.7
A12	364	29.6	38	364	100	0	740417	0.93	740118	370	831227	29.6	29.6
A13	111	32.7	76	111	100	1.7	870806	1.7	870806	760	930625	32.7	32.7
AL1	169	133	170	169	100	5.2	931208	5.2	931208	930	831220	133	133
AL2	283	73.7	95	283	100	4.8	870723	4.8	870723	930	850313	73.7	73.7
AR1	166	89	86	165	99	3.5	871118	3.5	871118	750	840322	88.5	88.5
AYB	38	52.3	29	38	100	23	690901	23	690901	130	690601	52.3	52.3
BF1	451	55.5	58	451	100	3.5	881026	3.5	881026	610	841120	55.5	55.5
BF2	449	52.4	75	449	100	0	760211	3.5	871117	930	830420	52.4	52.4
BF3	556	35.2	32	555	100	0	750205	3.5	870414	340	900412	35.1	35.1
C01	225	71.1	72	225	100	2	720314	2	720314	390	720413	71.1	71.1
C02	189	31.9	32	186	98	0	720725	1.7	870908	210	820804	31.4	31.5
C03	372	50.2	52	372	100	0	720725	1.7	890427	460	711103	50.2	50.2
C04	192	30.3	21	192	100	1.7	870908	1.7	870908	150	910123	30.3	30.3
C05	220	153	940	220	100	0	720725	1.7	890616	11000	830511	153	153
C06	232	98.4	500	232	100	1.7	890616	1.7	890616	5000	830511	98.4	98.4
C07	395	45.5	52	395	100	0	720725	1.7	870617	390	720413	45.5	45.5
C08	130	27.1	21	130	100	3.5	871005	3.5	871005	130	830413	27.1	27.1
C09	573	61.9	330	573	100	0	750417	1.7	870520	4800	830511	61.9	61.9

(continued)

TABLE 6-3
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
C10	426	25.8	41	426	100	0	720725	1.7	870803	560	831223	25.8	25.8
C11	484	105	610	484	100	0	720725	1.7	890824	7700	830511	105	105
C12	794	53.7	320	794	100	0	720725	1.7	870804	5600	821122	53.7	53.7
C13	96	22.3	27	96	100	1.7	890927	1.7	890927	200	830608	22.3	22.3
C14	857	27.8	28	857	100	0	720725	1	710219	320	710104	27.8	27.8
C15	702	77.3	83	702	100	0	721227	3.5	870312	460	700610	77.3	77.3
C16	67	33.2	40	67	100	3.5	870617	3.5	870617	270	860203	33.2	33.2
C17	288	154	1000	288	100	1.7	931104	1.7	931104	13000	830511	154	154
C18	114	29.1	31	114	100	1.7	870617	1.7	870617	210	840607	29.1	29.1
C19	77	34.5	51	77	100	3.5	930104	3.5	930104	350	830408	34.5	34.5
C20	271	57.8	69	271	100	1	700702	1	700702	350	711103	57.8	57.8
C21	221	23.9	23	221	100	0	720725	0.93	740107	230	831024	23.9	23.9
C22	94	26.4	34	94	100	0	740216	0.93	720725	220	860423	26.4	26.4
C23	60	34.5	43	60	100	1.7	890616	1.7	890616	200	910206	34.5	34.5
C24	204	26.3	37	204	100	0	740530	3.5	870401	370	751030	26.3	26.3
C25	74	18	19	74	100	3.5	891107	3.5	891107	150	930824	18	18
CB	262	48.5	48	262	100	0	740612	1.7	870721	360	690715	48.5	48.5
CBH	18	35.6	29	18	100	3.5	870708	3.5	870708	100	740611	35.6	35.6
CBY1	18	38.5	45	18	100	8.6	881201	8.6	881201	200	870406	38.5	38.5
CBY2	26	66	46	25	96	8.6	901206	8.6	901206	210	680415	63.4	64.4
CCC1	691	63.1	300	691	100	0	751031	1	710618	4800	821122	63.1	63.1
CCC2	62	22.3	13	62	100	3.5	930202	3.5	930202	87	880510	22.3	22.3
CCC3	737	46.9	41	737	100	0	751030	2.8	720725	480	930106	46.9	46.9
CCC4	87	24.8	23	87	100	1.7	890616	1.7	890616	160	830422	24.8	24.8
CCC5	137	28.3	42	137	100	0	720725	1.7	870617	320	860423	28.3	28.3
CCC6	172	31	34	170	99	0	720515	1.7	931104	360	910619	30.6	30.7
CCC7	206	183	1100	206	100	0.93	720725	0.93	720725	12000	830511	183	183
CCC8	117	34.7	37	117	100	3.5	930208	3.5	930208	220	900430	34.7	34.7

(continued)

TABLE 6-3
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
CP01	32	42	42	32	100	1.7	871117	1.7	871117	170	860206	42	42
CP02	331	40.7	42	329	99	0	740612	1.7	870203	450	910702	40.4	40.6
CP03	328	53.3	55	328	100	1.7	870421	1.7	870421	400	710915	53.3	53.3
CP04	233	44.6	74	231	99	0	740612	1.7	870622	930	880601	44.2	44.4
CP05	226	60.3	57	223	99	0	830208	1.7	870622	370	840711	59.5	59.8
CP06	135	70.6	71	135	100	3.5	870916	3.5	870916	370	850306	70.6	70.6
CP07	229	37.7	45	229	100	0	740612	1.7	870908	510	830602	37.7	37.7
CP08	296	43.2	51	291	98	0	740612	1.7	870622	420	880913	42.5	42.9
CP09	223	45.4	51	223	100	0	740612	1.7	870203	300	840321	45.4	45.4
CP10	379	38.7	44	372	98	0	720920	1.7	870319	420	710304	38	38.2
EF	61	23.1	17	61	100	1.7	870416	1.7	870416	97	930527	23.1	23.1
GR1	13	76.6	94	13	100	5.2	910515	5.2	910515	350	860318	76.6	76.6
GR2	330	67.8	86	330	100	1.7	871027	1.7	871027	930	831201	67.8	67.8
HI1	58	30.7	30	58	100	4.7	730517	4.7	730517	110	850212	30.7	30.7
HI2	64	22.2	17	64	100	1.7	870609	1.7	870609	120	910108	22.2	22.2
I1	2	45	0	1	50	45	930405	45	930405	45	930405	22.5	35
I2	88	65.8	61	87	99	5.2	890123	5.2	890123	350	711123	65	65.3
I3	162	51.5	55	160	99	0	740612	3.5	870818	470	760819	50.9	51.2
I4	188	53.3	57	185	98	3.5	880705	3.5	880705	400	920417	52.5	52.9
I5	221	38	41	221	100	0	750129	1.7	870603	340	831207	38	38
I6	253	29.6	45	248	98	0	720320	1.7	870105	560	831207	29	29.3
I7	361	25.7	22	357	99	0	740531	1.5	870112	280	700515	25.4	25.7
I8	96	26.1	26	96	100	1.7	870318	1.7	870318	170	930607	26.1	26.1
I9	238	25	36	238	100	0	720516	2.8	720725	330	750604	25	25
I10	190	50.8	47	190	100	0	710716	4.1	710716	200	711008	50.8	50.8
I11	101	21.9	21	101	100	0	750205	1.7	920128	130	921112	21.9	21.9
I12	164	25.5	27	163	99	3.5	870817	3.5	870817	190	750409	25.4	25.4
I13	336	30.1	22	330	98	1.7	870702	1.7	870702	130	680415	29.5	30

(continued)

TABLE 6-3
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
I14	106	19.1	17	106	100	1.7	890919	1.7	890919	94	841019	19.1	19.1
I15	153	29.5	36	153	100	0	760211	1.4	870110	350	751030	29.5	29.5
I16	53	25.7	23	53	100	3.5	920218	3.5	920218	120	850215	25.7	25.7
I17	134	36.6	31	133	99	6.9	901120	6.9	901120	240	750409	36.3	36.4
I18	96	38.8	25	96	100	3.5	871008	3.5	871008	170	670215	38.8	38.8
IH1	132	28.5	33	131	99	0	740611	0.5	780906	200	750917	28.3	28.4
IH2	2	12.5	1.5	2	100	11	820810	11	820810	14	820810	12.5	12.5
IH3	23	18.4	12	23	100	0	740611	4.7	740611	47	820810	18.4	18.4
IH4	9	47.2	25	9	100	21	820810	21	820810	93	791018	47.2	47.2
IH5	167	28.9	31	165	99	0	720315	3	920930	200	750806	28.5	28.6
IH6	114	26.3	21	113	99	6	880218	6	880218	170	750722	26.1	26.2
IH7	594	56.2	320	594	100	0	720514	2	711208	4800	821123	56.2	56.2
INL	29	27.5	29	29	100	5.2	910716	5.2	910716	110	880201	27.5	27.5
LAC	135	22.7	24	135	100	0	740612	3.5	880816	220	930607	22.7	22.7
LB	50	24.1	13	50	100	5.2	870609	5.2	870609	81	690801	24.1	24.1
LQ1	612	42.5	32	611	100	1.7	870416	1.7	870416	250	730319	42.5	42.8
LQ2	169	34.8	34	164	97	0	741024	1.9	720725	230	740530	33.8	34
LS1	45	60	43	45	100	3.5	881026	3.5	881026	200	900815	60	60
LS2	226	64.5	66	226	100	3.5	881026	3.5	881026	510	840815	64.5	64.5
M1	24	95	77	24	100	10	870319	10	870319	320	851113	95	95
M2	70	70	73	70	100	3.5	931217	3.5	931217	350	930324	70	70
MB1	179	64.1	63	176	98	3	870107	3	870107	320	900322	63	63.2
MB2	326	64.8	78	320	98	1.7	871118	1.7	871118	570	910311	63.6	64.1
NB1	168	66.6	53	168	100	1.7	871006	1.7	871006	280	770408	66.6	66.6
NB2	92	65.6	62	92	100	3.5	880201	3.5	880201	370	860317	65.6	65.6
NB3	104	61.9	59	104	100	6.9	891107	6.9	891107	340	850605	61.9	61.9
NB4	194	622	4300	194	100	1.7	870924	1.7	870924	50000	830512	622	622
NB5	487	278	2200	487	100	0	760518	3.5	870127	33000	830209	278	278
NB6	134	690	3600	134	100	6.9	910902	6.9	910902	29000	830512	690	690

(continued)

TABLE 6-3
(continued)

Segmt	No.of obs	Avg >DL	Std dev >DL	No. > DLs	% > DLs	Min	date	Min >0	date	Max	date	Avg w/ BDL=0	Avg w/ BDL=DL
NB7	188	49.4	60	187	99	3.5	870127	3.5	870127	560	830412	49.2	49.3
NB8	162	66	61	162	100	5.2	930121	5.2	930121	350	930625	66	66
NB9	135	54.2	48	135	100	3.5	870127	3.5	870127	300	870706	54.2	54.2
ND1	0												
ND2	18	54	35	18	100	5.2	871007	5.2	871007	140	790525	54	54
ND3	0												
ND4	5	67.4	39	5	100	12	881012	12	881012	120	921110	67.4	67.4
NR1	59	37.9	30	57	97	0	730227	4.7	720215	200	700806	36.7	37
NR2	0												
NR3	28	1470	3600	28	100	19	740611	19	740611	13000	830512	1470	1470
NR4	168	114	160	165	98	10	861202	10	861202	1800	880411	111	112
NR5	37	76.7	47	37	100	25	740617	25	740617	220	740213	76.7	76.7
OS1	73	86.2	200	71	97	8	910702	8	910702	1700	801126	83.9	90.7
GMI1	36	15.4	9.5	36	100	1.7	910926	1.7	910926	45	911127	15.4	15.4
GMI2	140	22.6	15	140	100	1.7	910926	1.7	910926	78	930602	22.6	22.6
GMI3	182	26.2	23	182	100	3.5	871113	3.5	871113	190	880202	26.2	26.2
GMI4	191	34.1	37	191	100	1.7	870720	1.7	870720	180	880202	34.1	34.1
GMI5	214	24.1	27	214	100	1.7	870720	1.7	870720	170	930913	24.1	24.1
GMI6	291	53.3	310	287	98.63	0	720216	1.7	870616	3800	830208	52.6	52.7
GMI7	461	20.7	22	461	100	1.7	870507	1.7	870507	120	880321	20.7	20.7
GMI8	164	32.2	30	164	100	1.7	881027	1.7	881027	140	930825	32.2	32.2
GMI9	90	42.3	30	90	100	3.5	900820	3.5	900820	160	890711	42.3	42.3
GMO1	0												
GMO2	2	49.8	24	2	100	26	791106	26	791106	74	801028	49.8	49.8
GMO3	0												
GMO4	62	13.5	16	62	100	1.7	870318	1.7	870318	110	891219	13.5	13.5
GMO5	367	13.4	14	367	100	0	870518	1.7	870318	160	890916	13.4	13.4
GMO6	205	12.9	17	205	100	0	720919	1.7	870217	110	870116	12.9	12.9
GMO7	367	15.4	20	367	100	1.7	870102	1.7	870102	160	920709	15.4	15.4
GMO8	0												
GMO9	0												

Table 6-4
Statistics by Hydrographic Area
of salinity (WQSAL), ppt, in upper 1 m

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
A1	463	16.4	7.8	0.3	680715	44	630828
A2	270	16.5	7.1	1.0	920226	36	890828
A3	364	16.2	7.3	1.0	920421	34	641130
A4	177	19.3	7.7	2.3	920421	40	590602
A5	168	17.7	6.8	1.9	920421	36	641130
A6	189	19.4	7.1	3.1	760720	37	641130
A8	108	18.8	8.2	1.0	920226	36	840913
A9	57	20.5	7.9	1.0	920114	38	850910
A10	269	19.2	7.1	1.2	831026	37	641130
A11	144	23.0	7.2	3.0	920609	40	891009
A12	307	21.8	7.1	3.0	880427	40	890919
A13	132	24.1	7.6	4.0	760720	40	890614
AL1	167	38.6	17.0	0.0	870616	77	890828
AL2	260	37.9	15.0	0.0	860921	90	900830
AR1	174	11.3	8.8	0.0	811118	38	891017
AYB	34	21.7	6.1	12.0	690515	34	890620
BF1	402	36.8	15.0	0.0	860921	65	910408
BF2	294	38.1	13.0	2.8	731017	63	891106
BF3	531	38.2	11.0	0.6	900807	61	641115
C01	206	28.6	11.0	2.4	710922	86	610628
C02	321	29.6	10.0	1.2	671002	89	620613
C03	320	29.1	9.2	1.3	710914	70	670816
C04	200	26.3	10.0	0.4	670930	40	630815
C05	149	26.1	8.2	1.1	671002	45	520824
C06	147	27.3	7.6	2.9	671003	45	520824
C07	186	28.7	7.0	0.0	860927	43	710618
C08	126	31.0	5.8	7.1	711105	43	630815
C09	571	30.2	5.6	9.4	711105	43	710618
C10	244	28.4	7.0	0.0	860927	44	520824
C11	401	27.2	7.6	0.0	860927	46	520824
C12	689	29.2	6.0	0.0	860927	46	880323
C13	51	28.3	8.2	5.5	670929	41	860916
C14	855	30.3	6.8	0.0	860927	54	800715
C15	976	25.1	11.0	0.0	860927	79	610927
C16	20	27.4	11.0	2.1	670930	36	520406
C17	411	28.2	7.6	0.0	870706	47	841220
C18	101	31.0	7.0	2.5	670930	42	520824
C19	119	29.3	6.1	10.0	810713	51	630807
C20	161	27.9	7.3	6.2	711020	43	520824
C21	250	30.2	5.5	5.6	731113	42	520824
C22	55	27.9	5.2	5.9	731113	36	520322
C23	46	31.0	4.4	20.0	870316	38	880810
C24	221	30.6	7.7	0.0	890122	47	880717

(continued)

Table 6-4
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
C25	132	30.7	7.2	11.0	671003	52	890612
CB	323	17.0	7.5	1.0	920312	39	850911
CBH	13	24.7	7.0	10.0	671003	34	900613
CBY1	18	18.6	9.7	3.0	920312	33	880707
CBY2	45	27.3	6.4	10.0	920113	38	670815
CCC1	349	28.6	9.8	0.0	860927	170	701012
CCC2	101	29.0	5.2	5.9	760720	39	870605
CCC3	370	28.8	6.1	0.0	860927	43	710702
CCC4	108	28.6	5.5	3.5	910926	39	600926
CCC5	105	30.0	7.0	0.0	860927	43	520824
CCC6	161	29.5	5.6	6.4	710916	54	910116
CCC7	291	27.9	7.6	0.0	870716	42	520824
CCC8	286	28.9	10.0	0.0	760115	99	610628
CP01	32	16.9	8.9	0.0	920416	32	891218
CP02	342	15.8	8.0	0.3	811208	35	890928
CP03	467	13.2	9.0	0.0	730615	42	641201
CP04	333	15.6	8.6	1.0	920221	45	630805
CP05	289	13.1	8.8	0.0	680615	50	690801
CP06	104	17.0	9.6	1.0	831026	38	641201
CP07	187	12.9	8.0	0.7	731015	38	641201
CP08	241	15.2	7.9	0.0	920408	40	890918
CP09	159	12.9	6.9	0.0	920604	39	641201
CP10	501	14.7	7.7	0.0	680715	39	641201
EF	73	30.8	4.3	20.0	920428	40	840914
GR1	13	46.4	19.0	5.0	930316	65	891016
GR2	283	36.7	16.0	0.5	731017	64	910117
HI1	59	26.4	7.2	7.1	670930	40	900703
HI2	92	28.0	5.9	9.4	670930	42	850611
I1	48	13.4	6.7	0.0	920311	24	901016
I2	95	19.2	7.2	0.0	920609	35	690716
I3	165	16.5	7.4	1.0	731019	32	841009
I4	202	18.8	7.6	0.1	920421	36	670815
I5	124	20.0	7.1	4.8	731015	35	650915
I6	324	21.0	9.2	2.6	760720	110	760712
I7	330	23.7	6.9	7.0	920507	38	670815
I8	82	28.4	6.1	5.0	920210	38	890710
I9	222	30.1	7.8	0.0	860927	54	880712
I10	118	31.4	8.5	6.0	760809	51	690815
I11	126	34.0	7.3	20.0	920703	51	900501
I12	141	34.8	8.4	0.5	900807	55	910408
I13	447	37.9	9.6	0.0	860921	64	641115
I14	109	38.4	7.3	23.0	920722	55	901212
I15	143	36.4	8.9	0.0	860921	53	901009
OS7	217	30.2	8.7	0.6	900806	78	850722

(continued)

Table 6-4
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
I16	63	37.8	8.7	18.0	920625	57	891114
I17	154	35.5	10.0	0.5	900807	58	900212
I18	170	39.5	9.9	12.0	870622	59	641015
IH1	161	28.1	8.1	0.0	920728	60	670816
IH2	4	35.1	1.5	33.0	820810	36	820810
IH3	34	27.8	6.8	12.0	731016	36	820810
IH4	29	29.8	11.0	10.0	780606	58	670816
IH5	200	27.9	7.6	0.6	710720	61	670816
IH6	142	29.0	5.8	14.0	731119	53	910409
IH7	265	26.6	9.9	3.8	710922	77	610628
INL	47	29.3	5.9	12.0	780509	40	881114
LAC	100	25.1	7.0	5.0	920608	36	770629
LB	59	21.1	6.6	5.0	810729	36	690815
LQ1	264	29.2	5.6	8.5	711020	43	710727
LQ2	181	29.5	5.1	15.0	731024	39	860814
LS1	77	37.8	18.0	6.8	930715	64	900815
LS2	254	36.0	15.0	1.1	731017	68	901220
M1	24	12.8	9.0	0.0	900724	28	900530
M2	101	15.7	11.0	0.0	831101	39	891024
MB1	294	18.1	8.4	0.0	920414	39	900123
MB2	338	19.6	8.5	0.1	920311	43	640826
NB1	211	24.6	11.0	0.0	870611	49	890907
NB2	150	24.1	11.0	0.0	811112	67	670816
NB3	102	25.2	10.0	0.5	850605	51	630710
NB4	357	26.1	8.9	0.0	800826	41	890729
NB5	765	25.4	9.6	0.0	680115	42	881207
NB6	457	24.1	8.8	0.2	710914	41	880922
NB7	572	25.5	8.2	0.0	870706	62	670816
NB8	312	26.7	9.4	0.0	680115	48	630710
NB9	264	26.2	8.5	0.0	680115	46	630710
ND1	0						
ND2	30	19.8	11.0	0.0	811112	35	890519
ND3	0						
ND4	327	21.1	9.0	0.0	920331	50	891008
NR1	80	0.9	1.6	0.0	670928	8.8	720725
NR2	0						
NR3	48	6.2	9.2	0.2	711105	54	710506
NR4	177	10.8	10.0	0.0	871119	39	840731
NR5	103	9.7	10.0	0.1	710914	35	710505
OS1	74	4.6	6.8	0.0	900806	41	720425
OS2	0						
OS3	55	22.6	12.0	0.7	730630	47	770906
OS4	50	32.3	11.0	5.0	870929	58	900626
OS5	28	35.7	7.7	20.0	920422	50	900730
OS6	89	31.4	9.8	0.6	900806	52	880809

(continued)

Table 6-4
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
PB1	164	12.9	8.8	0.0	831013	44	640401
PB2	201	14.5	8.9	0.0	790928	40	890918
RB1	145	22.5	7.4	4.0	760720	36	890615
RB2	98	25.3	8.1	4.0	920608	40	890918
RB3	189	25.3	7.2	5.0	920608	40	851107
RB4	153	25.9	6.2	4.2	760720	39	890718
RB5	291	27.7	5.8	4.9	760720	38	840914
RB6	120	25.9	6.5	8.0	920408	40	900703
RB7	165	28.8	5.2	14.0	780509	40	630815
RB8	275	25.9	6.4	4.2	760720	41	890227
RB9	220	28.6	6.5	1.8	670930	40	861007
SC1	187	11.1	8.0	0.0	680515	37	890620
SC2	446	13.4	9.4	0.0	680515	100	680515
SC3	543	15.1	7.2	0.3	680715	35	890717
UL01	68	33.9	5.8	22.0	870604	46	890523
UL02	180	33.1	6.8	11.0	671015	51	670715
UL03	339	35.8	8.2	8.9	671015	60	630826
UL04	86	32.6	6.6	0.5	900807	48	771205
UL05	106	35.5	8.2	17.0	870617	52	890407
UL06	234	37.0	8.6	11.0	671015	63	640915
UL07	249	36.5	9.3	11.0	671015	64	641115
UL08	97	37.1	7.9	24.0	820305	55	890919
UL09	104	36.5	7.2	19.0	920608	54	900925
UL10	203	38.3	9.1	18.0	680115	64	641115
UL11	30	35.3	7.2	11.0	731017	49	690916
UL12	0						
UL13	0						
UL14	38	35.3	10.0	19.0	590215	50	580715
GMI1	36	32.2	3.1	23.0	910521	37	910822
GMI2	140	32.6	3.8	3.6	900921	38	880713
GMI3	182	33.1	3.1	20.0	910521	38	880713
GMI4	178	31.9	4.8	16.0	731114	46	890718
GMI5	150	32.2	4.1	21.0	910613	39	880725
GMI6	214	30.0	5.4	3.0	930429	40	881114
GMI7	348	32.1	3.8	18.0	910604	40	880726
GMI8	181	31.3	5.2	10.0	920113-	39	890613
GMI9	90	31.4	4.4	20.0	930629	38	880726
GMO1	0						
GMO2	2	21.1	7.2	14.0	801028	28	791106
GMO3	0						
GMO4	10	30.3	3.4	22.0	870318	35	861016
GMO5	47	31.6	3.1	24.0	870318	41	920817
GMO6	35	29.7	4.1	19.0	780613	37	770630
GMO7	75	31.1	3.4	24.0	870302	40	870903
GMO8	0						
GMO9	0						

Table 6-5
Statistics by Hydrographic Area
of water temperature (WQTEMP), °C, in upper 1 m

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
A1	471	20.7	5.9	8.5	660115	32	780614
A2	273	21.5	6.5	2	831230	34	850610
A3	372	21.5	6.1	6.5	730114	33	790815
A4	180	20.7	6.3	7.3	850124	32	810818
A5	172	21.7	5.7	11	700101	33	820916
A6	190	21.5	6.3	6.1	891218	34	880525
A8	110	21.4	6.1	7.2	590111	33	890519
A9	60	21.9	6.5	4.5	791218	32	910911
A10	276	21.1	6.2	8.1	910108	35	910605
A11	144	23	6.2	1	770113	34	880725
A12	311	22.2	6.3	5.1	890208	33	900611
A13	133	22.9	6.6	6.7	891213	36	890131
AL1	167	25.4	5.4	11	850208	35	910717
AL2	260	24.6	5.3	9	850208	34	810824
AR1	176	23.4	6.1	0.1	731029	34	790807
AYB	34	23.3	6	9.8	700101	30	690615
BF1	394	23.6	5.7	8.2	920115	36	800724
BF2	294	23.5	6.1	8	801222	35	820820
BF3	504	23.6	5.9	1.4	890412	39	911015
C01	201	22.8	5.9	8.9	761202	33	730726
C02	317	22.4	5.8	8.3	680116	33	790709
C03	322	22.7	6	6	760109	37	690815
C04	198	24.5	5.5	9.5	630115	32	630815
C05	136	22.9	5.8	6	730113	31	710827
C06	135	22.8	5.7	9	730115	37	700815
C07	176	22.4	6.1	6.5	730115	32	730726
C08	121	23.3	6.3	9.1	761202	33	650915
C09	570	23.8	5.8	2.5	860415	34	900806
C10	241	22.1	6	7.4	761202	30	710719
C11	400	23	5.7	7	730115	31	760802
C12	687	22.9	6.1	7.8	870122	34	800825
C13	50	24.6	5.7	9.5	850212	32	900620
C14	847	23.3	6	2.2	670929	39	700815
C15	957	23	6.1	2.3	831227	34	870722
C16	14	21	6	13	830124	29	900827
C17	389	23.1	5.8	6.5	730113	36	890706
C18	82	23.6	6.5	8	870122	32	630815
C19	108	22	6	8.9	770113	33	910605
C20	142	21.9	5.7	12	880121	32	810713
C21	236	22.9	5.9	7	730115	35	820617
C22	49	21.7	6.3	7	730115	30	720725
C23	44	22.9	5.6	9.6	890209	30	880714
C24	221	24	6	2.2	670929	36	810713

(continued)

Table 6-5
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
C25	133	23.7	6	8	770201	37	920811
CB	323	22.6	5.8	6.5	730114	32	910605
CBH	14	26.5	3.9	15	921202	31	900613
CBY1	18	20.3	6.1	12	920312	30	900705
CBY2	45	21.9	7.3	8.3	660215	32	680815
CCC1	318	22.5	5.6	9	840125	34	820617
CCC2	91	22.4	6.4	8.6	870122	33	740723
CCC3	360	23.1	5.9	8	790109	33	930817
CCC4	109	21.7	5.8	7.9	870122	33	700815
CCC5	86	21.5	6.3	7.7	850124	30	720725
CCC6	156	22.5	6.3	7.6	770113	31	720714
CCC7	284	21.8	6	6	730113	31	710827
CCC8	276	22.3	6	6.4	880111	32	810713
CP01	32	23.7	6.8	4.5	891218	31	800617
CP02	342	22.7	6.1	4.4	891218	34	810811
CP03	467	21.2	6.1	0.5	831230	33	860826
CP04	335	21.7	6	8.3	800303	33	860724
CP05	286	21.6	6.2	1	831230	34	860610
CP06	105	22.7	6.3	9.4	800303	32	910528
CP07	188	22.6	6.1	2	831228	34	870908
CP08	241	23.3	5.9	2	831230	33	870805
CP09	161	22.1	6	2	831230	32	790626
CP10	489	21.9	6.2	5	891218	35	800821
EF	73	24.3	6.2	1.5	831230	34	800911
GR1	13	27.5	2.2	23	901220	31	910515
GR2	283	25.4	5.5	8.4	870123	36	860804
HI1	61	23	6	6.6	770113	32	900703
HI2	92	23.1	6.3	9.5	780201	35	850611
I1	3	24.2	1.1	23	930405	25	660915
I2	95	23.7	5.9	8.2	660215	32	690701
I3	165	23.3	6	5.3	730114	32	660515
I4	203	21.7	6.4	6	660115	31	890620
I5	123	21.8	6.6	6.6	660115	31	870617
I6	323	20.9	6.2	6.8	660115	32	810818
I7	331	22.8	6.3	7.5	850124	37	660915
I8	81	23.5	6.2	9.5	700101	36	890710
I9	215	22.4	6.1	6.1	750207	32	910626
I10	118	24.8	6.2	6.9	761202	34	810814
I11	108	24.1	5.9	7.9	770201	34	810814
I12	135	23.9	5.5	9	770111	33	920520
I13	405	23.5	6.4	3.5	630114	37	911015
I14	107	24.3	6.3	8.5	790116	38	830803
I15	142	24.1	6.1	5	850122	33	910703
I16	61	25.5	6.3	5	850122	35	920625

(continued)

Table 6-5
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
I17	147	23.8	5.7	8.5	770111	35	870702
I18	118	23.5	6.2	4	630114	32	920903
IH1	149	23.9	5.8	10	670118	32	810713
IH2	3	28.8	0.4	28	820810	29	820810
IH3	31	25.5	4.7	12	730221	30	720725
IH4	24	25.8	6.1	9.4	690128	33	821001
IH5	185	24.2	5.9	9.4	670118	35	850819
IH6	134	24	5.8	12	770105	32	850812
IH7	256	24.1	5.7	8.1	770113	33	690815
INL	47	23.6	6.4	6	831228	32	790831
LAC	88	22	6.1	7.3	660115	33	930809
LB	59	22.9	6.6	3.9	891218	33	810729
LQ1	265	23.2	5.9	9.4	770113	34	870622
LQ2	173	22.9	5.9	8.4	880111	32	810813
LS1	77	23.7	5.3	8	920115	33	910809
LS2	252	24.6	5.7	2.7	860508	35	820623
M1	24	25.9	5.1	11	851217	33	860611
M2	104	23.1	5.6	9	910122	33	860611
MB1	298	21.5	6.6	7.5	790116	33	680915
MB2	349	21.5	6.4	7.8	581216	32	810818
NB1	201	23	5.5	10	911204	36	890706
NB2	147	23	5.7	7.8	940202	32	810713
NB3	149	24.1	6	6.1	850124	33	930728
NB4	346	22	5.4	6.4	850124	32	910618
NB5	753	22.7	5.6	6.4	850124	33	910617
NB6	476	26.2	6.4	3	730113	39	850918
NB7	585	24.6	6.3	7.8	940202	38	930729
NB8	309	23.4	5.9	7.8	940202	33	630815
NB9	264	22.7	6.1	7	880111	33	890706
ND1	0						
ND2	30	23.6	5	12	780907	32	790724
ND3	0						
ND4	326	22.6	6	6.4	891220	36	950630
NR1	80	24.6	6.1	7	700105	32	720726
NR2	0						
NR3	48	25	3.7	18	721116	32	720725
NR4	171	23.6	6.2	2.2	831227	34	830826
NR5	103	24.3	5.3	9.9	740112	33	710719
OS1	76	23.6	6.2	6.7	720131	34	880809
OS2	0						
OS3	58	24	7	4.4	720115	35	900904
OS4	50	24.6	6.7	9.2	891220	35	860610
OS5	28	24.6	6.6	13	921218	38	910718
OS6	85	24.9	6.2	6.2	890209	34	920623
OS7	216	24.5	6.1	6.1	850123	35	910718

(continued)

Table 6-5
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
PB1	164	23.2	5.6	6.8	850124	33	840626
PB2	201	23.6	5.8	7.8	911105	33	830718
RB1	149	23.8	5.9	7	660115	34	930817
RB2	99	25.2	5.5	4.2	890208	33	900806
RB3	189	24.4	5.7	11	820209	36	660915
RB4	158	24.1	5.9	6	790109	35	870722
RB5	292	23.9	5.7	1	831230	32	800722
RB6	120	22.6	6.7	7.5	721215	34	900703
RB7	165	24.2	5.7	9.5	630115	34	810722
RB8	275	23.1	6	7.6	850207	34	850923
RB9	220	24	6.4	6	831228	34	910605
SC1	186	23.8	5.7	9.4	700301	34	800717
SC2	440	22.9	6.4	7.8	891220	45	690501
SC3	539	23.3	6	5.5	850122	34	860708
UL01	68	24.9	6	6	791217	35	880824
UL02	180	25	5.6	6.5	860109	37	860930
UL03	318	23.5	6.3	3.5	630114	37	860930
UL04	82	23.8	5.8	8	770111	32	860716
UL05	104	25.4	6.3	8	781211	38	860930
UL06	214	23.7	6.1	2.1	630114	34	860818
UL07	231	24.2	6.2	5.5	791217	35	920703
UL08	97	25.5	5.2	9	790116	34	910627
UL09	104	24.6	5.6	10	840124	33	890711
UL10	185	24.1	6.4	2	840308	33	790628
UL11	30	24.3	6	11	850118	31	680827
UL12	0						
UL13	0						
UL14	2	30	2.7	27	871006	33	880802
GMI1	36	24.7	4.0	18.0	931123	30	910822
GMI2	140	24.9	4.4	10.0	890210	32	910822
GMI3	182	24.6	4.8	9.3	890210	31	910812
GMI4	177	24.0	6.1	9.5	790222	33	830810
GMI5	150	24.6	5.1	12.0	910116	33	880725
GMI6	214	23.8	5.5	11.0	820209	32	860724
GMI7	348	23.7	5.7	11.0	850212	35	890713
GMI8	181	24.8	5.9	11.0	650301	33	880823
GMI9	90	24.8	5.3	15.0	880223	33	890823
GMO1	0						
GMO2	2	25.0	1.0	24.0	801028	26	791106
GMO3	0						
GMO4	10	20.8	4.4	15.0	900224	28	890916
GMO5	47	19.7	5.1	9.9	891226	29	920817
GMO6	36	21.3	4.8	12.0	780224	29	860818
GMO7	75	20.5	5.2	12.0	850212	35	920709
GMO8	0						
GMO9	0						

Table 6-6
Statistics by Hydrographic Area
of dissolved oxygen (WQDO), ppm, in upper 1 m

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
A1	191	8.5	1.6	4.4	900828	15	861029
A2	193	8.8	2.2	5	810826	21	850610
A3	196	8.8	1.6	5	831208	14	850130
A4	101	8.5	1.7	5.8	860927	13	720127
A5	115	8.8	2.1	0.1	870608	16	861119
A6	107	9.2	2.9	4	780810	19	861120
A8	57	9.1	3	2.4	930812	19	920723
A9	56	9.3	2.1	4.6	890828	14	870924
A10	151	8.5	1.9	2.6	930907	13	881102
A11	128	8.2	1.8	3.9	900710	14	840126
A12	242	8.7	2.2	3.9	900710	21	851008
A13	87	8.7	2.2	2.9	920903	16	811020
AL1	167	7.3	2	0.7	890919	15	870416
AL2	260	7.3	1.9	2	880518	14	820430
AR1	175	8.6	2	4.7	710708	17	850729
AYB	34	7.3	1.3	4.5	690815	10	691215
BF1	304	7.2	1.9	1	820212	18	861216
BF2	248	7.1	2	1.5	871019	14	930728
BF3	371	7	2.2	0.3	920722	15	740117
C01	127	8.2	1.6	4.2	920819	12	700825
C02	186	7.7	1.5	3.7	880323	12	740116
C03	222	8	2	2	690715	14	690425
C04	129	7.1	2.1	2.5	700915	13	720725
C05	138	7.7	1.6	3.4	520324	12	750130
C06	132	7.2	1.8	2.5	690815	12	671207
C07	160	8	1.5	3	840222	13	730115
C08	40	7.9	1.7	3.4	880323	12	720725
C09	427	8.1	1.7	2	811021	14	860127
C10	207	7.8	1.5	3.5	880323	13	730115
C11	366	7.8	1.5	4.1	520629	14	870817
C12	498	7.9	1.8	2	830330	18	870804
C13	46	8.1	2	4	841031	14	830307
C14	597	7.9	1.8	2	690815	15	860304
C15	732	7.6	1.5	1.6	710720	17	720204
C16	16	7.1	1.6	4	830608	9.3	671002
C17	336	8	1.9	3	831116	16	870312
C18	29	6.6	1.7	3	831116	11	870122
C19	51	8.4	2	5	781122	16	870128
C20	94	8	1.3	2.3	730726	11	700825
C21	150	8	1.7	2	781010	15	870416
C22	49	7.8	1.8	5.3	730918	12	730115
C23	41	8.2	1.8	3.6	880323	12	900925
C24	211	7.7	2.2	3	820127	16	861111

(continued)

Table 6-6
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
C25	129	7.6	2.4	2.5	800716	20	931223
CB	301	8.6	2.2	3	920803	18	871111
CBH	13	8.2	1.9	5	841010	11	850312
CBY1	17	9.1	1.9	5.9	900705	14	861014
CBY2	4	9.2	2.2	6.8	901206	13	920113
CCC1	293	7.8	1.7	1.6	740604	17	850226
CCC2	48	7.7	1.6	4	800522	11	870930
CCC3	289	8	1.8	3.7	880323	17	820521
CCC4	67	7	2.1	2.5	690715	12	860206
CCC5	66	7.5	1.4	3.8	880323	10	870402
CCC6	115	7.3	1.5	3.5	690717	14	770105
CCC7	255	8.3	1.7	4.8	880323	13	880215
CCC8	186	7.6	1.6	3.2	880412	13	700825
CP01	32	8.7	2.1	4.1	931020	13	891218
CP02	265	8.6	2.1	0.1	870507	15	860110
CP03	298	8.6	2.1	3.1	730615	16	831230
CP04	200	8.7	1.7	4	820818	16	811216
CP05	189	8.3	1.8	4.7	710915	16	831230
CP06	60	8.4	2	5	840925	13	861216
CP07	178	8.5	1.8	2	921026	16	840126
CP08	203	8.6	2.1	1.4	920623	19	900925
CP09	154	8.7	1.8	5	690901	16	861028
CP10	336	8.5	1.8	4	820806	15	800821
EF	73	8.5	2.2	3.9	901120	17	841210
GR1	13	7.4	2.7	4	890323	13	930512
GR2	282	7.2	2.2	0	820820	18	861216
HI1	43	8.4	2.2	4.4	930428	15	840105
HI2	92	8.3	1.9	3.6	911216	14	870616
I1	2	9.8	3.9	5.9	870825	14	930405
I2	92	7.9	1.6	4	690915	13	900924
I3	157	8.7	2.4	1.7	901008	18	871111
I4	90	8	1.5	5	690815	11	741119
I5	70	8.8	1.7	5	760819	17	731015
I6	149	8.2	1.7	4	820701	14	770120
I7	240	8	2	1.5	811116	16	880926
I8	64	8	2.2	4.6	900710	17	870401
I9	196	7.1	2.2	1.8	880412	14	720928
I10	72	7.7	2	4.3	900904	17	860324
I11	108	7.6	2.2	0.7	820315	13	931217
I12	135	7.7	1.8	3.7	861103	12	870416
I13	172	7.4	4.9	2	890308	67	860921
I14	107	6.8	2.4	1.9	910917	15	850709
I15	113	6.7	1.9	0.2	920812	12	720928
I16	61	6.7	1.9	0.9	910612	10	860903

(continued)

Table 6-6
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
I17	113	7.3	1.5	4.2	920211	12	740117
I18	53	6.8	1.9	3	831117	13	861104
IH1	145	7.3	2.6	0	690918	15	770127
IH2	13	6.6	1.6	4.7	720425	8.9	720428
IH3	42	6.8	2.3	2	720601	11	720327
IH4	26	6.9	2.1	4.3	670524	14	670816
IH5	187	7.4	2.6	0.6	690918	17	731024
IH6	133	6.6	2.4	0	700815	16	770127
IH7	223	6.7	1.7	1.3	711111	13	720725
INL	43	8	1.5	5.5	920903	13	870112
LAC	85	8.1	1.9	3.9	760819	14	870112
LB	59	8.6	2.5	4	690901	19	861112
LQ1	165	7.9	1.5	2	810313	12	831117
LQ2	160	7.9	1.9	3.3	520406	17	870416
LS1	22	7	2.6	3	910809	13	930526
LS2	228	7.3	2.1	2	880622	16	930726
M1	24	8.1	2	4.8	920624	13	850409
M2	72	8.3	2.1	1.5	870615	15	880614
MB1	189	8.7	2	4.8	930409	19	900924
MB2	219	8.4	1.9	4.6	900705	15	790514
NB1	184	7.8	2.2	2.9	880324	17	880216
NB2	91	7.8	2	3.1	880324	15	900912
NB3	127	7.4	1.8	2.3	880324	16	900912
NB4	302	7.9	1.6	3	811027	12	861016
NB5	656	7.9	1.7	1.5	690915	19	721213
NB6	389	7.1	1.6	0	770301	13	900912
NB7	390	7.3	1.9	0	770301	16	841114
NB8	97	7.5	1.5	4	791113	11	831018
NB9	120	8.2	2.1	3.9	880324	16	900918
ND1	0						
ND2	30	8.1	1.4	6	790525	11	790724
ND3	0						
ND4	326	7.6	1.9	2.3	950731	14	891220
NR1	78	8	1.8	3.5	710719	12	720726
NR2	0						
NR3	48	7.8	2.4	4	710719	13	730418
NR4	169	9.5	2.9	0.7	880901	24	820917
NR5	101	8.1	2.2	2.7	710505	15	701012
OS1	76	9.8	5	0	800211	27	750205
OS2	0						
OS3	59	8.1	2.3	0	740331	13	790206
OS4	50	8.3	2.4	3.8	880426	18	931216
OS5	28	8.5	1.8	5.3	920623	12	910816
OS6	84	7.6	2	3.2	930818	13	930318
OS7	155	8.2	2	4	791012	17	841031

(continued)

Table 6-6
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
PB1	158	8.4	1.8	0	780523	14	930422
PB2	180	9.2	2.6	0.1	870226	18	771219
RB1	137	9.1	2.5	2.8	920707	16	830913
RB2	94	9.2	3.2	1.1	870903	22	861008
RB3	180	8.5	2.2	4	890531	16	871007
RB4	145	8.6	5.2	3.6	921007	67	830511
RB5	282	8.5	2	3.2	920918	15	840523
RB6	120	8.3	1.8	4.2	930608	16	860407
RB7	96	8.3	2.2	5	840425	18	810722
RB8	266	7.8	1.5	4.3	880817	15	881123
RB9	137	8.4	2.3	2	820202	17	810708
SC1	165	7.9	1.7	4	690901	14	861216
SC2	312	8.6	2.4	3	690901	20	911111
SC3	517	8.4	2.5	0.1	870507	19	860708
UL01	68	7.8	2	4	690815	13	930520
UL02	151	7.6	2.2	1.4	880908	15	930520
UL03	226	6.5	2.5	0.3	920921	14	930513
UL04	81	7.9	1.6	4.8	850501	12	930422
UL05	104	7.9	2.2	1	890308	15	920622
UL06	150	6.3	2.2	1.8	920608	14	840207
UL07	134	7.5	1.7	4	690815	13	901002
UL08	97	6.6	2.2	2.1	930525	12	811110
UL09	104	7	1.7	3	831101	10	930825
UL10	117	7.1	1.6	2.6	930921	10	690415
UL11	30	6.6	2.2	3	850118	14	720928
UL12	0						
UL13	0						
UL14	2	8.2	1.8	6.3	871006	10	880802
GMI1	36	6.4	1.2	4.7	900620	8.9	931123
GMI2	140	6.4	1.1	4.4	900705	9	880225
GMI3	182	6.4	1.1	4.6	900614	9.4	890210
GMI4	177	7.0	1.6	4.6	890905	14	800909
GMI5	149	6.5	1.2	4.8	891108	11	900517
GMI6	211	7.1	1.4	4.3	721127	12	820209
GMI7	348	7.3	1.5	4.5	880926	15	880714
GMI8	164	7.4	1.5	4.8	880926	13	880823
GMI9	90	7.8	2.2	5.6	880726	17	880823
GMO1	0						
GMO2	2	7.5	0.5	7.0	791106	8	801028
GMO3	0						
GMO4	10	7.9	1.3	6.1	890916	10	850416
GMO5	47	8.3	2.3	5.7	920817	21	920618
GMO6	35	7.8	1.1	5.7	780613	9.7	870302
GMO7	75	8.2	1.5	4.0	851002	11	920709
GMO8	0						
GMO9	0						

Table 6-7
Statistics by Hydrographic Area
of dissolved oxygen deficit (WQDODEF), ppm, in upper 1 m

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
A1	185	-0.4	1.5	-7.1	861029	4.3	840207
A2	192	-0.7	2	-14	850610	4.1	840207
A3	190	-0.7	1.3	-5.3	850130	4.3	840207
A4	98	-0.4	1.3	-4.7	720127	2.1	850107
A5	112	-0.9	1.9	-7.4	861119	7.9	870608
A6	105	-1.3	2.8	-11	861120	4.6	800118
A8	55	-1.4	2.9	-12	920723	4.5	930812
A9	54	-1.4	2	-6.9	870924	3.3	910320
A10	148	-0.7	1.7	-5.5	881102	4	840207
A11	128	-0.7	1.6	-5.7	901003	3	850117
A12	240	-0.9	2.1	-14	851008	4.9	850117
A13	87	-1.4	2.1	-8.7	811020	3.8	920903
AL1	167	-0.7	1.8	-8.7	870416	4.2	890919
AL2	260	-0.6	1.7	-6.9	820430	4.8	850208
AR1	171	-0.5	1.9	-9.9	850729	5.5	731029
AYB	34	0.4	0.8	-2.1	691215	1.8	690815
BF1	300	-0.3	1.7	-11	861216	7.5	820212
BF2	247	-0.3	2	-6.7	930728	5	871019
BF3	369	-0.2	2.1	-7.3	910828	6.5	920722
C01	102	-0.9	1.3	-4.8	730628	2.6	920819
C02	157	-0.4	1.4	-4.7	720725	4	880323
C03	197	-0.6	2	-7.1	890801	5.2	701115
C04	127	0.2	2.2	-6.5	720725	5.4	850212
C05	131	-0.3	1.4	-4.5	720725	2.8	670930
C06	129	0.2	1.6	-3.6	671207	6.4	850212
C07	157	-0.5	1.3	-5.4	720725	5.6	840222
C08	35	-0.4	1.9	-5.4	720725	4.6	880323
C09	423	-0.9	1.7	-7.4	900806	5	811021
C10	204	-0.3	1.3	-4.6	720725	4.6	880323
C11	364	-0.4	1.3	-7.2	870817	2.4	860927
C12	492	-0.6	1.7	-12	870804	5.5	830330
C13	45	-0.8	1.9	-6.8	830307	2.5	820127
C14	592	-0.6	1.7	-7.7	860304	6	691115
C15	693	-0.1	1.3	-7	720204	5.1	700115
C16	13	0.6	1.7	-1.5	911122	3.5	670930
C17	327	-0.7	1.9	-8.5	910801	4.9	880323
C18	21	0.5	1.6	-1.9	850903	4.8	831116
C19	45	-1.3	2.1	-9	870128	2.8	781122
C20	88	-0.5	1.2	-3.1	700930	4.2	730726
C21	143	-0.7	1.7	-7.6	870416	5.3	840125
C22	48	-0.2	1.6	-5.6	720725	2.2	840308
C23	40	-0.8	1.9	-4.9	900925	5.1	880121
C24	209	-0.6	2.3	-9.6	861111	5.1	820127

(continued)

Table 6-7
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
C25	129	-0.5	2.3	-9.4	931223	5.8	831221
CB	301	-0.7	2	-10	900925	3.9	920803
CBH	13	-1.2	1.6	-3.6	850312	1.8	841010
CBY1	17	-0.8	1.6	-5.9	861014	0.7	921203
CBY2	4	-1.2	1.8	-3.1	920113	1.4	901206
CCC1	289	-0.3	1.7	-9.1	701012	5.3	740604
CCC2	45	-0.3	1.6	-4.7	870930	2.9	911125
CCC3	281	-0.7	1.7	-10	820521	4.3	801124
CCC4	65	0.3	2	-4.4	840525	4.8	700415
CCC5	61	0	1.3	-3.6	720725	4	880323
CCC6	111	0	1.3	-3.6	770105	5.5	850212
CCC7	250	-0.8	1.4	-6.3	720725	3.3	880323
CCC8	161	-0.1	1.2	-3	720725	4.2	880412
CP01	32	-0.9	1.8	-4.8	901012	3	931020
CP02	264	-0.6	2.1	-8.6	880816	7.9	870507
CP03	295	-0.4	1.8	-6.6	821014	5.1	730615
CP04	197	-0.7	1.7	-7.7	901002	3.4	820818
CP05	188	0	1.3	-5	720724	3.6	710915
CP06	57	-0.6	2	-6.4	901001	4.6	841207
CP07	177	-0.3	1.4	-5.2	850820	5.6	921026
CP08	203	-0.7	2	-12	900925	6.5	920623
CP09	153	-0.5	1.5	-9	861028	2.5	840223
CP10	327	-0.5	1.6	-8.5	800821	3.2	800215
EF	73	-1.4	2.3	-9.6	841210	3.6	831230
GR1	13	-1.4	2.1	-5.4	930512	1.4	890323
GR2	282	-0.5	2.1	-10	861216	6.5	820820
HI1	43	-1.1	1.8	-6.9	840105	3	930428
HI2	92	-0.9	2	-6.9	870616	5.1	911216
I1	1	-5.6	0	-5.6	930405	0	0
I2	92	-0.2	1.5	-6.1	900924	3.2	690915
I3	157	-0.8	2.1	-10	870923	5.1	901008
I4	88	-0.3	1.5	-4.3	890620	4.1	840207
I5	70	-0.8	1.6	-8.9	731015	1.8	760819
I6	145	-0.4	1.4	-5.6	760712	4.3	840207
I7	236	-0.4	1.9	-9.7	880926	6.3	811116
I8	64	-0.7	2.1	-8.9	870401	1.9	900710
I9	189	0.2	2.1	-7.6	720928	5.9	880412
I10	70	-0.8	1.9	-9.8	860324	3.1	820226
I11	108	-0.6	2.2	-6.2	931217	6.5	820315
I12	135	-0.8	1.7	-6.6	900918	3.1	861103
I13	169	-0.6	4.9	-60	860921	6.6	890308
I14	107	0	2.6	-9.1	850709	6.6	890308
I15	113	0.2	1.9	-5.6	720928	6.4	920812
I16	61	0	2.1	-4.2	860903	6.2	850122

(continued)

Table 6-7
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
I17	111	-0.4	1.1	-4.3	930915	3.5	920211
I18	53	-0.1	2	-6.2	861104	4.2	831117
IH1	136	0	2.4	-7	720725	6.2	690918
IH2	3	0.9	0.4	0.3	820810	1.2	820810
IH3	31	0.2	2.3	-4.3	720725	5	720601
IH4	15	0.3	1.7	-4	840531	2.2	840213
IH5	168	-0.1	2.4	-9.5	731024	5.6	690918
IH6	130	0.6	2.1	-7.4	770127	6.4	700815
IH7	194	0.8	1.5	-6.3	720725	6.5	711111
INL	42	-0.7	1.2	-3.4	850923	1.4	780509
LAC	85	-0.5	1.6	-4.8	881220	2.9	760819
LB	59	-0.8	2.3	-11	861112	2.5	690901
LQ1	163	-0.6	1.5	-4.5	800909	6.4	810313
LQ2	147	-0.6	1.8	-11	870416	3.6	811118
LS1	22	-0.6	2.1	-5.8	930526	2.5	910809
LS2	227	-0.5	2	-8.3	930726	4.4	921120
M1	24	-0.4	1.8	-4.4	850409	3	920624
M2	72	-0.5	1.9	-8.5	880614	6.2	870615
MB1	185	-0.7	1.6	-12	900924	3.7	930409
MB2	215	-0.6	1.6	-7.4	831121	3.1	930409
NB1	175	-0.2	2.4	-8.6	880216	5.6	880121
NB2	81	-0.4	2.1	-7.3	900912	4.5	880121
NB3	82	-0.1	1.8	-8.6	900912	5.3	880324
NB4	295	-0.3	1.5	-5.2	861016	5.2	811027
NB5	643	-0.2	1.5	-8.5	721213	4.6	690915
NB6	386	0.1	1.3	-5.9	900912	8.1	770301
NB7	375	-0.1	1.8	-8.7	841114	8	770301
NB8	90	-0.1	1.6	-4.4	831018	3.9	880121
NB9	117	-1	2	-9.3	900918	3.3	880324
ND1	0						
ND2	30	-0.4	1.7	-4.2	890519	2	811112
ND3	0						
ND4	326	0.1	1.6	-6	940430	4.6	950731
NR1	74	0.5	1.8	-4.7	720726	7.1	700105
NR2	0						
NR3	48	0.2	2.3	-4.8	730418	3.8	731016
NR4	167	-1.4	2.8	-17	820917	6.2	880901
NR5	101	0	2	-7.1	701012	4.1	710505
OS1	71	-1.6	5.4	-18	750205	10	800211
OS2	0						
OS3	54	-0.6	2	-5.3	730518	8.3	740331
OS4	50	-1.3	2.1	-11	931216	2.5	880426
OS5	28	-1.7	1.8	-6.1	910816	1.3	920623
OS6	84	-0.6	1.9	-5.5	841030	3.5	930209
OS7	155	-1.1	1.9	-10	841031	3.6	931104

(continued)

Table 6-7
(continued)

Segmt	*No.of obs*	*Avg*	*Std devn*	*Min*	*date*	*Max*	*date*
PB1	158	-0.3	1.5	-6.1	930422	7.5	780523
PB2	180	-1.3	2.5	-10	771219	9.2	870226
RB1	134	-1.6	2.5	-9	830913	4.1	920707
RB2	93	-2	3.2	-16	861008	6.5	921009
RB3	180	-1.2	2.2	-9.2	880427	2.8	861118
RB4	142	-1.3	5.3	-60	830511	4	921007
RB5	279	-1.2	1.9	-8.6	840523	3.6	831230
RB6	120	-0.8	1.6	-9.8	860407	2.3	930608
RB7	96	-1.1	2.2	-12	810722	2.5	791207
RB8	259	-0.3	1.3	-7.6	881123	2.6	791227
RB9	137	-1.2	2.5	-10	810708	6.5	820202
SC1	165	0.1	1.6	-5.1	860423	4.1	700601
SC2	312	-0.6	2.4	-13	880816	4.7	690901
SC3	516	-0.5	2.3	-13	860708	7.6	870507
UL01	68	-0.9	2	-6.1	930520	3.9	910115
UL02	151	-0.8	2.3	-8.3	930520	6.1	890308
UL03	226	0.4	2.4	-6.7	930513	6.3	920921
UL04	81	-0.9	1.5	-4.9	841011	1.7	850501
UL05	104	-1.2	2.3	-9	920622	7.3	890308
UL06	150	0.5	2.1	-6.5	880223	5.8	890308
UL07	133	-0.6	1.8	-7.6	901002	3.4	840124
UL08	97	0.1	2.1	-4	811110	5.2	930525
UL09	104	-0.2	1.7	-4.5	901002	4.5	890308
UL10	117	-0.3	1.7	-3.5	690415	5.9	840308
UL11	30	0.3	2.3	-8.2	720928	5.7	850118
UL12	0						
UL13	0						
UL14	2	-2.3	2.2	-4.5	880802	0	0
GMI1	36	0.6	0.8	-0.9	931123	2.0	911127
GMI2	140	0.5	0.7	-0.9	880225	2.9	900921
GMI3	180	0.5	0.6	-0.9	880225	1.7	910926
GMI4	173	0.1	1.1	-7.7	800909	1.9	901121
GMI5	149	0.4	0.8	-3.9	900517	2.3	931122
GMI6	208	0.1	1.1	-3.8	910716	3.2	700305
GMI7	343	-0.3	1.3	-8.9	880714	2.3	850212
GMI8	164	-0.4	1.3	-7.1	880823	1.8	880926
GMI9	90	-0.9	2.1	-11.0	880823	0.6	921027
GMO1	0						
GMO2	2	-0.1	0.0	-0.2	801028	0.0	
GMO3	0						
GMO4	10	-0.4	1.2	-2.8	850416	1.0	891020
GMO5	47	-0.7	2.4	-14.0	920618	2.5	850213
GMO6	34	-0.3	1.0	-2.7	720919	1.3	780613
GMO7	75	-0.7	1.4	-5.5	920709	3.0	851002
GMO8	0						
GMO9	0						

Table 6-8
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQSAL, upper 1 meter

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	15.3	15.0	15.9	15.3	15.4	13.8	12.2	22.7	21.8	18.9	16.1	16.4
A2	15.2	16.5	18.4	16.5	11.8	17.7	15.2	21.3	18.1	18.0	16.2	14.4
A3	16.9	17.3	17.5	16.8	15.6	15.3	11.3	18.4	18.2	16.6	15.2	15.3
A4	18.0	19.9	18.3	14.9	17.4	21.3	24.4	22.8	24.4	22.1	17.6	16.7
A5	14.9	17.7	17.8	18.0	16.4	17.8	16.3	22.4	18.7	18.9	18.5	16.9
A6	17.6	18.0	17.7	22.1	17.8	18.8	16.5	23.7	22.6	20.4	20.3	18.7
A8	15.2	14.1	20.3	20.7	20.9	13.4	9.3	21.4	23.5	23.3	19.3	17.1
A9	11.8	19.7	25.0	13.3	23.2	18.3	26.3	32.0	24.8	17.4	21.9	19.3
A10	16.9	17.3	19.1	17.7	21.7	16.8	16.2	26.6	23.0	21.2	19.9	17.5
A11	19.9	18.5	21.3	22.5	21.3	19.0	25.6	29.3	29.0	25.0	21.7	20.7
A12	19.7	19.0	23.3	20.8	18.3	22.2	22.7	28.0	29.3	22.5	18.2	20.7
A13	20.3	17.6	23.5	23.0	24.6	24.0	25.4	29.1	31.1	26.1	22.9	23.1
AL1	29.0	34.7	35.3	37.6	38.2	26.4	30.8	48.7	51.0	44.2	40.5	37.4
AL2	41.9	31.2	38.5	36.5	39.1	29.1	31.3	39.3	39.0	42.7	37.1	40.4
AR1	11.4	11.7	9.6	10.9	13.3	10.9	9.0	9.6	11.5	13.2	11.0	10.4
AYB		19.5	19.4	20.0	16.5	25.0	23.8	28.2	25.9	19.8	21.1	18.2
BF1	33.6	38.7	37.3	35.0	35.5	36.3	30.7	42.2	39.3	38.6	39.4	33.9
BF2	39.9	36.2	39.4	38.7	36.5	36.0	31.8	40.4	43.8	38.4	40.6	35.8
BF3	37.3	38.1	37.8	37.5	35.8	36.0	35.8	38.6	45.0	37.6	41.4	38.5
C01	28.4	25.6	27.5	29.2	29.7	34.4	28.7	32.3	31.2	25.8	24.9	26.2
C02	29.5	27.1	30.1	28.4	30.1	37.8	27.3	32.1	32.6	28.0	27.8	28.1
C03	28.8	26.0	27.7	28.5	31.3	32.1	31.6	35.6	29.7	29.4	23.7	27.5
C04	29.7	30.7	28.8	29.2	27.1	25.8	31.0	23.8	20.3	21.5	27.9	32.6
C05	24.6	30.0	29.2	29.7	28.3	28.0	26.7	24.2	17.1	24.4	20.8	27.3
C06	25.8	29.6	29.3	28.5	31.0	29.3	28.9	31.6	24.3	21.9	24.4	25.0
C07	27.8	26.4	30.0	30.4	29.8	30.0	32.5	29.6	27.0	26.4	26.0	26.0
C08	29.3	31.4	31.7	31.8	29.2	29.5	31.3	31.8	32.8	33.3	27.6	30.6

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C09	29.0	27.7	28.7	30.3	30.5	30.3	31.9	32.6	31.5	31.9	28.1	28.8
C10	27.4	28.5	28.5	29.4	31.0	31.4	30.8	31.1	26.0	26.5	26.4	26.2
C11	28.2	27.2	28.1	28.1	29.3	29.4	32.0	29.6	23.6	25.7	24.3	26.9
C12	27.9	27.3	28.3	28.7	28.2	28.7	32.0	32.9	32.6	30.9	27.2	27.7
C13	24.0	27.0	32.4	25.2	31.0	29.0		31.5	27.7	28.1	28.0	29.5
C14	29.1	29.4	28.9	29.7	28.4	31.3	34.1	34.8	32.3	29.4	27.8	29.3
C15	27.7	27.7	27.5	28.2	26.9	24.2	23.2	26.4	20.8	23.1	23.0	25.3
C16		29.1		36.0	34.6	29.0			2.4	18.4	27.3	
C17	29.2	28.6	28.6	29.5	28.6	25.1	25.1	26.5	26.5	29.2	27.9	31.2
C18	32.1	32.8	31.0	33.8	27.7	26.6	26.2	35.0	30.7	29.1	33.1	30.9
C19	28.9	27.7	30.3	29.7	28.4	25.2	28.0	34.4	31.2	30.9	29.4	26.7
C20	25.7	27.6	29.5	30.9	28.2	25.0	29.2	32.1	28.7	26.6	25.7	25.9
C21	28.8	30.4	30.7	30.9	29.5	28.7	29.5	32.8	33.2	31.7	25.1	29.7
C22	26.4	30.0	28.0	29.7	27.1	29.6	28.2	29.4	29.7	24.4	24.3	27.6
C23	30.6	29.5	30.5	31.3	28.5	34.0		35.1	29.8	31.1	32.1	
C24	28.4	29.2	28.7	30.5	31.6	33.1	31.2	33.5	31.3	29.9	29.4	32.1
C25		27.4	29.0	28.9	28.3	35.6		33.5	30.8	31.0	33.2	29.2
CB	16.2	18.5	17.9	15.7	14.8	14.7	14.4	23.4	25.5	16.1	16.7	14.3
CBH				15.1	27.3				29.0	19.5		
CBY1			13.0				23.3			21.7		27.7
CBY2	23.3	24.2	26.5	24.5	23.6	24.2	30.1	33.5	34.2	29.6	25.9	30.3
CCC1	27.3	27.6	28.7	28.8	29.2	29.6	33.3	34.6	26.9	29.0	23.6	27.7
CCC2	27.1	29.1	28.2	29.3	28.9	27.7	26.1	35.3	31.8	29.7	28.5	27.3
CCC3	28.3	26.7	28.1	28.7	29.5	28.7	31.9	32.3	28.8	29.4	27.2	25.4
CCC4	29.4	27.3	26.2	27.3	26.5	25.2	28.9	35.0	28.3	30.4	30.9	27.9
CCC5	28.9	32.5	29.8	32.3	30.1	33.9	28.9	35.0	29.3	33.5	27.0	23.8
CCC6	29.7	28.9	29.6	28.9	29.4	27.4	27.2	31.2	28.9	30.6	31.3	28.3

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC7	28.4	30.3	28.4	30.0	29.4	24.9	28.1	20.3	24.6	27.9	24.3	29.4
CCC8	27.8	28.0	29.7	26.5	28.2	35.0	26.7	31.2	31.7	28.9	27.2	27.4
CP01	22.0			10.5	18.8	21.7			17.2	19.0	13.0	13.2
CP02	18.4	16.4	16.1	17.4	13.9	13.2	15.0	14.2	19.5	15.1	13.9	14.9
CP03	13.9	12.9	14.5	12.7	14.5	12.1	8.1	13.1	11.6	15.2	10.0	14.3
CP04	17.4	15.8	15.4	14.4	15.5	13.2	13.8	18.6	16.5	15.9	14.3	17.1
CP05	14.5	13.8	15.4	14.0	12.5	11.3	10.3	16.0	11.6	13.6	12.4	10.7
CP06	18.4	22.4	14.1	17.1	15.1	17.1	13.2	17.1	19.1	19.2	12.7	19.7
CP07	12.8	12.9	14.0	18.8	11.3	15.8	9.7	9.6	12.4	10.1	9.0	14.7
CP08	17.1	17.3	14.4	15.8	14.2	13.3	12.9	12.9	18.1	14.7	15.6	14.0
CP09	12.7	13.6	12.8	13.4	12.1	13.4	11.1	12.8	14.9	11.5	11.0	16.0
CP10	14.6	14.6	15.0	15.5	14.3	13.9	12.2	17.1	15.1	16.0	11.7	16.5
EF	29.0	28.6	30.8	26.7	30.5	31.5	31.2	37.3	33.4	30.1	33.1	28.8
GR1			41.5	49.5	26.5					53.5		
GR2	44.7	32.3	33.0	40.4	39.2	28.0	29.0	32.2	40.6	39.7	33.7	37.3
HI1	26.8	24.8	29.9	25.6	26.7	35.5	34.4	33.3	23.5	24.0	22.8	20.5
HI2	27.8	25.1	30.3	26.7	22.8	31.5	30.0	34.5	27.8	26.8	29.8	28.3
I1	12.8	14.1	11.0	13.3						18.5	19.2	8.4
I2	17.9	20.0	19.9	17.9	16.0	13.3	27.6	26.3	17.8	22.2	18.7	17.2
I3	18.4	15.6	19.8	18.4	15.3	13.6	16.7	19.2	20.9	15.3	13.6	13.8
I4	15.3	17.4	17.1	17.7	19.4	17.9	15.8	23.9	25.7	22.0	19.6	15.1
I5	20.3	21.0	21.5	18.7	16.0	18.4	18.1	25.3	28.8	22.0	17.2	14.2
I6	17.5	19.3	20.7	19.6	20.8	20.5	26.6	28.4	22.2	22.6	20.4	18.3
I7	21.0	21.6	24.9	23.7	20.6	23.6	28.0	28.9	28.0	22.2	22.2	21.5
I8	26.5	22.9	28.3	28.0	22.5	29.5	34.1	33.8	33.1	26.5	27.8	26.3
I9	29.6	27.2	28.5	28.9	32.4	35.2	36.8	34.7	30.2	29.5	23.1	27.7
I10	22.2	26.3	29.1	31.7	32.6	33.7	35.3	34.0	35.0	29.7	26.9	25.6

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I11	26.9	28.8	27.4	33.6	37.5	34.3	37.4	37.1	37.3	34.9	31.8	33.0
I12	30.6	33.7	30.0	35.4	34.0	41.2	33.8	33.1	37.5	36.9	37.5	38.1
I13	32.2	33.9	34.2	38.7	38.3	38.4	38.5	44.2	43.3	36.0	38.6	36.8
I14	32.2	36.5	41.1	30.7	38.7	42.0	37.5	38.0	41.6	42.8	38.3	40.1
I15	33.9	38.1	33.6	35.2	33.1	35.8	34.1	40.9	38.0	39.9	39.4	36.0
I16	40.7	32.2	31.5	38.2	38.8	33.2	40.8	41.6	38.1	40.2	46.2	36.1
I17	31.7	36.8	35.9	35.9	35.1	31.4	34.1	34.3	38.0	37.8	38.0	40.1
I18	37.0	34.3	35.9	36.9	39.2	35.3	44.0	46.6	45.1	41.8	41.3	38.4
IH1	28.2	28.2	30.9	29.1	26.3	23.8	25.5	32.7	30.0	27.7	24.0	27.6
IH2								35.1				
IH3		28.3	20.9	24.6		21.3	26.3	35.0		20.9	29.0	
IH4	37.2	20.3		27.2	31.9	20.0	25.5	37.7		25.0		
IH5	28.3	27.6	28.2	27.5	27.1	22.8	24.9	33.1	27.8	27.3	27.1	25.8
IH6	26.6	28.8	28.4	26.2	27.6	28.9	26.7	32.7	31.2	30.6	27.7	27.7
IH7	28.6	24.5	27.7	26.3	27.9	26.9	26.1	34.3	27.5	23.9	19.2	22.7
INL		33.4	28.6		22.3	28.2	34.3	34.0	29.7	28.0	31.8	26.3
LAC	23.7	21.3	24.9	25.4	25.4	28.3	30.7	31.1	22.0	26.3	21.7	24.9
LB	23.0	20.7	22.0	20.7	17.3	19.4	21.0	27.3	22.2	21.2	21.3	23.9
LQ1	29.0	27.7	28.1	28.7	29.1	28.5	30.0	32.1	31.8	30.3	27.4	28.1
LQ2	27.6	31.0	29.1	28.1	30.0	26.5	28.1	30.3	34.4	31.5	29.4	29.4
LS1	24.7	33.1	32.7	38.1	32.5	42.6	31.4	55.9	35.3	36.6	54.0	38.9
LS2	36,9	38.1	41.9	36.5	34.6	36.4	23.8	42.2	30.2	37.8	37.3	38.9
M1					15.3	7.2			22.0	19.5	12.9	12.5
M2	23.5	13.2	7.3	14.4	12.8	17.2	11.5	14.5	20.2	17.3	18.2	12.8
MB1	16.8	17.4	16.4	17.0	17.1	15.5	18.9	23.4	23.6	17.5	19.2	15.7
MB2	16.1	17.5	14.4	18.8	20.0	18.2	25.7	26.7	24.2	20.8	20.5	17.1
NB1	21.4	21.7	22.4	27.5	25.1	20.8	28.9	32.5	25.5	25.5	19.0	28.1

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB2	26.4	23.4	26.5	31.4	23.6	17.1	20.9	24.3	25.2	24.9	20.1	25.5
NB3	22.3	31.4	26.6	25.9	29.9	23.6	20.1	25.0	27.0	22.0	28.8	
NB4	25.6	25.1	26.1	25.2	31.4	19.1	28.9	23.9	20.8	25.9	26.0	26.1
NB5	24.7	28.2	26.0	28.2	28.5	18.7	26.7	22.4	18.5	25.3	24.1	27.0
NB6	24.5	24.9	26.1	26.6	25.7	20.6	22.4	18.3	26.8	20.8	23.5	23.9
NB7	24.6	25.0	26.9	25.1	25.1	22.5	22.5	27.7	28.4	27.2	25.1	28.5
NB8	25.8	26.7	26.1	28.7	24.8	21.9	28.9	28.5	29.9	25.2	27.4	29.4
NB9	26.6	27.4	26.4	27.0	23.3	17.1	25.4	25.6	28.5	30.8	26.9	28.4
ND2	23.0				20.8		6.5	16.5	22.0	23.0	15.4	
ND4	23.8	20.7	21.1	21.1	15.4	15.0	17.6	23.9	23.2	22.0	25.8	21.6
NR1	0.8	1.8	0.7	0.9	0.7	0.4	2.7	0.9	0.4	0.4	0.3	0.5
NR3	2.9		5.9	6.9	20.2	0.8	0.9	1.0		5.6	3.1	
NR4	7.2	13.3	12.4	16.7	12.2	9.6	12.9	9.6	9.4	8.6	9.5	8.7
NR5	10.4	17.8	22.2	18.9	22.3	5.6	4.7	0.8	3.7	4.9	6.4	7.4
OS1	6.8	5.1	10.8	6.9	3.8	1.2	6.0	1.5	2.3	4.3	2.2	4.3
OS3	19.9	19.2	24.1	35.9	25.1	6.0	26.4	24.8	23.0	18.1	24.4	16.8
OS4	28.5	30.3	31.0	31.3	22.5	33.2	30.2	30.5	29.4	42.8	37.2	33.8
OS5	33.7		22.5	31.7			44.3	45.5		36.3	39.7	33.9
OS6	23.6	26.1	23.3	30.9	33.6	26.4	31.8	37.0	35.6	34.1	27.3	36.9
OS7	28.6	27.9	28.9	30.9	27.1	28.7	34.4	32.7	31.9	30.9	29.2	30.0
PB1	10.9	16.1	10.2	14.2	13.9	15.5	6.2	16.9	9.3	12.0	10.4	12.0
PB2	11.8	11.3	15.3	16.9	15.1	13.2	11.8	17.8	13.5	15.6	14.0	17.1
RB1	21.9	21.1	19.5	25.4	19.4	19.6	19.5	32.7	25.2	24.7	21.4	24.0
RB2	21.8	18.8	24.8	27.5	21.8	19.6	20.4	33.0	31.3	28.6	26.5	
RB3	23.9	24.9	23.8	25.9	25.1	24.0	26.9	31.5	25.0	24.7	23.8	25.2
RB4	25.5	23.7	23.7	26.1	24.9	22.2	25.1	29.7	29.0	27.3	26.6	27.3
RB5	25.4	27.0	24.6	28.2	25.8	28.3	28.1	33.0	29.5	27.8	27.3	28.4

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
RB6	24.5	23.6	24.7	24.0	29.0	26.7	30.4	32.4	30.3	24.0	23.4	22.3
RB7	29.4	27.0	25.9	28.7	26.5	26.3	30.4	30.7	32.2	30.3	29.6	30.1
RB8	22.8	25.8	26.5	25.3	25.6	25.5	28.6	32.6	25.6	25.0	23.0	25.5
RB9	29.2	28.8	28.8	29.6	27.9	28.4	28.9	26.6	27.7	29.5	28.0	31.0
SC1	11.6	12.1	9.4	14.3	9.2	10.4	9.2	11.8	14.7	10.5	11.0	5.0
SC2	13.0	11.6	14.4	15.0	13.8	9.7	9.1	12.9	16.9	14.0	11.9	13.6
SC3	13.3	14.8	15.5	15.1	13.3	15.6	14.2	19.3	16.9	16.6	14.5	12.3
UL01	32.0	28.8	33.5	32.7	31.1	34.3	43.9	40.0	34.3	36.4	32.9	30.2
UL02	29.6	29.2	30.2	32.1	32.6	30.9	35.4	38.7	36.2	33.9	33.6	32.5
UL03	32.2	30.6	32.6	34.8	37.1	37.3	39.0	42.7	39.0	36.0	34.6	33.0
UL04	29.6	31.4	30.9	31.8	31.3	40.3	33.6	29.3	35.3	35.6	32.4	42.4
UL05	32.5	28.6		34.9	34.3	33.2	35.8	41.7	38.6	35.9	35.3	33.9
UL06	31.8	31.9	32.4	37.9	37.6	38.0	41.6	42.5	41.1	35.9	37.1	34.7
UL07	30.1	31.4	35.1	33.9	38.5	41.2	37.2	43.6	42.9	35.0	36.0	31.8
UL08	34.1	32.4	29.3	35.4	34.7	38.7	35.2	37.9	44.4	38.6	35.6	38.7
UL09	33.8		35.1	35.9	34.7	32.5	39.5	40.2	40.4	39.9	33.3	33.8
UL10	33.4	32.8	36.5	37.2	41.6	37.8	36.6	47.9	42.0	38.9	40.2	38.3
UL11			30.7	39.0	34.8	37.2	34.2	35.6	44.9	32.9		33.0
GMI1	33.0				27.5	33.9	34.5	36.0	33.6	33.5	30.3	
GMI2	33.5	31.5	33.3	31.7	29.0	32.8	35.9	36.4	30.4	31.7	31.0	33.5
GMI3	31.3	31.5	33.0	30.5	28.8	34.6	36.0	35.6	34.8	32.8	32.3	34.3
GMI4	29.0	31.0	31.0	28.1	27.7	33.0	37.3	35.0	33.2	32.4	30.1	31.8
GMI5	31.2	28.6	30.4	34.0	29.1	25.8	35.9	35.9	34.8	32.5	31.2	35.0
GMI6	28.5	28.9	28.8	25.7	25.5	31.6	34.8	33.0	31.1	30.2	31.2	25.8
GMI7	29.4	30.9	31.2	30.1	30.1	30.9	35.6	35.4	32.3	31.8	31.3	32.7
GMI8	28.4	31.5	27.1	31.8	26.5	30.0	34.9	35.7	32.0	31.8	30.8	30.7
GMI9	30.5	34.5	33.3	32.0	25.1	27.0	36.0	33.8	33.7	31.3	29.6	34.4

(continued)

Table 6-8
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
GMO4		29.0								33.0	32.0	
GMO5	29.3	30.9	27.3					38.3	30.5	30.3	32.5	32.7
GMO6		28.7	28.5	25.5		30.2			31.7	30.3	31.5	31.0
GMO7	28.0	30.4	29.1	30.4	33.0		38.0	34.5	35.0	30.1	31.5	32.9
Aransas Bay	22.1	23.1	24.7	23.0	23.9	23.1	23.8	29.0	28.3	26.6	25.2	23.9
Copano Bay	15.5	15.5	14.6	15.5	13.7	13.7	11.8	14.6	15.4	14.6	12.3	15.3
St Charles	13.2	13.2	14.9	15.1	13.6	12.6	11.7	16.1	16.9	15.3	13.2	12.9
Mesquite	16.4	18.2	17.0	17.9	17.1	18.4	20.7	25.4	24.8	18.6	19.3	16.3
Redfish	25.3	24.9	25.4	26.9	25.8	25.1	27.3	31.2	28.8	27.2	26.0	27.1
Corpus Christi	28.1	28.7	29.5	30.0	29.4	29.6	29.5	31.2	26.8	27.1	26.7	28.2
CCSC (bay)	29.0	29.1	28.4	29.4	29.0	28.0	29.0	30.7	28.0	30.4	28.2	27.0
Inner Harbor	29.8	26.3	27.2	26.8	28.2	23.9	25.9	34.4	29.1	25.9	25.4	25.9
Nueces Bay	25.0	27.0	26.3	27.9	27.6	20.1	25.1	24.8	24.3	24.6	25.3	27.0
Aransas Pass	25.9	26.8	28.0	26.6	25.9	30.4	33.2	33.2	25.5	26.8	25.0	24.8
Causeway N	29.0	27.9	28.7	29.4	30.8	34.6	34.0	33.9	30.8	30.2	28.5	29.6
Causeway S	28.3	28.9	30.9	32.1	31.9	34.8	37.0	35.5	35.2	33.9	31.4	32.7
Laguna (King)	32.0	32.6	33.2	35.6	36.5	37.5	37.0	40.4	40.8	37.2	36.5	35.5
Laguna (Baffin)	36.4	34.5	34.5	37.0	37.7	33.3	39.6	40.8	40.4	39.9	41.8	38.2
Baffin Bay	39.5	35.3	37.2	37.6	37.2	33.1	31.7	38.5	41.5	39.4	38.4	37.2
GOM inlet	29.3	29.7	29.2	29.1	29.4	29.6	36.1	35.4	32.6	30.8	31.5	31.7

Table 6-9
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQTEMP, upper 1 metre

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	14.3	14.4	18.1	22.3	25.4	28.9	29.4	29.2	28.5	23.7	18.5	14.9
A2	12.8	14.0	19.1	21.6	26.5	28.9	29.6	29.2	28.3	23.5	18.7	14.1
A3	14.2	14.4	18.4	22.4	25.9	28.7	29.6	29.2	28.1	24.1	18.2	16.1
A4	13.2	14.4	17.3	22.3	25.8	28.9	29.7	29.7	27.3	23.7	18.5	14.7
A5	14.3	15.6	19.8	22.3	27.0	27.9	30.0	30.1	28.3	23.8	18.1	16.0
A6	13.6	15.9	18.6	23.0	27.2	28.3	28.9	30.9	28.4	24.5	19.2	17.2
A8	13.2	14.3	19.3	23.7	26.8	29.1	28.7	29.9	27.7	23.9	18.0	15.7
A9	9.6	18.7	18.2	23.1	26.6	29.5	30.4	27.9	28.2	24.0	20.0	13.5
A10	13.6	15.1	18.8	22.3	26.8	29.3	29.1	29.9	27.8	24.1	18.4	15.5
A11	11.3	15.5	19.1	21.7	26.4	28.4	29.6	30.0	28.7	24.2	19.8	15.8
A12	13.3	13.3	18.4	22.5	25.9	29.2	28.9	29.1	28.7	24.3	19.7	15.1
A13	15.9	15.2	18.1	24.3	27.3	29.3	30.1	30.7	28.0	24.8	18.7	15.1
AL1	15.7	18.0	21.2	25.7	28.6	29.6	30.6	29.9	29.3	27.2	21.0	15.9
AL2	16.3	15.5	20.5	25.8	27.3	29.6	29.5	29.4	28.8	25.9	21.9	19.3
AR1	15.3	16.1	22.8	23.4	26.6	28.4	30.3	29.5	26.7	22.8	18.7	12.5
AYB		14.2	19.0	21.1	25.5	27.5	28.9	29.4	27.7	22.3	16.5	15.7
BF1	13.4	17.8	19.2	24.0	26.2	29.1	29.9	29.8	28.2	24.5	21.2	17.1
BF2	12.8	17.4	19.9	23.3	26.4	29.5	29.1	30.3	28.6	25.2	20.8	18.0
BF3	12.8	17.4	20.6	23.5	26.7	29.6	30.0	29.8	28.2	24.1	21.5	16.0
C01	13.7	15.6	18.9	23.1	25.4	28.3	30.0	29.5	27.2	24.9	20.5	16.0
C02	12.7	16.0	18.1	23.0	25.3	28.6	29.9	29.5	27.2	24.5	20.3	15.6
C03	12.7	15.8	19.6	23.0	25.4	28.2	29.8	30.0	27.4	24.6	19.6	16.0
C04	14.4	15.0	20.5	22.7	26.3	28.8	30.2	30.3	28.3	25.2	19.6	16.2
C05	15.3	13.7	21.2	21.2	25.4	28.6	29.8	29.9	28.5	24.3	20.3	15.1
C06	16.1	13.5	19.4	21.9	25.3	28.8	29.3	30.6	27.9	24.4	19.1	16.5
C07	11.8	15.1	19.5	21.2	25.4	28.2	29.5	29.6	27.7	24.8	19.9	15.5
C08	12.6	14.8	19.1	23.0	27.2	29.4	30.2	30.2	29.1	25.0	21.1	15.2

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C09	14.1	15.3	19.4	23.3	26.3	29.5	30.4	30.3	28.6	25.6	20.4	16.8
C10	13.1	14.3	18.7	22.4	25.4	27.9	29.5	29.1	28.1	24.0	19.6	15.0
C11	13.0	14.0	19.8	22.3	25.4	28.9	29.3	29.1	27.7	24.5	20.2	14.7
C12	13.1	14.6	18.9	23.0	26.0	28.6	29.8	30.4	28.7	25.2	20.2	15.8
C13	13.5	11.3	19.9	24.5	25.4	30.1		29.5	28.1	25.2	18.9	12.9
C14	14.3	14.9	18.6	22.4	26.1	28.8	29.7	30.5	27.6	24.7	20.1	16.2
C15	14.0	15.4	19.1	23.0	25.9	28.5	29.5	29.9	27.8	24.7	19.0	15.9
C16						27.0			25.5	24.8	15.5	
C17	14.2	15.0	20.2	22.6	26.5	28.6	30.0	30.2	27.9	24.9	20.7	17.2
C18	12.2	15.8	18.5	24.2	27.7	28.5	30.3	31.4	29.2	25.0	20.4	16.3
C19	14.3	15.7	18.1	24.9	25.5	30.8	29.8	30.0	27.4	24.0	20.9	15.4
C20	13.8	15.3	18.6	21.8	25.1	28.0	30.2	29.8	27.4	25.0	18.9	17.4
C21	13.4	15.3	19.6	23.3	26.1	29.0	29.9	30.2	27.7	24.0	20.0	15.9
C22	8.5	13.8	20.9	20.3	25.9	27.4	29.4	29.3	27.6	24.4	18.7	13.5
C23	15.3	14.1	19.6	22.3	26.3	28.3		29.9	28.2	25.2	18.3	
C24	14.8	17.2	19.5	24.1	27.2	29.5	30.2	30.0	27.5	24.8	19.4	17.3
C25		16.2	20.3	23.3	25.9	29.7		30.5	27.5	26.0	20.3	14.8
CB	16.4	15.8	18.8	21.8	25.2	28.2	29.5	29.3	28.0	24.4	18.8	15.5
CBH				25.3	25.6	29.4			30.5	27.4		
CBY1			16.9				29.5			20.7		15.0
CBY2	15.0	12.9	14.2	18.8	26.2	28.8	29.6	30.6	30.4	24.5	21.9	19.1
CCC1	14.1	14.3	17.9	21.8	25.1	28.7	28.7	28.5	27.7	25.1	20.6	17.8
CCC2	11.8	14.9	18.2	19.5	25.0	29.1	29.2	29.2	28.7	24.0	17.6	15.0
CCC3	13.4	15.3	18.3	23.0	26.0	28.8	29.6	29.8	27.8	25.5	20.2	17.2
CCC4	13.3	16.1	18.3	21.6	24.4	28.8	30.0	31.9	27.7	25.1	19.4	16.3
CCC5	10.7	12.4	19.0	18.8	25.5	28.2	29.0	29.8	28.0	24.3	19.5	14.5
CCC6	12.4	14.4	18.3	22.7	25.1	28.3	29.2	29.4	28.3	24.2	19.5	14.7
CCC7	12.0	12.7	18.2	19.8	25.5	28.3	29.5	30.0	28.4	24.5	19.8	17.6

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC8	13.6	15.4	19.3	23.2	25.2	28.7	29.9	29.4	27.8	24.9	20.2	17.5
CP01	17.9			23.7	28.0	29.6			29.0	26.0	19.2	12.0
CP02	14.1	15.9	18.0	22.9	25.9	28.6	30.0	29.6	28.0	24.8	19.0	14.8
CP03	14.2	15.8	18.3	23.1	26.9	28.9	29.3	30.6	27.6	23.5	19.4	14.3
CP04	14.8	15.1	18.4	23.3	25.8	29.0	30.0	29.9	29.0	23.7	18.8	15.7
CP05	13.7	15.9	18.1	22.2	25.7	28.5	29.4	29.1	28.2	23.3	19.8	13.5
CP06	15.0	14.2	17.7	23.8	27.4	28.4	30.0	29.0	28.7	21.6	19.9	13.7
CP07	13.7	14.7	19.7	21.8	25.2	28.7	29.5	29.0	29.4	24.1	19.3	13.6
CP08	14.8	15.2	18.7	23.1	26.1	28.1	30.0	29.3	27.4	24.2	21.0	16.2
CP09	14.1	15.6	18.9	22.0	25.8	28.6	28.9	29.0	28.3	23.7	19.2	13.1
CP10	14.3	14.7	18.4	22.6	26.5	28.7	29.7	29.9	28.5	23.9	19.6	14.8
EF	12.7	15.2	19.9	24.4	26.7	30.7	29.3	31.4	30.0	24.1	21.4	15.5
GR1			26.5	29.5	27.9					29.4		
GR2	16.2	19.5	18.5	26.2	27.8	29.9	30.0	31.4	29.0	26.1	20.6	20.7
HI1	14.5	15.4	17.7	23.5	24.8	27.4	29.3	29.7	27.9	25.4	17.9	14.3
HI2	15.9	15.5	18.1	23.0	25.9	29.8	29.4	31.4	28.1	25.2	21.7	14.8
I1				23.7								
I2	12.2	13.1	20.2	23.9	26.4	28.8	29.7	29.4	28.5	24.4	20.7	15.6
I3	13.1	15.0	20.1	22.1	26.6	28.3	29.0	28.7	29.0	25.3	20.6	13.3
I4	13.4	14.1	17.9	23.3	26.0	28.1	29.5	29.5	28.1	23.8	18.2	15.0
I5	14.8	13.3	14.3	22.3	26.6	28.8	29.5	28.4	29.4	22.9	20.9	13.7
I6	12.9	14.6	18.1	23.4	25.0	28.7	29.0	30.2	27.7	24.0	17.8	15.9
I7	13.8	13.8	17.9	22.8	26.3	28.5	29.3	29.5	29.1	23.9	20.4	16.1
I8	13.5	14.0	16.8	20.8	26.1	28.4	29.4	28.9	29.2	25.2	19.6	15.9
I9	14.1	14.9	19.1	23.0	26.2	29.6	29.3	29.5	26.8	24.5	18.4	17.3
I10	14.2	14.9	19.8	24.1	25.5	29.2	30.6	30.5	29.0	25.4	21.2	13.9
I11	18.2	16.0	21.1	24.1	26.8	28.8	30.7	30.9	29.5	24.6	18.1	16.0
I12	13.5	17.6	20.9	23.5	25.8	30.4	29.3	29.9	28.7	25.1	21.7	20.4

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I13	13.0	17.1	19.4	22.6	26.6	29.6	30.3	30.3	29.1	24.7	20.7	14.6
I14	12.8	19.4	17.5	25.0	27.3	30.1	31.1	31.2	29.4	26.6	21.6	16.8
I15	12.3	17.1	20.3	23.6	27.2	29.3	29.9	29.8	29.3	24.8	21.1	16.3
I16	11.7	18.6	22.8	22.7	28.3	31.1	30.8	32.7	28.2	24.2	21.0	12.8
I17	12.7	18.1	21.1	23.4	26.2	29.8	29.9	29.8	28.7	24.4	21.5	16.4
I18	13.2	15.9	18.6	24.2	26.3	29.6	30.0	29.9	29.7	23.7	20.9	14.6
IH1	14.0	15.5	19.4	22.3	26.1	29.2	29.6	29.9	28.6	25.6	22.9	15.8
IH2								28.8				
IH3		12.2	26.5	22.0		28.5	30.0	28.7		26.2	20.2	
IH4	9.7				26.0	30.7	29.7	28.4		29.7		
IH5	13.3	15.8	20.8	23.6	26.3	29.5	29.9	29.7	28.5	25.5	21.9	16.3
IH6	14.2	15.7	17.3	23.9	25.0	28.6	29.9	29.7	28.8	25.5	21.8	18.2
IH7	13.7	14.3	20.0	23.6	26.2	28.6	29.9	29.3	28.5	25.5	21.0	17.2
INL		15.5	16.5		24.3	29.5	30.1	30.0	29.2	23.5	22.2	15.2
LAC	13.3	13.3	16.7	20.6	25.7	27.8	30.1	29.9	27.8	24.4	20.6	16.6
LB	14.4	16.1	19.4	23.5	26.4	27.3	29.4	29.6	29.1	23.7	18.5	12.2
LQ1	13.7	15.2	18.9	23.6	26.5	29.1	29.9	30.4	28.7	24.4	20.2	16.5
LQ2	14.5	15.3	19.3	24.0	25.7	28.8	28.9	30.5	28.0	24.9	20.1	15.4
LS1	12.3	20.0	21.3	25.1	26.5	28.2	29.9	29.3	28.2	24.2	17.8	16.3
LS2	14.6	17.3	21.8	24.7	27.4	30.3	29.3	30.1	30.0	24.2	19.8	18.1
M1					27.8	30.2			29.2	26.5	23.6	14.2
M2	14.6	17.0	19.4	19.6	26.8	29.4	29.4	31.5	28.8	23.5	20.1	12.8
MB1	14.1	14.5	16.9	22.0	25.9	28.8	29.6	29.1	27.8	22.8	19.3	14.4
MB2	12.7	14.7	16.5	22.6	25.6	28.3	29.4	29.6	27.1	22.7	19.1	14.8
NB1	13.4	16.6	20.9	21.1	25.9	28.8	29.1	29.1	27.4	22.8	21.8	16.9
NB2	13.1	16.6	20.7	23.4	26.0	29.2	27.6	29.1	28.4	24.1	20.2	16.1
NB3	11.4	16.5	16.9	21.6	25.9	29.4	29.4	28.7	27.2	23.8	19.5	
NB4	12.6	15.7	18.1	22.9	26.2	29.5	28.5	29.1	26.3	23.1	19.3	19.2

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB5	14.0	15.6	19.6	20.7	25.8	28.9	28.9	29.1	27.7	23.6	18.8	18.2
NB6	13.7	15.3	21.5	22.9	26.1	29.1	32.0	29.3	29.4	24.9	20.1	15.2
NB7	13.9	16.7	20.4	23.2	26.1	29.1	31.1	29.1	29.2	24.8	19.7	16.4
NB8	14.1	15.9	20.1	23.1	26.9	29.1	29.3	30.1	28.3	25.0	20.4	16.5
NB9	13.2	16.1	20.6	22.0	26.2	29.1	28.7	29.6	29.1	24.9	19.5	14.7
ND2	17.0				25.8		29.7	28.6	21.8	25.3	19.8	
ND4	17.8	17.1	19.1	23.6	26.6	30.1	28.7	28.5	26.5	24.3	15.7	15.4
NR1	14.3	16.1	21.5	24.9	26.8	30.6	31.8	30.4	30.3	25.4	20.6	17.1
NR3	21.7		22.7	22.7	25.4	29.3	31.4	28.2		24.3	20.5	
NR4	15.0	17.2	21.4	23.4	27.2	29.8	29.5	29.7	28.3	25.8	20.0	15.5
NR5	17.4	14.8	25.4	22.4	26.6	28.8	30.3	28.5	27.9	23.3	18.9	12.5
OS1	14.7	16.5	19.9	24.3	28.6	28.5	29.8	30.6	29.5	24.8	20.1	17.0
OS3	13.9	14.7	22.9	27.2	28.7	32.4	29.8	29.3	29.6	26.7	18.8	17.6
OS4	12.3	19.4	22.5	25.3	29.0	32.7	32.2	29.4	30.5	26.1	20.8	15.5
OS5	17.6		23.2	27.9			35.9	29.0		27.5	18.9	17.3
OS6	10.6	18.5	22.4	24.5	27.9	30.4	30.4	30.4	28.1	25.7	18.2	16.9
OS7	14.7	15.5	22.0	24.4	27.5	29.7	31.0	29.9	28.9	26.2	20.9	16.5
PB1	13.5	17.2	21.3	23.5	27.0	28.4	29.3	28.8	27.6	24.4	18.9	18.0
PB2	15.8	15.0	21.1	24.7	26.8	29.0	29.9	28.9	28.4	25.1	18.5	16.6
RB1	16.0	15.0	18.0	24.9	26.2	29.5	30.0	31.5	30.5	23.5	21.0	17.1
RB2	17.0	12.3	20.8	27.6	27.5	30.2	29.4	30.0	28.3	23.7	21.8	
RB3	13.6	16.6	20.4	24.8	26.5	28.8	30.6	30.7	29.4	25.2	21.0	19.1
RB4	12.7	14.8	17.5	23.2	26.9	29.2	30.3	29.8	28.5	26.3	19.3	17.1
RB5	12.5	16.1	19.3	22.3	26.0	29.0	29.1	29.8	27.6	26.4	20.0	15.2
RB6	10.6	14.8	22.0	21.8	26.4	28.3	30.4	30.8	28.4	24.7	20.2	13.1
RB7	13.9	15.6	18.2	23.5	27.0	29.5	31.0	30.2	29.1	25.6	21.9	16.6
RB8	13.2	14.3	19.1	22.9	25.2	29.0	29.8	29.5	28.1	25.1	20.2	16.0
RB9	13.2	15.6	18.6	23.5	27.2	29.5	30.4	31.0	29.0	25.1	19.9	16.6

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
SC1	13.3	15.7	16.4	22.7	26.2	28.1	29.8	30.3	28.4	24.7	22.3	15.4
SC2	13.7	14.6	19.0	22.6	27.6	27.7	30.4	29.3	29.1	23.9	20.5	15.8
SC3	13.5	15.4	18.8	23.0	26.7	28.0	29.4	29.3	28.7	24.2	20.4	15.6
UL01	13.8	17.3	20.6	24.6	26.6	29.0	31.2	32.1	30.3	26.5	20.3	12.8
UL02	13.5	14.9	20.1	24.3	26.8	29.4	30.9	30.2	29.8	26.0	19.8	19.6
UL03	13.4	14.8	18.9	23.0	26.7	29.4	30.3	29.8	29.5	23.9	19.7	15.0
UL04	13.1	18.4	18.5	23.5	25.5	29.5	29.9	30.5	28.0	25.1	21.5	17.5
UL05	14.2	16.0		24.8	26.9	31.0	31.2	31.1	29.7	23.3	19.8	15.0
UL06	11.9	15.3	19.8	23.6	26.4	29.2	30.2	29.5	28.9	25.7	20.8	16.6
UL07	14.5	16.7	20.2	24.2	27.1	29.9	30.7	30.5	29.2	25.7	20.0	14.2
UL08	11.6	20.1	20.0	24.4	27.2	30.2	32.3	30.9	30.1	25.0	20.1	19.0
UL09	14.6		18.6	23.2	27.3	30.3	29.9	30.5	28.9	26.3	20.8	18.7
UL10	11.9	16.9	18.7	24.3	27.0	30.6	30.1	30.3	28.7	25.7	20.6	16.3
UL11			19.2	24.5	28.9	29.5	29.7	30.6	29.6	24.2		14.7
GMI1	20.2				24.4	28.6	27.3	30.2	26.9	23.4	19.8	
GMI2	19.7	13.7	19.4	22.3	24.7	28.0	28.9	29.1	26.5	24.2	20.8	18.3
GMI3	18.4	13.7	18.7	22.5	25.6	29.4	28.0	29.2	28.1	25.3	21.1	16.4
GMI4	13.3	14.8	18.0	24.0	25.6	29.4	29.7	30.1	29.2	25.9	20.2	17.8
GMI5	15.1	14.6	16.6	25.9	25.4	27.8	29.4	29.1	28.3	25.7	20.9	14.8
GMI6	13.5	14.1	17.8	21.3	24.7	27.6	29.1	29.5	28.2	26.1	22.1	16.8
GMI7	14.8	14.8	17.4	21.0	24.8	28.9	29.5	29.4	27.3	25.4	20.8	15.2
GMI8	14.3	14.6	16.6	24.7	27.7	29.3	29.9	30.5	27.7	24.0	18.8	15.9
GMI9	15.4	16.2	18.4	22.4	25.6	29.7	30.5	31.4	28.0	23.3	19.0	19.1
GMO4		15.4								24.1	18.3	
GMO5	15.6	14.6	18.9					28.6	28.6	23.5	20.7	13.5
GMO6		13.6	17.0	21.3		26.7			28.8	24.8	21.9	18.9
GMO7	15.3	12.6	15.2	19.0	22.3		33.9	26.3	29.8	24.9	23.0	19.0

(continued)

Table 6-9
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	12.7	15.9	19.1	22.8	26.5	29.3	29.7	29.8	28.4	24.3	19.6	15.2
Copano Bay	14.3	15.2	18.5	22.8	26.1	28.6	29.6	29.5	28.3	23.6	19.6	14.4
St Charles	13.6	15.0	18.9	22.8	27.1	27.8	29.9	29.3	28.9	24.1	20.4	15.7
Mesquite	14.4	14.8	17.8	21.9	25.5	28.2	29.3	29.4	27.6	23.1	18.4	15.1
Redfish	13.3	15.0	19.5	23.7	26.6	29.2	30.1	30.2	28.5	25.3	20.5	16.2
Corpus Christi	13.4	14.7	19.4	22.6	25.9	28.6	29.8	29.9	27.8	24.7	19.6	15.6
CCSC (bay)	12.3	14.2	18.4	21.2	25.3	28.5	29.5	30.2	28.1	24.7	19.7	16.0
Inner Harbor	13.0	14.7	20.8	23.1	25.9	29.2	29.8	29.2	28.6	26.3	21.6	16.9
Nueces Bay	13.0	16.1	19.1	22.3	26.2	29.2	28.7	29.2	27.6	23.9	19.6	17.5
Aransas Pass	14.0	14.6	17.2	22.0	25.0	28.3	29.5	29.5	28.2	24.6	20.3	16.0
Causeway N	14.4	16.1	19.6	23.5	26.4	29.6	29.8	30.0	27.3	25.1	19.4	16.5
Causeway S	13.7	16.4	19.8	24.1	26.1	29.3	30.7	30.8	29.2	25.7	20.7	15.9
Laguna (King)	13.5	17.0	19.5	23.9	27.0	29.9	30.4	30.4	29.3	25.0	20.4	16.4
Laguna (Baffin)	12.5	17.5	20.8	23.4	27.0	30.2	30.2	30.8	28.9	24.1	21.1	14.6
Baffin Bay	14.3	17.5	19.7	24.5	26.9	29.5	29.7	30.1	28.6	25.2	21.2	18.2
GOM inlet	14.9	14.0	17.2	21.7	24.3	27.7	30.5	28.6	28.5	25.0	21.5	16.3

Table 6-10
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQPH

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	8.08	8.07	8.15	8.20	8.29	8.03	8.30	8.06	8.15	7.95	8.17	8.22
A2	8.22	8.33	8.21	8.21	8.27	8.16	8.35	8.31	8.36	8.08	8.21	8.23
A3	8.12	8.32	8.18	8.03	8.23	8.24	8.31	8.23	8.29	8.12	8.22	8.24
A4	8.16	8.25	8.30	8.21	8.18	8.24	8.36	8.14	8.23	8.00	8.25	8.17
A5	8.13	8.15	8.13	8.12	8.25	8.21	8.25	8.14	8.20	8.10	8.20	8.18
A6	8.07	8.32	8.20	8.30	8.35	8.22	8.33	8.16	8.00	8.00	8.06	8.13
A8	8.10	8.30	8.27	8.20		8.14	8.33	8.00	8.00	7.90	8.13	8.17
A9			8.40			8.10					8.45	
A10	8.16	8.30	8.26	8.12	8.24	8.19	8.36	8.21	8.13	8.11	8.26	8.20
A11		8.25	8.25	8.10	8.20	8.08	8.43	8.30	8.13	8.20	8.00	8.20
A12	8.18	8.30	8.38	8.09	8.27	8.29	8.47	8.39	8.45	8.20	8.29	8.27
A13		8.37		8.30		8.50	8.24	8.20		8.23		8.20
AL2		8.10		8.40				7.95	8.40	7.90		
AR1	8.12	8.23	8.22	8.01	8.12	7.84	8.53	8.21	8.16	8.28	8.22	8.37
AYB		8.40	8.30	8.35	8.35	7.88	8.27	8.30	7.70	8.27	8.00	8.47
BF1	8.27	8.04	8.13	8.16	8.08	8.26	8.26	8.06	8.23	8.25	8.14	
BF2		8.22	8.27	8.47	8.23	8.34	8.53	8.60	8.50	8.15	8.30	8.35
BF3	8.31	8.07	8.12	8.06	8.12	8.29	8.32	8.19	8.28	8.32	8.16	
C01	8.17	8.12	8.27	8.15	8.22	8.36	8.18	8.29	8.36	7.96	8.05	9.75
C02	8.13	8.13	8.40	8.19	8.16	8.39	8.16	8.17	8.18	8.35	8.28	8.50
C03	8.04	8.31	8.23	8.08	8.25	8.35	8.16	8.25	8.22	8.23	8.20	8.04
C04	8.26		8.17	8.07	8.22	7.70	8.29	8.12	8.15	8.15	8.18	8.20
C05	8.16	8.21	8.27	8.16	8.11	8.18	8.27	8.31	8.18	8.19	8.31	8.69
C06	8.16	8.23	8.28	8.04	8.27	8.25	8.24	8.37	8.21	8.28	8.30	8.17
C07	7.90	8.40	8.27	8.19	8.23	8.35	8.25	8.34	8.31	8.39	8.18	9.83
C08		8.40		8.11	8.20	8.24	8.20			8.40	8.39	
C09	8.13	8.25	8.38	8.16	8.24	8.30	8.25	8.24	8.33	8.23	8.25	8.20

(continued)

Table 6-10
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C10	7.96	8.38	8.40	8.19	8.30	8.35	8.28	8.37	8.27	8.27	8.33	8.30
C11	8.06	8.34	8.34	8.12	8.21	8.23	8.23	8.38	8.26	8.29	8.28	8.31
C12	8.14	8.28	8.28	8.18	8.24	8.26	8.22	8.22	8.36	8.26	8.29	8.19
C13									8.30			
C14	8.16	8.27	8.32	8.06	8.34	8.29	8.31	8.30	8.40	8.21	8.28	8.40
C15	8.21	8.07	8.14	8.07	8.12	8.18	8.18	8.18	8.16	8.26	8.04	8.41
C17	8.16	8.02	8.33	8.28	8.03	8.27	8.31	8.31	8.20	8.20	8.27	8.46
C18					8.30				8.08			8.53
C19					8.25	8.45	8.20	8.30	7.97		8.35	
C20	8.28	8.24	8.25	8.14	8.14	8.27	8.24	8.11	8.13	7.95	8.05	8.08
C21	7.80	8.46	8.23	8.32	8.28	8.38	8.32	8.62		8.34	8.32	8.33
C22			8.23	8.01	8.23		8.19			8.50	8.45	8.33
C24	8.13	8.20	8.52	7.81	8.41	8.10	8.34	8.24	8.68	8.37	8.32	9.40
C25		8.26	8.23	8.24	8.17	8.28	8.50	8.15	8.60	8.19	8.05	8.08
CB	8.20	8.36	8.15	8.14	8.21	8.19	8.39	8.47	8.41	8.10	8.16	8.33
CBH				8.23		8.43			8.50			
CCC1	8.14	8.24	8.33	8.22	8.20	8.16	8.18	8.19	8.07	8.23	8.24	8.13
CCC2	8.24		8.35		8.45	8.53	8.40	8.19				
CCC3	8.24	8.31	8.29	8.21	8.13	8.23	8.21	8.27	8.20	8.23	8.17	8.54
CCC4	8.20	8.05		8.30	8.20	8.03	8.24	7.97	8.28	8.17	8.23	8.30
CCC5	8.35		8.23	8.03	8.01	8.22	8.17				8.30	
CCC6	8.30	8.16	8.30	8.10	8.07	8.18	8.33	8.05	8.01	8.36	8.27	8.30
CCC7	8.13	7.95	8.27	8.12	8.06	8.10	8.24	8.30	8.09	8.18	8.17	8.69
CCC8	8.28	8.06	8.49	8.09	8.06	8.24	8.21	8.09	8.07	8.31	8.23	8.55
CP02	8.20	8.16	8.16	8.25	8.35	8.23	8.31	7.95	8.10	8.09	8.25	8.23
CP03	8.13	8.06	8.26	8.32	8.45	8.21	8.27	8.18	8.17	8.00	8.25	8.16
CP04	7.93	8.08	8.15	8.23	8.31	8.13	8.19	8.18	8.32	8.02	8.11	8.22
CP05	8.18	8.03	8.19	8.29	8.18	8.21	8.33	8.11	8.13	7.95	8.25	8.23

(continued)

Table 6-10
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CP06	8.05	7.90	8.24	8.23	8.35	7.97	8.15	8.03		7.70	8.20	8.10
CP07	8.10	8.00	8.03	8.29	8.26	8.23	8.39	8.29	8.07	8.05	8.26	8.19
CP08	8.20	8.18	8.13	8.29	8.21	8.11	8.34	8.23	8.10	8.16	8.24	8.53
CP09	8.13	8.11	8.11	8.31	8.29	8.19	8.38	7.90	7.93	7.94	8.00	8.25
CP10	8.17	8.17	8.18	8.18	8.26	8.11	8.26	8.27	7.90	8.08	8.18	8.20
GR1								7.90				
GR2		8.05		8.50				8.43	8.28	8.10		
HI1				8.29	8.30	8.40			8.57	8.38		8.23
HI2		8.17							8.55			
I2		8.25	8.35	8.35	8.24	8.07	8.20	8.10	8.13	8.33	8.00	8.40
I3	8.18	8.42	8.23	8.28	8.32	8.17	8.45	8.49	8.50	8.18	8.30	8.30
I4	8.16	8.32	8.28	8.26	8.24	8.06	8.33	8.10	8.04	8.09	8.22	8.23
I5	8.18	8.28	8.35	8.13	8.17	8.19	8.37	8.36	8.40	8.15	8.26	8.20
I6	8.30	8.13	8.16	8.20	8.20	8.13	8.30	8.10	8.15	8.30	8.21	8.12
I7	8.12	8.19	8.25	8.03	8.25	8.15	8.30	8.28	8.02	8.06	8.18	8.06
I8		8.05	8.15	8.00	8.18	7.98	8.23	8.10	7.87	8.07	8.05	7.97
I9	8.21	8.27	8.26	8.27	8.30	8.28	8.59	8.25	8.54	8.34	8.27	8.27
I10	8.49	8.34	8.22	8.23	8.35	8.59	8.47	8.10	8.51	8.00	8.34	7.95
I11		8.23	8.05	8.12		8.25	8.60	8.30	8.44	8.15	7.97	7.90
I12	8.28	8.15	8.00	8.21	8.37	8.33	8.44	8.12	8.00	8.42	8.03	
I13		8.30		8.10	8.50	8.42	8.35	8.30	8.06	8.35	8.27	8.15
I15		8.20	8.23	8.26	8.25	8.20	8.30	8.11	8.50	8.21	8.00	8.00
I17	8.32	8.13	8.03	8.14	8.23	8.53	8.41	8.16	8.04	8.46	8.12	
IH1	8.31	8.03	8.36	7.95	8.00	8.04	8.09	7.97	7.75	8.12	8.02	8.24
IH2								7.77				9.50
IH3	8.10	7.70	8.26	7.36		8.05	7.89	7.79		7.91	7.90	9.33
IH4		7.90		8.00	8.40	8.90	7.95	7.86				9.50
IH5	8.32	8.07	8.27	7.98	8.03	8.02	8.14	8.02	7.69	8.21	8.12	8.46

(continued)

Table 6-10
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH6	8.28	8.09	8.31	8.11	8.03	8.20	8.14	7.98	8.03	8.27	8.11	8.31
IH7	8.18	7.91	8.20	7.84	8.16	8.09	8.03	7.98	7.95	8.13	7.61	8.25
INL			8.35		8.45	8.50	8.30					
LAC	8.07	8.23	8.20	8.00	8.22	8.10	8.12	8.33	8.16	8.16	8.29	8.30
LB		7.60	7.85	7.20	8.10	7.68	8.17	7.00	7.40	7.10	7.40	7.53
LQ1	8.22	8.30	8.27	8.19	8.12	8.28	8.24	8.10	8.25	7.81	8.04	8.09
LQ2	8.17	8.20	8.20	8.11	8.13	8.26	8.17	8.09	8.15	8.37	8.20	7.90
LS1								8.30				
LS2		8.30		8.40				8.55	8.50	8.23		
M2		8.10	8.28	7.95		7.57				8.15	7.90	
MB1	8.32	8.46	8.21	8.14	8.26	8.25	8.09	8.18	8.22	8.24	8.03	8.34
MB2	8.15	8.33	8.31	8.25	8.25	8.17	8.14	8.21	8.06	8.02	8.06	8.32
NB2		7.97	8.13	8.10	8.22	8.24	7.93	8.60			8.35	
NB3			8.10	8.07	7.55	8.06	8.03	8.10		8.30		
NB4	8.03	8.13	8.10	8.10	7.90	8.13	8.35	8.15	7.90	8.24	8.30	9.00
NB5	7.93	8.00	8.07	7.94	8.13	8.33	8.36	8.15	8.07	8.26	8.05	8.63
NB6	7.74	7.94	8.17	7.91	8.09	8.26	8.11	8.32	8.05	8.19	8.16	8.77
NB7	8.04	7.97	8.23	8.05	8.04	7.75	8.04	8.05	8.13	8.28	8.11	8.20
NB8			8.20	8.35	7.98	8.17	7.48	7.42	7.60			
NB9			8.20		8.14	8.18	7.60	8.13	7.60			
ND2				7.40	7.45	7.20				7.95	7.85	7.20
ND4	8.36	8.40	7.92	8.04	8.08	8.12	8.14	8.27	8.27	8.45	8.44	8.26
NR1	8.70	7.76	7.51	7.97	8.22	7.91	7.65	8.10	8.18	7.43	7.79	
NR3	8.27		8.26	8.37	8.31	8.34	7.70	8.15		8.04	7.81	
NR4	8.34	8.48	8.28	8.00	8.14	8.21	8.30	8.45	8.37	8.27	8.41	8.17
NR5	8.45			8.38	8.23	8.48	7.66	8.23	7.96	8.19	8.26	8.28
OS1	7.85	8.18	7.75	8.18	7.73	7.87	8.46	7.83	8.14	8.04	8.03	7.79
OS3	8.58	8.65	8.58	8.60	8.33	8.43	8.42	8.30	7.79	8.96	8.70	8.80

(continued)

Table 6-10
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
OS6	8.20	8.17		8.12	7.93		8.43	8.12	7.70	8.29	8.08	8.23
OS7	8.27	8.07	8.11	8.11	7.89	8.20	8.35	7.96	8.01	8.64	8.21	8.34
PB1	8.17	8.11	8.13	8.03	8.26	8.13	8.30	8.33	8.03	8.37	8.18	8.24
RB1	8.03	8.13	8.45	7.30	8.55	8.49	8.38		8.30	8.28	8.44	
RB2			8.45		8.45	8.53	8.50					
RB3	8.14	8.18	8.26	8.38	8.33	8.36	8.44	8.19	8.14	8.40	8.21	8.29
RB4	8.10	8.26	8.44	8.36	8.44	8.44	8.50	8.40	8.32	8.34	8.40	
RB5	8.17	8.30	8.44		8.46	8.50	8.62	8.85	8.40	8.48	8.65	8.35
RB6		8.38					8.60			8.48	8.80	8.35
RB7		7.93	8.30		8.38	8.41			8.30		8.20	
RB8	8.22	8.24	8.22	8.19	8.21	8.29	8.29	8.12	8.08	8.30	8.19	8.18
RB9	8.30		8.20	8.17	8.12		8.28	8.35	8.19	8.20	8.20	
SC1	8.08	8.17	8.30	8.18	8.17	8.07	8.64	8.30	8.00	8.21	8.24	8.17
SC2	8.19	8.13	8.20	8.22	8.27	8.24	8.55	8.17	8.16	8.17	8.18	8.32
SC3	8.13	8.09	8.00	8.20	8.23	8.18	8.31	7.97	7.94	8.08	8.16	8.10
UL03			8.20	8.15	8.40	7.90	8.70	8.40	8.24	8.21	7.97	7.93
UL04	8.34	8.20	8.11	8.27	8.41	8.43	8.54	8.19	8.28	8.55	8.11	8.40
UL07									8.30	8.50	8.15	8.10
UL11			8.26	8.70		8.05	8.40	8.23	8.55	8.27		
GMI4	8.23	7.98	7.97	8.23	8.13	8.23	8.26	7.89	7.99	8.56	8.09	8.25
GMI6	8.20	8.29	8.25	8.18	8.32	8.11	8.20	8.12	8.19	8.20	8.22	8.20
GMO6		8.24	8.31	8.21	8.25	8.03			8.19	8.10	8.17	8.15

(continued)

Table 6-10
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	8.17	8.25	8.24	8.16	8.24	8.20	8.36	8.19	8.23	8.12	8.19	8.19
Copano Bay	8.12	8.08	8.16	8.26	8.30	8.15	8.29	8.13	8.09	8.00	8.19	8.23
St Charles	8.16	8.11	8.10	8.21	8.25	8.21	8.43	8.07	8.05	8.12	8.17	8.21
Mesquite	8.22	8.39	8.24	8.22	8.27	8.12	8.22	8.29	8.10	8.16	8.06	8.36
Redfish	8.19	8.21	8.33	8.27	8.34	8.42	8.46	8.38	8.24	8.37	8.38	8.29
Corpus Christi	8.10	8.27	8.28	8.14	8.22	8.27	8.24	8.30	8.21	8.25	8.26	8.53
CCSC (bay)	8.24	8.12	8.27	8.15	8.09	8.15	8.24	8.15	8.14	8.23	8.23	8.46
Inner Harbor	8.24	7.95	8.28	7.87	8.12	8.22	8.04	7.91	7.86	8.13	7.95	8.80
Nueces Bay	7.98	8.03	8.12	8.11	7.96	8.18	8.03	8.08	7.86	8.27	8.23	8.82
Aransas Pass	8.11	8.24	8.29	8.17	8.29	8.29	8.20	8.26	8.26	8.25	8.26	8.22
Causeway N	8.17	8.24	8.33	8.11	8.29	8.22	8.48	8.21	8.61	8.30	8.21	8.58
Causeway S	8.42	8.27	8.16	8.25	8.38	8.51	8.50	8.15	8.39	8.27	8.22	8.17
Laguna (King)	8.28	8.22	8.15	8.26	8.38	8.19	8.46	8.24	8.30	8.30	8.06	8.02
Laguna (Baffin)	8.32	8.13	8.03	8.14	8.23	8.53	8.41	8.16	8.04	8.46	8.12	
Baffin Bay	8.29	8.09	8.17	8.32	8.14	8.30	8.37	8.25	8.34	8.14	8.20	8.35
GOM inlet	8.20	8.26	8.28	8.19	8.29	8.07	8.20	8.12	8.19	8.15	8.20	8.17

Table 6-11
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQDO, upper 1 metre

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	9.7	9.1	9.2	8.6	8.4	7.4	8.1	7.2	7.5	8.2	9.5	8.5
A2	11.1	9.1	8.3	8.3	8.3	8.2	7.4	7.4	8.4	8.7	10.4	9.7
A3	11.1	9.2	8.9	8.2	8.4	8.2	8.1	7.8	8.1	8.3	9.6	9.8
A4	10.1	9.6	9.1	8.2	7.3	6.9	7.1	8.5	6.8	8.8	9.1	10.8
A5	10.7	9.6	9.1	8.6	7.9	6.7	7.8	8.1	7.8	9.1	10.7	9.2
A6	10.4	9.5	9.8	7.4	8.6	8.1	8.4	7.9	7.7	8.2	11.2	10.5
A8	8.8	9.7	9.1	8.3	10.6	9.0	11.7	4.5	8.6	9.8	10.4	8.1
A9	11.8	9.0	8.2	8.6	9.3	10.0	8.3	5.8	9.2	8.0	10.2	10.1
A10	10.4	9.7	8.9	8.6	7.7	7.3	7.7	6.9	6.6	8.3	9.8	9.8
A11	10.2	10.0	8.1	8.4	7.7	7.0	6.0	8.5	7.6	8.7	8.7	8.1
A12	9.4	9.7	8.9	8.4	8.6	7.6	7.9	7.0	7.2	9.2	9.0	10.6
A13	10.6	9.8	9.6	8.9	9.3	7.9	7.4	8.0	7.8	9.3	9.3	8.7
AL1	9.0	7.7	7.7	7.6	6.9	6.9	7.3	7.2	6.4	6.9	7.3	9.1
AL2	7.4	7.2	7.5	8.3	6.7	7.3	7.2	6.7	6.2	6.9	8.2	8.3
AR1	10.1	8.8	8.6	8.2	8.0	6.9	8.3	7.2	8.1	9.0	9.7	11.0
AYB		8.8	8.0	8.0	7.4	6.4	6.5	5.3	6.7	7.0	8.0	9.0
BF1	8.1	7.4	7.4	7.3	6.8	6.5	6.9	6.7	6.5	6.8	7.5	9.3
BF2	7.0	7.1	7.9	6.9	7.0	7.4	6.5	5.9	6.9	7.6	7.0	7.2
BF3	8.5	7.4	6.8	7.1	6.7	6.2	6.2	6.3	6.5	6.9	7.2	8.4
C01	9.2	8.6	8.6	8.1	7.8	7.7	7.3	7.5	7.9	9.7	9.0	8.3
C02	8.9	8.1	7.5	8.2	8.0	6.8	8.0	6.7	6.9	8.0	8.4	7.6
C03	9.2	8.9	8.0	8.5	7.1	7.8	7.8	7.3	7.0	8.5	8.3	8.3
C04	8.4	7.4	6.5	8.0	7.6	4.5	8.6	6.3	5.9	7.2	8.0	6.3
C05	11.1	8.8	7.5	7.7	7.3	6.2	7.6	6.4	6.5	7.3	8.5	8.6
C06	7.9	8.1	7.6	7.6	6.3	6.5	7.2	6.2	6.8	7.2	7.3	8.3
C07	9.2	8.9	8.1	8.1	7.2	8.1	7.2	6.7	7.3	7.8	8.2	9.1
C08		8.0	6.3	9.1	7.3		9.5	7.1	8.4	7.0	8.5	8.8

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C09	9.9	9.1	8.1	8.1	7.6	7.8	7.6	7.9	7.8	7.6	8.1	8.8
C10	9.0	9.0	7.8	7.6	6.9	7.4	7.3	6.5	7.3	7.6	8.0	9.0
C11	9.7	9.1	7.9	7.8	7.2	6.6	6.9	7.0	7.0	7.8	8.3	9.1
C12	8.9	8.7	7.8	8.0	7.6	7.3	7.3	8.2	7.1	7.7	8.3	9.4
C13	9.0	8.5	10.2	7.7	6.4	8.5			7.5	7.7	9.4	
C14	8.9	9.3	8.0	8.2	7.4	7.3	7.0	6.8	7.8	8.0	7.9	8.6
C15	9.0	8.6	7.8	7.9	7.0	7.0	6.9	6.8	7.0	7.6	8.2	8.8
C16		8.3				5.0			4.7	8.6	8.7	
C17	9.6	9.0	8.5	8.1	7.4	6.7	7.7	7.8	7.0	8.0	8.4	9.1
C18		7.2	6.2	6.0			5.8		6.3		5.3	8.4
C19	13.4	7.9	11.0	8.8	7.6	7.9		8.2	8.5	9.2	7.0	
C20	8.2	8.7	7.7	8.2	7.5	8.0	7.2	7.6	7.4	8.2	8.9	8.9
C21	8.8	9.0	7.4	8.7	7.3	7.5	7.2	6.7	7.9	7.3	8.4	9.8
C22	11.4	8.5	7.0	8.8	7.0	6.2	8.4	5.9	5.8	6.9	8.1	8.9
C23	6.5	9.4	6.8	7.1	8.0	6.9		7.5	9.4	8.5	10.2	
C24	8.4	9.1	7.3	7.8	7.0	7.1	7.5	7.6	6.9	7.4	9.4	7.1
C25		8.3	7.6	7.6	7.7	6.3		6.9	7.8	7.4	8.2	9.1
CB	11.3	9.2	8.3	8.9	8.5	6.8	7.1	6.0	9.2	8.5	9.6	10.2
CBH				8.0	8.8				7.5	7.4		
CBY1			9.4				6.7			10.9		8.5
CBY2												
CCC1	8.7	9.2	7.7	7.8	7.4	6.9	6.6	6.8	7.2	8.1	8.0	8.4
CCC2	8.4		8.5	7.8	7.6	7.5	6.7		7.6	6.8	8.0	8.9
CCC3	9.0	8.7	7.7	8.2	7.8	7.9	6.9	7.3	7.6	8.2	8.4	8.1
CCC4	7.2	9.0	8.0	7.5	7.9	5.5	5.7	4.0	6.7	6.7	7.5	7.6
CCC5	8.8	8.3	7.3	9.5	6.5		7.2		6.8	6.6	7.9	8.2
CCC6	9.6	8.2	7.8	7.9	7.2	6.0	6.2	6.8	6.0	7.0	7.8	7.1
CCC7	9.5	11.1	7.5	8.6	7.6	6.5	7.4	6.9	6.4	8.0	8.5	9.2

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC8	9.2	8.4	7.2	7.6	6.8	6.7	7.5	7.0	6.8	7.2	8.1	8.6
CP01	8.2			9.1	8.2	6.8			8.6	8.2	9.9	10.6
CP02	10.5	9.0	9.2	8.1	8.2	7.4	8.5	8.4	8.5	8.0	9.0	9.0
CP03	10.8	9.6	8.5	8.3	7.7	6.8	7.9	7.6	6.4	9.2	9.7	10.0
CP04	10.0	9.1	9.2	9.1	8.0	7.4	8.1	6.7	8.0	9.1	9.5	10.0
CP05	10.7	9.4	8.3	8.3	7.7	7.4	7.8	6.8	7.0	7.4	8.8	10.7
CP06	10.0		9.1	8.2	8.2	7.3	9.4	8.4	7.4	9.6	10.1	8.2
CP07	11.2	9.5	8.2	8.5	7.7	7.5	8.2	7.3	7.8	8.0	8.7	10.2
CP08	9.7	9.8	9.0	8.5	8.4	7.3	8.6	6.9	7.7	9.2	9.3	9.9
CP09	10.3	9.7	9.0	8.4	7.9	7.6	8.4	6.9	7.9	9.1	8.7	10.2
CP10	10.7	9.4	8.4	8.8	7.8	7.1	7.6	7.7	7.8	8.3	8.9	9.9
EF	9.6	8.9	7.8	9.6	7.5	7.6	8.7	7.2	8.7	9.7	6.7	10.3
GR1			8.3	5.5	11.2					5.0		
GR2	7.8	7.5	7.8	6.8	6.3	6.3	7.9	7.9	7.5	6.8	7.0	8.3
HI1	10.9	11.3	8.4	6.4	8.1	7.5		6.5	8.2	9.3	8.8	10.5
HI2	8.7	9.1	7.0	8.2	7.8	9.5	6.3	6.9	7.3	8.6	7.9	8.3
I2	9.1	8.1	8.3	8.1	8.3	7.4	6.7	5.5	7.3	8.3	8.1	8.6
I3	11.6	9.4	7.5	8.4	8.2	7.3	7.2	8.1	9.1	8.4	9.1	11.4
I4		8.8	8.7	8.4	8.2	8.4	7.3	6.7	7.3	7.4	9.1	8.4
I5	9.9	9.2	9.0	8.6	8.0	7.6	8.3	6.9		9.7	9.1	9.2
I6	9.9	9.0	9.0	7.7	8.1	6.8	7.3	6.8	6.9	8.1	9.1	8.9
I7	9.6	9.3	8.4	8.2	8.3	7.1	6.2	6.7	7.2	7.9	8.5	8.6
I8	10.8	9.6	9.1	8.9	8.9	7.0	6.9	5.9	7.1	7.8	7.5	7.3
I9	8.4	8.7	7.1	7.1	5.9	6.7	5.5	6.2	7.3	7.4	7.8	7.2
I10		8.7	8.7	8.1	6.7	6.9	6.7	7.2	8.0	7.4	9.3	10.5
I11	8.3	8.8	6.0	7.0	7.7	7.5	7.1	7.4	6.7	7.6	8.0	9.1
I12	9.3	8.2	8.8	7.9	7.8	7.4	6.7	6.1	8.1	7.6	7.0	8.3
I13	8.2	8.1	6.3	6.9	6.3	6.8	7.1	6.0	9.9	7.1	7.5	7.9

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I14	7.3	8.2	5.1	7.8	6.0	7.0	7.7	9.0	6.2	6.3	6.6	6.3
I15	7.7	6.7	6.8	6.9	6.5	6.1	5.2	4.7	7.5	7.1	7.0	7.6
I16	5.0	6.3	6.2	6.4	6.0	6.6	6.5	7.8	8.5	7.6	5.9	7.0
I17	9.3	7.7	6.9	7.5	6.4	5.8	6.7	6.4	7.4	7.4	7.6	8.0
I18	7.5	7.0		8.1	6.6	6.0	5.5	7.0	6.8	7.0	6.6	6.2
IH1	10.5	8.1	8.3	7.5	6.1	5.9	8.1	6.5	5.2	6.0	7.6	9.5
IH2				7.0				5.5				
IH3		7.4	11.0	6.7		4.9	10.9	4.9		7.6	9.9	
IH4	8.4			6.2	7.4	8.0		6.3		6.5		
IH5	10.2	8.0	8.0	7.1	6.5	7.0	7.9	7.4	4.6	7.2	7.6	7.7
IH6	10.2	8.1	6.3	6.5	6.6	4.1	5.8	5.9	5.2	5.9	6.2	6.6
IH7	7.4	8.3	7.1	7.0	6.2	6.0	6.5	5.8	5.8	6.6	6.8	7.0
INL		9.1	9.1		7.6	7.1	7.4	6.3	7.4	6.8	8.9	8.5
LAC	9.8	9.3	8.5	8.0	6.9	6.8	7.1	6.2	6.4	8.4	9.5	9.3
LB	10.6	10.5	7.7	8.5	8.4	7.3	7.0	6.5	6.5	8.1	12.4	9.2
LQ1	8.7	9.1	7.5	8.0	7.7	7.5	6.8	7.0	7.7	8.3	8.4	9.1
LQ2	9.5	8.8	8.7	7.8	7.0	6.8	7.2	6.8	8.8	7.2	7.3	8.6
LS1			7.9	6.0	9.0		8.6	4.1		5.3		9.5
LS2	7.8	7.5	7.5	7.2	6.9	6.3	8.7	7.6	7.7	6.7	7.4	7.1
M1					8.2	6.5			7.4	7.0	9.5	8.1
M2		9.9	8.7	9.0	8.2	7.1	6.5	9.4	6.8	8.4	9.5	9.8
MB1	10.1	10.0	9.1	8.9	8.0	7.7	7.4	7.6	7.7	8.1	9.8	10.1
MB2	10.8	9.0	9.1	8.5	8.4	7.4	6.7	6.8	7.5	8.5	9.9	9.6
NB1	6.2	9.0	5.0	6.6	7.8	7.5	7.1	7.2	8.6	8.9	9.2	8.2
NB2	6.6	8.8	7.0	7.5	7.8	7.3		8.0	8.5	8.2	8.0	7.9
NB3	9.7	7.3	7.6	7.5	6.1	6.9	7.1	6.4	7.1	8.4	8.1	
NB4	8.9	9.1	7.4	8.1	7.4	7.2	6.4	7.3	6.9	8.2	8.5	8.3
NB5	8.9	8.8	7.6	8.5	7.0	7.1	6.7	6.9	7.2	8.1	8.7	8.9

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB6	8.5	8.6	7.5	7.7	6.3	7.2	6.5	7.0	6.5	8.1	8.5	9.1
NB7	9.2	8.6	7.2	8.1	6.8	7.6	6.2	7.0	6.6	8.0	8.3	8.4
NB8	8.3		7.0	7.1	7.4	6.9		7.0	7.7	8.0	7.9	7.6
NB9	9.9	8.2	6.7	7.7	7.2	7.2	7.5	8.4	8.9	8.3	9.9	9.0
ND2	9.0				8.4		8.7	7.5	6.8	8.3	7.8	
ND4	8.5	9.2	7.7	7.9	6.6	6.9	6.3	5.9	6.4	7.7	8.9	9.1
NR1	8.2	9.4	8.3	9.9	8.0	7.0	7.4	6.5	7.6	7.3	8.1	9.0
NR3	8.2		8.5	10.0	5.8	6.7	7.7	6.5		7.0	8.0	
NR4	11.5	11.3	10.9	8.8	7.7	8.0	8.6	9.0	8.4	9.0	10.3	10.4
NR5	9.4	8.9	8.3	8.8	5.4	6.5	8.0	7.1	6.5	9.3	10.2	10.0
OS1	9.8	10.7	11.0	11.0	7.9	8.3	12.6	9.5	11.3	9.1	8.5	5.0
OS3	9.8	9.2	6.3	7.4	7.4	8.4	6.9	7.5	7.0	9.2	8.0	10.1
OS4	10.7	8.5	8.8	6.1	9.6	6.7	6.5	6.8	8.6	7.2	8.8	12.1
OS5	10.5		8.1	8.7			6.6	10.5		8.6	8.5	8.7
OS6	10.4	8.2	11.4	7.1	7.2	7.0	7.2	6.4	7.9	7.5	8.4	8.4
OS7	10.7	8.8	8.9	8.0	7.8	7.2	8.5	6.9	7.6	8.3	7.4	9.8
PB1	9.8	9.0	9.1	8.6	7.7	8.2	7.2	7.1	7.8	8.2	9.1	9.6
PB2	11.0	8.8	9.1	8.9	8.6	8.6	7.7	5.7	8.3	10.6	10.7	11.5
RB1	10.0	9.6	9.5	8.5	8.9	8.6	8.4	8.8	6.6	10.8	9.5	9.6
RB2	14.2	11.7	9.5	9.4	9.4	8.1	8.1	7.9	6.9	10.5	8.8	
RB3	9.7	8.9	9.0	8.5	7.2	8.9	9.0	6.9	8.4	8.8	8.0	9.9
RB4	8.9	9.1	9.3	8.3	10.8	8.2	7.9	7.2	7.6	8.4	8.7	6.7
RB5	10.1	8.9	9.3	8.7	8.7	8.3	7.6	7.4	7.5	8.1	9.3	9.0
RB6	11.1	8.8	8.3	9.0	7.6	7.5	6.7	7.7	7.6	7.8	8.3	10.5
RB7	9.4	10.6	9.5	7.7	9.0	6.7	13.3	5.8	7.6	8.5	8.3	7.4
RB8	9.6	8.7	8.0	7.5	7.2	7.2	7.6	6.6	6.9	7.6	8.3	8.4
RB9	9.8	7.1	7.3	8.4	8.6	8.1	8.6	8.2	7.9	8.9	8.1	8.9
SC1	10.1	9.5	8.4	8.7	7.6	6.6	6.6	6.6	7.5	8.3	7.7	9.2

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
SC2	10.0	9.4	9.0	9.1	8.1	6.9	7.8	7.3	7.4	9.4	9.6	9.2
SC3	10.9	9.4	8.3	8.5	8.4	7.3	7.4	6.7	8.1	8.3	9.1	9.9
UL01	8.7	9.5	7.4	8.0	8.2	7.0	7.0	6.7	7.5	7.2	7.8	11.0
UL02	8.2	7.8	6.8	8.0	8.7	7.1	6.6	6.8	7.1	8.4	7.0	7.5
UL03	6.5	7.4	7.5	7.0	6.5	6.2	6.5	5.0	5.7	5.2	7.8	8.2
UL04	9.3	8.3	8.3	8.8	7.1	7.7	6.8	6.8	8.4	8.6	7.2	8.2
UL05	9.1	9.1		7.8	8.3	7.6	7.8	8.3	7.7	7.7	7.9	9.0
UL06	8.2	8.9	6.0	5.9	6.5	5.4	4.4	5.1	5.3	6.3	6.3	8.0
UL07	7.3	7.3	8.3	8.4	6.9	6.8	6.9	5.9	7.5	7.8	7.7	8.0
UL08	9.0	6.6	6.7	7.7	6.3	4.6	5.6	5.1	6.0	5.8	9.4	6.5
UL09	7.3		6.9	7.5	7.1	6.3	6.9	5.7	7.5	6.8	6.3	8.1
UL10	7.8	7.6	7.3	7.3	7.1	7.2	6.3	5.8	6.5	7.0	7.0	8.2
UL11			6.8	5.8	6.0	5.4	5.3	4.8	9.7	7.3		8.7
GMI1	7.3				6.9	5.3	6.1	5.4	6.3	5.7	7.4	
GMI2	7.5	8.9	7.4	6.6	6.7	5.9	5.4	5.5	6.1	6.5	7.3	7.9
GMI3	7.9	8.7	7.2	7.0	6.1	5.5	5.8	5.5	5.7	6.1	6.9	8.1
GMI4	9.2	8.9	8.3	7.2	6.6	5.9	6.0	5.5	6.5	6.9	7.3	8.1
GMI5	8.8	7.9	8.4	6.6	6.8	6.0	5.7	6.0	5.8	6.3	6.2	8.5
GMI6	9.2	8.7	7.4	7.3	7.0	6.3	7.1	6.2	6.3	6.6	7.2	7.6
GMI7	8.6	8.3	7.8	9.6	7.3	6.5	7.2	6.4	6.4	6.8	7.6	8.1
GMI8	10.4	8.4	8.4	8.9	7.0	6.8	6.1	7.2	6.6	7.0	8.0	8.1
GMI9	8.2	8.4	7.7	10.0	8.1	6.4	7.0	8.2	7.1	7.3	9.5	9.3
GMO4		8.1								7.4	7.2	
GMO5	9.8	7.8	10.0					8.3	6.3	6.8	7.7	8.4
GMO6		8.0	8.6	7.6		6.2			8.1	7.1	7.7	8.4
GMO7	9.8	9.0	9.7	8.1	6.8		10.0	7.6	8.9	7.3	6.5	8.2

(continued)

Table 6-11
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	9.4	8.8	8.0	8.0	7.8	7.5	7.6	7.0	7.7	8.2	8.8	8.8
Copano Bay	10.4	9.4	8.8	8.5	8.0	7.3	8.3	7.4	7.6	8.7	9.2	9.8
St Charles	10.5	9.4	8.7	8.8	8.3	7.1	7.6	7.0	7.7	8.8	9.3	9.6
Mesquite	10.7	9.2	8.6	8.6	8.0	7.1	6.9	6.4	7.8	8.0	9.3	9.7
Redfish	10.3	9.2	8.8	8.4	8.6	7.9	8.6	7.2	7.6	8.6	8.5	8.7
Corpus Christi	9.3	8.5	7.8	8.0	7.3	7.0	7.5	6.9	7.2	7.9	8.2	8.6
CCSC (bay)	8.8	9.1	7.7	8.3	7.4	6.5	6.7	6.2	6.7	7.3	8.0	8.0
Inner Harbor	9.3	8.0	8.1	6.9	6.6	6.0	7.8	6.0	5.2	6.6	7.6	7.7
Nueces Bay	8.5	8.5	7.3	7.7	7.1	7.1	6.7	7.1	7.5	8.2	8.2	8.2
Aransas Pass	9.8	9.7	8.4	7.4	7.5	7.1	7.1	6.5	7.3	8.1	8.8	9.2
Causeway N	8.4	8.7	7.3	7.5	6.9	6.7	6.5	6.9	7.3	7.4	8.5	7.8
Causeway S	8.7	8.5	7.8	8.2	7.7	7.2	6.8	6.9	7.7	7.9	7.8	9.3
Laguna (King)	8.0	7.9	6.9	7.2	6.8	6.5	6.4	6.1	7.3	6.9	7.4	8.0
Laguna (Baffin)	7.3	7.0	6.6	7.3	6.4	6.1	6.2	7.1	7.6	7.3	6.7	7.1
Baffin Bay	7.7	7.3	7.5	7.3	6.7	6.7	6.9	6.7	6.7	7.0	7.4	8.3
GOM inlet	9.2	8.3	8.6	7.8	7.0	6.3	7.5	6.9	7.0	6.8	7.2	8.2

Table 6-12
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQDODEF, upper 1 metre

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	-0.3	0.1	0.1	-0.7	-0.9	-0.1	-0.8	0.4	-0.5	-0.6	-1.0	0.8
A2	-1.3	0.2	-0.1	-0.1	-0.7	-1.1	-0.2	-0.2	-1.2	-0.9	-2.0	-0.1
A3	-1.9	0.2	0.0	-0.3	-0.9	-1.0	-0.7	-0.3	-0.3	-0.6	-1.0	-0.7
A4	-0.6	-0.3	-0.2	-0.1	0.2	0.1	-0.3	-1.2	0.3	-1.3	-0.8	-1.7
A5	-1.6	-0.6	-0.3	-0.9	-0.6	0.5	-0.8	-1.0	-0.2	-1.4	-2.4	-0.4
A6	-0.9	-0.6		0.1	-1.4	-1.0	-1.2	-0.5	-0.8	-0.7	-3.1	-2.0
A8	0.3	0.3		-0.9	-3.7	-1.8	-4.3	2.2	-1.6	-2.5	-1.7	1.0
A9	-1.2	-0.7	2.1	-0.7	-2.3	-3.1	-1.8	0.7	-2.3	-0.4	-2.3	-0.8
A10	-1.2	-0.4	-0.1	-0.8	-0.7	-0.3	-0.6	-0.1	0.4	-0.9	-1.7	-1.1
A11	-0.9	-1.2	0.0	-0.7	-0.5	0.1	0.5	-2.2	-1.0	-1.4	-0.6	0.3
A12	-0.2	-0.3	-0.3	-0.7	-1.2	-0.8	-1.1	-0.4	-0.6	-1.8	-0.8	-1.8
A13	-1.7	-0.7	-1.1	-1.8	-2.5	-1.2	-0.8	-1.5	-1.2	-2.2	-1.6	0.2
AL1	-0.7	0.0	-0.5	-1.1	-0.7	-0.3	-1.0	-1.5	-0.8	-0.9	-0.3	-1.2
AL2	0.1	1.0	-0.4	-1.7	-0.4	-0.8	-0.8	-0.6	-0.1	-0.6	-1.1	-1.1
AR1	-0.6	0.4	-0.4	-0.1	-0.5	0.5	-1.0	0.1	-0.7	-0.8	-1.0	-1.4
AYB		0.3	0.3	0.0	0.1	0.5	0.3	1.3	0.2	0.8	0.6	-0.1
BF1	0.3	0.1	0.1	-0.4	-0.2	-0.2	-0.5	-0.6	-0.2	-0.3	-0.5	-1.0
BF2	1.1	0.6	-0.7	-0.1	-0.6	-1.2	0.0	0.2	-0.9	-1.1	0.0	0.4
BF3	-0.3	0.1	0.3	-0.2	-0.2	0.0	0.0	-0.1	-0.5	-0.2	-0.3	-0.9
C01	-0.7	0.0	-0.8	-0.4	-0.8	-1.9	-0.9	-0.4	-0.8	-2.2	-1.2	-0.2
C02	-0.2	0.2	0.4	-0.6	-1.1	-0.6	-1.4	0.3	0.0	-0.7	-0.6	-0.1
C03	-0.3	-0.4	-0.3	-0.8	-0.3	-1.5	-1.5	-0.7	-0.1	-1.4	-0.1	-0.1
C04	-0.1	1.4	0.9	-0.7	-0.6	2.5	-2.2	0.5	1.2	0.2	0.3	1.6
C05	-2.4	-0.2	-0.3	-0.4	-0.3	0.4	-1.0	0.4	0.6	0.1	-0.5	0.0
C06	0.5	0.7	0.1	-0.2	0.6	0.1	-0.7	0.2	0.1	0.2	0.7	0.1
C07	-0.2	-0.3	-0.3	-0.6	-0.3	-1.4	-0.8	-0.2	-0.4	-0.7	-0.5	-0.5
C08		0.7	1.3	-1.2	-0.4		-3.0	-0.6	-1.9	-0.2	-0.5	-0.8

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C09	-1.4	-0.5	-0.4	-0.9	-0.9	-1.4	-1.3	-1.5	-1.2	-0.8	-0.4	-0.6
C10	-0.2	-0.5	0.0	-0.3	-0.1	-0.8	-0.9	0.0	-0.4	-0.4	0.0	-0.7
C11	-0.9	-0.4	-0.2	-0.4	-0.3	-0.1	-0.5	-0.4	0.0	-0.5	-0.4	-0.6
C12	-0.1	0.0	0.0	-0.6	-0.6	-0.7	-0.9	-1.8	-0.7	-0.8	-0.5	-0.9
C13	0.0	0.7	-2.6	-0.4	0.5	-2.0			-0.7	-0.6	-1.1	
C14	-0.5	-0.8	-0.1	-0.8	-0.6	-0.8	-0.7	-0.7	-1.0	-1.0	-0.1	-0.5
C15	-0.4	-0.2	0.1	-0.4	0.0	-0.1	0.0	0.1	0.0	-0.1	-0.2	-0.2
C16						1.8			3.5	-1.1	-0.3	
C17	-1.0	-0.4	-0.9	-0.8	-0.6	0.0	-1.0	-1.1	-0.2	-1.0	-0.8	-1.2
C18			1.0				1.2		0.3		2.4	-0.2
C19	-5.6	0.3	-3.1	-1.9	-1.0	-1.4		-1.1	-1.7	-1.8	0.3	
C20	0.9	-0.4	0.2	-0.5	-0.5	-1.3	-0.7	-0.7	-0.5	-0.9	-0.8	-0.7
C21	-0.2	-0.8	0.2	-1.5	-0.3	-1.0	-0.7	-0.3	-1.3	-0.3	-0.2	-1.4
C22	-1.5	0.2	0.8	-1.5	0.0	0.5	-1.9	0.6	1.1	0.4	-0.1	-0.2
C23	1.9	-0.8	1.0	0.1	-1.1	-0.5		-1.2	-2.8	-1.6	-2.3	
C24	0.1	-1.0	0.5	-0.8	-0.4	-0.8	-1.1	-1.3	-0.1	-0.5	-1.7	0.8
C25		0.1	0.1	-0.3	-0.7	-0.1		-0.7	-1.1	-0.7	-0.8	-0.6
CB	-2.3	-0.4	0.1	-0.9	-0.8	0.5	0.1	0.8	-2.3	-0.8	-1.1	-1.0
CBH				-0.4	-1.8				-1.1	-0.3		
CBY1			-0.4				0.3			-3.0		-0.1
CCC1	0.0	-0.7	0.3	-0.3	-0.4	-0.3	-0.2	-0.4	-0.4	-1.1	-0.1	-0.3
CCC2	-0.2		-0.6	0.1	-0.5	-1.0	0.1		-0.9	0.5	0.1	-0.7
CCC3	-0.4	-0.3	0.2	-0.8	-0.9	-1.3	-0.5	-0.8	-0.9	-1.3	-0.8	-0.2
CCC4	1.9	-0.9	0.1	0.4	-0.6	1.2	0.7	2.0	0.1	0.2	0.1	0.7
CCC5	0.4	0.1	0.5	-1.6	0.4		-0.5		-0.1	0.3	-0.1	0.4
CCC6	-0.9	0.3	0.0	-0.6	-0.3	0.6	0.5	-0.3	0.5	0.1	-0.3	1.3
CCC7	-0.6	-2.3	0.4	-1.1	-0.7	0.2	-0.8	0.0	0.4	-0.8	-0.6	-1.4
CCC8	-0.5	0.0	0.4	0.3	0.4	-0.2	-0.3	-0.2	-0.2	-0.1	-0.3	-0.7

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CP01	0.2			-1.0	-1.1	0.0			-1.5	-0.8	-1.3	-0.6
CP02	-1.2	0.0	-0.5	-0.3	-0.6	-0.2	-1.5	-1.3	-1.4	-0.4	-0.5	0.4
CP03	-1.1	-0.5	0.0	-0.3	-0.3	0.5	-0.4	-0.1	1.2	-1.3	-1.0	-0.3
CP04	-0.8	0.0	-0.7	-1.3	-0.5	-0.2	-0.9	1.1	-0.9	-1.2	-0.8	-0.8
CP05	-0.7	-0.3	0.3	-0.2	0.0	0.0	-0.4	0.4	0.6	0.7	-0.2	-0.5
CP06	-0.8		0.2	-0.7	-0.8	-0.1	-1.9	-0.3	-0.2	-2.3	-1.0	1.0
CP07	-1.5	-0.2	0.2	-0.6	0.0	-0.4	-0.9	0.1	-0.6	-0.1	0.1	-0.4
CP08	-0.4	-0.8	-0.3	-0.5	-0.9	0.0	-1.5	0.4	-0.4	-1.4	-1.1	-0.5
CP09	-0.7	-0.5	-0.2	-0.3	-0.2	-0.3	-1.0	0.4	-0.6	-1.1	-0.1	-0.4
CP10	-1.2	-0.3	0.2	-0.9	-0.3	0.0	-0.3	-0.5	-0.6	-0.5	-0.3	-0.5
EF	-0.7	-0.5	-0.2	-2.4	-0.8	-1.3	-2.3	-1.2	-2.4	-2.7	0.5	-1.6
GR1			-2.0	0.1	-4.4					0.5		
GR2	-0.3	0.1	-0.1	-0.4	-0.1	0.3	-1.5	-1.7	-1.5	-0.4	0.4	-1.1
HI1	-2.9	-2.8	-0.5	1.0	-0.9	-1.0		-0.2	-1.1	-2.2	-0.5	-2.3
HI2	-0.4	-0.5	0.9	-0.8	-0.6	-3.1	0.2	-0.8	-0.6	-1.5	-0.5	0.2
I2	0.5	1.0	-0.3	-0.4	-0.9	-0.1	-0.2	1.1	-0.2	-0.9	0.0	0.3
I3	-2.2	-0.3	0.9	-0.5	-0.7	0.0	-0.1	-1.1	-2.2	-0.8	-0.8	-1.8
I4		0.5	0.1	-0.7	-1.0	-1.3	-0.1	0.3	-0.4	0.1	-1.1	0.6
I5	-1.1	0.0	-0.1	-0.6	-0.5	-0.6	-1.2	0.0		-2.1	-0.8	-0.2
I6	-0.5	0.1	0.0	-0.3	-0.7	0.0	-0.7	-0.1	0.4	-0.7	-0.9	-0.4
I7	-0.4	-0.1	-0.2	-0.6	-1.0	-0.3	0.3	0.2	-0.5	-0.4	-0.5	-0.2
I8	-1.5	-0.5	-1.1	-1.2	-1.7	-0.4	-0.6	0.4	-0.7	-0.7	0.5	1.1
I9	0.1	-0.1	0.7	0.1	0.7	-0.5	0.8	0.1	-0.6	-0.3	0.2	0.9
I10		0.3	-0.9	-1.1	0.0	-0.8	-0.6	-1.0	-1.6	-0.6	-1.6	-1.9
I11	-0.3	-0.6	1.5	-0.2	-1.3	-1.1	-1.1	-1.2	-0.6	-0.8	-0.3	-1.0
I12	-0.7	-0.5	-1.3	-1.0	-1.1	-1.5	-0.4	0.2	-1.9	-1.0	0.1	-1.1
I13	0.0	-0.3	1.3	-0.1	0.1	-0.5	-1.0	0.2	-3.9	-0.3	-0.4	0.0
I14	1.3	-0.8	2.4	-0.9	0.3	-1.1	-1.7	-2.9	-0.2	-0.1	0.4	1.2

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I15	0.9	1.1	0.6	0.0	0.1	0.1	1.1	1.3	-1.4	-0.5	0.1	0.2
I16	3.5	1.4	0.9	0.5	0.2	-0.4	-0.5	-2.0	-2.2	-1.1	0.8	1.5
I17	-0.7	-0.1	0.7	-0.6	0.0	0.4	-0.3	0.0	-1.2	-0.7	-0.6	-0.4
I18	0.1	0.8		-1.5	-0.2	0.5	0.4	-1.1	-0.9	-0.4	0.5	1.2
IH1	-2.4	0.2	-0.6	-0.2	0.8	0.8	-1.3	-0.2	1.3	1.0	-0.1	-1.2
IH2								0.9				
IH3		1.5	-3.8	0.2		2.0	-4.3	1.4		-0.3	-2.3	
IH4					-1.9	-1.4		1.3		0.2		
IH5	-2.1	0.3	-0.4	0.4	0.5	-0.2	-1.2	-0.8	2.5	-0.2	0.0	0.7
IH6	-1.4	0.2	1.7	0.8	0.4	2.5	0.7	0.4	1.3	1.0	1.3	1.4
IH7	1.0	0.5	0.7	0.6	1.0	0.7	0.0	0.9	1.1	0.6	1.2	1.2
INL		-1.1	-0.8		-0.2	-0.6	-1.2	-0.1	-0.9	0.4	-1.7	0.2
LAC	-1.0	-0.1	-0.2	-0.3	0.2	-0.1	-0.7	0.2	0.6	-1.3	-1.5	-0.9
LB	-1.6	-1.8	0.4	-0.9	-1.0	-0.2	-0.1	0.1	0.3	-0.6	-4.1	0.1
LQ1	-0.1	-0.6	0.3	-0.8	-0.8	-1.0	-0.3	-0.7	-1.2	-1.2	-0.6	-1.0
LQ2	-0.7	-0.7	-1.0	-0.8	-0.1	-0.1	-0.1	-0.5	-2.3	-0.3	0.3	-0.7
LS1			-0.7	0.1	-2.3		-2.2	1.3		0.9		-2.2
LS2	0.0	0.1	-0.7	-0.5	-0.4	-0.2	-1.7	-1.6	-1.2	-0.1	0.0	0.6
M1					-0.9	0.8			-0.6	0.3	-1.6	1.4
M2		-1.7	0.0	-0.5	-0.7	0.1	0.8	-2.5	0.2	-0.7	-1.3	-0.2
MB1	-0.8	-0.9	-0.5	-0.9	-0.5	-0.5	-0.3	-0.5	-0.7	-0.3	-1.6	-0.8
MB2	-1.2	-0.1	0.0	-0.7	-1.0	-0.3	0.0	0.2	-0.4	-0.9	-1.7	-0.6
NB1	2,9	-0.5	2.8	1.0	-0.4	-0.4	-0.3	-1.1	-1.8	-1.4	-1.2	0.0
NB2	2.5	-0.8	0.8	-0.4	-0.7	-0.2		-1.0	-1.7	-0.8	0.4	0.5
NB3	-0.4	0.7	1.5	0.4	0.9	0.3	-0.4	0.3	-0.4	-0.9	-0.3	
NB4	0.2	-0.6	0.5	-0.7	-0.6	-0.2	0.3	-0.5	0.3	-0.7	-0.5	-0.4
NB5	0.1	-0.3	0.3	-0.5	-0.1	0.0	0.1	0.0	0.0	-0.8	-0.5	-0.9
NB6	0.5	0.0	0.1	-0.1	0.7	-0.1	0.2	0.0	0.1	-0.7	-0.6	-0.2

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB7	-0.9	-0.3	0.6	-0.5	0.2	-0.8	0.5	-0.5	0.1	-0.9	-0.3	-0.2
NB8	0.7		1.0	0.6	-0.6	-0.1		-0.2	-1.1	-0.6	0.1	0.3
NB9	-1.1	-0.8	0.7	0.2	-0.2	-0.2	-0.8	-2.4	-2.3	-1.5	-2.2	-0.7
ND2	-0.6				-1.1		-1.2	-0.4	1.1	-1.0	0.5	
ND4	-0.2	-0.7	0.4	-0.3	0.8	0.2	0.8	0.9	0.7	-0.3	-0.4	-0.4
NR1	2.0	0.5	0.6	-1.5	0.1	0.6	0.0	1.9	0.1	0.9	1.2	0.6
NR3	0.5		-0.1	-1.7	1.5	1.1	-0.2	1.4		1.2	0.9	
NR4	-1.8	-2.4	-2.6	-1.0	-0.1	-0.7	-1.5	-1.7	-1.0	-1.1	-2.0	-0.8
NR5	-0.3	0.1	-1.1	-1.0	1.7	1.1	-0.6	0.7	1.3	-1.0	-1.3	0.2
OS1	0.0	-1.1	-2.4	-2.9	-1.3	-0.5	-5.1	-2.7	-3.7	-0.9	0.4	3.1
OS3	-0.6	-0.1	1.2	-1.0	-1.1	-1.2	-0.3	-0.7	-0.3	-2.2	-0.8	-0.7
OS4	-1.8	-0.8	-1.6	0.8	-2.8	-0.7	-0.3	-0.3	-2.2	-0.9	-1.7	-4.0
OS5	-2.8		-0.5	-2.1			-1.3	-4.7		-2.2	-1.3	-0.9
OS6	-0.8	-0.1	-3.8	-0.1	-0.7	-0.5	-1.0	-0.3	-1.5	-0.8	-0.4	-0.6
OS7	-2.0	-0.1	-1.6	-0.9	-0.9	-0.7	-2.4	-0.5	-1.1	-1.4	0.3	-1.6
PB1	0.0	-0.2	-0.7	-0.7	-0.2	-1.0	0.3	0.0	-0.2	-0.3	-0.3	-0.7
PB2	-1.6	0.5	-0.9	-1.3	-1.2	-1.4	-0.5	1.2	-1.0	-3.0	-1.9	-2.8
RB1	-1.7	-0.8	-1.1	-1.3	-1.5	-1.7	-1.5	-2.6	0.0	-3.4	-1.6	-1.2
RB2	-5.8	-2.1	-1.8	-2.6	-2.4	-1.3	-1.2	-1.6	-0.4	-3.3	-1.3	
RB3	-0.8	-0.5	-1.1	-1.3	-0.2	-2.1	-2.5	-0.6	-1.6	-1.6	-0.1	-1.8
RB4	0.4	-0.3	-0.5	-0.9	-3.8	-1.4	-1.3	-0.6	-1.0	-1.5	-0.8	1.5
RB5	-0.8	-0.5	-1.2	-1.3	-1.7	-1.7	-1.0	-0.9	-0.8	-1.2	-1.6	-0.5
RB6	-1.7	0.0	-0.7	-1.3	-0.8	-0.8	-0.4	-1.4	-1.0	-0.5	-0.3	-1.4
RB7	-0.8	-1.9	-1.4	-0.4	-2.1	-0.1	-6.9	0.7	-1.2	-1.5	-0.9	0.9
RB8	-0.5	0.1	-0.1	-0.1	-0.1	-0.5	-0.9	-0.1	-0.1	-0.4	-0.6	0.1
RB9	-1.0	1.4	0.3	-1.2	-1.8	-1.6	-2.1	-1.5	-1.2	-1.8	-0.3	-0.7
SC1	-0.4	-0.3	1.3	-0.7	0.2	0.8	0.7	0.5	-0.2	-0.4	0.5	0.5
SC2	-0.6	0.0	-0.4	-1.1	-0.7	0.6	-0.5	-0.2	-0.3	-1.5	-1.2	-0.2

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
SC3	-1.2	-0.3	0.3	-0.6	-0.9	-0.1	-0.1	0.3	-0.9	-0.6	-0.7	-0.6
UL01	-0.3	-1.4	-0.1	-1.1	-1.4	-0.6	-1.3	-0.9	-1.3	-0.7	-0.3	-2.2
UL02	0.4	0.7	0.7	-1.0	-2.1	-0.6	-0.5	-0.8	-0.9	-1.8	0.4	-0.2
UL03	1.8	1.0	0.2	-0.1	0.0	0.0	-0.4	1.1	0.5	1.6	-0.3	-0.2
UL04	-0.5	-0.5	-0.5	-1.7	-0.3	-1.6	-0.6	-0.4	-2.0	-2.0	0.1	-0.7
UL05	-0.7	-0.8		-1.1	-1.7	-1.4	-1.7	-2.5	-1.6	-0.7	-0.5	-0.7
UL06	0.4	-0.7	1.5	0.8	0.0	0.9	1.6	1.0	0.8	0.2	0.9	-0.5
UL07	0.9	0.5	-1.1	-1.3	-0.5	-0.7	-0.7	0.1	-1.4	-1.2	0.0	0.3
UL08	-0.3	0.8	0.9	-0.9	0.2	1.4	0.4	0.9	-0.2	0.7	-2.1	0.8
UL09	1.0		0.6	-0.6	-0.6	0.0	-0.8	0.2	-1.4	-0.4	1.1	-0.5
UL10	1.1	0.3	0.5	-0.5	-0.8	-1.1	0.0	0.0	-0.4	-0.6	0.3	-0.9
UL11			0.9	0.8	0.3	0.8	1.0	1.3	-3.8	-0.3		-0.5
GMI1	0.1				0.3	1.1	0.4	0.8	0.3	1.3	0.3	
GMI2	0.0	-0.4	0.1	0.6	0.4	0.7	0.9	0.7	0.6	0.4	0.1	-0.2
GMI3	-0.1	-0.1	0.5	0.2	0.8	0.8	0.6	0.8	0.7	0.7	0.5	-0.2
GMI4	-0.4	-0.5	-0.4	0.0	0.3	0.4	0.2	0.7	-0.2	-0.2	0.3	-0.2
GMI5	-0.6	0.5	-0.4	0.1	0.2	0.8	0.5	0.3	0.6	0.4	1.2	-0.4
GMI6	-0.5	-0.1	0.6	0.2	0.2	0.3	-0.8	0.1	0.3	0.2	-0.1	0.7
GMI7	-0.2	0.0	0.1	-2.1	-0.3	0.0	-1.0	-0.1	0.2	0.1	-0.2	0.1
GMI8	-1.7	0.0	-0.4	-2.1	-0.2	-0.3	0.1	-1.1	0.0	-0.1	-0.2	0.1
GMI9	0.1	-0.5	-0.1	-2.8	-1.0	0.2	-0.9	-2.0	-0.7	-0.2	-1.8	-1.8
GMO4		0.2								-0.5	0.6	
GMO5	-1,5	0.6	-2.1					-2.1	0.3	0.3	-0.4	0.2
GMO6		0.6	-0.5	0.0		0.5			-1.2	-0.2	-0.4	-0.7

(continued)

Table 6-12
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
GMO7	-1.4	-0.2	-1.3	-0.4	0.4		-4.2	-0.9	-2.7	-0.4	0.7	-0.6
Aransas Bay	-0.2	0.0	0.5	-0.5	-0.8	-0.7	-0.8	-0.4	-0.9	-1.0	-0.9	-0.1
Copano Bay	-0.9	-0.3	-0.1	-0.6	-0.4	-0.1	-1.0	0.0	-0.3	-0.8	-0.6	-0.2
St Charles	-0.9	-0.2	-0.1	-0.8	-0.8	0.2	-0.3	0.0	-0.6	-1.0	-0.9	-0.4
Mesquite	-1.4	-0.3	0.0	-0.6	-0.6	0.1	0.0	0.5	-0.8	-0.3	-0.9	-0.6
Redfish	-1.4	-0.5	-0.8	-1.1	-1.6	-1.2	-2.0	-0.8	-0.9	-1.5	-0.7	-0.3
Corpus Christi	-0.6	0.0	-0.1	-0.7	-0.4	-0.5	-1.0	-0.3	-0.3	-0.7	-0.3	-0.3
CCSC (bay)	0.1	-0.6	0.3	-0.7	-0.4	0.2	-0.1	0.2	0.0	-0.3	-0.4	0.2
Inner Harbor	-1.3	0.6	-0.5	0.4	0.2	0.7	-1.2	0.5	1.6	0.4	0.0	0.5
Nueces Bay	0.6	-0.2	0.8	-0.1	-0.2	0.0	0.0	-0.3	-0.6	-0.8	-0.2	-0.1
Aransas Pass	-1.3	-1.1	-0.3	0.1	-0.3	-0.5	-0.7	-0.1	-0.4	-1.0	-0.9	-0.8
Causeway N	0.1	-0.3	0.4	-0.3	-0.1	-0.4	-0.2	-0.6	-0.6	-0.5	-0.8	0.4
Causeway S	-0.1	-0.2	-0.2	-1.2	-0.9	-0.9	-0.8	-0.8	-1.5	-1.2	-0.3	-1.3
Laguna (King)	0.4	0.0	0.7	-0.4	-0.4	-0.3	-0.3	0.0	-1.2	-0.3	-0.1	-0.2
Laguna (Baffin)	1.0	0.7	0.8	-0.5	0.0	0.1	-0.2	-1.0	-1.5	-0.7	0.2	0.8
Baffin Bay	0.2	0.4	-0.2	-0.6	-0.3	-0.4	-0.5	-0.6	-0.6	-0.5	-0.3	-0.7
GOM inlet	-0.8	0.2	-0.6	-0.4	0.1	0.4	-1.4	-0.5	-0.4	0.1	0.1	-0.1

Table 6-13
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQAMMN

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1				0.000						0.005		
A2	0.100	0.060	0.223	0.038	0.067	0.100	0.123	0.100	0.100	0.100	0.077	0.133
A3	0.082	0.025	0.210	0.060	0.052	0.043	0.108	0.100	0.090	0.058	0.054	0.098
A4	0.020		0.027		0.032		0.020		0.020		0.023	
A5	0.010			0.005	0.000	0.020		0.005				
A10						0.030						
A12	0.064	0.060	0.087	0.054	0.042	0.072	0.058	0.050	0.120	0.078	0.045	0.093
AL2	0.046	0.180	0.044	0.115	0.044	0.025	0.030		0.030	0.088	0.036	
AR1	0.123	0.030	0.000	0.082	0.032	0.000	0.058	0.018	0.037	0.081	0.073	0.055
BF1	0.075	0.047	0.075	0.129	0.034	0.017	0.132	0.042	0.025	0.054	0.028	0.026
BF2	0.099	0.055	0.074	0.066	0.060	0.015	0.085	0.021	0.098	0.070	0.019	0.112
BF3	0.054	0.043	0.035	0.061	0.036	0.017	0.069	0.040	0.011	0.052	0.024	0.009
C02	0.075	0.040	0.051	0.065	0.015	0.130	0.167	0.019	0.000	0.046	0.024	0.223
C03	0.335	0.098	0.054	0.075	0.063	0.132	0.210	0.167	0.069	0.118	0.123	0.246
C04	0.075	0.045	0.045	0.048	0.021	0.181	0.245	0.013	0.049	0.012	0.066	0.147
C05	0.080	0.045	0.110	0.090	0.083	0.065	0.100	0.073	0.050	0.112	0.080	0.088
C06	0.100		0.100	0.050	0.032	0.085	0.100	0.100	0.073	0.048	0.100	0.100
C07	0.063	0.096	0.042	0.082	0.060	0.120	0.067	0.068	0.048	0.087	0.048	0.325
C08	0.112	0.036	0.058	0.057	0.016	0.157	0.267	0.011	0.061	0.020	0.055	0.238
C09	0.010	0.027	0.075	0.053		0.050		0.030		0.225		
C10	0.062	0.075	0.040	0.072	0.045	0.099	0.112	0.042	0.047	0.053	0.046	0.146
C11	0.071	0.059	0.064	0.060	0.042	0.076	0.070	0.068	0.098	0.053	0.102	0.105
C12	0.180	0.041	0.037	0.052	0.034	0.101	0.077	0.039	0.046	0.034	0.035	0.139
C14	0.071	0.051	0.031	0.022	0.048	0.056	0.036	0.025	0.065	0.027	0.037	0.121
C15	0.120	0.049	0.118	0.117	0.098	0.070	0.105	0.053	0.118	0.086	0.058	0.130
C17	0.048	0.038	0.047	0.059	0.041	0.068	0.091	0.044	0.038	0.110	0.046	0.156
C20	0.072	0.031	0.067	0.060	0.048	0.146	0.173	0.012		0.019	0.028	0.130

(continued)

Table 6-13
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C21	0.100	0.090	0.055	0.077	0.084	0.103	0.102	0.073	0.100	0.092	0.096	0.100
C22	0.150		0.200			0.100	0.100	0.100	0.100	0.100	0.100	0.100
C23	0.024	0.035	0.067	0.062	0.011	0.174	0.298	0.013	0.050	0.016	0.168	0.108
C24	0.027	0.070	0.039	0.060	0.018	0.074	0.100	0.016	0.024	0.020	0.027	0.220
CB	0.078	0.038	0.068	0.049	0.052	0.066	0.133	0.046	0.103	0.162	0.062	0.088
CBY1	0.004		0.010	0.009		0.058	0.033					
CCC1	0.033	0.039	0.037	0.050	0.026	0.047	0.067	0.011	0.061	0.033	0.051	0.099
CCC2					0.317		0.100					
CCC3	0.046	0.073	0.027	0.068	0.048	0.184	0.086	0.040	0.050	0.036	0.049	0.153
CCC4							0.100					
CCC5	0.029	0.044	0.038	0.052	0.023	0.160	0.084	0.012	0.097	0.033	0.032	0.280
CCC6	0.040	0.062	0.100	0.061	0.036	0.046	0.086	0.031	0.065	0.067	0.041	0.193
CCC7	0.071	0.041	0.045	0.065	0.041	0.080	0.067	0.053	0.073	0.027	0.039	0.035
CCC8	0.066	0.144	0.055	0.664	0.102	0.180	0.277	0.114	0.180	0.069	0.059	0.219
CP02				0.036	0.023	0.020		0.025		0.003	0.033	
CP03	0.170	0.043	0.303	0.046	0.080	0.073	0.107	0.068	0.118	0.042	0.077	0.100
CP05	0.095	0.050	0.170	0.043	0.045	0.075	0.070	0.070	0.090	0.053	0.056	0.133
CP07	0.064	0.024	0.196	0.033	0.029	0.053	0.123	0.063	0.093	0.071	0.059	0.105
CP09						0.010				0.200		
CP10	0.045	0.057	0.211	0.037	0.245	0.058	0.044	0.074	0.103	0.073	0.048	0.084
GR2		0.217		0.215	0.170	0.000			0.000	0.067		
I2			0.100			0.100	0.125					
I3	0.116	0.024	0.148	0.087	0.035	0.047	0.092	0.067	0.100	0.138	0.124	0.093
I4					0.000			0.057				
I5	0.045	0.020		0.035	0.049	0.040	0.115	0.005	0.085	0.050	0.033	
I6	0.097	0.107	0.075	0.142	0.047	0.050	0.091	0.021	0.058	0.071	0.038	0.144
I7	0.060	0.025	0.032	0.010	0.102	0.045	0.029		0.027	0.000	0.040	
I9	0.055	0.056	0.077	0.075	0.086	0.063	0.141	0.149	0.114	0.043	0.097	0.154

(continued)

Table 6-13
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I10	0.006	0.034	0.025	0.014	0.008	0.018	0.015	0.003	0.020	0.007	0.007	0.008
I11								0.460	0.000	0.020		
I12	0.049	0.098	0.000	0.179	0.031	0.000	0.225	0.037	0.000	0.120	0.038	
I13	0.025	0.017	0.023	0.018	0.021	0.016	0.063	0.012	0.033	0.023	0.022	0.006
I15	0.028	0.075	0.027	0.041	0.031	0.015	0.044	0.125	0.016	0.170	0.017	0.008
I17	0.057	0.079	0.054	0.187	0.041	0.011	0.082	0.029	0.005	0.089	0.037	0.006
IH1	0.369	0.340	0.097	0.671	0.274	0.510	0.624	0.252	0.726	0.413	0.569	
IH2								0.155				
IH3						0.300		0.178				
IH4								0.158				
IH5	0.226	0.317	0.975	0.885	0.504	0.324	0.184	0.255	0.516	0.547	0.174	0.247
IH6	0.297	0.256		0.531	0.168	0.165	0.334	0.201	0.190	0.163	0.189	
IH7	0.235	0.222	0.328	0.293	0.117	0.236	0.140	0.208	0.120	0.238	0.175	0.355
INL							0.100					
LAC	0.037	0.003		0.048	0.067	0.022	0.068		0.193	0.265	0.036	
LQ1				0.000								0.117
LQ2	0.056	0.168	0.000	0.238	0.027	0.003	0.027	0.012	0.000	0.065	0.011	0.040
LS1	0.049	0.112	0.018	0.018	0.019	0.042	0.075	0.006	0.019	0.019	0.009	0.005
LS2	0.061	0.053	0.019	0.049	0.039	0.020	0.008	0.005	0.006	0.012	0.009	0.005
MB1	0.071	0.435	0.039	0.003	0.037	0.110	0.028	0.000	0.037	0.017	0.000	0.128
MB2	0.006		0.008	0.006		0.067	0.044					
NB1	0.151	0.051	0.034	0.074	0.192	0.152	0.189	0.040	0.066	0.049	0.046	0.112
NB2	0.111	0.034	0.020	0.118	0.134	0.131	0.192	0.019	0.073	0.037	0.016	0.244
NB3	0.061	0.047	0.041	0.059	0.077	0.135	0.069	0.034	0.038	0.075	0.028	0.177
NB4	0.120	0.106	0.042	0.121	0.125	0.117	0.176	0.016	0.046	0.033	0.033	0.178
NB5	0.136	0.097	0.061	0.061	0.086	0.103	0.093	0.056	0.053	0.063	0.053	0.109
NB6	0.395	0.080	0.051	0.090	0.135	0.107	0.128	0.070	0.090	0.062	0.093	0.106
NB7	0.270	0.127	0.075	0.099	0.036	0.000	0.113	0.023	0.048	0.082	0.016	0.100

(continued)

Table 6-13
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB8	0.086		0.016	0.003	0.060	0.149	0.151	0.013		0.034	0.019	0.163
NB9			0.021	0.006			0.171	0.020				
ND2		0.200	0.085	0.073	0.045	0.158				0.085	0.075	0.045
NR1		0.120	0.007	0.000	0.030	0.038	0.127		0.023		0.028	
NR3							0.155			0.287		
NR4	0.315	0.236	0.162	0.142	0.063	0.110	0.055	0.170	0.056	0.158	0.195	0.320
NR5	0.065		0.100	0.327	0.043	0.073	0.157	0.220	0.100	0.082	0.100	0.100
OS1	11.880	5.846		6.885			3.728	8.600	3.750	4.369	9.306	
OS3	0.140	0.305		0.285	0.065		0.975		0.120	0.490		
OS6	0.180	0.522		0.112	0.055		0.030	0.027	0.070	0.098	0.100	0.027
OS7	1.154	0.417		0.600	3.076		0.040	0.059	0.070	0.114	0.113	0.140
PB1	0.069	0.056	0.070	0.315	0.051	0.065	0.031	0.047	0.055	0.110	0.044	0.000
RB1	0.065	0.015		0.000	0.085	0.035	0.040				0.050	
RB3	0.092	0.166	0.036	0.136	0.029	0.023	0.029	0.044	0.042	0.117	0.039	0.040
RB5	0.100		0.100			0.100	0.100	0.100	0.100	0.100	0.100	0.100
RB6	0.100		0.100			0.100	0.100	0.100	0.100	0.100	0.100	0.100
RB8	0.066	0.042	0.025	0.063	0.023	0.018	0.030	0.012	0.028	0.079	0.021	0.033
RB9							0.073					
SC2	0.030	0.040		0.034	0.045			0.025		0.000	0.296	
SC3	0.059	0.047	0.052	0.231	0.043	0.044	0.041	0.049	0.055	0.070	0.034	0.041
UL03		0.008	0.010	0.036	0.012	0.029	0.064	0.002	0.030		0.009	0.004
UL04	0.028	0.070	0.000	0.080	0.054	0.000	0.084	0.083	0.027	0.063	0.039	
UL11			0.200			0.037				0.013		
GMI4	0.080	0.088	0.050	0.522	0.023		0.117	0.042	0.057	0.125	0.028	
GMI6	0.086	0.029	0.287	0.061	0.175	0.028	0.081	0.012	0.073	0.107	0.031	0.073
GMO6			0.670		0.015	0.000			0.088			

(continued)

Table 6-13
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	0.059	0.060	0.105	0.063	0.044	0.045	0.072	0.081	0.058	0.083	0.042	0.068
Copano Bay	0.094	0.044	0.220	0.039	0.085	0.048	0.086	0.060	0.101	0.074	0.054	0.106
St Charles	0.044	0.044	0.052	0.133	0.044	0.044	0.041	0.037	0.055	0.035	0.165	0.041
Mesquite	0.052	0.236	0.038	0.019	0.044	0.081	0.069	0.023	0.070	0.089	0.031	0.108
Redfish	0.089	0.104	0.065	0.100	0.026	0.060	0.066	0.064	0.068	0.099	0.065	0.068
Corpus Christi	0.096	0.057	0.069	0.063	0.043	0.113	0.143	0.055	0.060	0.061	0.075	0.155
CCSC (bay)	0.046	0.055	0.053	0.061	0.037	0.117	0.085	0.034	0.071	0.041	0.040	0.165
Inner Harbor	0.282	0.284	0.467	0.595	0.266	0.307	0.321	0.201	0.388	0.340	0.277	0.301
Nueces Bay	0.103	0.071	0.036	0.072	0.096	0.127	0.136	0.028	0.052	0.048	0.030	0.174
Aransas Pass	0.035	0.021	0.037	0.049	0.046	0.034	0.078	0.011	0.127	0.149	0.043	0.099
Causeway N	0.041	0.063	0.058	0.068	0.052	0.068	0.121	0.082	0.069	0.031	0.062	0.187
Causeway S	0.017	0.052	0.012	0.047	0.031	0.009	0.049	0.043	0.023	0.035	0.023	0.008
Laguna (King)	0.034	0.049	0.052	0.069	0.024	0.019	0.099	0.127	0.016	0.069	0.022	0.006
Laguna (Baffin)	0.057	0.079	0.054	0.187	0.041	0.011	0.082	0.029	0.005	0.089	0.037	0.006
Baffin Bay	0.068	0.108	0.057	0.117	0.069	0.015	0.079	0.034	0.033	0.066	0.027	0.049
GOM inlet	0.086	0.029	0.478	0.061	0.095	0.014	0.081	0.012	0.080	0.107	0.031	0.073

Table 6-14
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQNO3N

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1				0.005						0.000		
A2	0.030	0.015	0.020	0.008	0.017	0.035	0.020	0.030	0.030	0.180	0.023	0.030
A3	0.016	0.010	0.014	0.008	0.007	0.008	0.018	0.030	0.015	0.133	0.020	0.030
A4	0.020		0.012		0.017		0.010		0.010		0.010	
A5	0.000			0.000	0.000	0.000		0.005				
A10						0.000						
A12	0.010	0.007	0.020	0.006	0.032	0.006	0.018	0.016	0.015	0.040	0.026	0.027
AL2	0.012	0.070	0.042	0.000	0.016	0.030	0.010		0.006	0.023	0.010	
AR1	0.035	0.154	0.013	0.609	0.022	0.020	0.245	0.052	0.038	0.027	0.034	0.030
BF1	0.033	0.026	0.019	0.073	0.017	0.011	0.014	0.027	0.008	0.040	0.008	0.003
BF2	0.035	0.004	0.023	0.012	0.014	0.010	0.021	0.006	0.028	0.019	0.012	0.016
BF3	0.023	0.015	0.010	0.099	0.022	0.004	0.019	0.021	0.002	0.036	0.008	0.002
C02	0.029	0.039	0.034	0.200	0.023	0.190	0.274	0.003	0.003	0.016	0.041	0.034
C03	0.030	0.021	0.026	0.012	0.021	0.073	0.093	0.024	0.104	0.031	0.061	0.040
C04	0.026	0.026	0.031	0.180	0.011	0.227	0.144	0.003	0.339	0.017	0.039	0.036
C05	0.016	0.008	0.016	0.016		0.007	0.024	0.018	0.015	0.010	0.030	0.027
C06	0.030		0.040	0.010	0.006	0.015	0.030	0.030	0.015	0.010	0.030	0.027
C07	0.025	0.014	0.015	0.008	0.014	0.017	0.017	0.020	0.017	0.020	0.027	0.026
C08	0.027	0.025	0.033	0.024	0.020	0.213	0.115	0.006	0.105	0.010	0.069	0.051
C09	0.000	0.000		0.010		0.000		0.003		0.000		
C10	0.015	0.019	0.016	0.013	0.017	0.030	0.045	0.012	0.050	0.012	0.026	0.030
C11	0.014	0.013	0.015	0.011	0.019	0.015	0.015	0.017	0.042	0.009	0.019	0.025
C12	0.014	0.013	0.016	0.010	0.016	0.036	0.042	0.011	0.036	0.008	0.013	0.030
C14	0.022	0.007	0.015	0.011	0.038	0.039	0.013	0.010	0.042	0.008	0.021	0.024
C15	0.038	0.042	0.026	0.143	0.070	0.018	0.095	0.022	0.075	0.076	0.046	0.032
C17	0.017	0.024	0.019	0.039	0.013	0.037	0.032	0.011	0.032	0.008	0.020	0.033
C18							0.013					

(continued)

Table 6-14
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C20	0.031	0.027	0.028	0.015	0.062	0.179	0.059	0.001		0.021	0.038	0.035
C21	0.017	0.015	0.015	0.008	0.020	0.017	0.014	0.018	0.030	0.020	0.011	0.025
C22	0.030		0.030			0.030	0.030	0.030	0.030	0.030	0.030	0.027
C23	0.032	0.023	0.025	0.010	0.025	0.276	0.213	0.006	0.124	0.021	0.039	0.040
C24	0.019	0.026	0.017	0.015	0.013	0.102	0.050	0.000	0.008	0.010	0.018	0.027
C25		0.010	0.050	0.013	0.010		0.040			0.010		
CB	0.014	0.008	0.015	0.011	0.020	0.011	0.020	0.016	0.015	0.055	0.024	0.027
CBY1	0.026		0.012	0.072		0.375	0.012					
CCC1	0.012	0.022	0.011	0.036	0.017	0.023	0.017	0.005	0.466	0.850	0.015	0.018
CCC3	0.011	0.012	0.008	0.005	0.025	0.127	0.032	0.009	0.276	0.404	0.008	0.018
CCC4							0.027					
CCC5	0.016	0.022	0.013	0.021	0.015	0.092	0.038	0.005	0.039	0.013	0.013	0.026
CCC6	0.043	0.016	0.040	0.128	0.047	0.036	0.127	0.011	0.025	0.022	0.011	0.020
CCC7	0.012	0.033	0.012	0.029	0.009	0.036	0.021	0.012	0.110	0.104	0.033	0.081
CCC8	0.036	0.124	0.035	0.145	0.116	0.166	0.340	0.250	0.068	0.037	0.062	0.283
CP02			2.537	0.006	0.033	0.007		0.005		0.030	0.053	
CP03	0.020	0.010	0.820	0.008	0.013	0.053	0.023	0.018	0.108	0.088	0.078	0.025
CP05	0.015	0.015	0.023	0.047	0.025	0.035	0.027	0.027	0.120	0.023	0.052	0.027
CP07	0.014	1.090	1.096	0.013	0.014	0.021	0.038	0.015	0.015	0.038	0.051	0.027
CP09						0.040				0.030		
CP10	0.052	0.038	1.021	0.027	0.368	0.012	0.012	0.123	0.042	0.024	0.020	0.020
GR2		0.047		0.010	0.020	0.000			0.000	0.021		
I2			0.030			0.040	0.040					
I3	0.016	0.008	0.012	0.015	0.028	0.018	0.020	0.030	0.030	0.065	0.064	0.027
I5	0.003	0.000		0.000	0.000	0.000	0.000		0.000	0.005	0.050	
I6	0.048	0.019	0.030	0.167	0.032	0.050	0.143	0.003	0.012	0.014	0.028	0.022
I7	0.010	0.000	0.010	0.003	0.006	0.000	0.009		0.007	0.000	0.005	
I9	0.019	0.006	0.025	0.062	0.031	0.019	0.036	0.334	0.514	0.010	0.009	0.672

(continued)

Table 6-14
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I10	0.005	0.006	0.011	0.004	0.005	0.002	0.012	0.004	0.017	0.003	0.006	0.008
I11								0.150	0.050	0.000		
I12	0.024	0.027	0.020	0.140	0.017	0.045	0.022	0.017	0.000	0.039	0.007	
I13	0.009	0.003	0.007	0.005	0.006	0.002	0.009	0.005	0.013	0.005	0.008	0.007
I15	0.009	0.000	0.007	0.004	0.009	0.002	0.009	0.141	0.003	0.000	0.009	0.008
I17	0.023	0.026	0.009	0.114	0.024	0.001	0.019	0.014	0.016	0.047	0.014	0.006
IH1	0.204	0.197	0.078	0.167	0.234	0.096	0.271	0.264	0.063	0.065	0.057	
IH2								0.050				
IH3							0.020	0.067				
IH4								0.120				
IH5	0.184	0.397	0.103	0.301	0.350	0.240	0.489	1.132	0.103	0.227	0.231	0.203
IH6	0.118	0.227		0.264	0.226	0.205	0.197	0.062	0.123	0.107	0.122	
IH7	0.130	0.106	0.174	0.045	0.226	0.022	0.029	0.050	0.008	0.062	0.058	0.180
INL							0.030					
LAC	0.000	0.000		0.010	0.015	0.004	0.018		0.200	0.007	0.006	
LQ1							0.025					
LQ2	0.043	0.016	0.000	0.165	0.019	0.030	0.176	0.003	0.000	0.020	0.023	0.000
LS1	0.019	0.003	0.004	0.007	0.002	0.006	0.006	0.005	0.024	0.000	0.008	0.002
LS2	0.027	0.001	0.005	0.005	0.004	0.004	0.012	0.004	0.006	0.007	0.007	0.002
MB1	0.329	0.015	0.161	0.089	0.035	0.177	0.026	0.000	0.017	0.032	0.000	0.042
MB2	0.023		0.004	0.091		0.134	0.015					
NB1	0.033	0.076	0.174	0.060	0.106	0.146	0.092	0.012	0.103	0.022	0.079	0.064
NB2	0.015	0.063	0.203	0.212	0.018	0.098	0.094	0.015	0.095	0.027	0.034	0.038
NB3	0.014	0.342	0.073	0.163	0.054	0.183	0.032	0.008	0.040	0.012	0.036	0.043
NB4	0.026	0.063	0.093	0.089	0.084	0.151	0.036	0.025	0.060	0.020	0.027	0.044
NB5	0.040	0.085	0.062	0.077	0.080	0.078	0.048	0.019	0.059	0.022	0.034	0.209
NB6	0.024	0.217	0.081	0.100	0.041	0.087	0.064	0.018	0.083	0.028	0.082	2.048
NB7	0.130	0.062	0.085	0.238	0.034	0.050	0.183	0.025	0.024	0.022	0.079	0.075

(continued)

Table 6-14
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB8	0.029		0.077	0.012	0.037	0.144	0.110	0.009		0.037	0.036	0.051
NB9			0.087	0.009			0.105	0.078				
ND2		0.075	0.020	0.040	0.030	0.093				0.033	0.020	0.040
NR1		0.000	0.057	0.000	0.700	0.000	0.072		0.206	0.500	0.149	0.635
NR3							0.013			0.160	0.010	
NR4	0.155	0.113	0.250	0.080	0.061	0.103	0.039	0.021	0.034	0.201	0.233	0.285
NR5	0.015		0.045	0.038	1.410	0.030	0.034	0.020	0.075	0.030	0.035	0.080
OS1	0.640	1.024		1.262			0.134	0.350	0.887	1.787	1.335	
OS3	0.025	0.730		0.400	0.215		0.065		0.035	0.053		
OS6	0.050	0.236		0.174	0.020		0.005	0.090	0.170	0.072	0.058	0.000
OS7	0.020	0.055		0.314	0.050		0.340	0.120	0.043	0.039	0.018	0.035
PB1	0.018	0.081	0.040	0.262	0.026	0.065	0.364	0.020	0.055	0.031	0.030	0.065
RB1	0.000	0.000		0.000	0.000	0.000	0.000				0.018	
RB3	0.038	0.005	0.020	0.300	0.025	0.010	0.258	0.005	1.143	0.340	0.049	1.875
RB5	0.030		0.030			0.030	0.030	0.030	0.030	0.030	0.030	0.030
RB6	0.030	0.165	0.030			0.030	0.030	0.030	0.030	0.030	0.030	0.027
RB8	0.023	0.012	0.032	0.091	0.012	0.008	0.082	0.003	0.003	0.023	0.049	0.013
RB9							0.023					
SC2	0.000	0.000		0.002	0.018			0.000		0.050	0.140	
SC3	0.038	0.036	0.094	0.116	0.029	0.024	0.120	0.008	0.034	0.040	0.016	0.028
UL03		0.000	0.012	0.005	0.004	0.004	0.009	0.005	0.025		0.010	0.008
UL04	0.046	0.029	0.040	0.041	0.038	0.100	0.025	0.025	0.000	0.015	0.006	
UL11			0.067			0.007				0.000		
GMI4	0.017	0.038	0.055	0.577	0.065		0.743	0.018	0.000	0.040	0.015	
GMI6	0.038	0.004	0.019	0.129	0.109	0.024	0.163	0.010	0.050	0.021	0.042	0.022
GMO6				0.045	0.000	0.035			0.000			

(continued)

Table 6-14
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	0.018	0.012	0.014	0.024	0.017	0.009	0.016	0.046	0.015	0.067	0.017	0.020
Copano Bay	0.025	0.288	1.099	0.020	0.090	0.028	0.025	0.037	0.071	0.039	0.051	0.025
St Charles	0.019	0.018	0.094	0.059	0.023	0.024	0.120	0.004	0.034	0.045	0.078	0.028
Mesquite	0.122	0.011	0.060	0.064	0.028	0.107	0.020	0.008	0.016	0.043	0.012	0.034
Redfish	0.030	0.060	0.028	0.196	0.019	0.020	0.085	0.017	0.301	0.106	0.039	0.486
Corpus Christi	0.024	0.020	0.024	0.040	0.022	0.091	0.071	0.014	0.068	0.016	0.033	0.032
CCSC (bay)	0.020	0.021	0.018	0.046	0.024	0.073	0.049	0.009	0.113	0.136	0.017	0.036
Inner Harbor	0.159	0.232	0.118	0.194	0.259	0.141	0.201	0.249	0.074	0.115	0.117	0.192
Nueces Bay	0.025	0.138	0.102	0.111	0.055	0.131	0.064	0.015	0.063	0.023	0.033	0.077
Aransas Pass	0.006	0.011	0.011	0.023	0.016	0.014	0.021	0.005	0.333	0.428	0.011	0.018
Causeway N	0.019	0.014	0.031	0.030	0.018	0.060	0.042	0.167	0.261	0.010	0.013	0.349
Causeway S	0.025	0.017	0.025	0.023	0.021	0.051	0.019	0.014	0.008	0.009	0.006	0.008
Laguna (King)	0.014	0.008	0.023	0.039	0.009	0.012	0.012	0.064	0.018	0.009	0.008	0.008
Laguna (Baffin)	0.023	0.026	0.009	0.114	0.024	0.001	0.019	0.014	0.016	0.047	0.014	0.006
Baffin Bay	0.026	0.033	0.024	0.039	0.018	0.011	0.016	0.018	0.009	0.028	0.009	0.007
GOM inlet	0.038	0.004	0.019	0.087	0.054	0.030	0.163	0.010	0.025	0.021	0.042	0.022

Table 6-15
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQTOTP

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	15.3	15.0	15.9	15.3	15.4	13.8	12.2	22.7	21.8	18.9	16.1	16.4
A2	15.2	16.5	18.4	16.5	11.8	17.7	15.2	21.3	18.1	18.0	16.2	14.4
A1				0.075						0.085		
A2	0.075	0.035	0.090	0.080	0.228	0.040	0.160	0.060	0.075	0.085	0.073	0.065
A3	0.062	0.063	0.055	0.078	0.090	0.063	0.152	0.060	0.055	0.072	0.060	0.065
A4	0.093		0.077		0.120		0.122		0.123		0.105	
A5	0.060			0.060	0.100	0.030		0.050				
A10						0.015						
A12	0.052	0.040	0.078	0.080	0.072	0.046	0.114	0.060	0.035	0.070	0.060	0.053
AL2	0.128	0.090	0.208	0.260	0.104	0.205	0.142		0.078	0.165	0.106	
AR1	0.092	0.136	0.127	0.164	0.143	0.115	0.126	0.282	0.186	0.168	0.102	0.123
BF1	0.100	0.100	0.137	0.101	1.030	0.145	0.103	0.147	0.084	0.096	0.096	0.100
BF2		0.138	0.060	0.147	0.115	0.093	0.068		0.059	0.117	0.051	0.109
BF3	0.147	0.065		0.106	0.086	0.063	0.059	0.127	0.058	0.084	0.076	
C02	0.066	0.062		0.074	0.088		0.145	0.119	0.080	0.065	0.068	
C03	0.385	0.097	0.080	0.080	0.110	0.053		0.100		0.116	0.187	
C04					0.070							
C05	0.055	0.061	0.077	0.146	0.050	0.072	0.070	0.073	0.040	0.072	0.060	0.044
C06	0.035		0.025	0.163	0.036	0.073	0.035	0.050	0.033	0.060	0.040	0.040
C07	0.053	0.042	0.058	0.045	0.068	0.048	0.076	0.058	0.068	0.058	0.057	0.045
C09	0.060	0.057	0.065	0.037		0.053		0.080		0.068		
C10	0.056	0.042	0.050	0.037	0.060	0.047	0.074	0.067	0.068	0.059	0.057	0.038
C11	0.050	0.053	0.061	0.075	0.069	0.058	0.065	0.059	0.060	0.049	0.069	0.029
C12	0.041	0.030	0.041	0.077	0.065	0.055	0.067	0.058	0.045	0.061	0.064	0.030
C14	0.048	0.017	0.045	0.102	0.086	0.030	0.068	0.060	0.059	0.052	0.054	0.033
C15	0.089	0.077	0.088	0.100	0.110	0.125	0.153	0.116	0.098	0.098	0.100	0.095
C17	0.059	0.066	0.061	0.115	0.064	0.072	0.090	0.065	0.065	0.084	0.063	0.038

(continued)

Table 6-15
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C21	0.032	0.044	0.040	0.038	0.074	0.042	0.058	0.060	0.030	0.042	0.054	0.038
C22	0.040		0.025			0.045	0.095	0.040	0.030	0.045	0.045	0.050
C24	0.063		0.065		0.082		0.058		0.060		0.070	
CB	0.073	0.097	0.164	0.113	0.120	0.110	0.180	0.094	0.075	0.123	0.090	0.076
CCC1	0.051	0.119	0.052	0.049	0.085	0.057	0.047		0.051	0.053	0.044	0.015
CCC2							0.036					
CCC3	0.057	0.045	0.052	0.054	0.073	0.035	0.050	0.175	0.064	0.048	0.047	
CCC4							0.063					
CCC5	0.058		0.064		0.068		0.074		0.085		0.063	
CCC6	0.041	0.063	0.033	0.057	0.044	0.072	0.041	0.079	0.061	0.058	0.077	0.080
CCC7	0.074		0.054	0.118	0.078	0.073	0.111	0.070	0.093	0.065	0.057	0.047
CCC8	0.104	0.101		0.082	0.102	0.170	0.083	0.104	0.075	0.085	0.093	
CP02				0.076	0.193	0.057	0.265	0.065		0.060	0.050	
CP03	0.080	0.057	0.078	0.080	0.136	0.192	0.080	0.083	0.205	0.148	0.082	0.085
CP05	0.128	0.035	0.113	0.117	0.240	0.108	0.083	0.080	0.090	0.065	0.064	0.063
CP07	0.066	0.046	0.077	0.079	0.089	0.070	0.162	0.095	0.045	0.089	0.070	0.075
CP09						0.090				0.125		
CP10	0.086	0.066	0.068	0.082	0.074	0.061	0.127	0.082	0.078	0.115	0.069	0.117
GR2		0.210		0.345	0.210	0.225			0.110	0.310		
I2			0.084			0.152	0.036					
I3	0.066	0.068	0.156	0.050	0.138	0.088	0.145	0.070	0.095	0.135	0.100	0.070
I5	0.066	0.075		0.092	0.097	0.083	0.127		0.040	0.075	0.073	
I6	0.071	0.056	0.040	0.069	0.092	0.030	0.044	0.081	0.073	0.084	0.067	0.043
I7	0.065	0.020	0.058	0.100	0.088	0.038	0.103		0.058	0.070	0.065	
I9	0.046	0.056	0.047	0.062	0.088	0.051	0.066	0.095	0.056	0.049	0.061	0.038
I11								0.090	0.035	0.085		
I12	0.031	0.046	0.000	0.075	0.037	0.100	0.041	0.052	0.043	0.049	0.042	
I13	0.052		0.080		0.060		0.052		0.053		0.064	

(continued)

Table 6-15
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I15	0.050	0.053	0.085	0.205	0.070		0.068	0.080	0.022	0.055	0.067	
I17	0.034	0.055		0.050	0.061		0.043	0.063	0.040	0.051	0.057	
IH1	0.197	0.116	0.158	0.159	0.389	0.218	0.180	0.166	0.147	0.165	0.195	
IH2								0.070				
IH3								0.062				
IH4								0.063				
IH5	0.144	0.106	0.101	0.099	0.177	0.138	0.107	0.154	0.139	0.142	0.104	0.136
IH6	0.109	0.109		0.116	0.119	0.160	0.111	0.102	0.088	0.128	0.111	
IH7	0.160	0.144	0.113	0.198	0.177	0.115	0.073	0.146	0.120	0.219	0.128	0.100
INL							0.061					
LAC	0.043	0.030		0.043	0.099	0.048	0.042		0.050	0.030	0.038	
LQ2	0.047	0.046	0.020	0.061	0.065	0.053	0.043	0.067	0.055	0.067	0.067	0.025
LS2		0.140		0.265	0.100	0.095			0.083	0.195		
MB1	0.115	0.080	0.132	0.093	0.124	0.125	0.189	0.085	0.187	0.132	0.120	0.083
NB3	0.132		0.130		0.162		0.202		0.153		0.147	
NB4	0.139		0.120	0.190	0.162		0.209		0.143		0.140	
NB5	0.108	0.127	0.121	0.124	0.131	0.112	0.167	0.200	0.116	0.129	0.121	0.065
NB6	0.404	0.150	0.093	0.144	0.145	0.083	0.107	0.123	0.128	0.150	0.103	0.073
NB7	0.102	0.115	0.030	0.113	0.121	0.115	0.142	0.151	0.116	0.092	0.124	0.080
ND2		0.125	0.263	0.315	0.223	0.293				0.193	0.213	0.097
NR1		0.070	0.121	0.085	0.180	0.132	0.410		0.057		0.138	
NR3							0.145			0.853		
NR4	0.565	0.569	0.581	0.535	0.473	0.464	0.440	0.657	0.520	0.697	0.402	0.441
NR5	0.130		0.105	0.313	0.227	0.163	0.120	0.258	0.325	0.286	0.170	0.120
OS1	3.818	2.134		2.304			1.578	3.160	1.670	3.043	1.761	
OS3	0.301	0.450		0.282	0.280		0.332		1.175	0.424		
OS6	0.110	0.296		0.243	0.392		0.303	0.239	0.145	0.214	0.324	0.083
OS7	0.712	0.345		0.208	1.643		0.176	0.249	0.373	0.231	0.159	0.175

(continued)

Table 6-15
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
PB1	0.121	0.082	0.131	0.128	0.067	0.190	0.073	0.076	0.130	0.070	0.083	0.075
RB1	0.042	0.020		0.030	0.087	0.020	0.103				0.043	
RB3	0.044	0.047	0.027	0.060	0.042	0.063	0.048	0.112	0.046	0.061	0.067	0.055
RB5	0.025		0.015			0.030	0.035	0.035	0.025	0.050	0.040	0.040
RB6	0.065		0.010			0.025	0.030	0.015	0.025	0.050	0.040	0.040
RB8	0.061	0.060	0.071	0.080	0.045	0.058	0.052	0.053	0.049	0.067	0.082	0.059
RB9							0.045					
SC2	0.109	0.040	0.270	0.062	0.090		0.315	0.070		0.095	0.048	
SC3	0.076	0.085	0.084	0.115	0.087	0.082	0.094	0.087	0.101	0.176	0.093	0.078
UL03				0.035								
UL04	0.034	0.048	0.000	0.047	0.064	0.100	0.048	0.071	0.043	0.042	0.046	
UL11			0.063			0.033				0.060		
GMI4	0.046	0.118	0.007	0.030	0.060		0.063	0.070	0.060	0.048	0.163	
GMI6	0.048	0.052	1.127	0.060	0.033	0.021	0.027	0.030	0.045	0.033	0.028	0.082
GMO6					0.010				0.005			

(continued)

Table 6-15
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	0.061	0.049	0.077	0.095	0.107	0.041	0.110	0.065	0.058	0.070	0.070	0.061
Copano Bay	0.090	0.051	0.084	0.087	0.146	0.096	0.143	0.081	0.105	0.100	0.067	0.085
St Charles	0.093	0.063	0.177	0.088	0.089	0.082	0.205	0.079	0.101	0.135	0.071	0.078
Mesquite	0.094	0.089	0.148	0.103	0.122	0.117	0.185	0.089	0.131	0.127	0.105	0.079
Redfish	0.049	0.053	0.031	0.070	0.043	0.044	0.042	0.054	0.036	0.057	0.057	0.049
Corpus Christi	0.080	0.054	0.052	0.088	0.070	0.054	0.078	0.068	0.053	0.064	0.069	0.039
CCSC (bay)	0.058	0.054	0.051	0.076	0.066	0.060	0.068	0.108	0.076	0.057	0.061	0.063
Inner Harbor	0.152	0.119	0.124	0.143	0.215	0.158	0.118	0.109	0.123	0.164	0.135	0.118
Nueces Bay	0.126	0.127	0.124	0.157	0.151	0.112	0.193	0.200	0.137	0.129	0.136	0.065
Aransas Pass	0.047	0.074	0.052	0.046	0.092	0.052	0.050		0.051	0.042	0.041	0.015
Causeway N	0.055	0.056	0.056	0.062	0.085	0.051	0.062	0.095	0.058	0.049	0.066	0.038
Causeway S	0.034	0.048	0.000	0.047	0.064	0.100	0.048	0.071	0.043	0.042	0.046	
Laguna (King)	0.044	0.050	0.057	0.105	0.056	0.067	0.053	0.074	0.038	0.062	0.058	
Laguna (Baffin)	0.034	0.055		0.050	0.061		0.043	0.063	0.040	0.051	0.057	
Baffin Bay	0.125	0.121	0.135	0.192	0.309	0.146	0.093	0.137	0.078	0.154	0.082	0.105
GOM inlet	0.048	0.052	1.127	0.060	0.021	0.021	0.027	0.030	0.025	0.033	0.028	0.082

Table 6-16
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQXTSS

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	18.9	28.4	45.3	47.9	45.5	46.2	31.0	53.3	37.8	31.5	35.6	27.9
A2	16.2	48.4	86.4	68.5	84.2	50.0	39.4	24.4	52.8	47.2	45.1	26.6
A3	23.8	27.2	46.8	39.7	32.1	42.5	23.6	46.5	19.4	43.7	38.1	20.1
A4	14.4	25.6	67.2	41.9	44.7	38.4	37.1	25.9	39.4	45.6	28.1	18.5
A5	11.2	19.8	52.1	39.6	35.0	31.5	29.9	16.6	23.6	20.7	33.4	23.5
A6	29.0	22.9	20.7	33.4	28.1	41.8	40.2	26.8	22.0	25.5	21.6	25.7
A8	15.5	108.3	29.5	35.4	34.8	21.3	28.6	33.9	63.9	35.9	13.4	16.7
A9	43.9	20.3	24.8	42.5	24.1	33.4	22.0	29.6	29.5	27.4	18.9	28.0
A10	14.4	21.7	38.8	37.1	73.3	56.3	31.9	36.5	41.5	26.1	36.2	21.3
A11	16.1	25.3	31.6	38.2	42.8	39.9	23.0	43.1	36.4	34.5	26.4	40.3
A12	14.6	18.7	33.1	25.0	29.6	48.0	25.6	19.0	32.7	25.3	36.7	46.6
A13	18.2	17.5	30.8	67.9	38.8	89.2	23.5	19.9	21.0	18.5	17.7	22.4
AL1	97.1	92.4	190.2	166.1	143.2	236.4	53.0	81.8	77.0	109.0	89.6	178.5
AL2	40.6	84.1	114.2	95.8	72.8	97.7	31.9	64.3	88.9	87.6	53.2	41.9
AR1	96.9	83.2	211.2	100.5	83.6	71.2	88.6	88.9	94.8	45.0	61.6	79.1
AYB		44.7	58.6	75.6	42.5	62.7	84.1	48.2	34.7	37.5	31.0	47.2
BF1	50.1	62.4	60.3	56.1	61.6	75.5	68.9	51.0	41.3	45.2	48.0	48.0
BF2	46.6	48.8	47.4	82.3	58.5	48.3	61.6	55.9	36.2	39.2	48.4	53.2
BF3	31.1	34.3	39.3	45.2	33.3	34.8	39.8	42.4	26.1	30.7	32.9	30.1
C01	68.4	31.2	68.2	126.4	82.8	98.8	84.0	63.0	28.0	65.0	78.5	35.5
C02	19.3	20.2	21.9	44.9	37.6	42.6	33.5	42.8	19.3	28.9	23.7	18.2
C03	41.4	30.3	46.5	47.1	48.8	63.8	52.3	48.0	59.7	39.4	70.9	46.0
C04	38.1	32.9	23.1	47.3	35.2	26.5	19.1	24.2	26.2	21.4	23.8	35.0
C05	19.4	167.1	371.5	36.1	685.3	335.7	21.6	17.4	53.8	18.8	223.5	23.3
C06	18.4	205.5	168.9	36.2	351.2	156.4	20.8	20.1	32.5	25.5	262.0	37.5
C07	24.8	27.8	34.4	74.3	59.1	61.2	46.0	30.6	29.1	44.5	35.4	53.5
C08	20.9	16.8	25.0	38.2	38.1	19.1	23.9	31.0	37.1	19.8	30.3	13.6

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
C09	47.6	53.0	99.9	33.8	112.4	105.5	37.7	29.2	24.4	31.3	124.8	26.1
C10	20.4	21.2	17.2	25.6	24.0	40.4	17.9	25.8	30.5	24.3	25.8	37.1
C11	27.0	104.6	224.2	30.9	283.7	184.2	16.6	21.8	23.9	26.1	184.3	18.6
C12	21.4	41.5	64.5	34.5	89.5	103.6	35.3	31.6	32.8	25.3	112.2	25.1
C13	20.4	14.1	25.4	29.1	17.2	33.3	12.8	12.3	29.4	18.7	13.4	26.4
C14	31.8	20.8	29.4	26.5	28.3	38.8	30.0	26.1	20.9	26.6	30.3	21.7
C15	54.4	43.2	98.7	102.0	85.4	95.7	94.2	72.7	72.0	87.1	44.8	60.6
C16	23.7	85.4	18.4	24.8	33.0	43.8	32.1	22.2		15.5	20.0	17.3
C17	14.9	175.1	200.8	88.4	449.6	546.8	43.5	41.5	45.1	28.4	159.5	29.0
C18	20.0	19.6	30.8	34.2	42.8	36.7	19.7	29.6	22.8	29.1	41.7	23.8
C19	17.9	14.7	21.9	57.1	53.2	39.0	29.6	22.0	20.9	30.6	18.9	129.8
C20	28.8	20.3	55.3	86.5	113.6	86.7	42.7	61.4	41.9	54.3	69.9	31.3
C21	25.4	14.2	20.2	20.0	38.6	30.1	14.5	23.1	17.6	28.1	27.4	17.1
C22	9.6	12.6	36.5	43.7	54.7	17.1	12.5	19.0	21.5	31.1	21.1	17.7
C23	26.7	53.2	53.5	16.8	48.2	26.5	18.6	58.1	16.4	30.2	15.7	16.7
C24	15.9	23.8	21.9	32.5	18.8	21.3	13.5	16.5	25.6	45.0	31.2	10.6
C25		11.7	15.0	15.2	13.7	35.0		50.5	14.3	12.7	16.6	12.9
CB	20.4	44.0	87.0	56.8	71.0	42.0	70.8	33.0	34.9	47.3	35.8	32.5
CBH				22.6	23.5	73.5			19.9			
CBY1			18.5				50.4			19.0		25.4
CBY2	34.2	60.7	57.7	105.7		79.1	89.7	59.6	42.4	54.9		16.0
CCC1	40.1	89.2	74.3	36.5	95.5	80.3	28.8	36.4	43.6	54.0	127.8	41.7
CCC2	20.1	18.1	18.1	20.9	30.9	20.7	17.5	26.7	21.9	20.4	20.0	26.1
CCC3	45.2	36.0	48.2	49.8	69.7	51.3	46.1	34.3	41.1	40.0	44.6	50.0
CCC4	13.9	14.0	14.7	46.0	16.8	18.5	25.9	29.0	24.6	35.5	24.3	23.8
CCC5	22.9	13.5	19.5	68.3	40.4	25.5	25.0	31.0	33.1	16.5	24.3	17.1
CCC6	18.4	26.2	21.0	38.4	26.7	72.9	30.8	33.7	40.2	25.4	20.8	25.3
CCC7	18.6	176.8	467.1	43.2	424.5	436.2	19.3	25.4	37.9	22.7	382.0	20.8

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC8	25.4	26.5	31.5	43.5	28.8	32.3	43.2	50.3	54.9	25.4	15.8	8.6
CP01	21.6			81.5	25.0	32.3			30.6	27.4	6.1	76.2
CP02	25.0	31.4	58.4	39.3	29.4	55.7	62.5	45.6	42.2	38.2	25.5	39.9
CP03	37.8	27.5	68.5	59.7	62.7	58.9	64.5	49.7	73.1	44.7	45.4	50.0
CP04	31.6	32.9	66.7	44.2	47.9	80.0	42.2	41.9	31.4	28.6	46.6	36.6
CP05	45.9	29.0	105.5	92.0	77.3	54.5	84.8	42.1	41.4	40.3	28.6	48.4
CP06	78.8	38.7	168.4	49.5	88.3	104.6	66.6	87.0	59.3	33.0	31.6	35.9
CP07	39.8	21.1	72.8	41.6	29.9	51.1	49.1	39.3	30.9	30.4	32.9	26.5
CP08	22.2	40.2	45.8	34.6	57.2	34.7	45.8	38.0	52.5	36.6	46.6	41.4
CP09	30.2	21.5	63.7	47.9	32.8	62.1	55.1	50.0	58.0	43.6	34.5	42.5
CP10	23.9	53.6	78.6	46.0	37.6	29.0	32.0	33.2	32.8	35.6	26.3	28.1
EF		27.1	31.0	19.4	31.4	30.3	15.2	31.7	17.8	15.9	16.6	22.3
GR1			137.9	23.4	11.2					29.4		
GR2	81.0	57.6	64.3	79.4	88.2	65.3	45.1	72.8	68.7	45.8	45.6	159.1
HI1	17.2	102.5	23.3	12.8	24.0	82.4		17.7	17.4	19.1		
HI2	35.3	20.5	40.4	27.4	18.5	16.3	20.8	19.9	14.6	20.7	21.8	20.3
I2	29.0	35.3	69.7	66.1	84.1	109.2	73.8	41.8	81.0	42.6	79.7	30.0
I3	32.0	38.2	99.4	43.6	53.3	47.9	28.6	78.2	36.7	47.8	67.8	38.7
I4	20.3	45.0	61.4	100.4	70.9	57.9	67.8	39.7	39.2	35.0	39.4	17.8
I5	21.8	49.9	43.4	23.6	32.8	51.1	20.3	33.3	32.7	37.2	58.8	59.2
I6	17.8	15.4	29.1	36.1	43.2	36.6	32.2	25.6	26.7	19.4	21.9	38.2
I7	14.6	22.9	25.6	26.7	25.9	25.8	26.5	23.7	17.9	32.0	30.7	25.6
I8	26.4	17.2	29.7	29.8	26.0	38.5	19.6	17.9	26.8	15.0	25.8	40.8
I9	17.9	11.8	30.5	36.1	18.7	49.1	22.1	10.6	23.2	20.3	24.8	19.4
I10	41.1	23.4	36.3	59.3	58.1	58.8	28.8	30.9	68.7	133.5	65.6	27.5
I11	13.3	12.3	20.0	21.2	22.3	36.9	13.9	34.8	20.0	18.6	35.1	17.7
I12	25.1	20.8	20.2	27.1	25.6	36.6	37.4	25.5	16.4	26.3	21.4	41.2
I13	24.2	25.0	30.2	34.0	35.7	26.7	27.2	43.1	24.5	28.1	26.3	25.5

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I14	14.6	15.5	23.3	17.5	25.2	10.7	20.6	12.5	11.5	32.1	14.8	25.6
I15	17.3	13.2	34.3	29.6	24.1	31.1	28.8	41.4	17.3	49.4	20.1	27.2
I16	51.0	49.6	27.4	32.9	28.1	22.6			23.7	21.8	12.1	
I17	26.4	32.2	44.6	56.4	34.4	27.1	37.5	41.8	27.5	35.0	27.8	29.1
I18	41.5	59.8	44.6	36.5	56.0	24.2	42.0	46.7	32.1	31.3	31.3	38.2
IH1	30.7	25.4	37.1	35.0	26.7	8.5	32.1	43.6	42.9	19.0	11.4	
IH3				12.0		6.4	19.2	30.7		27.7		
IH4						71.2		28.5		59.5		
IH5	24.8	25.9	20.9	36.1	19.3	15.1	36.4	42.9	30.7	29.3	13.0	22.9
IH6	29.5	26.5	32.2	27.9	22.7	29.4	35.8	20.8	23.7	28.0	21.3	22.7
IH7	63.3	135.7	101.2	41.9	24.1	59.0	38.0	30.4	23.2	23.4	141.8	17.8
INL		112.5	14.3		7.8	35.3	16.2	15.6	17.2		17.3	22.5
LAC	28.8	19.9	28.8	19.9	12.5	35.2	24.6	9.6	13.1	24.9	34.0	23.8
LB	12.4	22.8	40.3	23.2	23.9	20.3	23.3	42.2	23.3	23.1	18.8	24.4
LQ1	27.0	21.5	50.1	41.1	52.6	59.4	44.7	39.4	37.8	50.8	34.0	31.5
LQ2	20.8	19.1	38.3	35.2	65.0	41.3	28.5	28.1	40.8	19.6	33.9	41.7
LS1	43.4	36.6	72.4	58.4	66.0	50.6	81.5	91.9		41.8	50.0	57.7
LS2	45.9	43.8	54.1	88.9	84.5	55.2	37.0	135.5	59.0	43.2	44.1	52.4
M1					71.0	113.0			73.7	38.1	212.7	17.3
M2		48.0	225.0	84.8	97.7	118.3	82.2	26.8	62.3	36.9	32.9	16.2
MB1	30.7	63.4	102.0	54.6	98.4	70.1	84.3	44.6	46.7	44.6	50.5	32.3
MB2	43.6	27.0	125.8	71.4	92.1	73.0	84.0	69.4	43.1	36.6	53.8	40.2
NB1	30.0	106.9	91.0	105.5	63.3	69.7	70.9	55.2	65.1	58.8	45.9	69.2
NB2	30.8	88.1	82.8	84.3	58.7	65.7	88.7	78.1	51.2	40.7	50.7	79.3
NB3	27.8	50.1	47.4	78.4	63.7	98.4	78.1	51.4	70.9	105.9	42.2	21.3
NB4	19.6	3693.3	1205.9	118.0	2711.1	721.0	120.4	48.1	62.9	44.0	170.4	43.3
NB5	55.2	1052.7	828.8	110.0	544.9	393.6	103.2	81.7	75.3	53.4	193.7	52.5
NB6	118.6	2032.6	2596.2	71.0	2292.6	971.4	68.6	72.0	53.2	46.9	612.6	26.1

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
NB7	31.3	56.9	48.9	77.9	59.8	69.9	68.0	39.2	40.2	37.5	39.0	19.9
NB8	53.3	43.8	54.0	89.7	73.4	94.5	70.1	59.2	60.9	60.2	53.4	43.0
NB9	29.0	25.8	64.4	74.2	64.9	83.9	91.1	57.4	44.7	46.2	27.0	30.0
ND2					65.3					56.0	54.0	
ND4										42.4		
NR1	30.6	14.4	19.7	23.9	32.7	30.9	46.0	71.6	26.9	52.7	49.5	30.0
NR3			4575.3	59.6	6280.3	1690.3	36.9	30.2		46.0	5923.3	
NR4	84.3	66.2	135.5	298.2	179.9	136.7	130.9	77.3	83.5	60.6	75.3	47.1
NR5	73.2			89.5		35.3	47.7	83.4	140.2	68.6	61.6	46.6
OS1	41.4	54.7	53.5	65.2	111.3	113.3	43.0	-27.4	77.7	61.3	258.7	54.3
OS3	293.4	45.9	301.0	242.7	52.9	182.5	211.2	57.3	168.9	230.5	81.8	43.4
OS4	36.4	29.9	111.5	61.4	32.9	45.3	69.4	23.3	70.9	24.0	24.2	34.9
OS5	13.8		57.1	38.1			40.4	21.6		44.3	27.1	17.7
OS6	40.0	138.3	17.3	199.4	230.3	51.1	100.0	131.5	95.5	75.2	151.5	50.3
OS7	63.1	82.0	102.0	93.8	96.4	49.4	67.8	67.2	70.0	85.7	50.1	41.0
PB1	66.2	79.7	185.4	110.5	34.6	35.4	58.7	46.4	53.2	46.1	45.7	103.6
PB2	35.1	38.4	58.6	38.1	34.5	36.5	41.9	20.7	26.0	15.8	30.0	55.0
RB1	25.5	33.0	18.3	20.2	25.3	21.8	24.3	14.1	20.5	20.8	28.7	13.8
RB2	16.9	16.1	39.8	13.5	20.0	28.8	11.4	12.5	18.8	19.6	25.7	14.7
RB3	17.1	15.3	19.0	24.8	16.6	28.5	33.6	16.3	18.6	20.3	13.3	15.2
RB4	28.6	100.2	25.9	20.1	31.6	26.1	21.6		19.2	16.8	19.0	8.6
RB5	12.8	16.9	38.3	36.9	23.1	30.6	19.9	20.3	20.1	18.5	19.1	12.1
RB6	10.2	14.5	12.4	14.1	22.3	39.5	27.9	18.4	16.4	51.4	28.6	14.4
RB7	26.4	16.2	21.8	23.7	25.4	16.7	25.3	19.0	18.4	21.7	18.5	15.6
RB8	42.7	212.3	217.3	33.6	242.4	145.7	54.6	23.6	26.8	34.0	348.1	26.3
RB9	21.5	15.7	29.1	28.7	30.4	25.5	14.8	27.2	18.4	19.2	20.3	24.6
SC1	51.9	42.1	96.0	42.5	57.7	86.8	81.1	85.8	56.8	61.2	51.2	65.3
SC2	35.5	46.3	52.3	40.6	52.5	53.0	42.2	49.3	42.2	39.0	45.7	55.3

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
SC3	32.2	33.0	65.3	58.4	41.5	38.2	51.3	41.9	45.1	41.1	32.4	24.3
UL01	23.1	13.9	20.8	12.4	20.5	18.8	33.9	35.9	22.1	19.4	16.7	
UL02	34.6	28.9	21.8	36.7	27.2	17.9	29.8	25.8	21.0	22.5	29.8	25.3
UL03	22.4	19.6	23.3	24.8	23.5	18.9	27.1	19.0	20.6	20.5	27.5	26.2
UL04	29.7	27.2	45.5	27.5	29.4	61.5	35.0	25.7	24.7	24.1	21.8	36.5
UL05	89.0	10.3		13.7	22.7	10.2	12.1	15.5	19.8	14.6	14.1	17.7
UL06	27.8	22.4	19.2	28.6	26.2	11.9	17.1	31.7	21.8	22.9	24.8	22.5
UL07	36.1	36.2	17.0	39.5	38.4	19.5	32.2	28.9	17.3	25.0	27.7	29.3
UL08		10.3	18.2	14.5	23.6	26.6	16.4	17.2	11.8	20.9	19.9	14.0
UL09	12.8	13.3	24.3	18.4	21.2	17.3	14.5	9.3	20.9	17.1	21.4	16.7
UL10	32.0	40.0	26.4	29.3	33.6	17.3	22.0	28.9	25.0	25.2	24.9	23.4
UL11			32.6	23.5	14.2	26.4	21.3	16.9	38.1	15.7		
GMI1	13.0				13.8	16.2	9.5	8.6	11.4	12.1	20.9	
GMI2	13.0	51.6	23.6	22.2	27.0	21.0	22.8	20.1	13.3	23.4	20.1	22.1
GMI3	35.5	63.1	17.9	11.2	27.2	21.8	41.3	20.0	23.8	16.0	28.7	25.4
GMI4	23.2	53.7	14.6	28.0	26.2	29.9	51.6	60.2	21.5	37.0	20.3	26.5
GMI5	32.7	39.2	22.9	26.2	35.9	11.0	30.8	20.1	37.6	9.8	19.3	21.6
GMI6	34.3	203.6	73.7	34.1	10.0	22.3	22.9	15.7	14.0	22.0	150.7	29.7
GMI7	39.9	36.8	37.4	26.5	16.2	27.7	12.3	6.2	9.9	16.2	27.1	14.0
GMI8	35.1	45.0	33.3	33.9	29.3	32.6	43.5	22.7	18.9	21.7	50.0	46.3
GMI9	44.1	71.4	55.6	60.6	47.2	32.5	54.3	25.2	46.7	28.4	63.6	13.0
GMO4	13.4	15.1	12.9	11.0	22.4	7.5	6.6	12.0	8.6	9.1	15.5	27.9
GMO5	12.3	16.7	13.7	15.8	13.4	10.8	9.3	10.4	18.4	10.8	10.8	18.9
GMO6	23.6	17.0	13.4	9.2	14.1	14.5	10.7	14.4	8.7	10.3	13.1	12.8
GMO7	13.5	9.8	12.1	13.0	19.2	21.9	23.9	20.6	11.0	11.7	13.9	11.7

(continued)

Table 6-16
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	22.1	33.4	41.0	39.4	40.2	36.0	29.1	34.0	33.3	35.0	27.2	27.3
Copano Bay	37.3	32.9	80.9	50.5	51.5	58.9	55.9	47.4	46.9	36.7	35.3	38.8
St Charles	33.9	39.6	58.8	49.5	47.0	45.6	46.7	45.6	43.6	40.1	39.1	39.8
Mesquite	31.6	44.7	93.4	64.6	76.0	61.9	80.8	48.8	39.9	41.5	42.8	38.1
Redfish	22.0	50.9	50.5	24.4	51.5	42.7	26.1	19.6	19.6	25.2	61.6	16.4
Corpus Christi	25.9	54.4	74.6	46.7	126.3	96.4	29.6	32.0	30.4	30.3	68.8	32.5
CCSC (bay)	23.8	53.3	114.1	49.1	115.6	120.9	29.4	30.7	35.4	28.0	99.2	27.4
Inner Harbor	37.1	53.4	47.8	30.6	23.2	31.6	32.3	29.9	30.1	31.1	46.9	21.1
Nueces Bay	37.4	985.6	443.8	96.1	690.4	274.7	92.1	63.7	64.2	60.9	102.1	47.9
Aransas Pass	28.7	81.0	35.2	23.1	34.9	58.3	23.2	19.8	22.8	32.7	59.7	29.3
Causeway N	16.9	15.8	22.5	28.0	17.1	35.1	17.8	25.9	21.0	26.0	24.2	14.3
Causeway S	32.1	23.3	31.1	34.0	33.8	39.2	31.9	29.6	34.1	49.9	33.5	29.8
Laguna (King)	28.6	19.9	24.1	24.7	25.9	22.3	22.4	25.0	20.4	24.3	23.2	23.9
Laguna (Baffin)	39.6	47.2	38.9	41.9	39.5	24.6	39.8	44.2	27.8	29.4	23.7	33.7
Baffin Bay	49.9	57.4	65.1	71.8	62.9	64.3	49.5	57.3	52.2	49.7	45.6	66.4
GOM inlet	26.0	53.8	28.9	20.8	18.1	18.1	18.3	14.6	16.6	13.5	39.1	18.1

Table 6-17
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQTOC

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1				5.4								
A2		23.0	30.7	38.2	12.1	17.5	29.0	20.0		17.0	18.0	16.5
A3	25.0	17.5	13.2	9.0	15.7	7.7	26.0	19.5		9.6	15.5	16.8
A4	4.0		4.0		4.5		4.5		4.8		4.5	
A5				9.6								
A12	18.0	24.4	17.6	8.4	16.5	8.8	25.0	27.6		10.4	12.5	11.8
AL2	10.0		10.0	12.0	9.8		10.0		14.3		8.0	
AR1	10.5	6.8	7.5	8.3	7.3	7.0	24.0	9.8	9.5	11.0	6.2	16.7
BF1	9.7	10.0	11.1	10.6	9.0	20.5	11.6	9.8	10.7	7.9	9.7	20.5
BF2		9.0	9.5			11.0				8.6		
BF3	7.4	8.0		9.5	9.1	11.5	11.4	9.3	13.3	7.1	9.0	
C02	3.0	2.3		2.7	9.2		18.3	4.5	7.0	5.0	6.6	
C03	10.0	5.5	9.5		8.1	14.0		6.4		8.5		
C05		8.8	8.7	8.6	10.2	9.4	33.0	15.0	14.0	9.3	9.6	11.2
C06		23.0	19.5	16.5	19.0	15.3	32.5	24.0		13.0	12.0	17.0
C07	13.0	12.7	8.5	8.6	9.5	13.6	11.1	12.1	6.0	12.9	6.2	17.3
C09		5.0	4.7	4.2		5.7				6.4		
C10	6.6	18.8	5.9	11.2	6.9	14.4	12.5	16.1	6.8	11.3	6.0	17.5
C11	8.8	14.1	7.2	8.2	9.0	12.2	17.5	18.5	7.0	12.3	7.3	13.9
C12	10.2	24.5	5.6	10.8	8.4	11.4	12.7	16.3	6.0	14.4	5.5	20.0
C14	8.1	17.0	7.9	9.5	9.1	14.0	7.3	22.0	9.6	18.5	6.4	15.8
C15	8.9	6.4	5.8	7.9	6.7	9.4	11.4	7.4	7.3	8.8	5.4	11.1
C17	3.6	9.6	8.1	6.0	7.9	10.4	14.0	28.0	6.9	8.1	6.0	11.1
C21	12.0	17.3	4.2		10.2	14.3	21.3	13.3		12.4	10.0	17.3
C22		22.5	14.5	19.0	14.5		32.0	20.0		16.0	14.0	19.7
C24	3.7		4.0		7.0		6.0		6.0		5.4	
CB	20.4	19.7	23.2	30.9	18.5	9.8	25.7	16.5		9.8	15.5	14.6

(continued)

Table 6-17
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC1	3.3	4.3	3.9	2.9	5.0	2.2	2.2		2.3	3.3	2.8	2.6
CCC2							8.0		14.5			
CCC3	8.6		4.9		5.7		2.5	6.9	2.8		3.3	
CCC4	11.0						8.3					
CCC5	8.1		3.2		3.4		3.8		4.0		3.0	
CCC6	5.8	3.1		3.4	4.3	7.7	6.5	4.1	4.5	3.6	7.2	
CCC7	11.1		6.6	9.4	9.3	18.9	12.8	17.0	5.6	18.1	7.6	15.5
CCC8	4.8	3.2		4.1	5.7	5.5	6.6	4.7	5.0	3.3	6.4	
CP02				5.1	21.0							
CP03	26.0	25.5	29.3	16.8	23.6	19.2	44.5	19.6	19.5	16.9		20.5
CP05		28.0	35.3	19.5	20.7	33.0	39.0	37.5		11.7		21.0
CP07		106.0	16.4	8.6	11.6	17.7	29.0	26.3	13.3	11.0		17.1
CP09						7.9				9.7		
CP10	13.0	11.0	15.2	9.3	10.9	13.3	11.5	8.3	9.7	8.9	10.5	11.2
GR2				18.0						13.0		
HI1								7.0				
I1		0.0										
I2		0.0										
I3	19.8	16.2	14.9	23.7	11.3	14.4	27.0	19.5		12.0	11.0	22.0
I4	13.6		13.8									
I5	13.1			4.5		5.5						
I6	5.8	3.0	3.5	2.6	7.6	8.5	4.2	2.9	6.0	5.0	3.8	9.5
I7	8.7		3.5		7.7	7.6	5.0		3.5		4.2	
I9	4.0	6.6	5.5	4.9	10.9	10.9	13.9		8.0	6.9	6.2	4.9
I10											0.5	
I11											1.0	
I12	4.7	4.0	4.0	9.1	8.4	17.0	17.0	7.5	9.7	7.1	5.9	
I13	5.6		6.2		7.6		7.2		7.0		7.4	9.2

(continued)

Table 6-17
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I15	6.0		7.0		7.8		7.5				7.0	9.4
I16											0.7	11.8
I17	5.8	6.7		8.8	8.0		10.4	6.9	12.0	8.9	9.0	13.7
I18											0.5	14.6
IH1	7.3	4.8	505.5	6.8	5.4	5.7	15.8	4.7	6.4	6.8	9.2	
IH2								3.0				
IH3			5950.0					3.5				
IH4								2.8				
IH5	4.8	4.9	504.5	5.8	5.9	6.0	13.0	4.0	5.3	5.1	6.6	
IH6	4.6	4.0	736.3	5.5	8.7	6.5	13.3	3.4	3.8	4.4	7.0	
IH7	11.0	5.8	452.4	7.6	10.8	5.5		3.9		5.4	5.5	2.8
INL							10.5					
LAC	22.8			3.0	3.6	2.6	5.7					
LQ1												0.7
LQ2	2.4	3.9	4.0	3.5	5.9	4.8	13.4	3.6	4.5	3.3	2.2	6.4
MB1	3.0	6.0	5.2	7.7	2.0	7.5	7.2	7.5	7.1	5.2	7.0	3.0
NB3	6.0		5.7		5.8		6.7		5.8		6.8	
NB4	6.0		5.5	0.0	5.7		5.4		5.8		5.4	
NB5	6.6	10.4	7.2	8.2	8.0	46.6	11.1	7.6	8.9	8.6	6.8	12.3
NB6	33.4	22.5	19.5	20.2	17.0	23.0	40.0	25.0	17.5	23.1	19.0	21.0
NB7	5.8	4.8	4.0	4.8	5.8		8.8	3.6	8.4	8.0	3.0	8.8
ND2		5.5	3.5	5.8	9.7	3.1				5.9	4.9	3.5
NR1					13.5							
NR4	11.0	11.4	14.9	15.9	11.4	10.9	9.2	16.5	14.4	16.1	13.5	9.5
NR5	24.5	41.5	18.0	11.7	22.0	26.3		20.6		11.9	19.5	20.5
OS1	6.3	13.3		15.4			20.0	24.3	18.0	13.7	17.0	
OS3		10.0			12.5		26.0		12.0			
OS6	5.5	6.0		11.0	12.0		7.0	9.6	5.5	7.4	6.3	5.0

(continued)

Table 6-17
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
OS7	5.3	4.2		9.9	11.3		14.0	7.3	7.8	9.8	6.6	7.5
PB1	8.3	7.9	6.0	10.4	15.0	10.5	23.5	11.0	17.0	9.8	7.3	12.0
RB3	5.7	2.8	6.0	10.0	4.7	8.0	11.3	4.6	7.0	6.3	4.3	4.0
RB5		29.0	15.0		14.0	16.5		12.5		16.0	13.5	20.5
RB6		24.0	12.0	15.0	17.0	20.5	34.5	16.5		17.0	15.0	28.0
RB8	2.7	2.0	2.4	3.3	2.6	4.2	6.4	2.8	3.5	4.5	3.3	3.0
RB9							8.3					
SC2				6.1	20.5							
SC3	11.8	8.2	7.8	10.4	9.9	9.0	13.6	11.2	8.9	11.1	5.9	10.5
UL03				9.6								
UL04	4.4	4.3	4.0	6.0	5.0	9.0	10.2	6.1	7.7	4.3	5.1	
UL11			6.3			12.0						
GMI4	5.5	1.8		11.0	4.8		18.3	5.2	4.0	6.0	4.8	
GMI6	7.5	2.7	2.5	3.1	3.0	2.8	7.5	2.4	7.5	3.3	5.1	3.8
Aransas Bay	11.8	17.9	14.5	14.0	10.8	11.3	17.1	18.5	8.4	11.5	9.6	13.3
Copano Bay	19.5	42.6	24.1	11.8	17.5	18.2	31.0	22.9	14.2	11.6	10.5	17.5
St Charles	11.8	8.2	7.8	8.3	15.2	9.0	13.6	11.2	8.9	11.1	5.9	10.5
Mesquite	11.7	12.8	14.2	19.3	10.3	8.7	16.4	12.0	7.1	7.5	11.3	8.8
Redfish	4.2	14.4	8.9	9.4	9.6	12.3	15.1	9.1	5.2	11.0	9.0	13.9
Corpus Christi	8.1	13.8	9.4	10.0	10.3	13.1	19.9	16.3	8.2	11.6	8.4	15.6
CCSC (bay)	8.9	3.1	4.9	6.4	5.7	13.3	6.8	9.3	4.2	10.9	5.3	15.5
Inner Harbor	6.9	4.8	1629.7	6.4	7.7	5.9	14.0	3.6	5.2	5.4	7.1	2.8
Nueces Bay	6.2	10.4	6.1	4.1	6.5	46.6	7.7	7.6	6.8	8.6	6.3	12.3
Aransas Pass	13.0	4.3	3.9	2.9	4.3	2.4	6.1	7.0	2.3	3.3	2.8	2.6
Causeway N	3.8	6.6	4.8	4.9	8.9	10.9	9.9		7.0	6.9	5.8	4.9
Causeway S	4.4	4.3	4.0	6.0	5.0	9.0	10.2	6.1	7.7	4.3	2.8	
Laguna (King)	5.4	4.0	5.9	9.4	7.9	14.5	10.6	7.5	8.3	7.1	5.3	9.3
Laguna (Baffin)	5.8	6.7		8.8	8.0		10.4	6.9	12.0	8.9	3.4	13.4
Baffin Bay	9.0	9.0	10.2	12.5	9.3	14.3	11.0	9.6	12.8	9.1	8.9	20.5
GOM inlet	7.5	2.7	2.5	3.1	3.0	2.8	7.5	2.4	7.5	3.3	5.1	3.8

Table 6-18
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQCHLA

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A2					50.0							
A4	7.2		4.0		5.2		1171.7		4.5		5.0	
A12	171.6											
AL2	8.8		17.0		8.0		7.8		6.0		11.2	
AR1	16.2	22.5	11.7	9.4	9.5		11.3	18.0	31.4	11.4	7.4	
BF1	13.8	11.4	9.9	10.2	9.1	25.0	16.6	13.2	12.7	18.0	11.5	26.0
BF2				43.0			30.0			18.3		
BF3	16.1	10.8		13.4	11.6		15.3	11.1	14.3	14.3	9.0	
C02	5.9	5.5	4.7	10.7	5.6	6.0	5.0	7.9	4.5	8.6	2.1	1.5
C03	5.4	5.7	9.0	3.1	7.8	3.0	6.4	9.3	4.7	5.7	4.5	6.8
C04	7.0	3.8	3.9	7.0	7.3	9.8	10.2	7.3	8.7	5.9	5.3	1.7
C05							27.7					
C07	28.4	1.7	5.8		5.9	0.0	5.9		6.5	1.8	3.3	
C08	7.9	2.2	2.4	4.4	5.7	7.4	8.8	6.5	5.3	4.1	5.0	1.4
C10	4.2	2.5	3.6	3.1	2.8	3.1	6.5	4.4	5.3	3.3	3.8	2.1
C11	4.7	2.5	10.6	0.2	5.9	0.0	8.0	2.6	4.0	5.2	3.0	
C12	9.7	3.9	4.9	2.1	5.6	13.2	3.9	2.2	3.3	2.3	3.8	1.9
C14	5.4	2.3	5.2	2.6	6.4	6.4	8.1	7.7	4.5	7.9	3.9	2.2
C15	9.8	2.0	8.4	10.2	4.5	4.0	10.1	6.9	4.9	7.2	5.0	2.7
C17	15.1	2.9	3.9	2.6	5.3	5.4	7.5	5.8	3.8	4.2	5.2	2.1
C18							22.7					
C20	4.5	2.6	2.2		4.3	6.6	8.4	7.7		6.3	3.2	1.4
C21	2.5	2.0	7.0		1.0	0.0	3.0			1.8		
C23	3.2		3.5	4.3	4.2	6.9	6.8	7.2	4.1	5.1	5.6	1.7
C24	5.3		3.8	2.1	3.4	7.4	3.9	6.0	2.8	4.3	4.5	3.4
CB	39.6			0.4	2.7							
CBY1			8.9	10.9		9.5	6.3					

(continued)

Table 6-18
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC1	4.1	3.9	6.3	5.6	5.7	3.4	6.6	1.3	2.9	4.0	3.6	1.7
CCC3	7.4	4.2	15.4	5.6	6.2	3.9	7.2	2.6	2.3	4.4	4.1	1.7
CCC4							16.3					
CCC5	4.6	2.1	3.8		5.0	9.6	5.7	6.6	4.7	6.1	3.5	3.2
CCC6	2.8	3.2		11.7	4.9	2.3	12.3	4.8	2.5	5.0	1.3	
CCC7	17.7	5.3	7.6	8.1	6.5	8.1	5.9	5.6	5.0	4.5	4.4	2.7
CCC8	9.4	4.9	7.4	12.8	6.6	7.9	8.8	12.1	8.1	7.9	6.6	5.5
CP02				0.3	32.6							
CP03				0.2	39.3							
CP05					33.2							
CP07					34.3							
CP10	3.5	5.2	14.3	4.3	14.8		2.8	12.2		8.3	4.5	2.6
GR2										0.7		
I2			10.5			19.0						
I3					57.0							
I5	104.3			0.4	12.4							
I6	7.2	1.4		4.2	4.4	0.0	7.0	1.8	0.0	11.2	0.9	0.0
I7	36.9		3.7		4.0		670.0		3.0		4.7	
I9	4.9	1.2	5.3	11.7	7.1	4.2	4.5	1.4	2.7	4.1	2.9	1.9
I12	4.1	2.1	0.0	6.9	3.3	20.0	9.3	8.4	3.3	8.0	5.8	
I13	2.6		5.4		2.6		3.4		2.7		4.4	
I15	3.8		7.3		2.5		6.5				9.3	
I17	10.9	7.8		16.4	7.4		11.5	5.8	13.3	13.3	6.1	
IH1	18.9	14.0		11.5	9.7	50.0	56.8	62.8	54.7	14.8	9.8	
IH3							26.5	8.0				
IH4								10.0				
IH5	19.7	15.7	24.5	10.0	9.0	8.5	22.0	28.7	13.8	15.3	10.9	
IH6	17.9	13.7		9.3	8.4	10.0	23.7	9.7	6.3	10.3	6.0	

(continued)

Table 6-18
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH7				0.3			32.3	1.7				
LAC							17.5					
LQ1							21.0					
LQ2	3.0	2.2		4.9	6.4	2.5	13.0	2.8	2.5	4.8	1.4	0.0
MB1	8.3	25.0	6.6	7.0	14.0	10.8	7.5	0.0	9.9	10.9	6.3	8.5
MB2			12.1	12.8		15.8	7.6					
NB1	10.9	17.9	7.1	8.1	13.9	10.4	10.5	11.9	8.7	13.0	12.9	7.7
NB2	16.1	11.8	6.1	5.4	12.6	12.0	8.9	14.8	7.7	10.1	15.6	8.9
NB3	12.5	4.7	7.5	14.4	9.0	15.0	8.9	12.4	10.2	20.7	13.1	14.1
NB4	9.9	12.7	6.2	7.5	10.2	6.4	8.9	6.7	6.7	7.3	11.3	4.9
NB5	9.0	7.4	8.0	7.8	8.8	7.8	13.1	9.1	6.0	11.0	8.3	4.1
NB6	26.6	5.2	15.9	4.2	17.6	9.3	12.2	15.2	9.0	10.1	17.2	9.9
NB7	6.0	6.1		7.8	7.9		29.3	8.8	11.0	15.5	5.8	5.0
NB8	2.7		5.2	4.6	4.2	3.1	15.7	8.3		6.5	6.1	2.8
NB9			11.1	6.0			9.5	12.8				
NR1			13.5			12.0						
NR4	67.2	62.1	42.4	52.3	65.9	68.1	61.4	56.3	51.1	64.3	32.9	33.3
OS1	106.1	66.6		111.1			59.1	184.4	107.5	66.8	31.2	
OS3	21.3	10.0		34.3	6.5		20.0		3.5	16.4		
OS6	3.5	8.6		19.9	18.7		38.0	15.0	8.4	5.9	11.2	4.0
OS7	30.9	12.4		11.6	10.9		12.8	9.8	24.3	14.0	13.9	
PB1	6.4	6.1	8.5	7.2	12.0		6.3	4.2	7.0	9.3	3.6	4.5
RB3	3.6	3.4	5.5	8.5	6.0	8.5	23.0	14.8	5.7	10.9	5.8	6.5
RB8	3.9	1.7	3.3	6.2	5.6	8.8	4.6	2.5	4.1	5.5	3.8	0.9
SC2	20.5			0.3	32.7							
SC3	1.5	3.9	2.3	3.5	5.3	18.8	1.3	15.5	2.8	10.6	0.0	0.3
UL04	5.5	0.9	0.0	6.1	4.6	15.0	11.4	8.0	4.3	7.1	0.8	
GMI4	4.0	1.8	4.5	4.0	13.7		24.5	6.0	24.0	5.3	5.0	
GMI6	6.8	1.4	3.5	3.7	5.3	3.0	3.3	0.0	0.0	4.0		

(continued)

Table 6-18
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Aransas Bay	48.3	7.8	5.6	16.4	16.3		396.6	5.8	8.9	13.3	6.8	
Copano Bay	3.5	5.2	14.3	1.6	30.8		2.8	12.2		8.3	4.5	2.6
St Charles	11.0	3.9	2.3	1.9	19.0	18.8	1.3	15.5	2.8	10.6	0.0	0.3
Mesquite	23.9	25.0	9.4	6.7	8.3	13.3	7.5	0.0	9.9	10.9	6.3	8.5
Redfish	3.8	2.6	4.4	7.3	5.8	8.7	13.8	8.7	4.9	8.2	4.8	3.7
Corpus Christi	7.8	3.1	5.1	4.2	5.2	4.5	9.6	6.6	5.1	5.0	4.1	2.3
CCSC (bay)	8.1	3.7	8.9	8.5	5.6	6.0	9.5	4.9	3.6	5.0	3.3	2.5
Inner Harbor	18.8	14.5	24.5	7.8	9.0	22.8	32.3	20.1	24.9	13.4	8.9	
Nueces Bay	10.0	9.1	6.6	7.9	8.9	8.8	11.1	10.2	7.6	11.1	10.9	7.0
Aransas Pass	4.1	3.9	6.3	5.6	5.7	3.4	12.1	1.3	2.9	4.0	3.6	1.7
Causeway N	5.1	1.2	4.5	6.9	5.3	5.8	4.2	3.7	2.7	4.2	3.7	2.7
Causeway S	5.5	0.9	0.0	6.1	4.6	15.0	11.4	8.0	4.3	7.1	0.8	
Laguna (King)	3.5	2.1	4.2	6.9	2.8	20.0	6.4	8.4	3.0	8.0	6.5	
Laguna (Baffin)	10.9	7.8		16.4	7.4		11.5	5.8	13.3	13.3	6.1	
Baffin Bay	12.9	11.1	13.4	22.2	9.6	25.0	17.4	12.2	11.0	12.8	10.6	26.0
GOM inlet	6.8	1.4	3.5	3.7	5.3	3.0	3.3	0.0	0.0	4.0		

Table 6-19
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQPHEO

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	15.3	15.0	15.9	15.3	15.4	13.8	12.2	22.7	21.8	18.9	16.1	16.4
A2	15.2	16.5	18.4	16.5	11.8	17.7	15.2	21.3	18.1	18.0	16.2	14.4
AR1		0.0		0.8	3.7			1.2	4.5	0.0	4.8	
BF1	0.5	3.4	0.0	3.3	1.8	0.0	5.3	3.2	0.0	2.8	1.8	
BF3	1.6	2.3		6.7	2.0		0.0	1.1	0.0	3.2	1.8	
C02	0.8	1.1	1.8	0.4	1.7	1.4	3.0	2.8	0.0	0.7	0.9	1.1
C03	1.3	1.8	1.7	0.8	1.3	1.1	1.1	2.2	5.6	0.9	1.5	1.4
C04	1.2	2.5	2.1	1.2	2.2	2.6	2.0	1.7	4.4	1.8	1.6	0.8
C08	2.3	1.4	1.5	1.6	1.9	1.3	2.1	1.5	5.3	0.8	1.4	0.6
C10	1.7	2.5	1.1	2.3	1.5	3.4	1.8	1.5		1.3	1.6	0.9
C12	1.6	2.0	0.7	1.7	2.1	1.2	0.4	0.7	2.6	2.7	0.9	0.6
C14	1.7	2.2	0.8	1.3	2.5	1.3	2.2	1.9	4.7	2.9	1.0	0.8
C15	2.9	0.8	6.0	19.8	1.1	0.5	4.7	0.8	0.9	3.5	2.4	0.6
C17	1.4	1.9	1.5	1.2	2.2	1.3	2.5	2.1	3.3	2.0	1.2	0.7
C20	0.5	1.7	1.3		2.2	1.5	1.4	2.4		2.6	0.8	0.6
C23	0.9		1.8	1.4	1.4	1.3	1.4	2.1	3.1	1.6	1.2	1.6
C24	2.0		1.8	1.2	1.7	1.4	1.1	1.3		1.4	2.0	1.0
CBY1			1.1	4.6		4.3	2.5					
CCC1	1.4	3.1	1.5	2.1	3.9	0.9	0.4	0.4	2.5	2.2	2.4	0.7
CCC3	2.1	4.5	2.2	2.2	6.1	2.3	0.4	1.0	3.7	2.4	2.5	0.8
CCC5	0.9	1.3	3.9		4.2	11.8	1.7	1.7	7.3	3.2	1.2	1.6
CCC6	0.3	0.4		1.0	0.3	0.0	21.7	0.8	0.0	0.8	1.3	
CCC7	1.5	3.4	2.1	2.5	2.4	1.7	3.5	2.0	3.6	2.6	1.5	0.9
CCC8	2.7	1.5	3.0	1.0	1.3	1.2	6.3	1.5	1.7	1.5	2.4	1.4
CP10	0.6	3.4		0.6	4.0		0.5	4.0		1.9	0.0	1.9
I6	0.3	0.1		2.1	0.7	0.0	6.7	0.3	0.0	4.0	0.7	0.0
I9	1.8	1.2	1.8	1.9	1.2	2.5	1.0	0.7	2.9	3.9	1.4	1.2

(continued)

Table 6-19
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
I12	0.3	0.0	0.0	2.6	0.3	0.0	0.6	1.3	0.0	2.5	2.3	
I17	0.0	0.9		6.0	2.2		0.0	1.6	0.0	2.0	1.0	
IH1	1.9	2.2		6.3	1.0	0.0	5.9	2.0	1.1	2.9	3.4	
IH3								0.0				
IH4								0.0				
IH5	1.1	1.2		3.6	2.4	0.0	4.8	1.9	0.5	1.2	2.8	
IH6	2.6	1.8		0.4	1.0	0.0	1.5	2.2	0.0	2.6	5.9	
IH7								0.0				
LQ2	0.0	0.2		0.3	0.6	0.0	20.0	1.2	0.0	0.6	0.5	0.0
MB1	1.8	0.0	0.8	7.4	1.4	5.5	4.2	0.0	2.4	0.0	0.0	2.0
MB2			5.4	14.4		11.0	2.6					
NB1	4.5	19.9	8.5	2.8	9.5	3.3	10.4	3.8	6.2	8.3	5.4	3.0
NB2	6.2	20.9	10.2	4.1	6.4	5.9	8.7	4.4	5.9	4.9	5.1	3.6
NB3	4.9	7.1	4.9	2.1	7.5	6.4	13.8	6.8	4.1	16.0	9.3	3.6
NB4	2.0	16.0	12.4	5.6	6.4	2.3	11.4	1.8	4.6	6.3	6.5	2.5
NB5	3.6	4.7	9.3	3.1	6.3	5.9	9.2	2.2	2.0	8.4	2.5	1.5
NB6	5.3	4.1	4.9	3.5	9.0	1.7	6.8	5.2	4.7	10.6	4.7	2.1
NB7	0.0	1.2		28.8	0.3		3.0	0.0	1.0	1.0	1.1	0.0
NB8	1.3		3.7	2.0	2.3	0.6	8.6	2.4		3.1	1.6	1.0
NB9			10.1	1.5			14.4	4.2				
NR4	3.6	6.8	4.9	8.4	9.6	10.8	11.1	4.0	5.2	4.9	3.4	4.5
OS1		8.2		86.1				26.2	8.9	14.5	1.8	
OS3		0.0							0.0			
OS6	0.0	8.4		10.1	2.8		1.2	3.7	10.1	2.3	2.2	0.0
OS7	1.3	2.6		4.5	2.3			2.6	3.0	6.4	2.7	
PB1	5.0	2.8		9.9	1.7			1.0	0.0	0.6	1.2	0.0
RB3	5.0	1.8		5.0	1.4	0.0		1.0	0.0	0.6	0.5	0.0
RB8	0.3	1.3	1.8	0.0	0.2	1.4	0.6	1.1	2.5	3.2	1.1	0.4
SC3	1.2	1.5	0.8	3.7	0.4	0.3	0.0	2.7	0.0	0.5	1.0	0.0

(continued)

Table 6-19
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
UL04	0.6	1.0	2.5	1.8	0.5	0.0	0.0	2.0	0.0	4.1	0.9	
GMI4		0.0			1.7			0.0	0.0		0.0	
GMI6		2.8		0.3	0.0	0.0		0.4	0.0	0.0		
Aransas Bay	0.0	0.9		6.0	2.2		0.0	1.6	0.0	2.0	1.0	
Copano Bay	0.6	3.4		0.6	4.0		0.5	4.0		1.9	0.0	1.9
St Charles	1.2	1.5	0.8	3.7	0.4	0.3	0.0	2.7	0.0	0.5	1.0	0.0
Mesquite	1.8	0.0	3.1	10.9	1.4	8.2	3.4	0.0	2.4	0.0	0.0	2.0
Redfish	2.6	1.6	1.8	2.5	0.8	0.7	0.6	1.1	1.2	1.9	0.8	0.2
Corpus Christi	1.3	1.9	1.5	1.3	1.9	1.7	1.9	2.0	3.8	1.6	1.2	0.9
CCSC (bay)	1.2	2.4	2.7	1.9	3.2	3.9	6.8	1.4	3.6	2.3	1.6	1.1
Inner Harbor	1.9	1.7		3.5	1.5	0.0	4.0	1.0	0.5	2.2	4.0	
Nueces Bay	3.6	12.2	8.1	3.4	5.8	4.2	10.3	3.5	4.1	7.7	5.0	2.4
Aransas Pass	1.4	3.1	1.5	2.1	3.9	0.9	0.4	0.4	2.5	2.2	2.4	0.7
Causeway N	1.9	1.2	1.8	1.5	1.4	1.9	1.0	1.0	2.9	2.6	1.7	1.1
Causeway S	0.6	1.0	2.5	1.8	0.5	0.0	0.0	2.0	0.0	4.1	0.9	
Laguna (King)	0.3	0.0	0.0	2.6	0.3	0.0	0.6	1.3	0.0	2.5	2.3	
Laguna (Baffin)	0.0	0.9		6.0	2.2		0.0	1.6	0.0	2.0	1.0	
Baffin Bay	1.1	2.9	0.0	5.0	1.9	0.0	2.6	2.1	0.0	3.0	1.8	
GOM inlet		2.8		0.3	0.0	0.0		0.4	0.0	0.0		

Table 6-20
Monthly average values for period-of-record by hydrographic segment and principal bay
Water quality parameter WQFCOLI

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	3.3	75.4	3.2	2.6	2.0	2.0	2.0	27.0		2.4	3.2	3.3
A2	13.3	15.8	2.7	2.0		2.0	2.0			2.9	7.1	8.8
A3	2.0	3.7	3.1	2.8	3.8	2.0	2.0	24.7	2.0	3.1	117.9	2.8
A4	2.6	3.5	7.2	2.0	2.0	2.0		36.0		2.0	11.7	5.0
A5	4.9	2.0	2.3	2.4	1.3	2.0	2.0	8.7		2.0	5.1	2.0
A6	16.1	2.0	5.9	2.0	2.0	2.0	2.0	12.0		2.2	9.0	162.4
A8	3.9	6.7	6.6	3.6		2.0	2.0	111.0		2.0	7.1	4.3
A10	3.0	2.6	2.4	2.0	2.0	2.0	2.0	17.5	2.0	3.2	2.8	3.6
A12	2.0	2.0	2.6	1.7	2.7	2.0	2.0	19.3		2.0	5.0	2.2
A13	7.2	2.0	2.0	2.0		2.0	2.0	12.5		2.0	15.3	2.0
AR1	75.0	5.0	4.0	934.2	9.7		1.0	3000.0	10.0	382.5	8.7	80.0
BF1	1.0	0.0		2.0	0.7		1.3	3.0		0.5	1.0	
BF2				6.0			1.5			5.0		
BF3	0.7	7.5		2.6	1.0		1.3	3.0		0.5	0.5	
C01	345.4	11014.8	240.6	238.0	155.7	114.8	200.1	66.2	13799.5	88.2	9775.5	10.4
C02	2.5	5.0	50.9	54.6	17.3	78.6	195.3	57.2	4.3	18.6	27.4	44.2
C03	280.7	15.0	767.9	21.8	49.2	15.8	15467.0	35.5	78.1	4509.7	55.0	101.7
C05						3.0				13.0		
C09	2.0	2.0	2.5		2.0	8.3	2.0		2.0	2.6	3.4	3.0
C12	2.3	2.2	2.0	1.3	1.8	1.8	2.0		2.0	1.8	3.6	3.8
C15	5.0	8.1	17.4	23.5	7.9	164.2	27.7	27.2	6.0	621.7	8.8	8.7
C17	5.0	4.1	2.6	1.5	1.7	1.7	2.0		1.5	2.4	2.0	3.8
C19	2.0	2.7	2.0		2.0	2.0	3.5			2.0	14.7	2.0
C20	2.0	2.4	2.5	2.0	2.0	2.0	2.0			2.0	13.0	2.0
CB				0.5	1.3					2.0		
CCC2					4.0	5.3	2.0					
CCC3	4.9	13.0	2.6	5.0	2.0	1.8	1.3		1.0	2.0	2.4	3.5

(continued)

Table 6-20
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
CCC4	2.0	2.0	2.0		2.0	2.0	2.0			2.0	51.7	2.5
CCC6		0.0		6.7	1.0			1.0		1.3	1.0	
CCC8	380.1	27.8	192.2	18.5	56.3	152.4	167.1	30.6	37854.2	40.8	19.8	8.7
CP02	23.2	22.0	18.4	1.3	1.3		2.0			39.3	62.3	9.0
CP03	18.8	3.1	92.9	14.0	1.6	1.6	11.7			56.7	69.0	32.2
CP04	3.0	2.3	31.5	2.9	2.0	2.0	2.0			6.3	9.2	7.3
CP05	16.3	2.0	9.4	1.6	1.3		12.5			1.8	15.1	6.0
CP06	2.0		102.9	5.7			3.0			103.0	2.0	4.0
CP07				1.5	4.0	1.5				10.5		
CP10	3.4	2.4	7.8	2.1	1.7		3.0	1.3		18.5	9.2	4.8
GR2										200.0		
I2			2.0			2.0						
I4	9.2	5.0	6.3	3.5		2.0	2.0	134.5		2.4	17.4	10.3
I5				0.5	0.7							
I6	2.9	17.6	2.0	3.8	3.6	2.0	1.2	9.5	2.0	2.1	2.2	1.9
I7					1.0	1.7						
I9	17.5			105.0			6.0			3.3		
I10			206.7	24.7	28.1	46.2	15.9	91.1	45.2	86.8		
I12	0.7	0.0		4.6						0.5	0.0	
I13					2.0		2.0					
I17	1.0	0.0		4.0	1.0		1.2	0.7		2.4	0.5	
IH1		5.0		12.8	5.3	23.0	35.0	4.6	21.0	1.0	341.6	
IH3								50.0				
IH4							326.7	1365.0				
IH5		16.0		43.3	105.3		27.4	212.1		2.8	61.0	
IH6		4.3		25.3	2.5		0.0	2120.5		2.7	105.0	
IH7		17.3	493.7		62.3	337.8	258.1	3339.7	1040.7	162.5	75.0	
INL					2.0	2.0						

(continued)

Table 6-20
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
LQ1	3.0		38.5			0.0						
LQ2	0.0	30.0	28.5	4.3	0.0	4.3	6.0	0.0		0.7		
M2	2.8	3.0	268.3	5.8		13.7				8.7	5.0	176.0
MB1	23.3	8.7	3.5	2.0	21.0		0.0	36.0	0.8	8.0	4.0	10.0
MB2	5.7	2.4	11.4	2.0		2.0		26.8	2.0	2.0	3.5	13.1
NB2	81.0	45.9	52.4	8.0	8.5	14.0				16.4	46.5	3.5
NB4				176.5								
NB5				8.0	0.7		0.0	0.0		16.0	8.7	
NB6	43.5	70.0	40.9	5.5	1.9	2.0		7.5	1.5	16.1	9.9	2.0
NB7	11.6	38.0	125.9	7.3	5.4	602.3	17.0	7.8	6.3	26.4	21.7	4.4
NB8	45.6	59.9	8.3	28.0	2.0					6.0	26.7	6.5
NB9	24.8	13.3	17.6	11.3	3.0	2.0		20.5	5.0	16.0	8.2	2.0
NR1	30.0			42.0	12.0	82.5	1874.0	5.0	11.5	74.8	28.7	
NR4	69.4	257.6	25.8	185.4	231.2	61.9	619.6	58.4	103.6	310.8	17.9	179.8
OS1	796.3	559.3		225.2			448.0	368.5	507.0	316.4	1342.5	
OS3	24.8	215.0		7.3			17.5		260.0	59.3		
OS6		0.0		170.8				21.0		0.0		29.0
OS7	322.5	144.3		12.2	0.0			15.8		4.0		0.0
PB1		5.0	65.0	15.5	47.5			0.0		14.3		
RB1	2.0	54.5	23.0		93.0	43.6	2.5		23.0		33.0	
RB2					2.0	39.7	2.0					
RB3		1.5								4.5		
RB4	24.0	807.0	20.5		13.2	69.2	18.0				43.5	
RB5	2.0	11.0	6.5		11.7	315.7	9.5		885.0		5.0	
RB7		2.0	3.5		5.3	46.0			12.5			
RB8	6.5	3.9	8.6	30.3	3.4	301.8	28.8	5.0	32.1	7.0	14.6	1.4
SC2	55.1	89.8	66.5	13.9	1.3	3.0				10.1	60.2	7.7
SC3	553.3	22.7	107.5	17.3	2.5	0.0	205.0	40.0	17.5	67.6	8.0	2.5

(continued)

Table 6-20
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
UL01			213.0	120.0	99.4	159.6	49.4	30.3	55.2	24.3		
UL04	15.0	5.0		3.3						0.0	1.0	
GMI6				8.7			2.0			1.0		
GMO6			205.3		4.3	26.5	3.5		332.0	14.0		
Aransas Bay	3.9	13.7	4.0	2.6	2.2	2.0	1.9	33.7	2.0	2.5	19.4	4.3
Copano Bay	11.1	6.4	43.8	4.1	2.0	1.7	5.7	1.3		33.7	27.8	10.5
St Charles	304.2	56.2	87.0	15.6	1.9	1.5	205.0	40.0	17.5	38.9	34.1	5.1
Mesquite	14.5	5.6	7.5	1.5	11.2	2.0	0.0	31.4	1.4	4.0	3.8	11.6
Redfish	10.8	165.1	9.8	30.3	7.1	154.5	14.6	5.0	309.9	5.8	21.0	1.4
Corpus Christi	106.3	1840.7	177.8	63.6	38.0	31.1	2645.0	53.0	3470.9	662.3	1647.9	27.4
CCSC (bay)	3.4	5.0	2.3	5.8	1.7	1.9	1.7	1.0	1.0	1.8	18.4	3.0
Inner Harbor		10.6	493.7	27.1	43.8	180.4	129.4	1182.0	530.8	42.2	145.7	
Nueces Bay	63.3	52.9	30.4	55.1	3.7	14.0	0.0	0.0		12.8	27.3	5.0
Aransas Pass					2.0	2.0						
Causeway N	17.5			105.0			6.0			3.3		
Causeway S	15.0	5.0	209.8	49.3	63.7	102.9	32.7	60.7	50.2	37.0	1.0	
Laguna (King)	0.7	0.0		4.6	2.0		2.0			0.5	0.0	
Laguna (Baffin)	1.0	0.0		4.0	1.0		1.2	0.7		2.4	0.5	
Baffin Bay	0.8	3.8		3.5	0.8		1.4	3.0		51.5	0.8	
GOM inlet			205.3	8.7	4.3	26.5	2.8		332.0	7.5		

Table 6-21
Monthly average values (with BDL=0) for period-of-record by hydrographic segment and principal bay
Water quality parameter WQMETCDT

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
BF1								0.0				
C14												0.0
C15								0.0				
CCC2					0.0				0.0			
CCC3			0.0		0.0							
CCC4	0.0		0.0									0.0
CCC5	0.0		0.0									0.0
CCC6	0.0	10.0	0.0		2.3	0.0	3.3	0.0				0.0
CCC7	0.0		0.0									0.0
CCC8			0.0					0.0				0.0
CP10							5.0					
HI1								0.0				
I1		67.0										
I2		66.5										
I3	0.0				0.0							
I4	0.0		4.4		0.0			0.0				
I5	0.0											
I6	0.0											
I10											0.0	
I11											0.0	
I13									0.0			0.0
I14									0.0			
I16									0.0		0.0	0.0
I17												0.0
I18									0.0		0.0	0.0
IH1		10.0						0.0				
IH2			0.0					0.0				0.0

(continued)

Table 6-21
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH3			0.0			0.0		0.0				0.0
IH4			0.0					0.0				0.0
IH5		10.0	0.0				3.3	0.0				0.0
IH6		6.7	0.0			0.0		0.0				0.0
IH7		0.0	0.0			0.0		0.0				0.0
LQ1			0.0	5.5								7.3
LQ2			0.0	6.3			5.0		20.0		458.5	1130.4
NB7					4.6			0.0				
OS7								5.0				
RB3								0.0				
RB8								3.3				
GMI6			0.0	0.0		0.0						
GMO6			0.0	0.0		0.0						
Aransas Bay									0.0		0.0	0.0
Copano Bay							5.0					
St Charles												
Mesquite												
Redfish								1.7				
Corpus Christi												0.0
CCSC (bay)	0.0	10.0	0.0		1.2	0.0	3.3	0.0				0.0
Inner Harbor		6.7	0.0			0.0	3.3	0.0				0.0
Nueces Bay												
Aransas Pass								0.0				
Causeway N												
Causeway S											0.0	
Laguna (King)									0.0		0.0	0.0
Laguna (Baffin)									0.0		0.0	0.0
Baffin Bay								0.0				
GOM inlet			0.0	0.0		0.0						

Table 6-22
Monthly average values (with BDL=0) for period-of-record by hydrographic segment and principal bay
Water quality parameter WQMETCUT

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
BF1								7.0				
C14												0.0
C15								0.0				
CCC2					0.0				0.0			
CCC3			0.6		0.0							
CCC4	0.0		0.0									6.3
CCC5	0.0		0.2									0.0
CCC6	0.0		0.0		13.0	0.0	56.7	7.1				0.0
CCC7	0.0		0.0									22.0
CCC8		2.8	2.4					11.0				13.3
CP10							50.0					
HI1								0.0				
I1		0.0										
I2		0.0										
I3	0.0				0.0							
I4	0.0		0.0		0.0			5.3				
I5	0.0											
I6	0.0											
I10											0.0	
I11											0.0	
I13									0.0			0.0
I14									0.0			
I15												0.0
I16									0.0		0.0	0.0
I17												0.0
I18									0.0		0.0	0.0
IH1								6.2				

(continued)

Table 6-22
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH2			2.3					10.0				20.0
IH3			2.6			0.0		13.3				23.3
IH4			5.1					20.0				20.0
IH5			3.2				46.7	12.9				25.0
IH6		3.8	2.6			0.0		12.3				25.0
IH7		6.2	2.5			0.0		18.0				26.7
LQ1			0.5	0.0								10.2
LQ2			0.0	0.0			50.0		160.0		120.0	6.9
NB7					5.8			12.8				
OS7								50.0				
RB3								6.0				
RB8								33.3				
GMI6			0.4	0.0		0.0						
GMO6			0.0	0.0		2.0						
Aransas Bay									0.0		0.0	0.0
Copano Bay							50.0					
St Charles												
Mesquite												
Redfish								19.7				
Corpus Christi												0.0
CCSC (bay)	0.0		0.2		6.5	0.0	56.7	7.1				7.1
Inner Harbor		5.0	3.0			0.0	46.7	13.2				23.3
Nueces Bay												
Aransas Pass								0.0				
Causeway N												
Causeway S											0.0	
Laguna (King)									0.0		0.0	0.0
Laguna (Baffin)									0.0		0.0	0.0
Baffin Bay								7.0				
GOM inlet			0.2	0.0		1.0						

Table 6-23
Monthly average values (with BDL=0) for period-of-record by hydrographic segment and principal bay
Water quality parameter WQMETHGT

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
BF1								0.7				
C14												0.0
C15								0.0				
CCC2					0.2				0.0			
CCC3			0.4		0.3							
CCC4	0.0		0.0									0.0
CCC5	0.0		0.1									0.0
CCC6	0.0	0.6	0.0		0.6	0.8	0.3	0.0				0.0
CCC7	0.0		0.0									0.1
CCC8			0.0					0.3				0.1
HI1								0.0				
I1		0.0										
I2		0.0										
I3	0.0				0.0							
I4	0.0		0.0		0.0			0.0				
I5	0.0											
I6	0.0											
I10											0.0	
I11											0.0	
I13									0.0			0.0
I14									0.0			
I15												0.0
I16									0.0		0.0	0.0
I17												0.0
I18									0.0		0.0	0.0
IH1		0.3						0.0				
IH2			0.3					0.0				0.0

(continued)

Table 6-23
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH3			0.3			0.0		0.0				0.1
IH4			0.3					0.3				0.2
IH5		0.0	0.4				0.4	0.0				0.0
IH6		0.0	0.5			0.0		0.0				0.3
IH7		0.0	0.3			0.0		0.0				0.0
LQ1			0.3	0.0								0.0
LQ2			0.4	0.0			2.7		0.0		0.0	0.1
NB7					0.0			0.1	0.0			
OS7								0.0				
RB3								0.0				
RB8								0.2				
GMI6			0.2	0.0		0.0						
GMO6			0.1	0.0		0.0						
Aransas Bay									0.0		0.0	0.0
Copano Bay												
St Charles												
Mesquite												
Redfish								0.1				
Corpus Christi												0.0
CCSC (bay)	0.0	0.6	0.1		0.4	0.8	0.3	0.0				0.0
Inner Harbor		0.1	0.4			0.0	0.4	0.0				0.1
Nueces Bay												
Aransas Pass								0.0				
Causeway N												
Causeway S											0.0	
Laguna (King)									0.0		0.0	0.0
Laguna (Baffin)									0.0		0.0	0.0
Baffin Bay								0.7				
GOM inlet			0.2	0.0		0.0						

Table 6-24
Monthly average values (with BDL=0) for period-of-record by hydrographic segment and principal bay
Water quality parameter WQMETPBT

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
BF1								30.0				
C15								130.0				
CCC2					0.0				0.0			
CCC3			0.0		0.0							
CCC4	0.0		0.0									0.0
CCC5	0.0		0.0									0.0
CCC6	0.0		0.0		33.3	20.0	0.0	53.0				0.0
CCC7	0.0		0.0									2.0
CCC8			0.0					30.0				13.3
CP10							0.0					
HI1								0.0				
I1		0.0										
I2		0.0										
I3	0.0				0.0							
I4	0.0		0.0		0.0			0.0				
I5	0.0											
I6	0.0											
I10											0.0	
I11											0.0	
I13									0.0			0.0
I14									0.0			
I15												0.0
I16									0.0		0.0	0.0
I17												0.0
I18									0.0		0.0	0.0
IH1								53.3				
IH2			1.0					55.0				15.0

(continued)

Table 6-24
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH3			1.3			0.0		23.3				26.7
IH4			2.2					77.5				35.0
IH5			3.1				0.0	8.3				30.0
IH6			2.2			0.0		13.3				0.0
IH7		0.0	3.2			0.0		0.0				16.7
LQ1			0.0	0.0								1.4
LQ2			0.0	0.0			0.0		30.9		451.1	223.0
NB7					8.3			35.0	37.5			
OS7								85.0				
RB3								33.3				
RB8								70.0				
GMI6			0.0	0.0		0.0						
GMO6			0.0	0.0		0.0						
Aransas Bay									0.0		0.0	0.0
Copano Bay							0.0					
St Charles												
Mesquite												
Redfish								51.7				
Corpus Christi												0.0
CCSC (bay)	0.0		0.0		16.7	20.0	0.0	53.0				0.5
Inner Harbor		0.0	2.2			0.0	0.0	33.0				20.6
Nueces Bay												
Aransas Pass								0.0				
Causeway N												
Causeway S											0.0	
Laguna (King)									0.0		0.0	0.0
Laguna (Baffin)									0.0		0.0	0.0
Baffin Bay								30.0				
GOM inlet			0.0	0.0		0.0						

Table 6-25
Monthly average values (with BDL=0) for period-of-record by hydrographic segment and principal bay
Water quality parameter WQMETZNT

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
A1	15.3	15.0	15.9	15.3	15.4	13.8	12.2	22.7	21.8	18.9	16.1	16.4
A2	15.2	16.5	18.4	16.5	11.8	17.7	15.2	21.3	18.1	18.0	16.2	14.4
BF1								42.0				
C14												3.2
C15								30.0				
CCC2					0.0				0.0			
CCC3			2.5		0.0							
CCC4	0.0		79.5									15.0
CCC5	0.0		132.8									1.4
CCC6	0.0	100.0	161.6		240.0	105.3	43.3	258.1				12.1
CCC7	0.0		213.8									26.0
CCC8			323.0					36.8				48.0
CP10							50.0					
HI1								0.0				
I1		0.0										
I2		0.0										
I3	52.7				0.0							
I4	39.5		3.6		0.0			0.0				
I5	5.7											
I6	1.8											
I10											0.0	
I11											0.0	
I13									0.0			8.0
I14									0.0			
I16									0.0		0.0	4.6
I18									0.0		0.0	8.7
IH1		100.0						27.3				

(continued)

Table 6-25
(continued)

Seg ID	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
IH2			20.0					30.0				80.0
IH3			35.3			0.0		41.5				100.0
IH4			57.0					49.8				225.0
IH5		100.0	66.0				130.0	35.0				125.0
IH6		80.3	69.3			0.0		32.3				65.0
IH7		12.4	17.8			0.0		28.2				90.0
LQ1			1.9	10.0								36.1
LQ2			2.0	19.7			59.5		49.0		525.0	424.6
NB7					57.3			44.0				
OS7								50.0				
RB3								6.7				
RB8								33.3				
GMI6			7.7	0.0		0.0						
GMO6			0.0	0.0		0.0						
Aransas Bay									0.0		0.0	4.1
Copano Bay							50.0					
St Charles												
Mesquite												
Redfish								20.0				
Corpus Christi												3.2
CCSC (bay)	0.0	100.0	118.0		120.0	105.3	43.3	258.1				13.6
Inner Harbor		73.2	44.2			0.0	130.0	34.9				114.2
Nueces Bay												
Aransas Pass								0.0				
Causeway N												
Causeway S											0.0	
Laguna (King)									0.0		0.0	7.8
Laguna (Baffin)									0.0		0.0	4.4
Baffin Bay								42.0				
GOM inlet			3.9	0.0		0.0						

Table 6-26
Summary by principal bays of average (with BDL=0) total metals in water, for selected metals.
Highest three concentrations for each metal in boldface

metals:	*Cd*	*Cu*	*Hg*	*Pb*	*Zn*
Aransas Bay	0.0	2.2	0.00	4.0	13.1
Copano Bay	**2.5**	**27.0**	**0.40**	0.5	35.0
St Charles	0.0	4.0	0.00	25.0	10.0
Mesquite					
Redfish	**1.6**	**19.7**	0.08	**51.7**	20.0
Corpus Christi	0.0	2.8	0.00	11.9	**105.9**
CCSC (bay)	**2.2**	10.1	0.08	3.4	**63.0**
Inner Harbor	0.8	11.5	0.12	18.0	52.8
Nueces Bay	0.0	14.0	0.00	**100.0**	44.0
Aransas Pass	0.0	0.0	0.01	0.0	2.2
Causeway N	0.0	0.0	0.00	0.0	0.0
Causeway S	0.0	0.0	0.00	**70.0**	5.0
Laguna (King)	0.8	10.5	**0.33**	14.7	22.7
Laguna (Baffin)	0.0	0.0	0.00	8.0	5.4
Baffin Bay	**1.6**	**31.3**	**2.22**	36.2	**59.3**
GOM inlet	0.0	0.3	0.07	0.0	1.7

Table 6-27
Stratification in salinity (WQSAL) by hydrographic area

Segment	no. obs	strat ppt/m	st dev ppt/m	percent positive	Segment	no. obs	strat ppt/m	st dev ppt/m	percent positive
A1	50	-0.48	0.82	2	GR2	13	-0.07	0.55	8
A2	66	-0.61	1.10	6	HI1	13	-0.42	1.20	31
A3	80	-0.53	0.96	10	HI2	4	-0.82	0.74	0
A4	55	-0.54	0.96	7	I3	66	-0.29	0.96	20
A5	17	-0.47	1.20	6	I5	51	-0.66	1.00	12
A10	16	-0.46	1.00	6	I6	67	-0.31	4.20	28
A12	95	-0.70	1.00	5	I7	66	-0.98	1.30	6
AL2	30	-0.08	2.00	20	I9	99	-0.10	0.47	18
BF1	195	0.32	3.10	36	I10	65	-0.24	0.52	23
BF2	66	-0.10	0.53	21	I11	18	-0.11	0.34	11
BF3	147	-0.21	3.90	40	I12	74	-0.30	2.30	41
C01	65	-0.27	1.00	29	I13	98	-0.06	0.35	15
C02	91	-0.47	2.60	26	I15	70	-0.08	0.33	13
C03	121	-0.31	0.86	19	I17	106	-0.01	2.10	42
C04	71	-0.95	1.90	6	IH1	115	-0.13	0.53	28
C05	96	-0.40	1.10	15	IH3	16	-0.25	0.33	0
C06	92	-0.46	1.00	9	IH5	109	-0.14	0.40	28
C07	151	-0.22	0.65	18	IH6	89	-0.09	0.41	34
C08	23	-0.24	0.60	9	IH7	155	-0.39	0.59	12
C09	110	-0.10	0.44	18	LAC	45	-0.22	0.51	7
C10	164	-0.22	0.69	15	LQ1	73	-0.30	0.45	18
C11	250	-0.40	0.98	11	LQ2	94	-0.12	0.33	30
C12	216	-0.24	1.10	16	LS1	27	-0.55	1.10	22
C13	3	-0.64	0.19	0	LS2	35	-0.13	0.91	20
C14	257	-0.23	0.75	14	MB1	59	1.01	4.30	41
C15	322	-0.53	3.00	18	MB2	9	-0.04	0.09	11
C17	127	-0.60	1.60	12	NB1	56	-0.58	1.80	18
C18	9	-1.29	2.40	22	NB2	12	-0.33	0.94	8
C20	81	-0.40	1.10	22	NB3	20	-0.81	3.10	25
C21	67	-0.16	0.39	9	NB4	77	-1.05	4.70	18
C22	36	-0.04	0.18	14	NB5	283	-0.32	2.90	22
C23	12	-0.02	0.20	17	NB6	144	-2.14	4.70	10
C24	84	-0.23	0.87	15	NB7	66	-1.92	5.00	24
C25	40	-0.13	0.61	10	NB8	12	0.55	3.50	17
CB	93	-0.14	0.53	11	NB9	4	-1.08	2.00	25
CBH	4	0.16	0.57	25	NR1	24	-0.50	1.20	0
CBY1	5	-0.12	0.04	0	NR3	36	-3.70	3.40	3

(continued)

Table 6-27
Stratification in salinity (WQSAL)
(continued)

Segment	*no. obs*	*strat ppt/m*	*st dev ppt/m*	*percent positive*	*Segment*	*no. obs*	*strat ppt/m*	*st dev ppt/m*	*percent positive*
CCC1	186	-0.08	0.91	15	NR4	9	-0.75	0.70	11
CCC2	7	-0.05	0.11	43	NR5	44	-1.59	5.50	9
CCC3	150	-0.24	0.44	9	RB1	10	-0.52	0.71	0
CCC4	3	0.02	0.12	33	RB3	64	-0.54	0.83	16
CCC5	54	-0.16	0.39	7	RB4	12	-0.63	1.30	8
CCC6	77	-0.17	0.42	30	RB5	27	-0.31	0.44	11
CCC7	146	-0.35	0.66	10	RB6	28	-0.58	1.80	18
CCC8	99	-0.33	0.56	14	RB8	104	-0.54	1.10	20
CP02	34	0.03	0.95	15	RB9	28	-1.48	2.30	4
CP03	63	-0.41	1.40	10	SC1	12	-0.38	1.20	8
CP04	31	0.03	0.59	3	SC2	26	-0.48	1.30	12
CP05	62	-0.33	0.79	8	SC3	49	-0.31	1.20	12
CP07	100	-0.35	1.00	9	UL03	37	-0.02	0.35	35
CP08	21	-0.11	0.58	19	UL04	67	-0.04	1.40	42
CP09	51	-0.25	0.61	8	UL11	13	-0.11	2.50	31
CP10	124	-0.59	1.50	11	GMI6	54	-0.13	0.30	22
					GMO6	15	-0.06	0.16	27

Component Bay	*no. obs*	*strat ppt/m*	*st dev ppt/m*	*percent positive*
Aransas Bay	538	-0.40	1.24	14
Copano Bay	486	-0.35	1.12	10
St Charles	75	-0.37	1.24	12
Mesquite	161	0.29	2.63	22
Redfish	263	-0.62	1.29	16
Corpus Christi	1719	-0.32	1.06	14
CCSC (bay)	430	-0.25	0.52	13
Inner Harbor	487	-0.21	0.50	23
Nueces Bay	404	-0.46	3.31	21
Aransas Pass	245	-0.13	0.87	14
Causeway N	223	-0.16	0.67	16
Causeway S	132	-0.14	1.06	33
Laguna (King)	310	-0.12	1.27	24
Laguna (Baffin)	106	-0.01	2.10	42
Baffin Bay	451	0.05	3.07	33

Table 6-28
Stratification in water temperature (WQTEMP) by hydrographic area

Segment	*no. obs*	*strat ℃/m*	*st dev ℃/m*	*percent positive*	*Segment*	*no. obs*	*strat ℃/m*	*st dev ℃/m*	*percent positive*
A1	51	0.072	0.29	49	GR2	13	0.009	0.09	15
A2	67	0.106	0.46	39	HI1	30	0.050	0.15	47
A3	81	0.092	0.28	52	HI2	4	0.207	0.21	75
A4	56	0.028	0.27	46	I3	67	0.015	0.38	45
A5	18	0.068	0.27	28	I5	67	0.008	0.14	40
A10	32	-0.012	0.17	38	I6	82	0.108	0.24	65
A11	15	-0.225	0.91	33	I7	96	0.072	0.31	59
A12	112	0.033	0.22	45	I9	101	0.051	0.13	57
AL2	30	0.368	1.50	33	I10	79	0.089	0.13	71
BF1	194	0.138	0.32	51	I11	18	0.072	0.16	50
BF2	66	0.075	0.21	50	I12	74	0.203	0.22	77
BF3	147	0.096	0.30	47	I13	98	-0.090	1.40	43
C01	81	0.094	0.19	63	I15	68	0.073	0.13	63
C02	105	0.077	0.19	63	I17	106	0.138	0.21	69
C03	138	0.053	0.27	42	IH1	114	0.030	0.14	67
C04	70	0.061	0.14	63	IH3	16	0.042	0.07	75
C05	92	0.053	0.16	42	IH5	107	0.089	0.23	82
C06	89	0.040	0.21	43	IH6	88	0.065	0.08	85
C07	152	0.077	0.16	55	IH7	170	0.055	0.10	75
C08	42	0.056	0.08	57	LAC	46	-0.016	0.09	24
C09	111	0.074	0.14	58	LQ1	88	0.045	0.09	74
C10	179	0.046	0.14	51	LQ2	118	0.070	0.11	82
C11	267	0.050	0.25	43	LS1	27	-0.066	0.66	30
C12	216	0.068	0.28	44	LS2	35	0.048	0.22	37
C13	3	-0.010	0.01	0	MB1	60	0.725	4.20	43
C14	284	0.019	0.54	51	MB2	9	0.150	0.26	67
C15	335	0.045	0.27	41	NB1	47	0.112	0.37	47
C17	123	0.049	0.19	42	NB2	9	0.109	0.29	33
C18	7	0.026	0.18	43	NB3	39	-0.032	0.91	28
C19	15	0.024	0.08	40	NB4	71	0.011	0.67	37
C20	76	0.059	0.12	58	NB5	271	0.119	0.69	32
C21	69	0.000	0.29	43	NB6	141	-0.651	2.30	20
C22	36	0.063	0.19	53	NB7	66	-0.405	3.10	30
C23	11	0.114	0.08	91	NB8	9	-0.056	0.06	0
C24	83	0.015	0.16	39	NB9	18	0.236	0.49	56
C25	42	0.091	0.23	45	NR1	24	0.066	0.17	54
CB	94	-0.003	0.50	27	NR3	36	0.207	0.68	58
CBH	5	0.102	0.13	60	NR4	7	0.560	0.54	71
CBY1	5	0.039	0.18	60	NR5	44	0.248	0.50	48

(continued)

Table 6-28
Stratification in water temperature (WQTEMP)
(continued)

Segment	*no. obs*	*strat ℃/m*	*st dev ℃/m*	*percent positive*	*Segment*	*no. obs*	*strat ℃/m*	*st dev ℃/m*	*percent positive*
CCC1	183	0.023	0.07	52	RB1	11	0.032	0.15	73
CCC2	20	0.026	0.08	45	RB3	65	0.170	0.21	77
CCC3	163	0.028	0.07	65	RB4	14	0.003	0.08	29
CCC4	3	0.040	0.03	67	RB5	27	0.078	0.38	52
CCC5	60	0.010	0.05	52	RB6	28	0.055	0.69	36
CCC6	91	0.037	0.08	67	RB8	104	0.105	0.22	62
CCC7	156	0.038	0.12	53	RB9	28	0.070	0.20	57
CCC8	97	0.061	0.09	77	SC1	13	-0.019	0.14	23
CP02	34	0.140	0.34	41	SC2	26	0.110	0.45	35
CP03	63	0.211	0.98	43	SC3	49	0.039	0.59	29
CP04	31	0.048	0.11	52	UL03	37	0.080	0.36	32
CP05	62	0.171	0.66	40	UL04	67	0.158	0.15	81
CP07	100	0.097	0.32	35	UL11	13	-0.068	0.50	31
CP08	22	0.102	0.23	41	GMI6	54	0.047	0.08	67
CP09	51	0.074	0.23	47	GMO6	16	0.025	0.06	56
CP10	125	0.098	0.21	54					

Component Bay	*no. obs*	*strat ℃/m*	*st dev ℃/m*	*percent positive*
Aransas Bay	588	0.067	0.30	51
Copano Bay	488	0.119	0.48	45
St Charles	75	0.064	0.55	31
Mesquite	163	0.274	2.58	35
Redfish	266	0.104	0.32	59
Corpus Christi	1841	0.046	0.28	47
CCSC (bay)	473	0.031	0.09	60
Inner Harbor	498	0.058	0.14	76
Nueces Bay	399	0.081	0.70	32
Aransas Pass	260	0.019	0.09	47
Causeway N	226	0.045	0.16	48
Causeway S	146	0.120	0.14	75
Laguna (King)	308	0.047	0.82	54
Laguna (Baffin)	106	0.138	0.21	69
Baffin Bay	450	0.127	0.48	47

Table 6-29
Stratification in dissolved oxygen deficit (WQDODEF) by hydrographic area

Segment	*no. obs*	*strat ppm/m*	*st dev ppt/m*	*percent positive*	*Segment*	*no. obs*	*strat ppm/m*	*st dev ppt/m*	*percent positive*
A1	18	-0.07	0.41	33	GR2	5	-0.24	0.41	20
A2	27	-0.18	0.32	19	HI1	4	-0.04	0.14	50
A3	30	-0.34	0.69	20	I3	35	-0.17	0.55	29
A4	31	-0.14	0.36	35	I6	33	-0.22	0.29	24
A5	6	0.14	0.22	67	I7	40	-0.14	0.19	18
A10	4	-0.73	1.30	50	I9	63	-0.02	0.15	38
A12	38	-0.26	0.28	11	I10	19	-0.10	0.15	11
AL2	15	-0.07	0.40	47	I11	13	-0.12	0.12	0
BF1	46	-0.16	0.42	39	I12	42	-0.30	0.47	12
BF2	14	-0.39	0.60	14	I13	23	-0.04	0.15	39
BF3	29	-0.24	0.43	21	I15	34	-0.20	0.33	15
C01	14	-0.40	0.78	14	I17	42	-0.35	0.46	19
C02	43	-0.12	0.24	23	IH1	97	-0.20	0.25	7
C03	40	-0.27	0.55	20	IH3	15	-0.34	0.28	7
C04	34	-0.49	0.67	18	IH5	99	-0.21	0.22	4
C05	52	-0.29	0.55	8	IH6	83	-0.15	0.15	6
C06	50	-0.49	1.60	14	IH7	141	-0.18	0.21	12
C07	59	-0.16	0.47	19	LAC	31	-0.03	0.14	32
C08	6	-0.02	0.15	33	LQ1	50	-0.10	0.15	14
C09	43	-0.23	0.50	14	LQ2	75	-0.14	0.12	3
C10	70	-0.28	1.20	24	LS2	3	0.20	0.43	67
C11	131	-0.32	0.78	21	MB1	15	-0.36	0.37	13
C12	97	-0.20	0.49	26	NB1	17	-0.59	2.60	35
C14	92	-0.19	0.57	22	NB3	10	-0.68	0.72	10
C15	185	-0.17	0.40	28	NB4	39	-0.34	1.00	46
C17	72	-0.38	0.86	19	NB5	131	-0.21	0.52	37
C18	7	-1.45	2.50	0	NB6	91	-0.60	1.00	22
C20	23	-0.16	0.31	17	NB7	42	-0.55	1.30	31
C21	30	-0.14	0.23	20	NB8	4	-0.80	1.40	0
C22	22	-0.12	0.18	18	NR1	12	-0.60	0.75	33
C24	33	-0.09	0.23	30	NR3	31	-1.95	2.20	16
C25	27	-0.04	0.13	44	NR4	3	0.82	2.00	33
CB	43	-0.07	0.34	30	NR5	24	-0.23	0.67	33
CCC1	115	-0.05	0.17	26	RB1	6	-0.42	0.90	50
CCC2	4	-0.05	0.02	0	RB3	44	-0.26	0.38	18
CCC3	93	-0.07	0.19	22	RB4	7	-0.16	0.22	43
CCC4	3	-0.09	0.04	0	RB5	12	-0.14	0.29	17
CCC5	27	-0.04	0.07	22	RB6	10	0.02	0.33	20
CCC6	59	-0.08	0.11	12	RB8	71	-0.11	0.18	23

(continued)

Table 6-29
Stratification in dissolved oxygen deficit (WQDODEF)
(continued)

Segment	no. obs	strat ppm/m	st dev ppt/m	percent positive	Segment	no. obs	strat ppm/m	st dev ppt/m	percent positive
CCC7	86	-0.11	0.18	19	RB9	18	-0.98	1.10	17
CCC8	83	-0.11	0.16	17	SC1	4	-0.94	1.50	50
CP02	20	-0.06	0.30	35	SC2	12	-0.11	0.26	25
CP03	40	-0.29	0.75	25	SC3	24	0.10	0.43	29
CP04	17	-0.09	0.19	29	UL03	10	-0.43	0.94	20
CP05	36	-0.18	0.26	17	UL04	39	-0.16	0.16	21
CP07	58	-0.16	0.34	17	UL11	9	-0.01	0.42	11
CP08	4	-0.18	0.18	25	GMI6	35	-0.04	0.07	17
CP09	23	-0.30	0.49	9	GMO6	12	-0.04	0.04	8
CP10	62	-0.22	0.30	11					

Component Bay	no. obs	strat ppt/m	st dev ppt/m	percent positive
Aransas Bay	224	-0.24	0.46	21
Copano Bay	260	-0.20	0.42	18
St Charles	36	0.03	0.38	28
Mesquite	60	-0.14	0.35	27
Redfish	162	-0.25	0.45	21
Corpus Christi	751	-0.26	0.79	18
CCSC (bay)	268	-0.08	0.16	18
Inner Harbor	438	-0.19	0.21	8
Nueces Bay	186	-0.28	0.69	36
Aransas Pass	151	-0.04	0.16	28
Causeway N	123	-0.04	0.17	37
Causeway S	58	-0.14	0.16	17
Laguna (King)	131	-0.20	0.43	17
Laguna (Baffin)	42	-0.35	0.46	19
Baffin Bay	109	-0.20	0.45	31

Table 6-30
Stratification in pH (WQPH) by hydrographic area

Segment	*no. obs*	*strat 10^{-3} pH/m*	*st dev 10^{-3} pH/m*	*percent positive*	*Segment*	*no. obs*	*strat 10^{-3} pH/m*	*st dev 10^{-3} pH/m*	*percent positive*
A1	43	21.8	47	37	CP09	45	29.9	60	38
A2	35	33.0	70	34	CP10	93	12.4	57	32
A3	49	12.2	40	33	GR2	11	12.7	73	27
A4	27	21.9	38	30	HI1	12	35.8	79	42
A5	16	0.0	0	0	I3	40	23.1	68	38
A10	15	17.0	43	27	I5	48	24.0	34	52
A12	66	18.7	32	45	I6	63	14.2	56	32
AL2	6	13.9	31	17	I7	37	30.5	39	59
BF1	78	-11.2	94	19	I9	56	4.0	26	36
BF2	22	16.2	63	41	I10	24	7.6	54	46
BF3	82	8.1	50	24	I11	18	7.0	19	33
C01	5	20.5	37	40	I12	70	2.0	69	19
C02	73	2.5	43	25	I13	7	2.8	16	29
C03	42	17.6	110	29	I15	21	3.3	24	38
C04	48	9.3	23	21	I17	70	10.5	70	36
C05	58	4.3	39	26	IH1	105	12.7	25	57
C06	56	1.0	46	30	IH3	13	22.0	29	62
C07	28	18.5	38	32	IH5	100	8.3	17	52
C08	16	5.0	18	31	IH6	79	3.8	13	44
C09	47	5.6	55	30	IH7	104	9.5	28	53
C10	82	9.8	25	27	LAC	42	9.7	16	36
C11	147	11.2	34	35	LQ1	25	-3.2	50	48
C12	78	20.4	40	42	LQ2	85	9.5	16	55
C14	77	-1.4	63	29	LS2	9	7.9	22	11
C15	172	2.3	53	28	MB1	53	-28.4	140	19
C17	57	12.8	59	32	NB3	5	0.0	0	0
C18	3	130.0	120	100	NB4	23	64.6	170	43
C20	4	9.3	16	25	NB5	165	14.3	100	24
C21	30	-9.2	60	20	NB6	57	59.6	290	44
C22	9	11.2	16	33	NB7	39	25.9	120	31
C24	35	-10.1	77	29	NR1	20	32.1	150	55
C25	34	4.5	26	29	NR3	31	156.0	160	81
CB	62	16.2	74	16	NR5	20	71.4	220	35
CBH	4	16.0	18	50	RB1	11	13.1	29	45
CCC1	100	2.8	22	40	RB3	57	25.9	39	61
CCC3	56	6.8	23	64	RB4	14	25.3	65	50
CCC5	12	18.6	11	83	RB8	96	13.2	52	41
CCC6	70	3.6	11	46	RB9	21	43.0	57	57

(continued)

Table 6-30
Stratification in pH (WQPH)
(continued)

Segment	*no. obs*	*strat 10^{-3} pH/m*	*st dev 10^{-3} pH/m*	*percent positive*	*Segment*	*no. obs*	*strat 10^{-3} pH/m*	*st dev 10^{-3} pH/m*	*percent positive*
CCC7	64	12.6	18	69	SC1	11	58.7	120	36
CCC8	80	2.7	23	44	SC2	22	7.6	66	9
CP02	30	7.1	130	20	SC3	19	33.6	97	16
CP03	32	46.7	120	34	UL03	15	5.6	21	7
CP04	27	16.0	51	30	UL04	64	4.6	29	39
CP05	31	8.6	65	16	UL11	13	16.6	40	15
CP07	66	33.5	69	45	GMI6	49	4.2	11	51
CP08	19	32.2	100	21	GMO6	16	6.1	6	69

Component Bay	*no. obs*	*strat 10^{-3} pH/m*	*st dev 10^{-3} pH/m*	*percent positive*
Aransas Bay	326	17.1	51	37
Copano Bay	343	22.5	79	32
St Charles	41	19.6	82	12
Mesquite	115	-4.4	109	17
Redfish	189	21.2	50	49
Corpus Christi	736	6.7	47	27
CCSC (bay)	204	8.2	17	60
Inner Harbor	404	9.3	22	53
Nueces Bay	193	19.9	110	26
Aransas Pass	155	7.2	29	39
Causeway N	125	0.2	46	32
Causeway S	88	5.4	38	41
Laguna (King)	144	4.5	51	22
Laguna (Baffin)	70	10.5	70	36
Baffin Bay	199	1.9	73	24

Table 6-31
Stratification in ammonia (WQAMMN) by hydrographic area

Segment	no. obs	strat 10^{-3} ppm/m	st dev 10^{-3} ppm/m	percent positive	Segment	no. obs	strat 10^{-3} ppm/m	st dev 10^{-3} ppm/m	percent positive
A3	13	-1.2	20.0	38	GR2	8	10.8	17.0	38
A5	5	1.1	12.0	40	I3	9	-29.6	53.0	22
A12	24	2.3	22.0	29	I5	19	-2.7	8.4	32
AL2	7	-4.9	13.0	14	I7	15	-7.0	18.0	20
BF1	85	-3.0	12.0	27	I9	57	1.6	23.0	28
BF2	50	-2.2	12.0	28	I10	28	-0.1	2.3	32
BF3	64	-4.3	21.0	31	I11	3	25.2	36.0	33
C02	14	8.5	20.0	57	I13	62	1.8	10.0	45
C03	17	-38.3	150.0	35	I15	35	-4.8	17.0	23
C04	13	1.2	8.4	38	I17	31	-0.9	3.1	35
C05	22	9.1	51.0	23	IH1	19	-31.3	58.0	21
C06	7	-11.8	8.2	0	IH3	3	-9.2	0.4	0
C07	13	1.5	11.0	31	IH5	8	8.0	14.0	63
C08	12	-0.5	4.6	50	IH6	3	9.4	14.0	67
C09	3	0.8	4.7	67	IH7	46	2.0	21.0	54
C10	21	5.9	19.0	43	LAC	11	1.4	8.9	36
C11	44	-2.3	8.0	23	LQ2	4	-6.6	6.2	0
C12	34	1.8	14.0	38	LS1	26	2.0	26.0	31
C14	79	1.9	18.0	42	LS2	31	-5.4	9.8	13
C15	26	1.7	22.0	35	MB1	6	0.7	2.2	33
C17	38	-8.5	57.0	32	MB2	11	-3.1	10.0	27
C20	11	-2.3	5.7	45	NB1	55	-8.7	78.0	35
C21	10	-2.4	11.0	40	NB2	12	-17.7	28.0	25
C23	12	5.0	21.0	50	NB3	12	-29.0	32.0	33
C24	11	-3.5	14.0	45	NB4	30	-3.6	36.0	37
CB	10	-1.2	39.0	50	NB5	57	1.0	51.0	40
CBY1	6	-2.0	8.6	67	NB6	13	-11.2	51.0	62
CCC1	37	-0.5	2.7	27	NB8	10	6.4	60.0	30
CCC3	31	-1.5	3.8	19	NB9	4	10.0	19.0	50
CCC5	13	-2.2	4.6	31	NR1	13	-2.7	28.0	15
CCC6	3	0.0	0.0	0	NR4	7	-5.6	68.0	43
CCC7	41	0.7	17.0	41	RB1	9	-0.5	11.0	44
CCC8	15	-4.3	15.0	33	RB3	9	-6.2	11.0	22
CP02	3	2.8	9.9	67	RB8	7	-4.6	4.8	0
CP05	5	10.6	45.0	40	UL03	24	-2.1	27.0	46
CP07	19	-3.9	31.0	26	GMI6	23	-1.1	3.4	13
CP10	9	-5.3	23.0	22	GMO6	3	-1.5	2.5	33

(continued)

Table 6-31
Stratification in ammonia (WQAMMN)
(continued)

Component Bay	*no. obs*	*strat 10^{-3} ppm/m*	*st dev 10^{-3} ppm/m*	*percent positive*
Aransas Bay	108	-1.4	15.9	31
Copano Bay	38	-1.6	29.8	32
St Charles	insufficient data			
Mesquite	27	-1.6	24.6	37
Redfish	17	-5.2	8.6	12
Corpus Christi	313	-0.6	39.6	32
CCSC (bay)	90	-0.5	11.8	30
Inner Harbor	82	-5.7	32.5	44
Nueces Bay	121	-4.6	45.0	36
Aransas Pass	49	-0.1	4.8	29
Causeway N	68	0.8	21.8	31
Causeway S	28	-0.1	2.3	32
Laguna (King)	126	-0.2	17.3	38
Laguna (Baffin)	31	-0.9	3.1	35
Baffin Bay	214	-2.7	15.5	29

Table 6-32
Stratification in nitrate (WQNO3N) by hydrographic area

Segment	*no. obs*	*strat 10^{-3} ppm/m*	*st dev 10^{-3} ppm/m*	*percent positive*	*Segment*	*no. obs*	*strat 10^{-3} ppm/m*	*st dev 10^{-3} ppm/m*	*percent positive*
A3	13	-2.32	14.0	15	GR2	8	-1.25	11.0	13
A5	5	-2.22	4.4	0	I3	9	0.54	12.0	22
A12	24	0.25	2.3	17	I5	19	-4.01	13.0	5
AL2	7	1.59	15.0	14	I7	15	0.02	1.0	7
BF1	85	0.58	4.1	58	I9	49	-9.05	56.0	16
BF2	50	0.31	5.1	62	I10	28	0.04	0.4	39
BF3	64	-0.47	6.4	55	I11	3	-17.30	12.0	0
C02	14	14.80	32.0	71	I13	62	0.89	7.6	55
C03	17	-0.81	31.0	47	I15	35	6.26	38.0	37
C04	13	5.70	10.0	69	I17	31	-0.13	1.0	65
C05	19	0.98	3.6	21	IH1	22	0.54	2.3	23
C06	7	0.00	0.0	0	IH3	4	3.16	3.2	75
C07	13	-0.83	2.0	0	IH5	8	32.80	60.0	50
C08	13	1.19	1.7	69	IH6	3	4.44	5.7	67
C09	3	0.00	0.0	0	IH7	50	6.34	24.0	66
C10	24	0.65	5.1	29	LAC	11	-1.72	4.9	0
C11	38	-0.18	11.0	13	LQ2	5	-1.32	2.2	0
C12	35	3.09	17.0	26	LS1	26	-2.19	12.0	62
C14	79	-0.51	12.0	39	LS2	31	0.72	2.2	55
C15	24	10.50	54.0	29	MB1	6	21.00	42.0	50
C17	34	3.21	10.0	32	MB2	11	4.87	9.7	73
C20	11	-5.09	8.5	36	NB1	56	-17.40	82.0	50
C21	10	0.37	1.1	10	NB2	12	18.30	94.0	42
C23	12	2.08	6.4	67	NB3	12	-16.10	66.0	58
C24	11	-4.81	21.0	73	NB4	30	2.46	41.0	50
C25	6	0.83	1.9	17	NB5	58	8.12	39.0	62
CB	10	17.20	34.0	40	NB6	14	-42.20	200.0	50
CBY1	6	28.20	64.0	67	NB8	10	19.30	95.0	20
CCC1	34	-3.83	14.0	26	NB9	4	7.40	13.0	50
CCC3	34	-3.84	15.0	24	NR1	15	-14.50	34.0	0
CCC4	3	0.00	0.0	0	NR3	3	-1.85	2.6	0
CCC5	13	0.88	2.9	62	NR4	7	24.50	41.0	71
CCC6	4	0.00	0.0	0	NR5	3	-9.00	6.4	0
CCC7	43	8.51	53.0	37	RB1	9	-2.64	6.8	0
CCC8	15	1.55	6.4	53	RB3	11	-24.80	500.0	9
CP02	4	-2.08	3.6	0	RB8	7	0.66	1.6	14
CP05	5	-1.67	3.3	0	UL03	24	-1.93	6.7	33
CP07	21	-84.50	260.0	14	GMI6	18	-0.98	4.5	11
CP10	9	5.71	19.0	11	GMO6	5	0.06	2.1	20

(continued)

Table 6-32
Stratification in nitrate (WQNO3N)
(continued)

Component Bay	*no. obs*	*strat 10^{-3} ppm/m*	*st dev 10^{-3} ppm/m*	*percent positive*
Aransas Bay	108	1.65	22.2	36
Copano Bay	41	-42.40	186.0	10
St Charles	3	-111.00	130.0	0
Mesquite	27	13.00	29.3	56
Redfish	19	-14.10	380.0	11
Corpus Christi	306	0.77	12.8	32
CCSC (bay)	97	2.54	36.4	33
Inner Harbor	90	7.06	25.4	54
Nueces Bay	122	6.26	56.3	53
Aransas Pass	46	-3.24	12.3	20
Causeway N	66	-7.44	49.0	26
Causeway S	28	0.04	0.4	39
Laguna (King)	126	1.40	21.0	44
Laguna (Baffin)	31	-0.13	1.0	65
Baffin Bay	214	0.17	6.1	55

Table 6-33
Stratification in chlorophyll-a (WQCHLA) by hydrographic area

Segment	no. obs	strat 10^{-3} ppb/m	st dev 10^{-3} ppb/m	percent positive	Segment	no. obs	strat 10^{-3} ppb/m	st dev 10^{-3} ppb/m	percent positive
A3	13	-1.2	20.0	38	GR2	8	10.8	17.0	38
A5	5	1.1	12.0	40	I3	9	-29.6	53.0	22
C02	11	-166.0	250	9	CCC5	11	-78.8	110	18
C03	12	-1.4	470	50	CCC7	18	-84.6	370	39
C04	12	93.3	1000	25	CCC8	12	94.0	270	58
C08	12	-89.3	240	17	I9	12	-220.0	780	50
C10	11	-143.0	210	27	MB1	5	-850.0	830	0
C12	13	106.0	480	38	MB2	8	-1600.0	870	0
C14	33	-79.7	660	27	NB1	56	-1450.0	4100	32
C15	11	-152.0	300	36	NB2	12	-731.0	2300	33
C17	12	-95.4	140	25	NB3	12	-2690.0	4000	17
C20	10	90.0	410	40	NB4	30	-606.0	2100	40
C23	11	5.0	220	36	NB5	52	-1180.0	2500	27
C24	10	43.5	340	40	NB6	12	-1210.0	2900	42
CBY1	5	-727.0	1600	40	NB8	10	170.0	900	50
CCC1	13	61.5	420	23	NB9	4	-887.0	2200	25
CCC3	13	8.2	96	46	NR4	7	5550.0	7500	57

Component Bay	no. obs	strat 10^{-3} ppm/m	st dev 10^{-3} ppm/m	percent positive
Aransas Bay	insufficient data			
Copano Bay	insufficient data			
St Charles	insufficient data			
Mesquite	13	-1312	855	0
Redfish	insufficient data			
Corpus Christi	129	-31	509	26
CCSC (bay)	44	-44	249	36
Inner Harbor	insufficient data			-
Nueces Bay	116	-1025	2493	32
Aransas Pass	13	62	420	23
Causeway N	22	-100	620	45
Causeway S	insufficient data			
Laguna (King)	insufficient data			
Laguna (Baffin)	insufficient data			
Baffin Bay	insufficient data			

Table 6-34
Stratification in total suspended solids (WQTSS) by hydrographic area

Segment	*no. obs*	*strat ppm/m*	*st dev ppm/m*	*percent positive*	*Segment*	*no. obs*	*strat ppm/m*	*st dev ppm/m*	*percent positive*
CCC6	4	-2.42	5.1	25	IH3	3	0.12	1.6	33
CCC8	3	-2.57	1.0	0	IH5	4	-0.51	0.3	0
IH1	3	-3.35	4.0	0	IH6	4	-0.16	0.7	25

Component Bay	*no. obs*	*strat ppm/m*	*st dev ppm/m*	*percent positive*
Aransas Bay	insufficient data			
Copano Bay	insufficient data			
St Charles	insufficient data			
Mesquite	insufficient data			
Redfish	insufficient data			
Corpus Christi	insufficient data			
CCSC (bay)	6	-3.50	4.9	17
Inner Harbor	19	-2.32	4.3	16
Nueces Bay	insufficient data			
Aransas Pass	insufficient data			
Causeway N	insufficient data			
Causeway S	insufficient data			
Laguna (King)	insufficient data			
Laguna (Baffin)	insufficient data			
Baffin Bay	insufficient data			

Table 6-35
Stratification in proxy TSS (WQXTSS) by hydrographic area

Segment	no. obs	strat ppm/m	st dev ppm/m	percent positive	Segment	no. obs	strat ppm/m	st dev ppm/m	percent positive
A1	28	-8.13	19.0	18	CP02	10	-2.60	6.6	20
A2	20	-23.00	55.0	20	CP03	10	-10.60	22.0	30
A3	31	-8.08	22.0	10	CP04	6	-2.48	5.5	33
A4	13	-6.48	7.2	8	CP05	10	-7.99	14.0	20
A5	12	-2.65	6.2	8	CP07	22	-5.51	22.0	36
A10	12	-9.08	17.0	8	CP08	7	-2.83	4.1	14
A12	35	-4.29	6.9	14	CP09	12	-10.20	12.0	17
AL2	3	-23.80	40.0	33	CP10	14	-4.17	5.4	7
BF1	6	3.94	7.5	50	GR2	4	-6.78	10.0	25
BF2	9	-6.17	11.0	22	HI1	8	-2.64	5.7	13
BF3	7	-5.22	4.7	0	I3	21	-15.60	32.0	19
C01	60	-7.96	15.0	18	I5	31	-8.73	12.0	3
C02	6	-5.06	4.7	0	I7	21	-4.64	4.3	10
C03	86	-5.81	11.0	15	I9	19	-3.90	12.0	16
C04	14	-6.53	5.7	7	I10	36	-0.73	3.6	25
C05	10	-5.06	5.6	0	I11	6	-5.14	5.5	0
C06	12	-3.37	3.5	8	I13	4	-6.23	9.1	25
C07	86	-3.49	9.3	23	I15	7	-4.28	3.3	14
C08	3	-4.08	2.4	0	IH1	6	-1.80	3.2	0
C09	73	-7.11	9.5	4	IH3	5	-0.01	1.3	20
C10	43	-3.42	8.5	7	IH5	7	-0.04	0.9	29
C11	49	-5.44	7.7	2	IH6	5	-0.13	0.7	20
C12	94	-6.14	9.0	13	IH7	80	-2.56	6.4	28
C14	87	-3.93	8.0	21	LAC	23	-1.35	4.2	22
C15	75	-17.60	25.0	17	LQ1	60	-1.80	2.9	20
C17	6	-11.10	9.9	0	LQ2	11	-1.28	1.9	9
C20	63	-5.56	12.0	29	LS2	4	-16.50	17.0	0
C21	23	-2.21	2.4	4	NB5	31	-26.30	37.0	3
C22	3	-4.24	2.7	0	NB6	8	-34.70	42.0	0
C24	23	-2.57	6.5	4	NR3	4	-8.30	7.5	0
CB	36	-27.30	48.0	14	NR5	6	-10.00	24.0	33
CCC1	76	-1.71	3.7	21	RB1	4	-2.54	1.7	0
CCC3	75	-3.76	4.9	11	RB3	10	-4.76	4.9	0
CCC4	3	-3.77	4.6	0	RB8	11	-4.83	9.7	27
CCC5	5	-2.98	3.2	0	RB9	7	-5.36	5.1	0
CCC6	5	-1.94	4.7	20	SC2	11	-9.22	17.0	18
CCC7	10	-3.76	3.4	10	SC3	7	-7.45	14.0	14
CCC8	3	-2.57	1.0	0	GMI6	9	-0.99	1.1	11
					GMO6	3	0.00	0.0	0

(continued)

Table 6-35
Stratification in proxy TSS (WQXTSS)
(continued)

Component *Bay*	*no.* *obs*	*strat* *ppm/m*	*st dev* *ppm/m*	*percent* *positive*
Aransas Bay	146	-8.98	25.0	14
Copano Bay	91	-6.03	14.9	23
St Charles	18	-8.53	15.9	17
Mesquite	36	-27.30	48.0	14
Redfish	28	-4.94	7.2	11
Corpus Christi	552	-4.84	9.8	16
CCSC (bay)	98	-3.63	4.7	10
Inner Harbor	106	-2.05	5.6	25
Nueces Bay	33	-28.30	36.6	3
Aransas Pass	108	-1.69	4.0	20
Causeway N	43	-3.00	9.3	12
Causeway S	36	-0.73	3.6	25
Laguna (King)	20	-7.32	11.5	15
Laguna (Baffin)	insufficient data			
Baffin Bay	29	-5.76	15.3	24

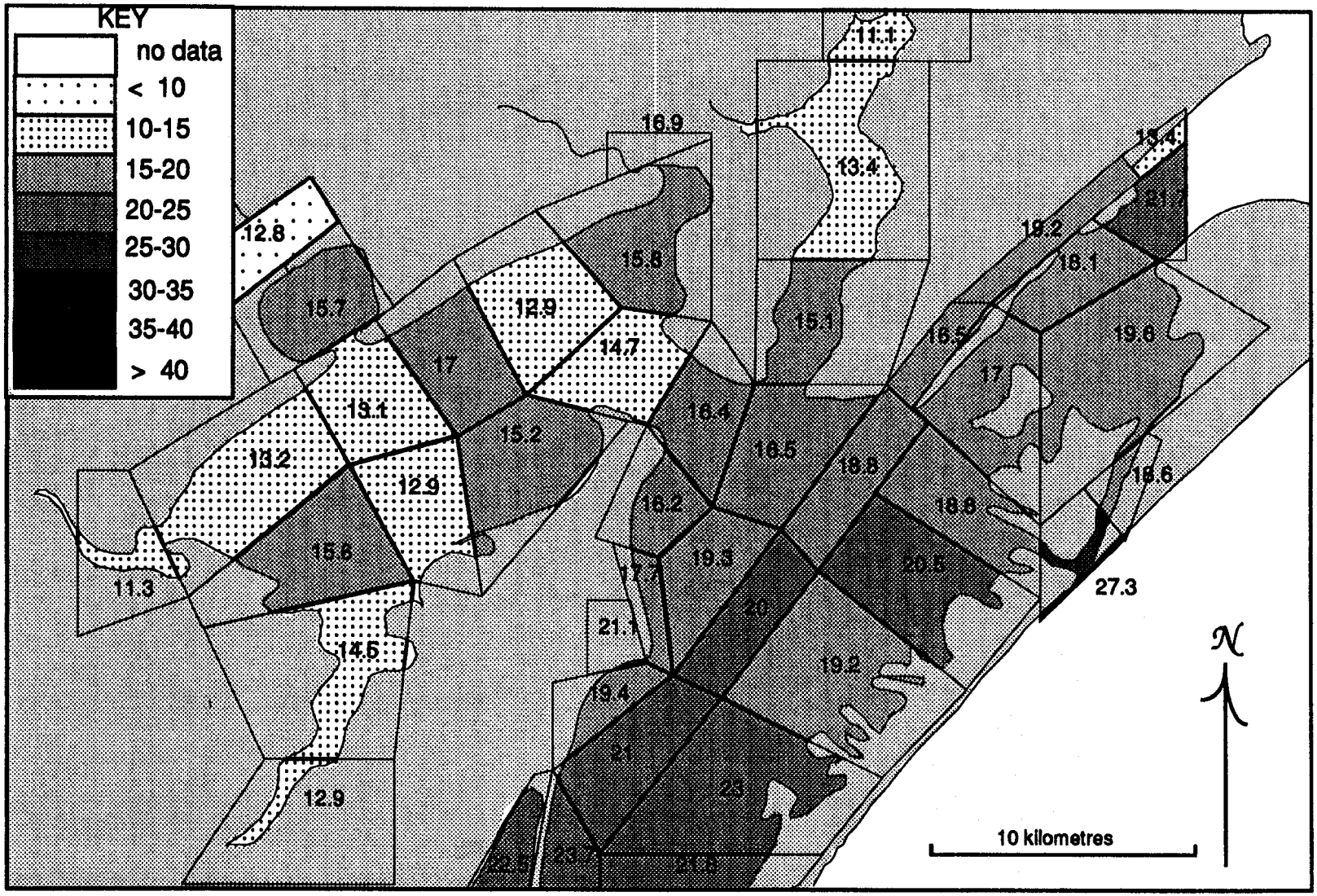


Figure 6-1. Period-of-record means of WQSAL, upper 1 m, for Aransas-Copano system

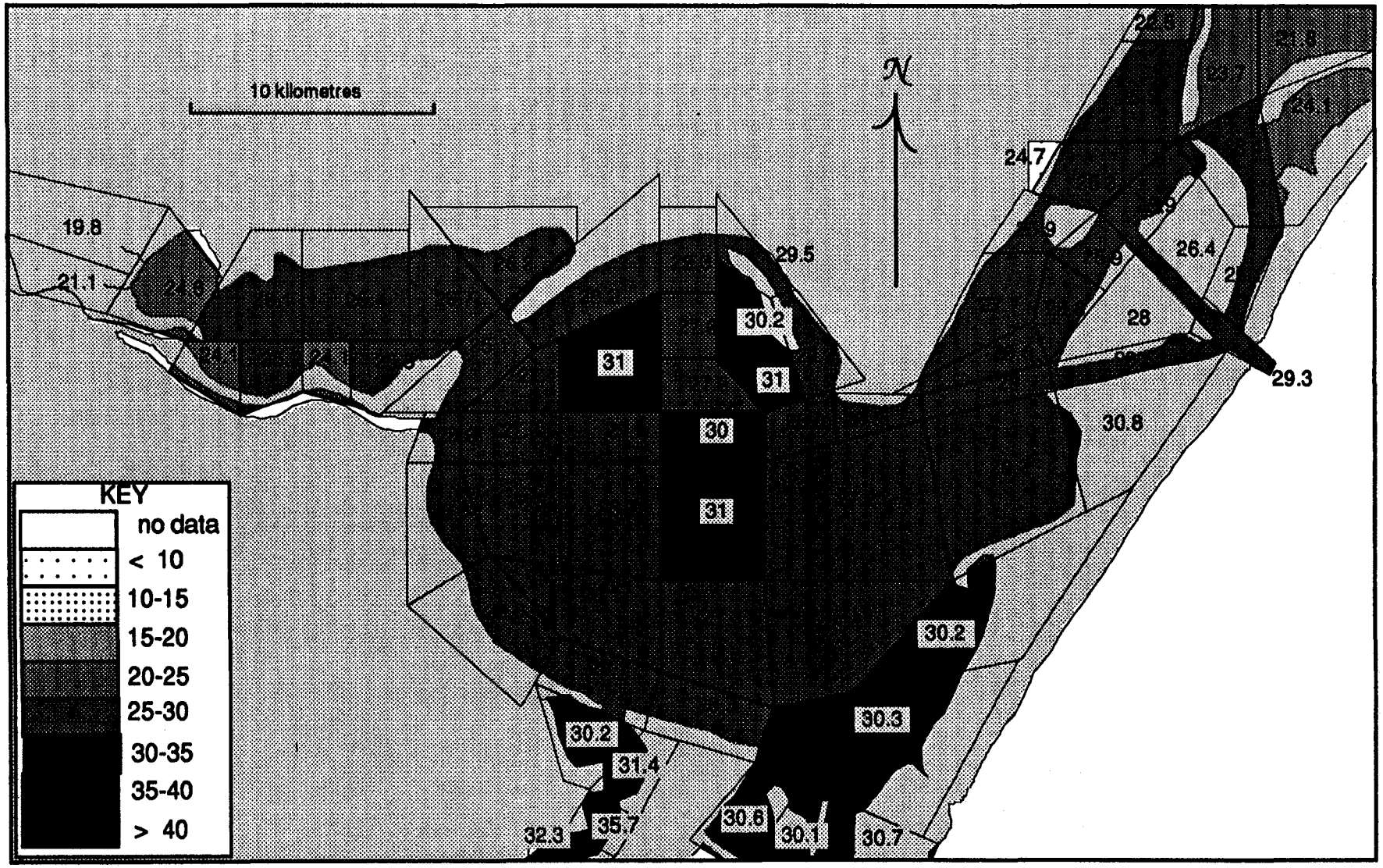


Figure 6-2. Period-of-record means of WQSAL, upper 1 m, for Corpus Christi system

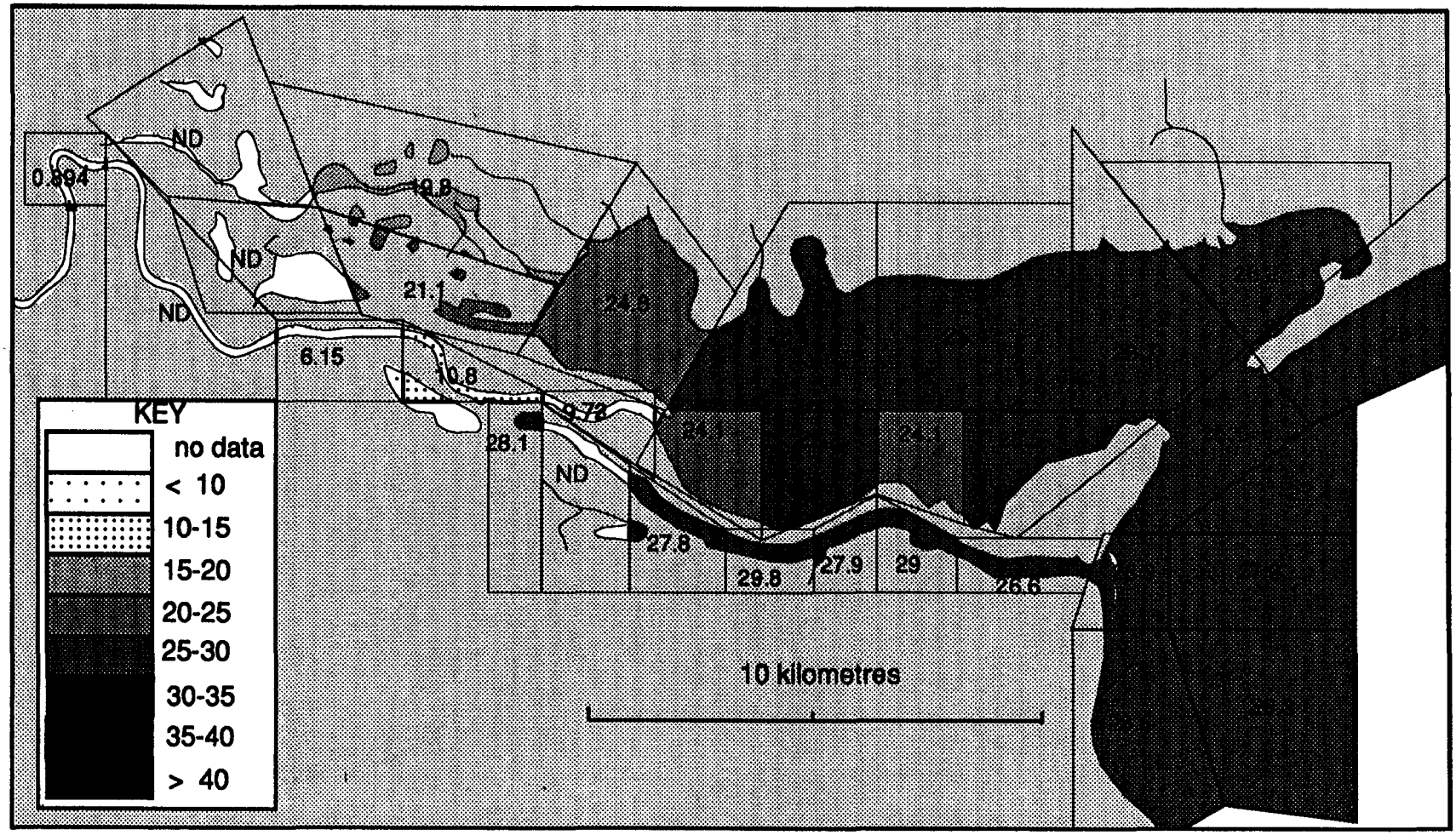


Figure 6-3. Period-of-record means of WQSAL, upper 1m, for Nueces Bay region, including Inner Harbor

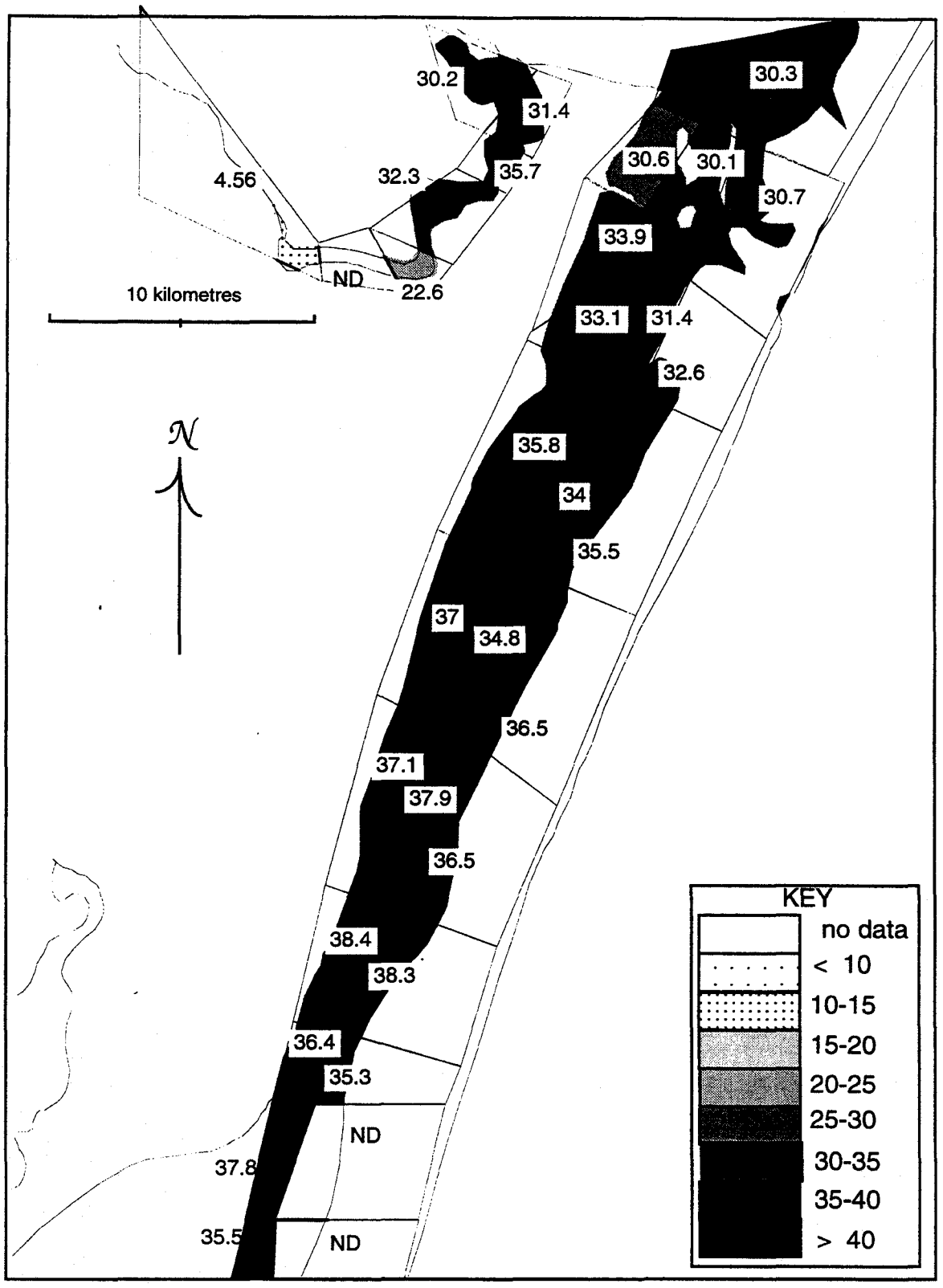


Figure 6-4. Period-of-record means of WQSAL, upper 1 m, for Upper Laguna Madre

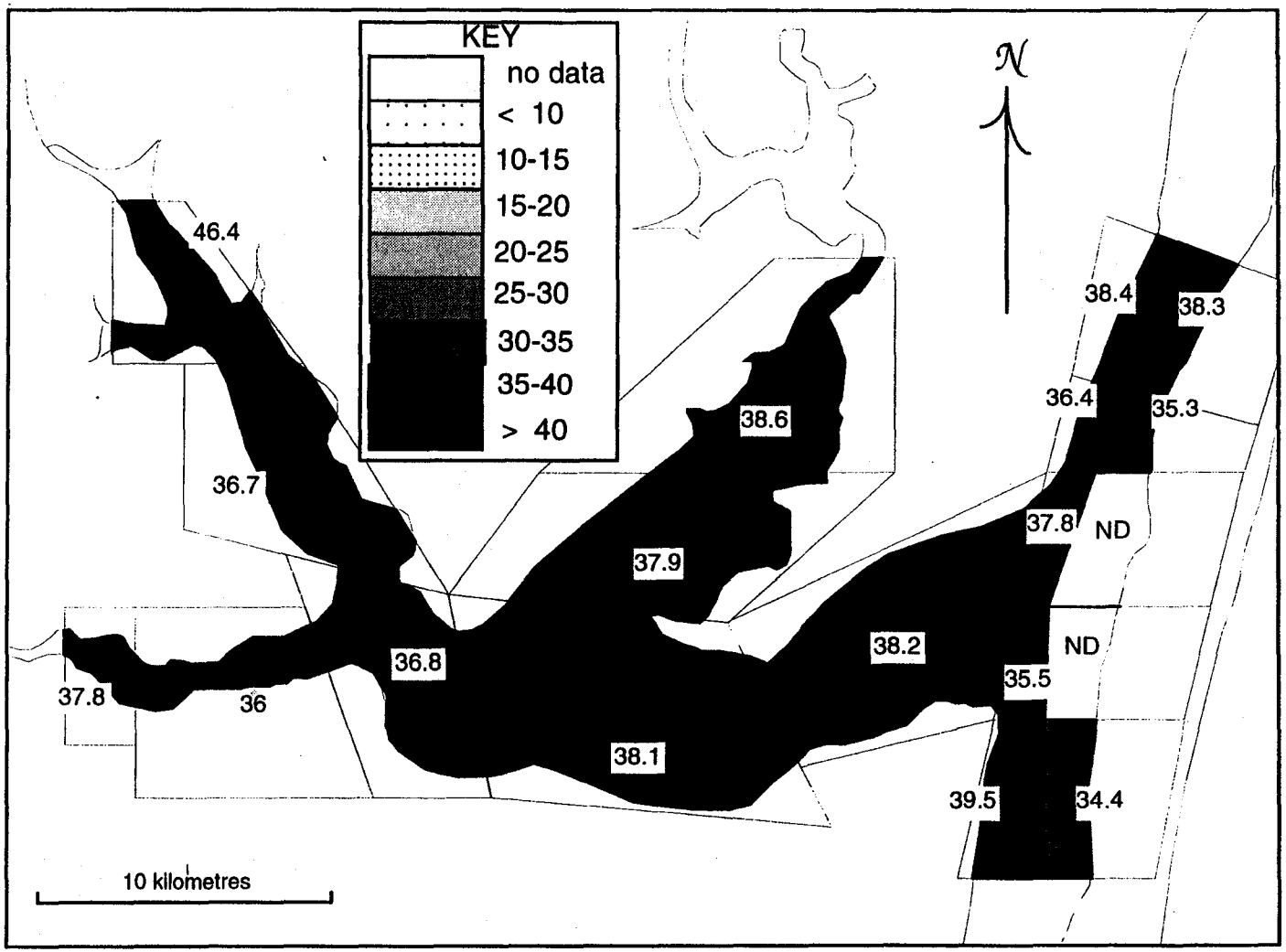


Figure 6-5. Period-of-record means of WQSAL, upper 1m, for Baffin Bay region

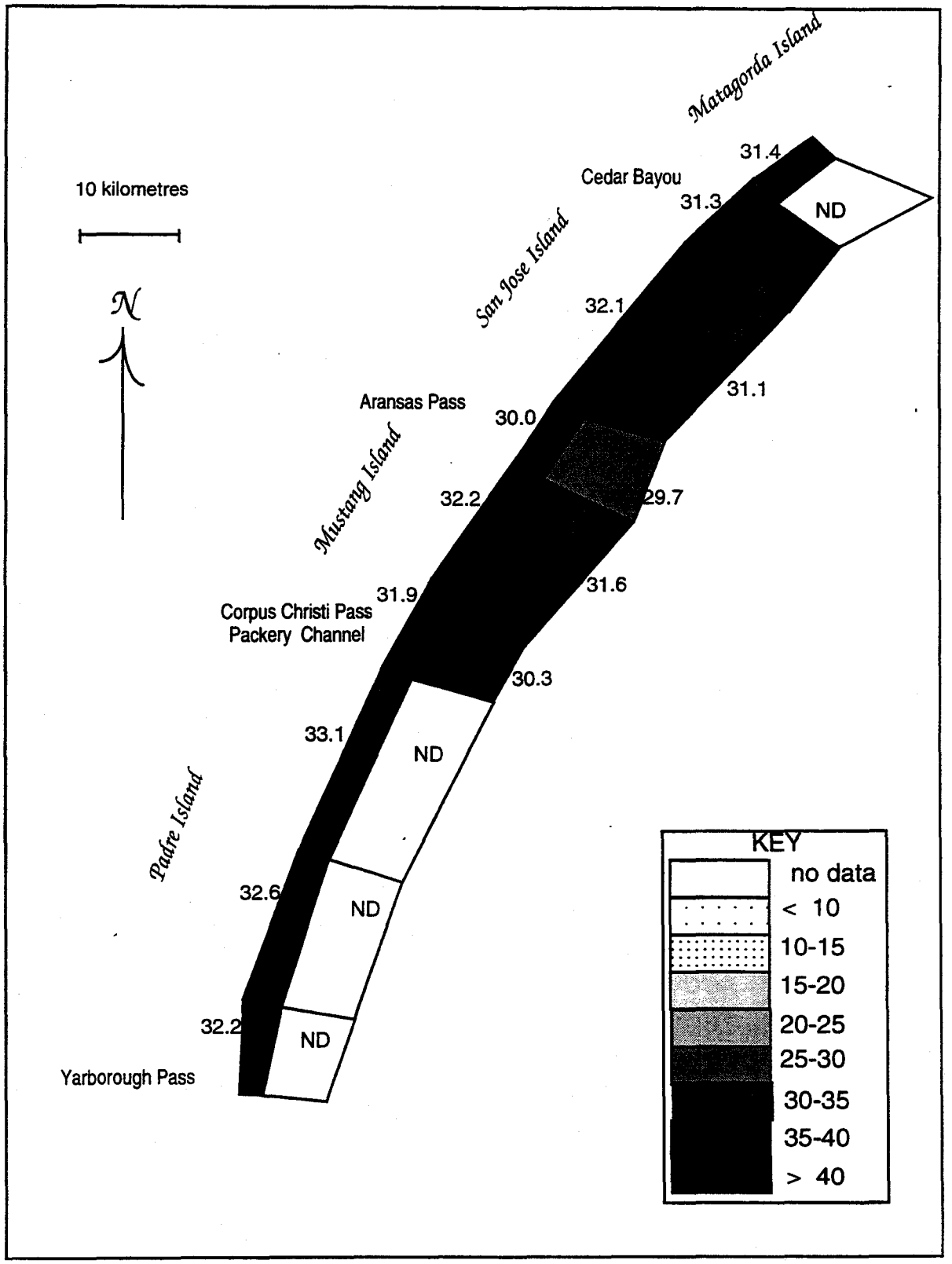


Figure 6-6. Period-of-record means of WQSAL, upper 1 m, for Gulf of Mexico

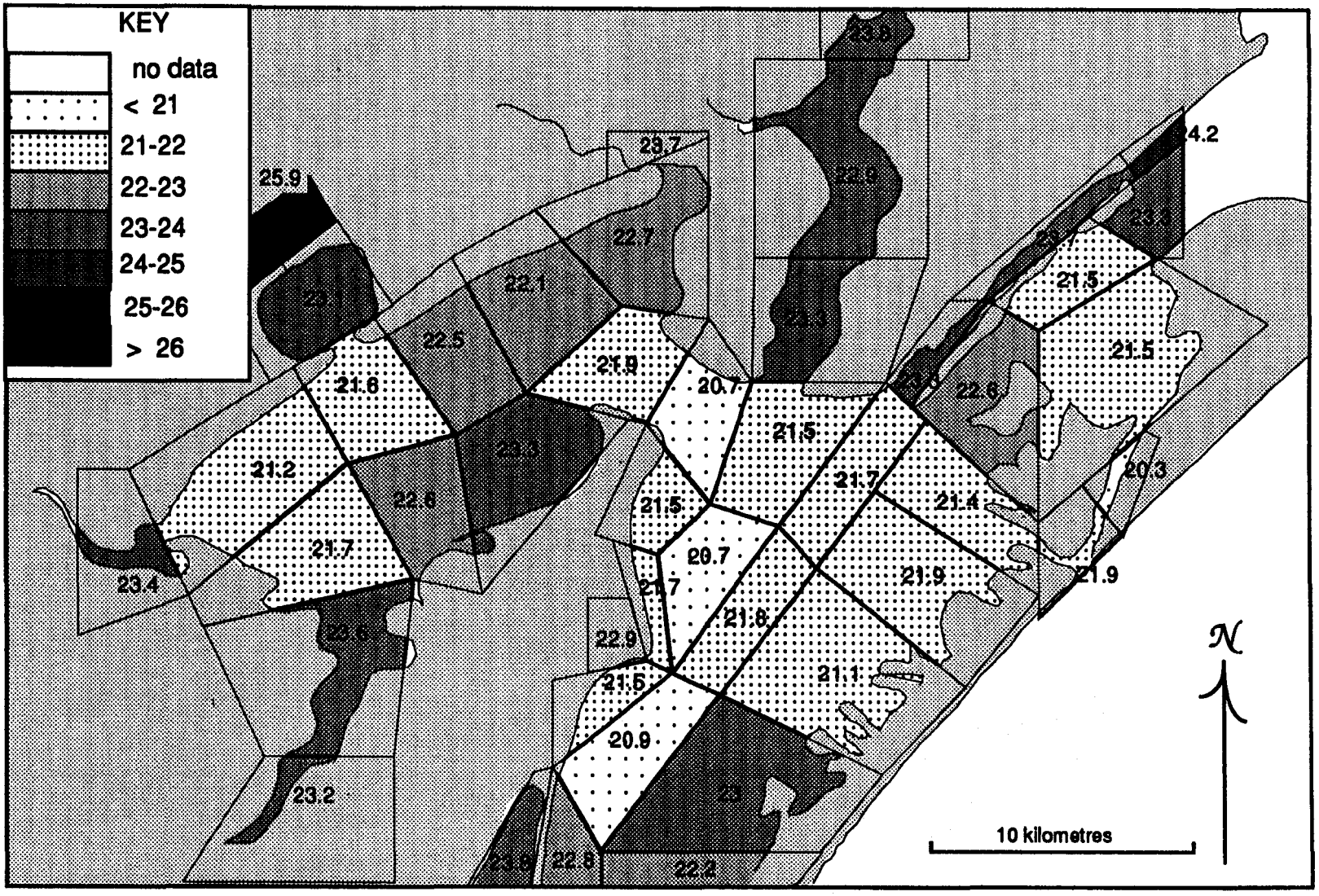


Figure 6-7. Period-of-record means WQTEMP, upper 1 m, for Aransas-Copano system

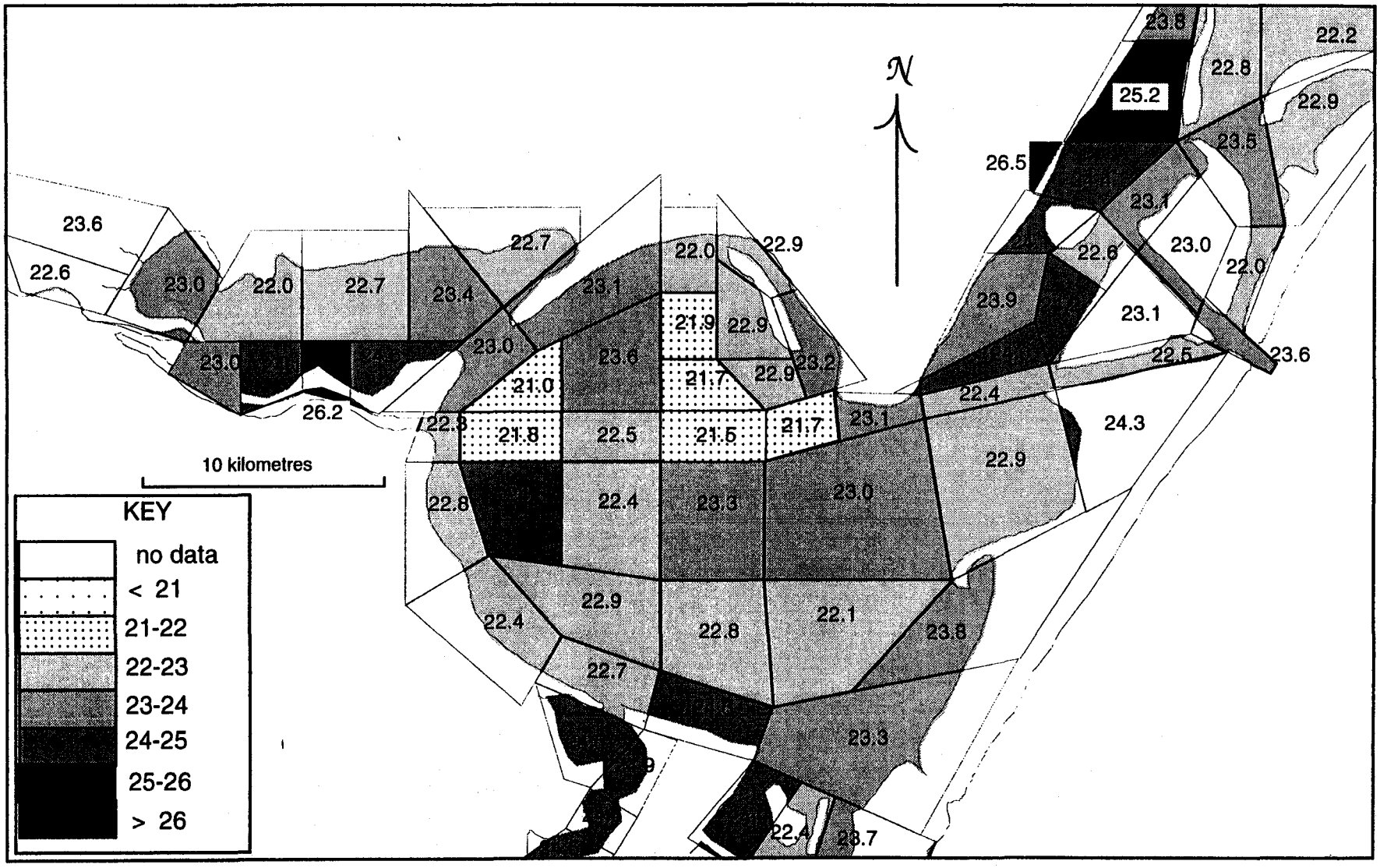


Figure 6-8. Period-of-record means of WQTEMP, upper 1 m, for Corpus Christi system

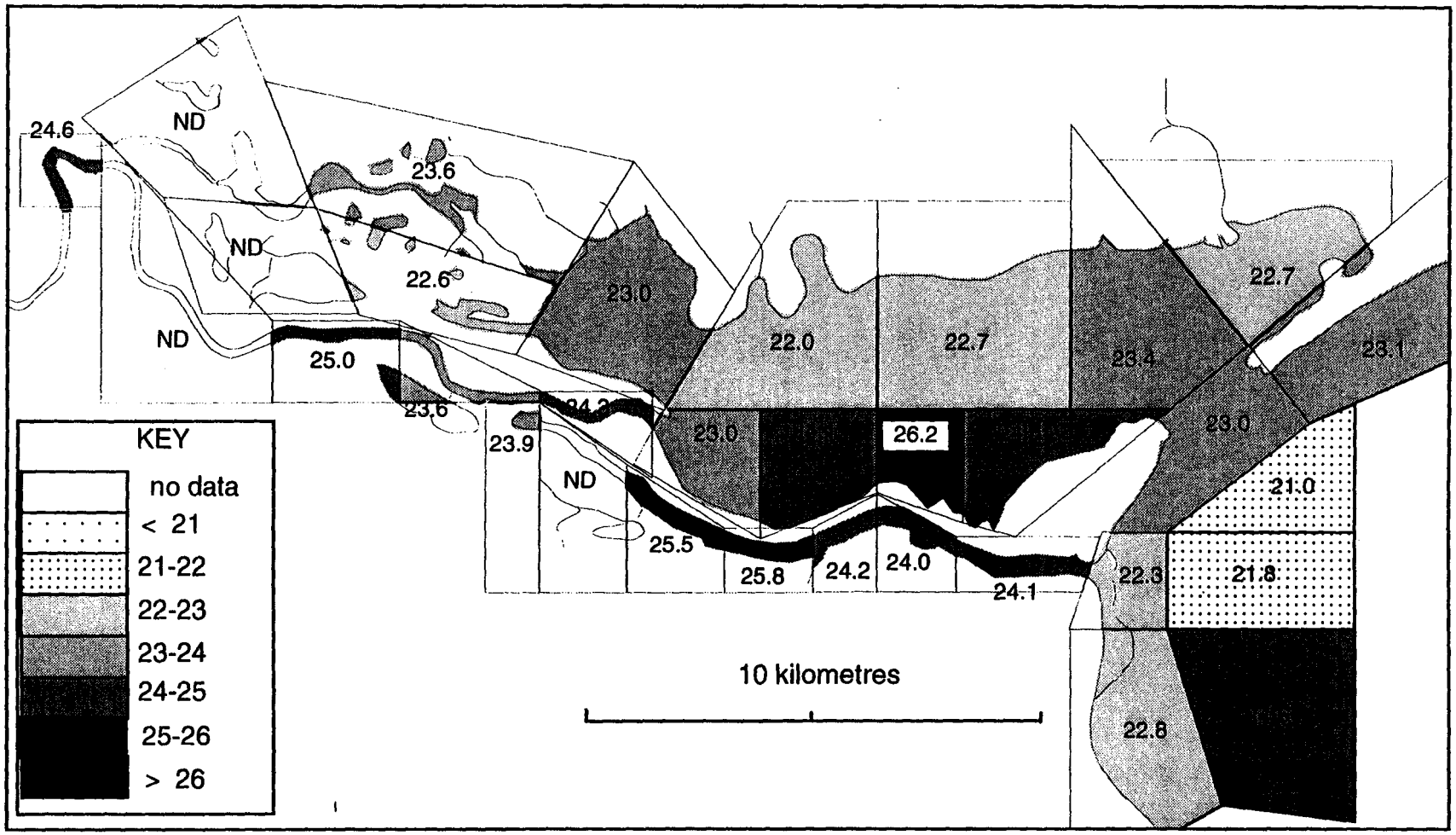


Figure 6-9. Period-of-record means of WQTEMP, upper 1 m, for Nueces Bay region, including Inner Harbor

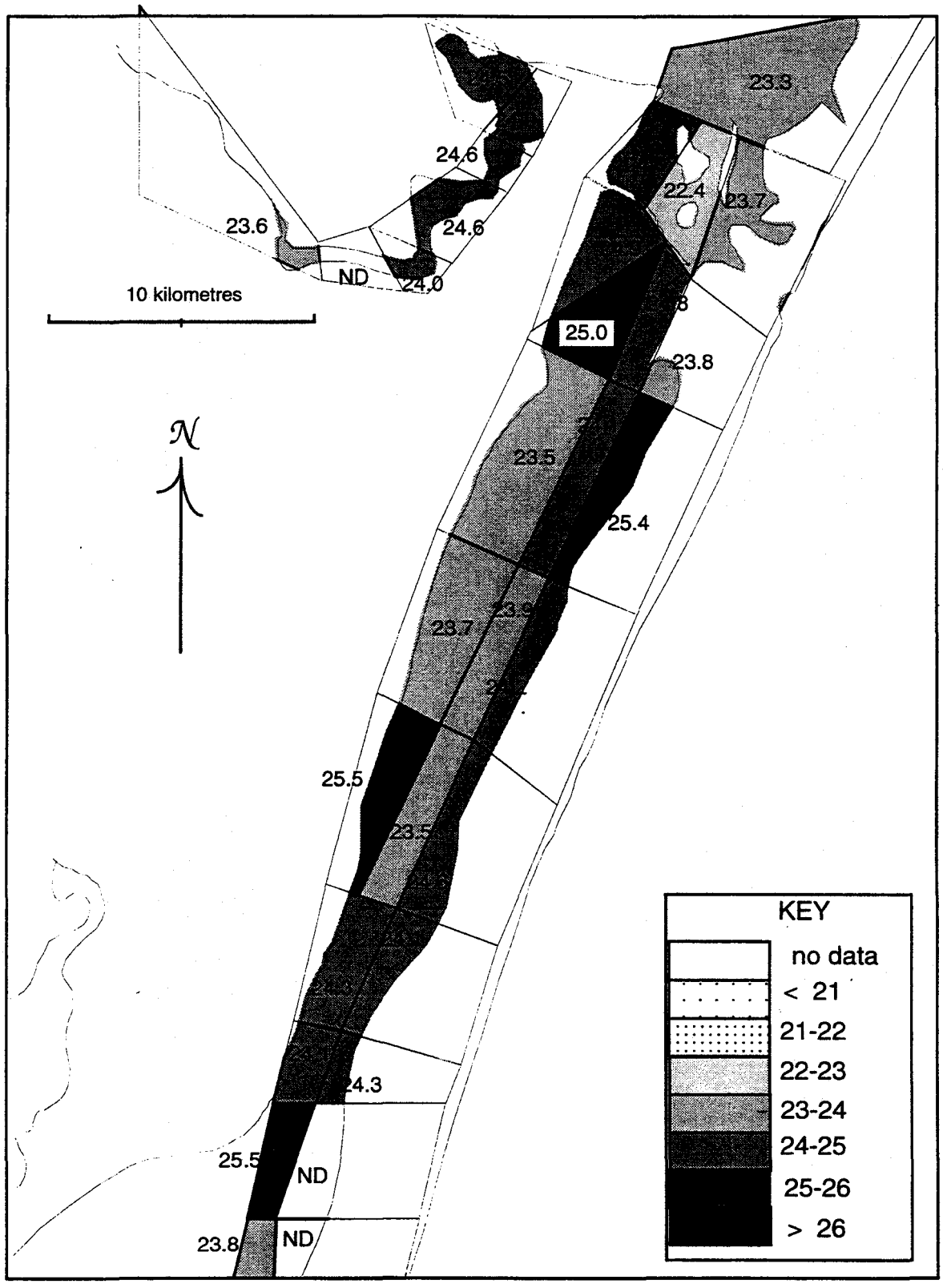


Figure 6-10. Period-of-record means of WQTEMP, upper 1 m, for Upper Laguna Madre

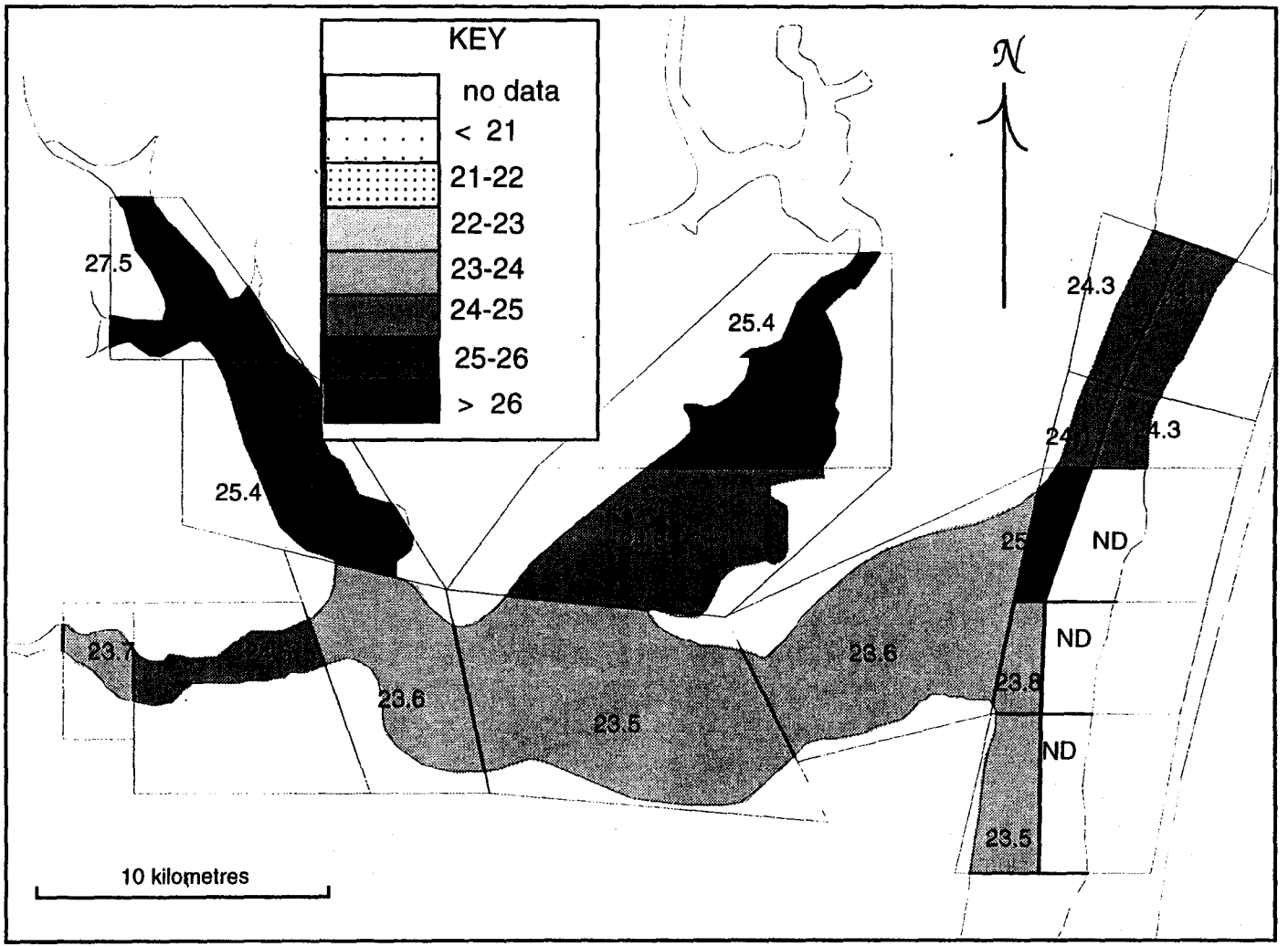


Figure 6-11. Period-of-record means of WQTEMP, upper 1 m, for Baffin Bay region

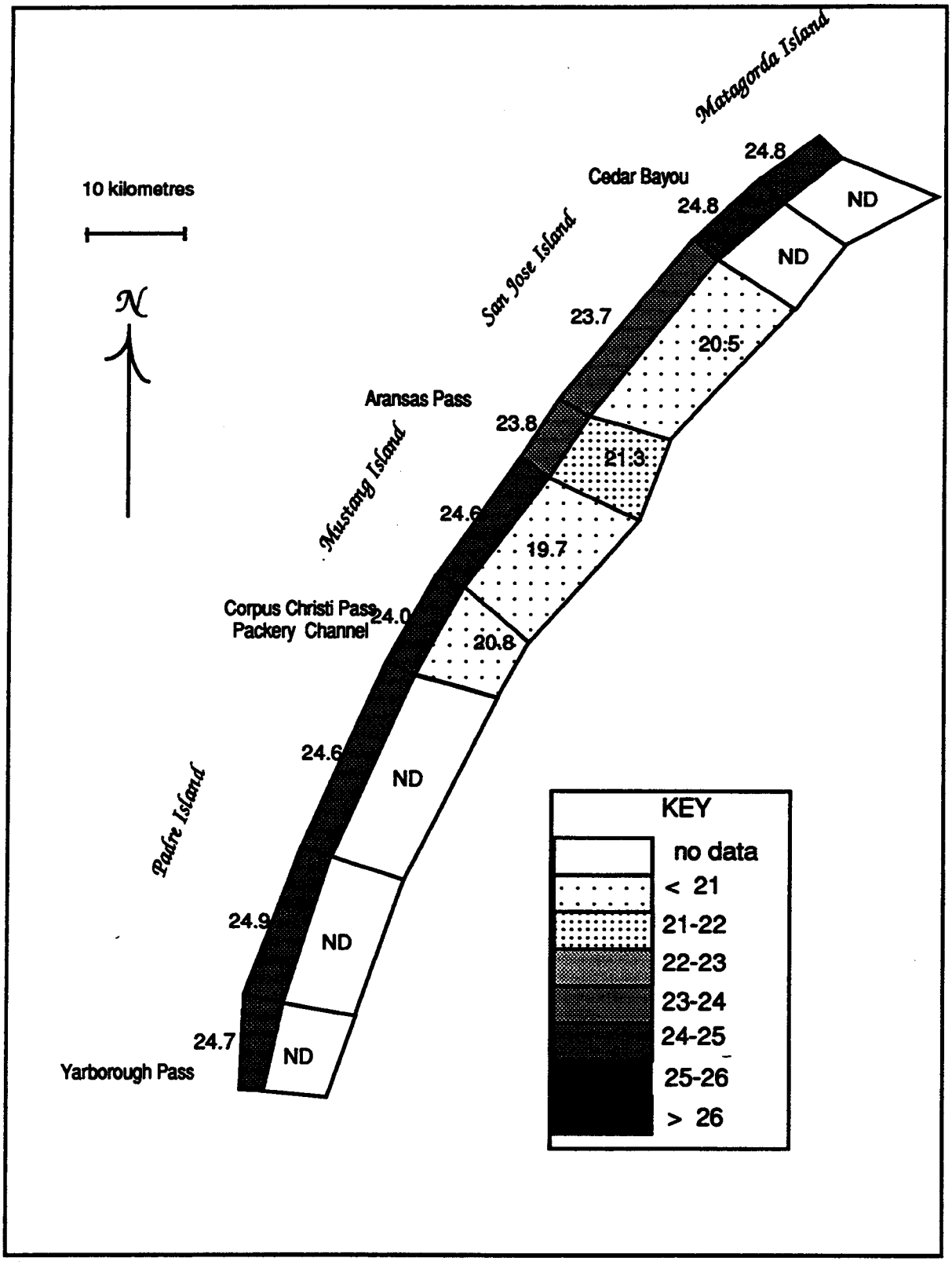


Figure 6-12. Period-of-record means of WQTEMP, upper 1 m, for Gulf of Mexico

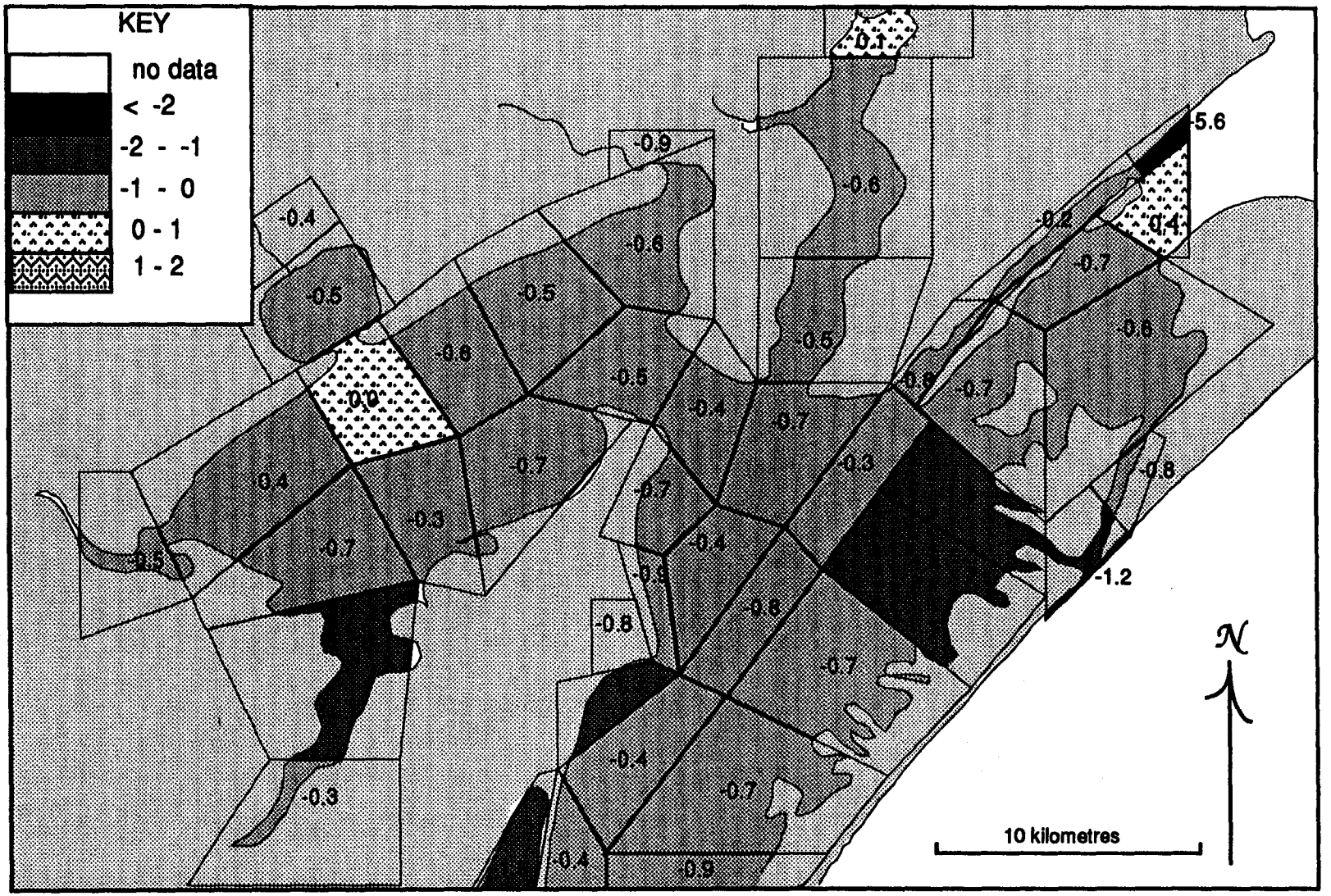


Figure 6-13. Period-of-record means of WQDODEF, upper 1 m, for Aransas-Copano system

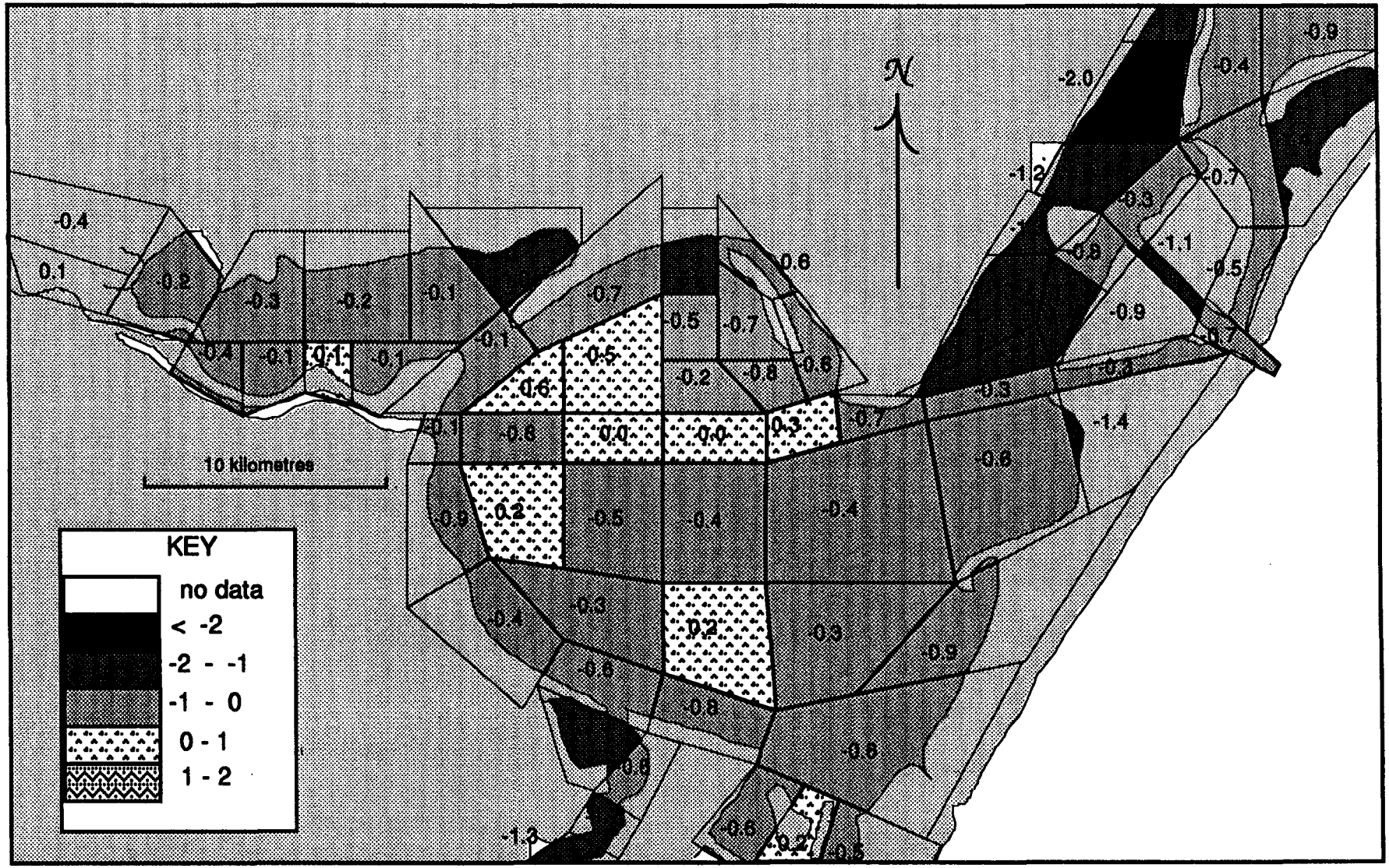


Figure 6-14. Period-of-record means of WQDODEF, upper 1 m, for Corpus Christi system

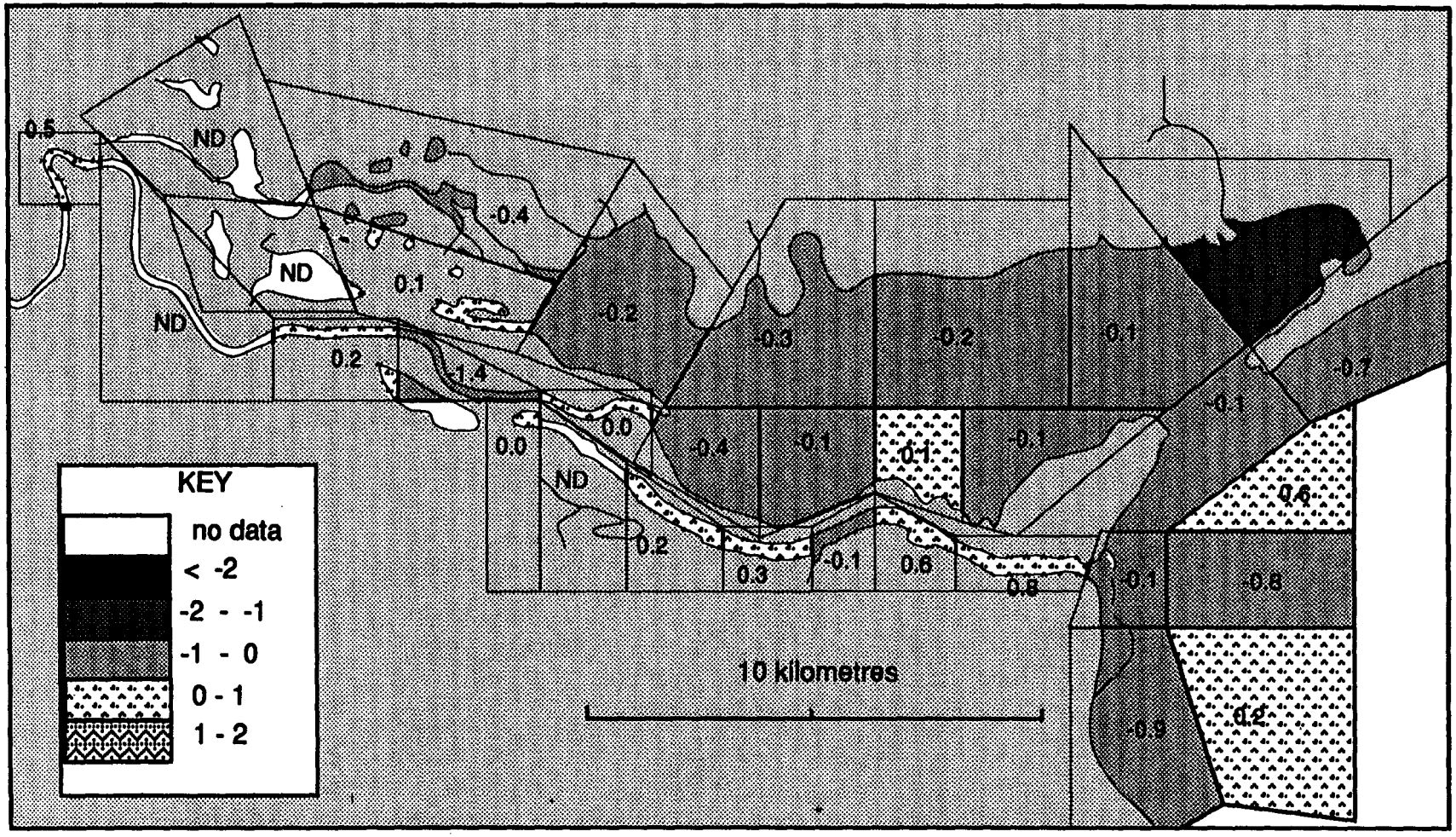


Figure 6-15. Period-of-record means of WQDODEF, upper 1m, for Nueces Bay region, including Inner Harbor

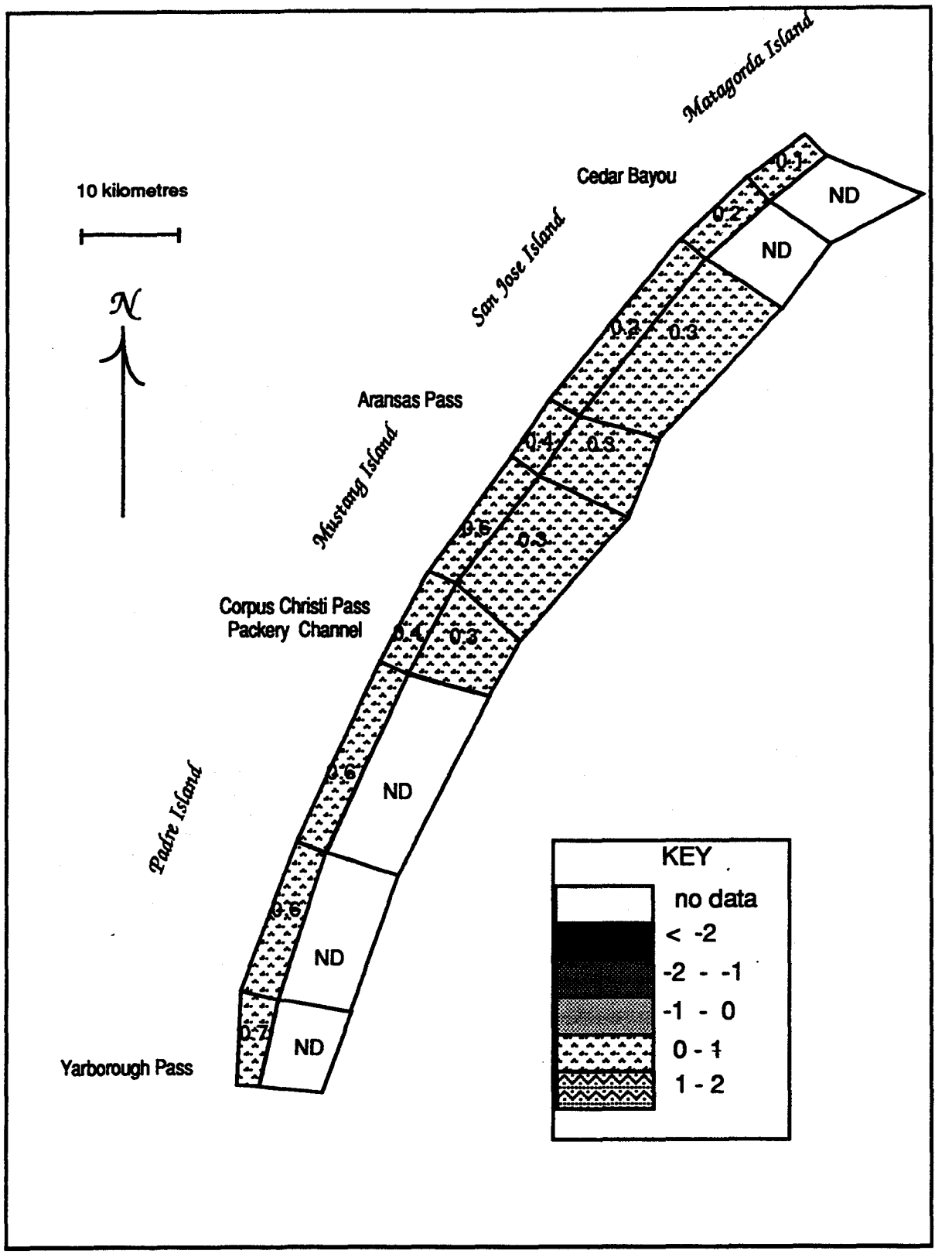


Figure 6-18. Period-of-record means of WQDODEF, upper 1 m, for Gulf of Mexico

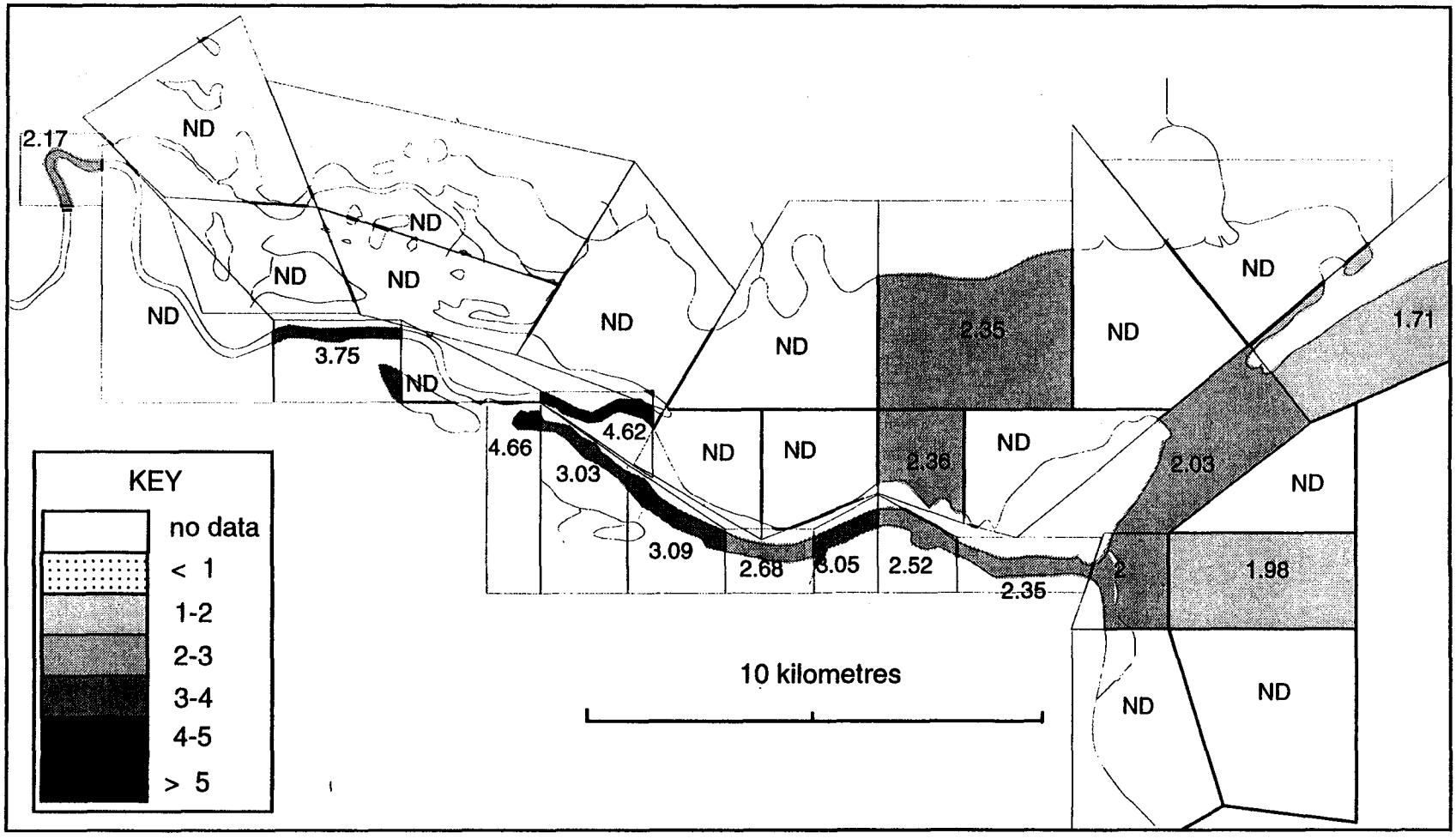


Figure 6-19. WQBOD5 period-of-record means for Nueces Bay region, including Inner Harbor

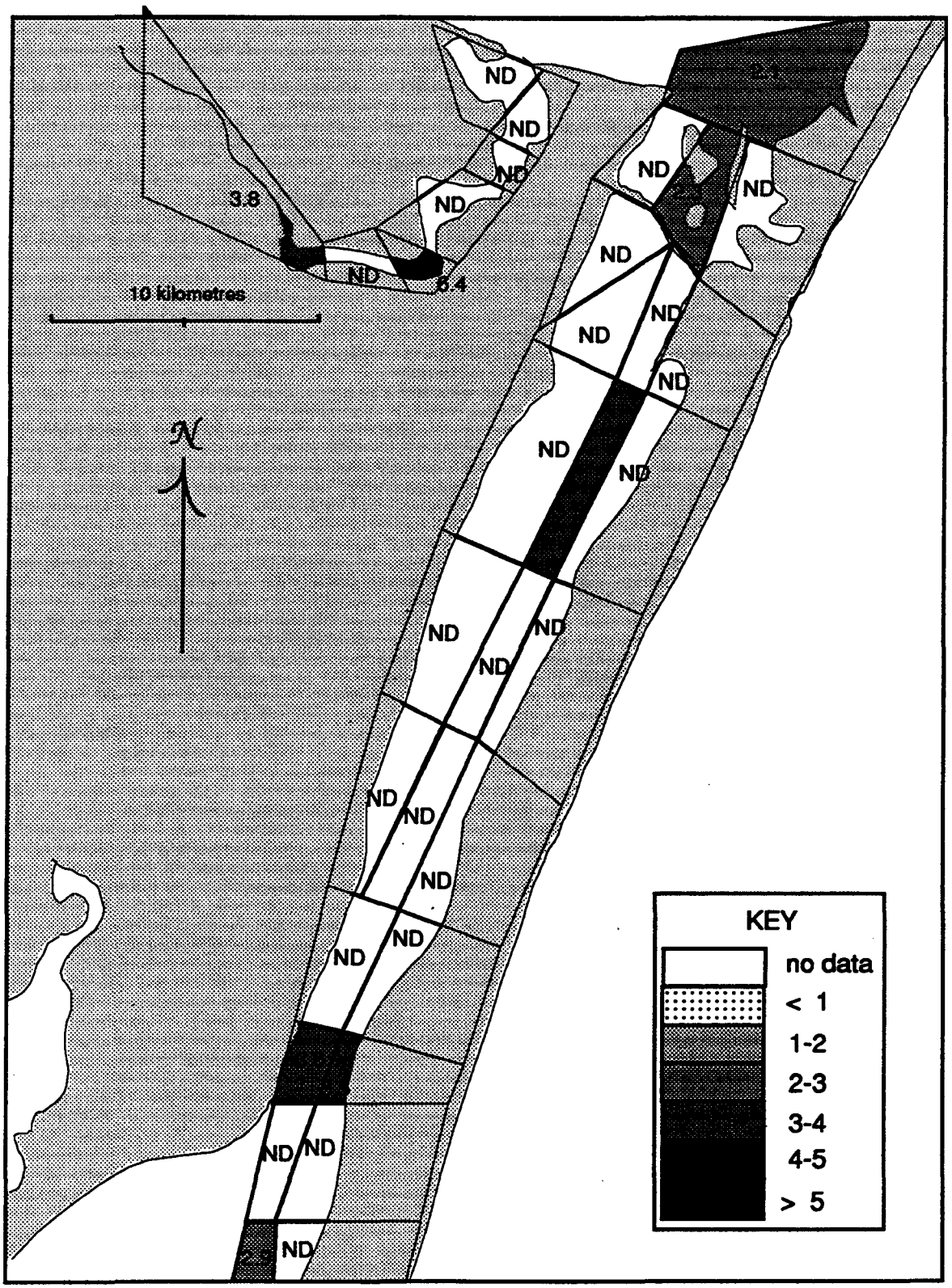


Figure 6-20. Period-of-record means of WQBOD5 for Upper Laguna Madre and Oso Bay

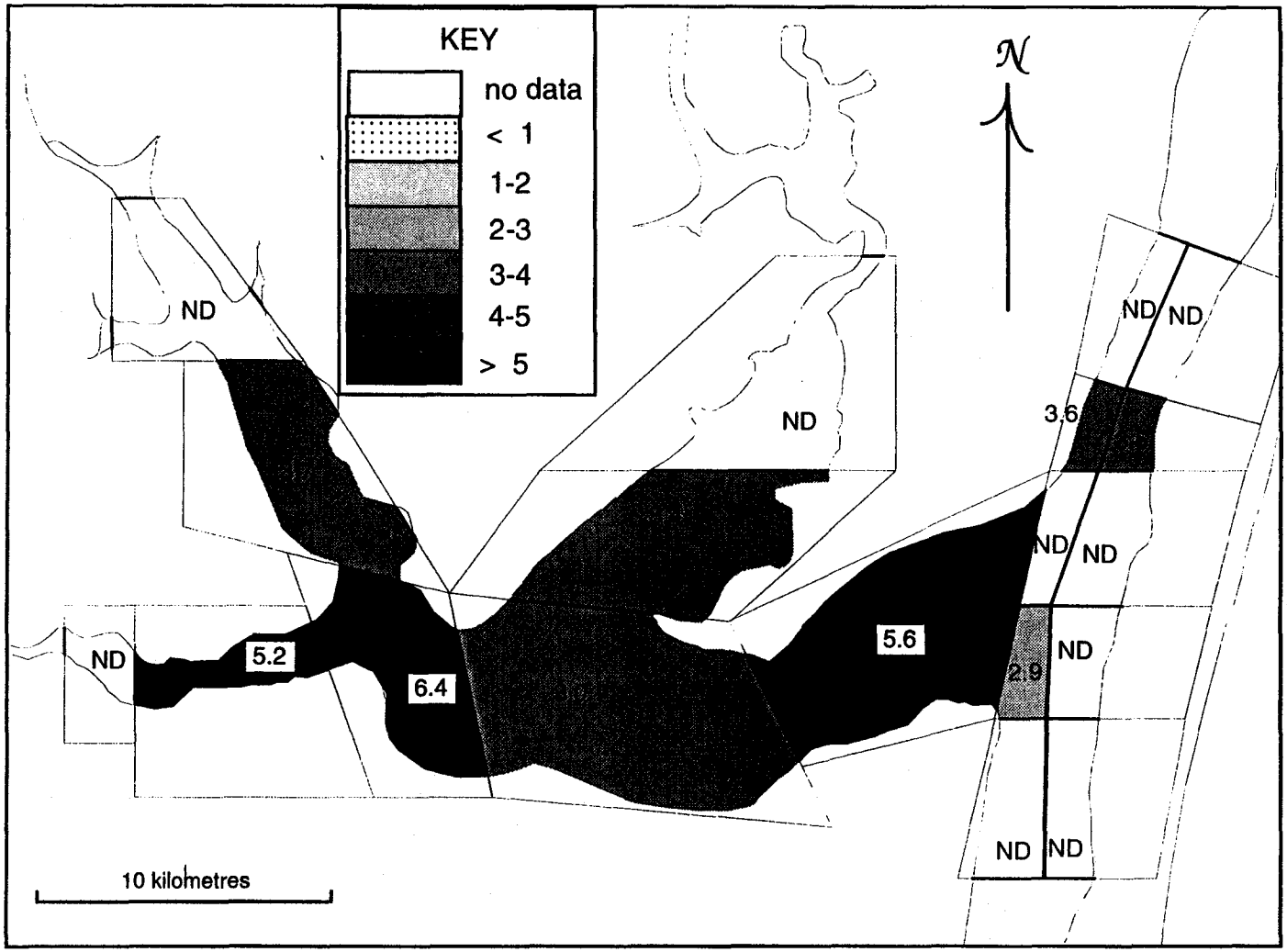


Figure 6-21. Period-of-record means of WQBOD5 for Baffin Bay region

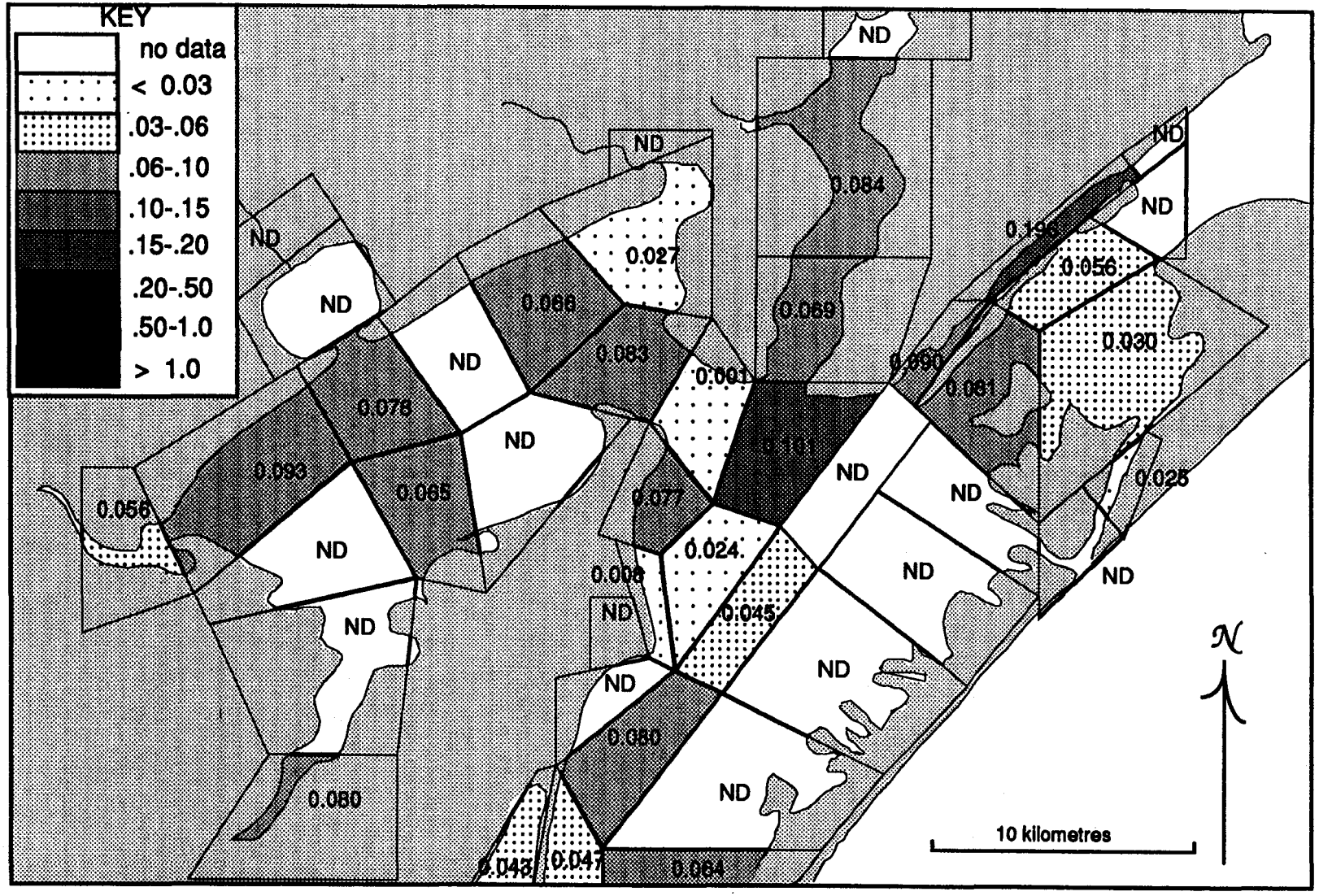


Figure 6-22. Period-of-record means of WQAMMN for Aransas-Copano system

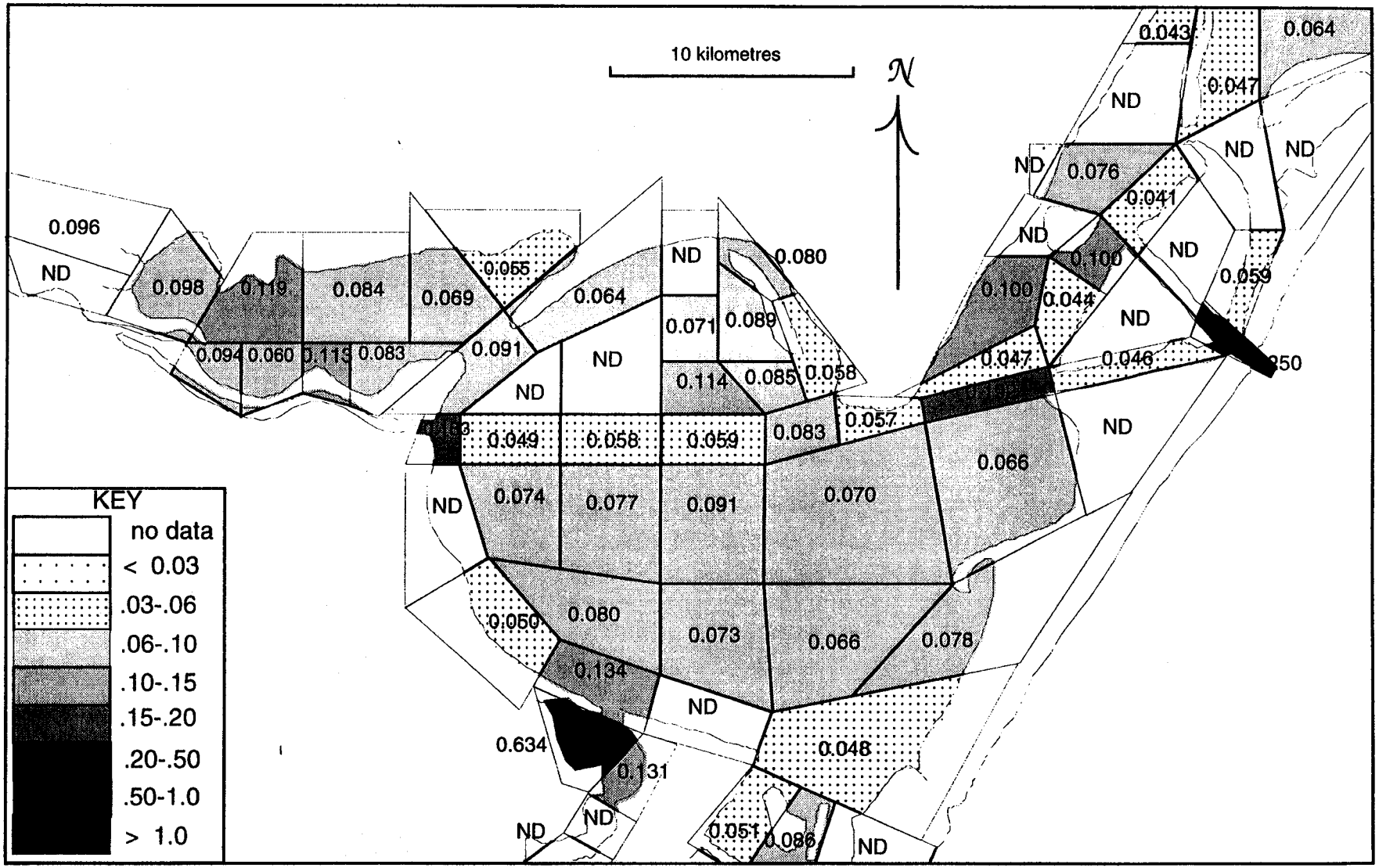


Figure 6-23. Period-of-record means of WQAMMN for Corpus Christi system

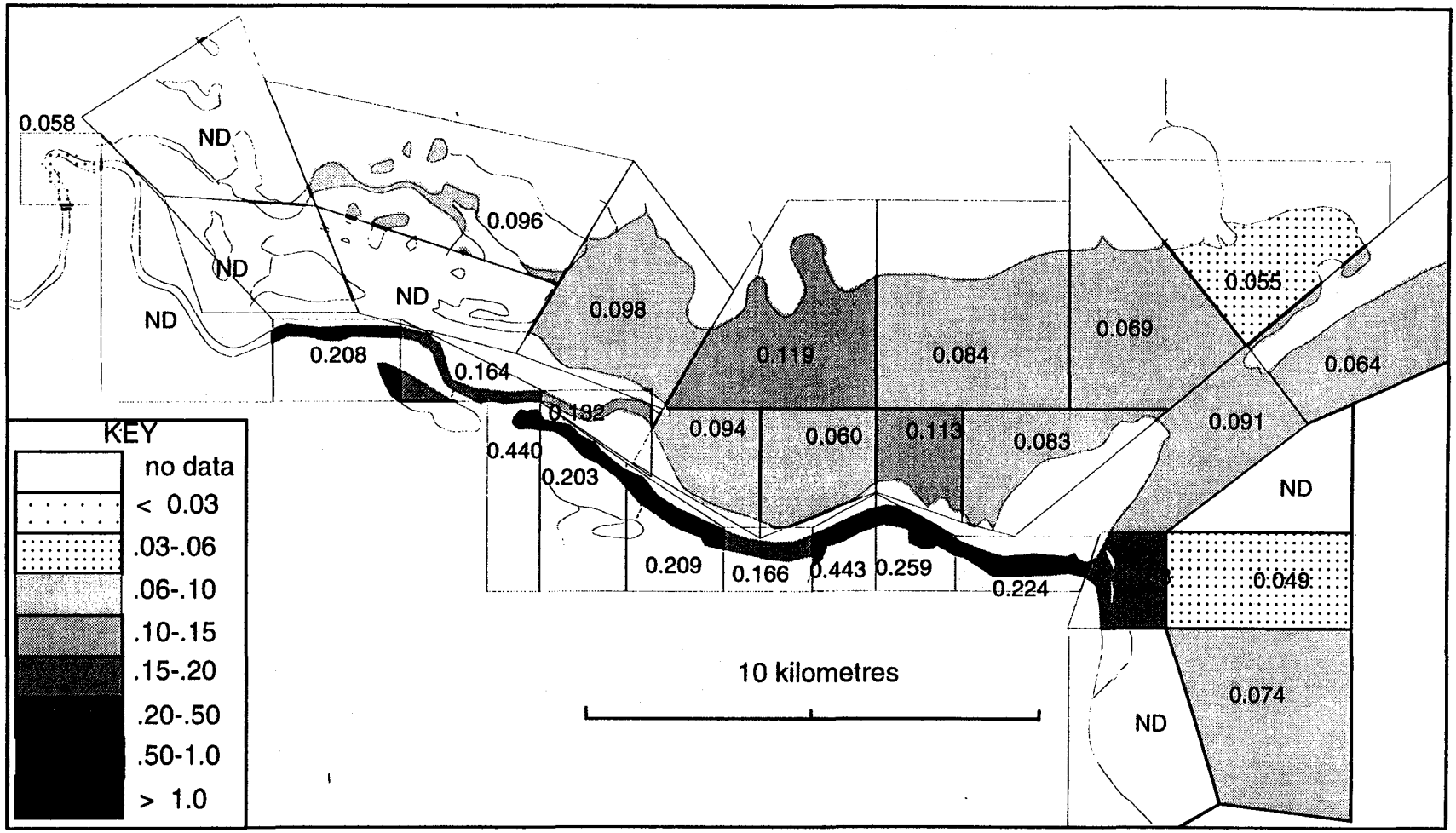


Figure 6-24. Period-of-record means of WQAMMN for Nueces Bay region, including Inner Harbor

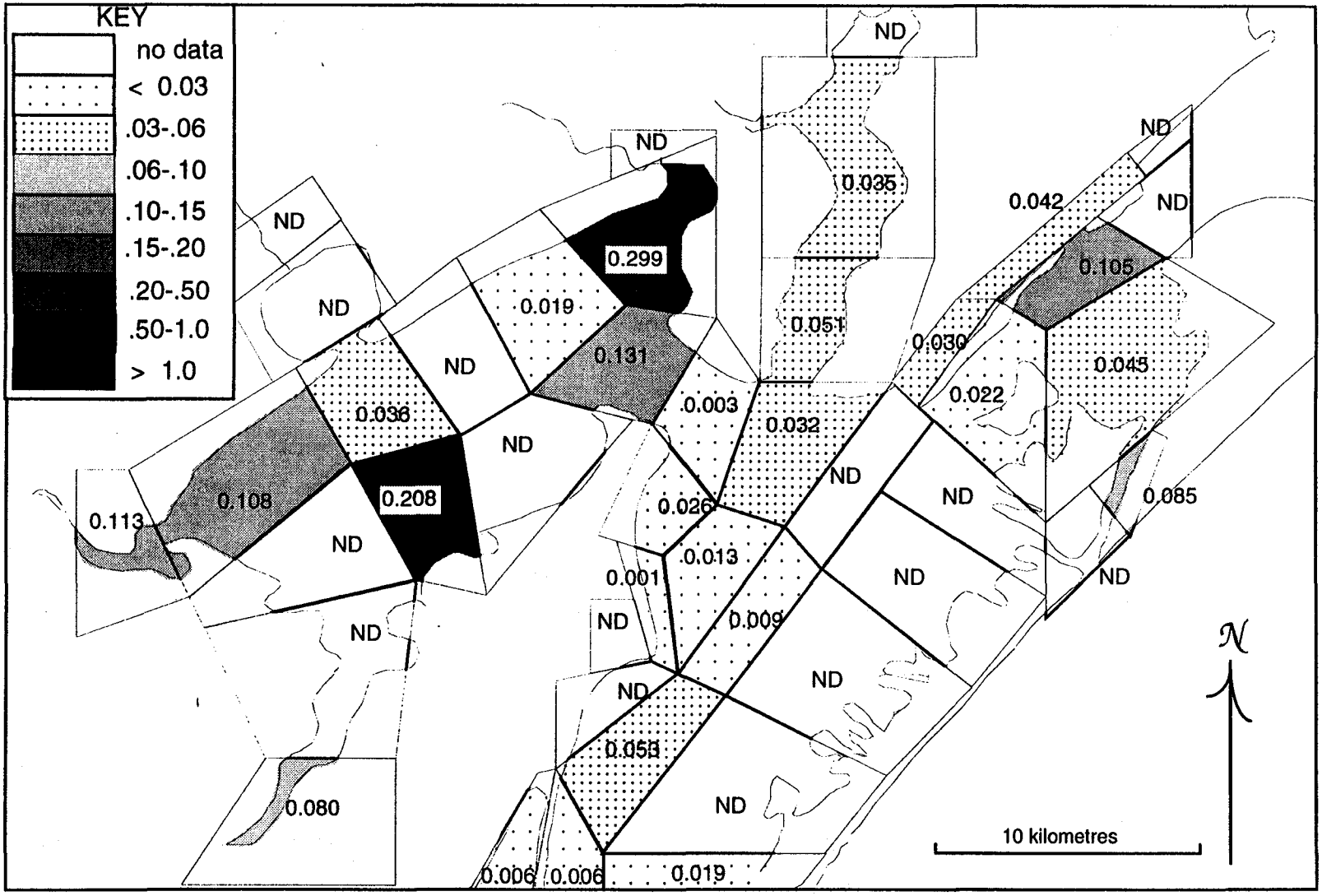


Figure 6-25. Period-of-record means of WQNO3N for Aransas-Copano system

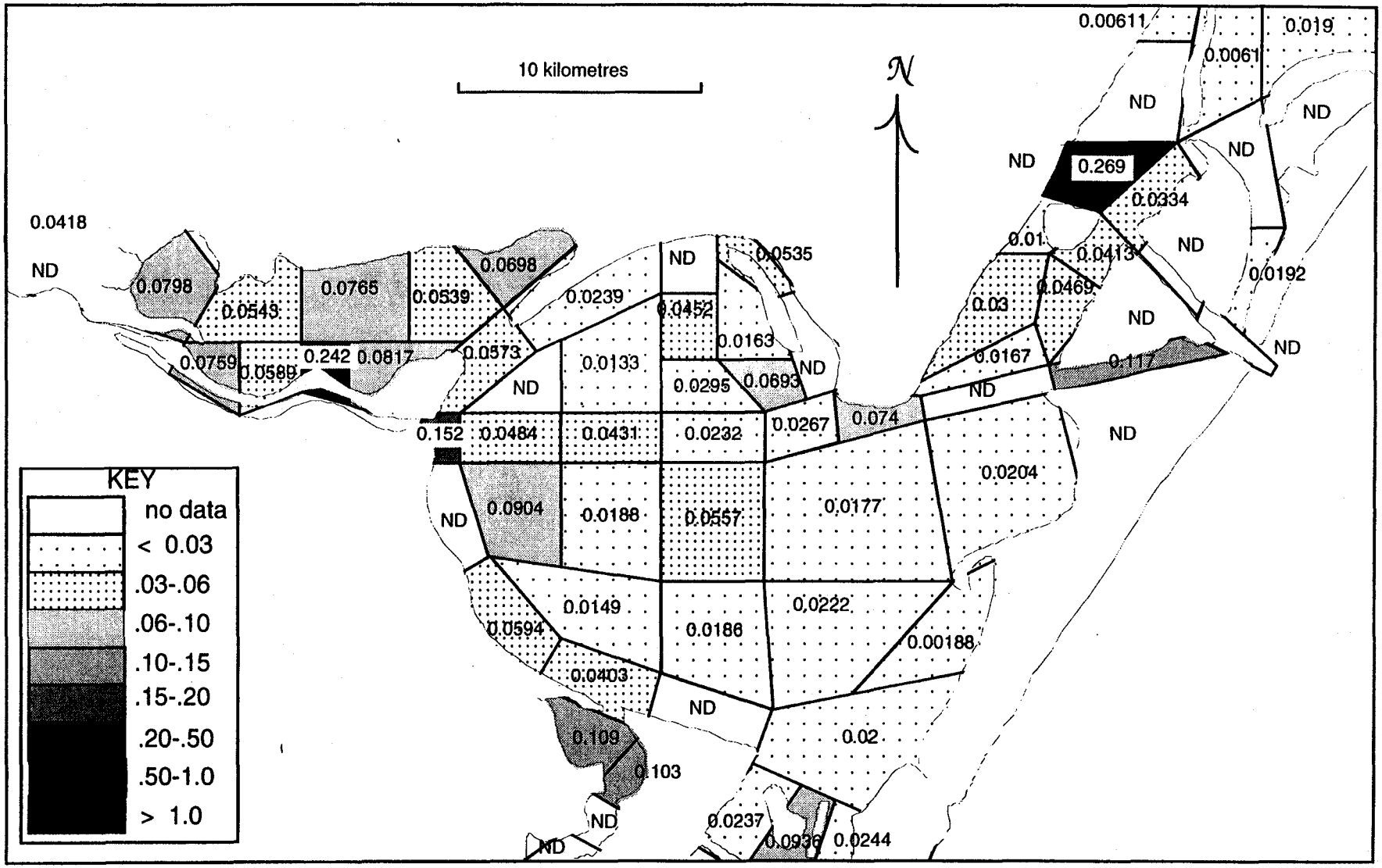


Figure 6-26. WQNO3N period-of-record means for Corpus Christi system

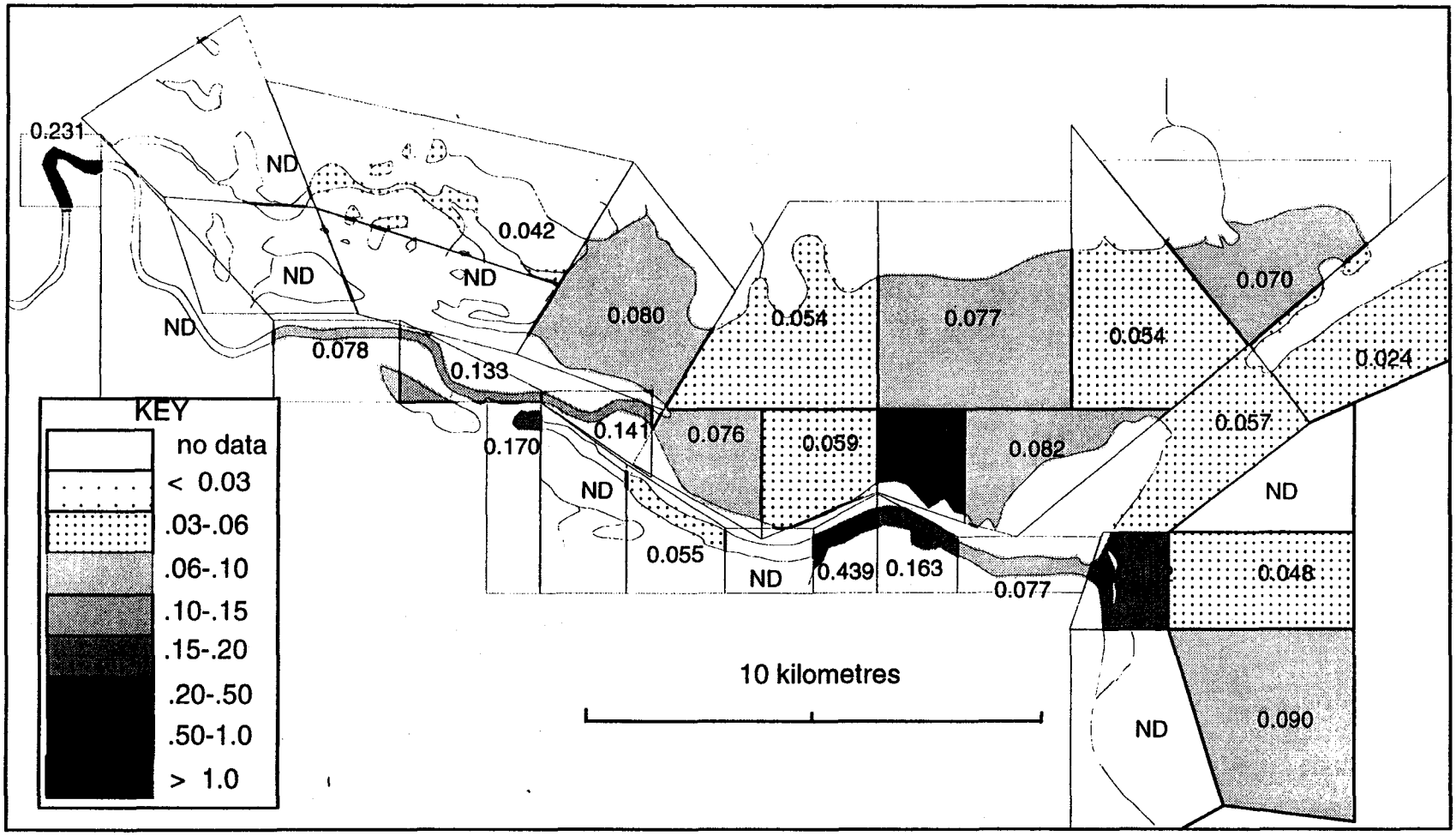


Figure 6-27. Period-of-record means of WQNO3N for Nueces Bay region, including Inner Harbor

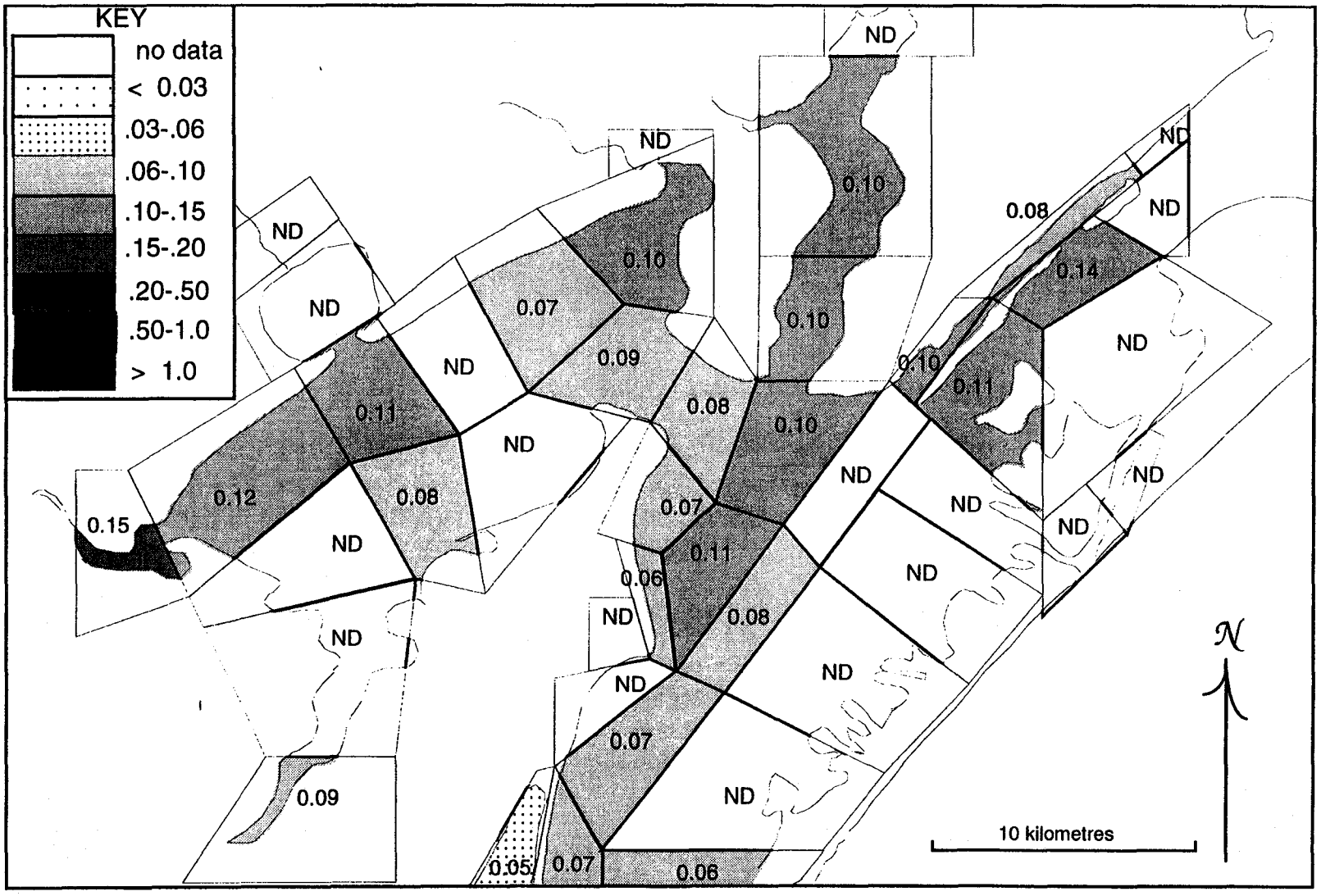


Figure 6-28. Period-of-record means of WQTOTP for Aransas-Copano system

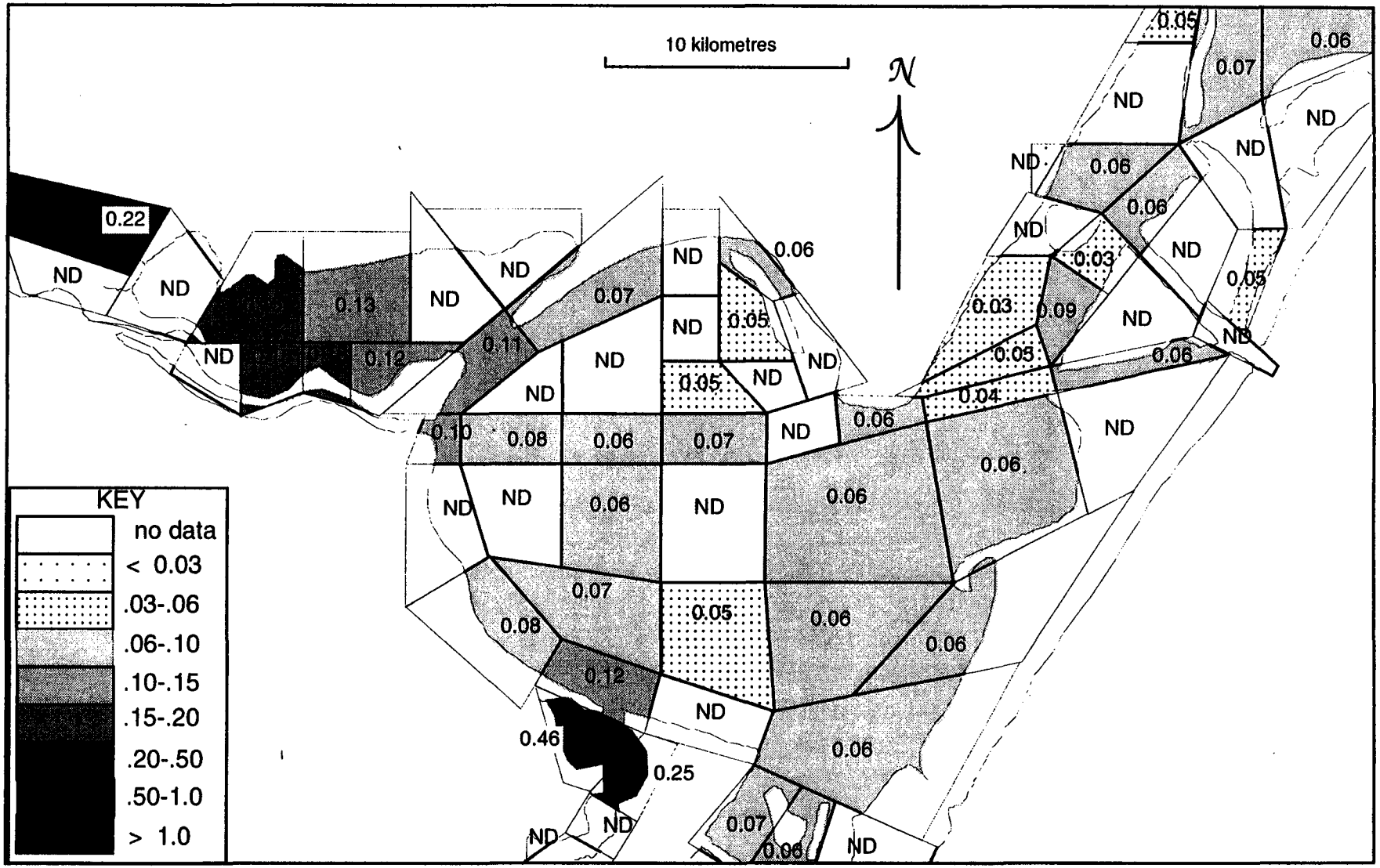


Figure 6-29. Period-of-record means of WQTOTP for Corpus Christi system

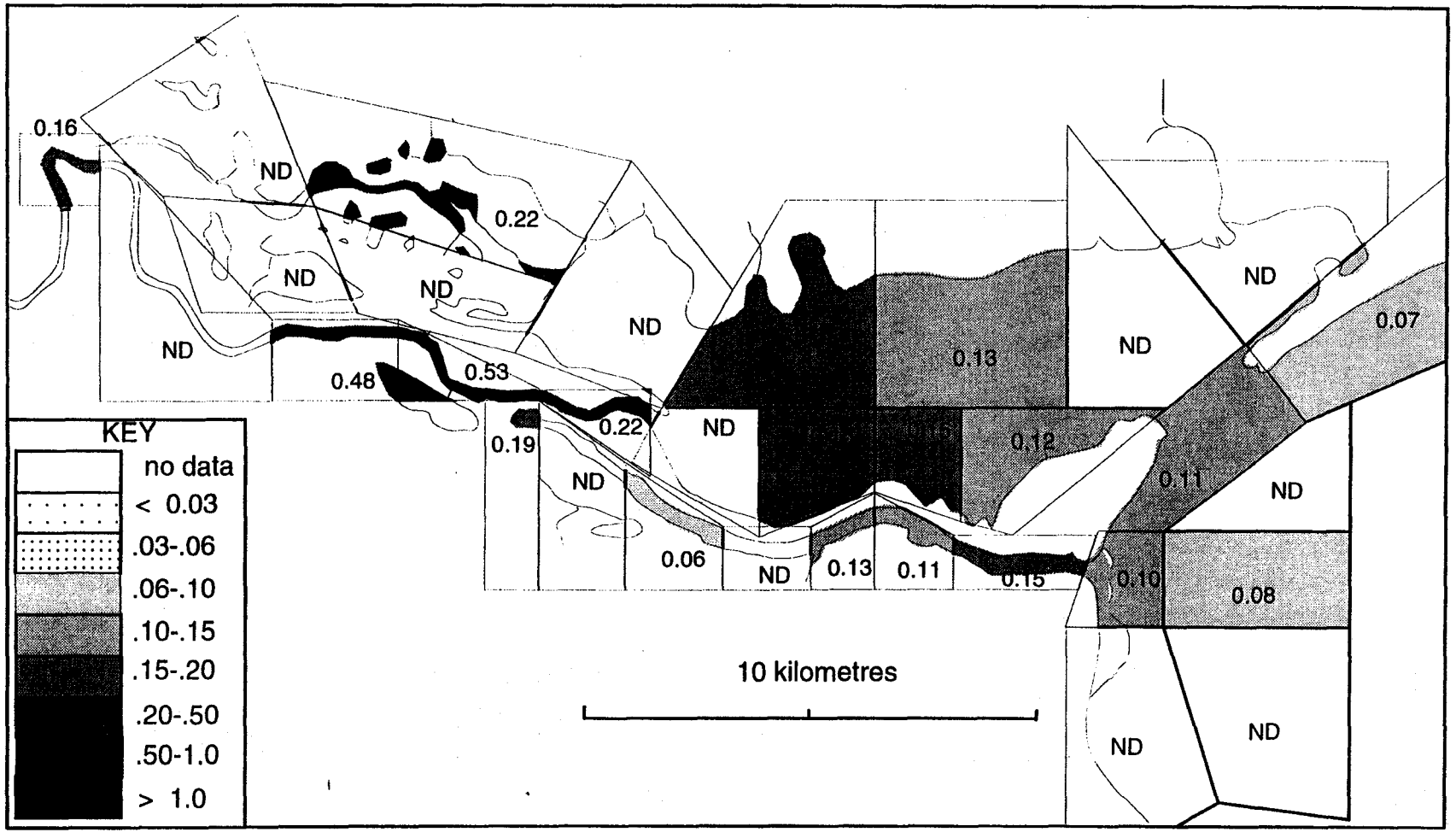


Figure 6-30. Period-of-record means of WQTOTP for Nueces Bay region, including Inner Harbor

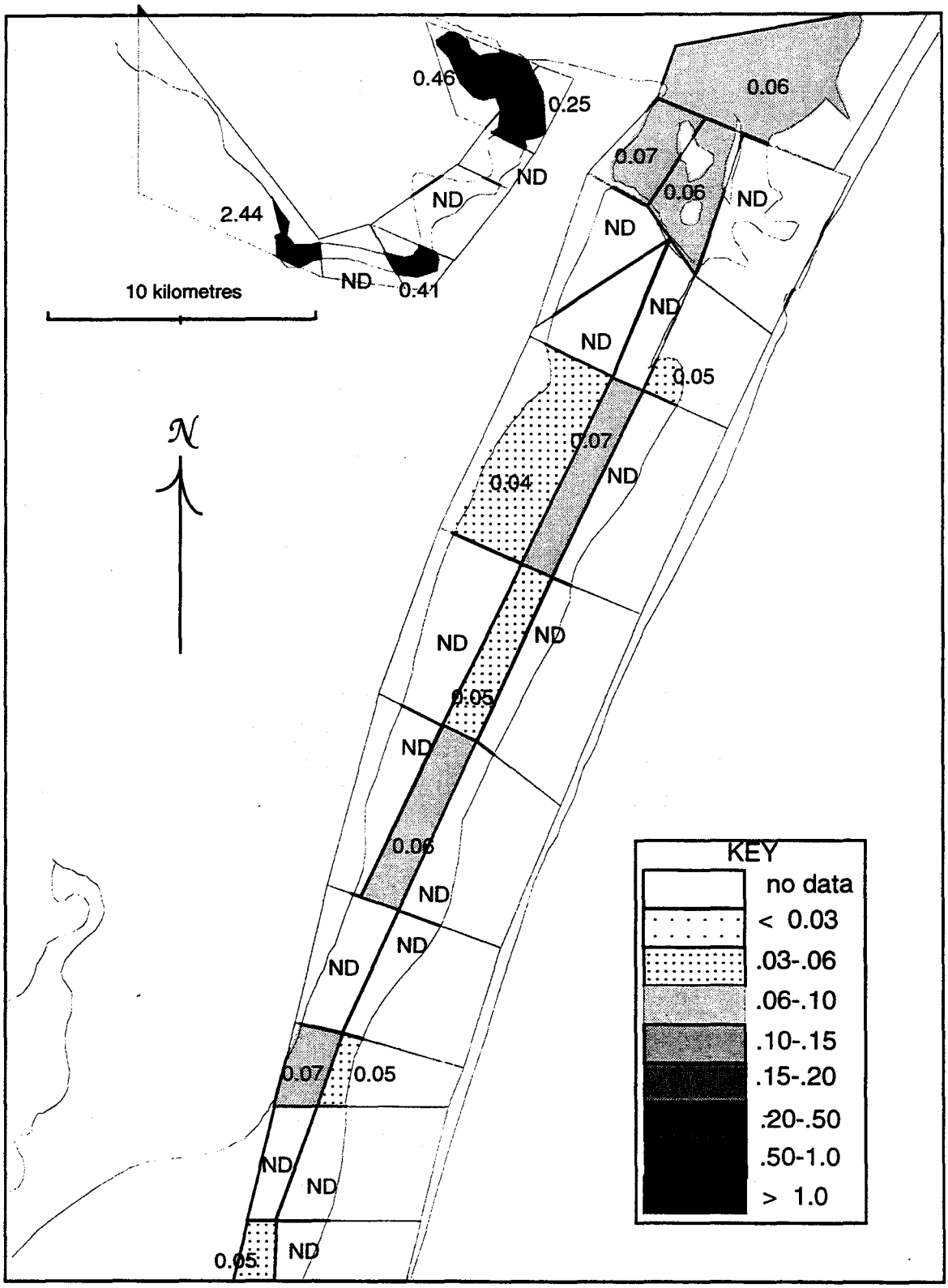


Figure 6-31. Period-of-record means of WQTOTP for Upper Laguna Madre and Oso Bay

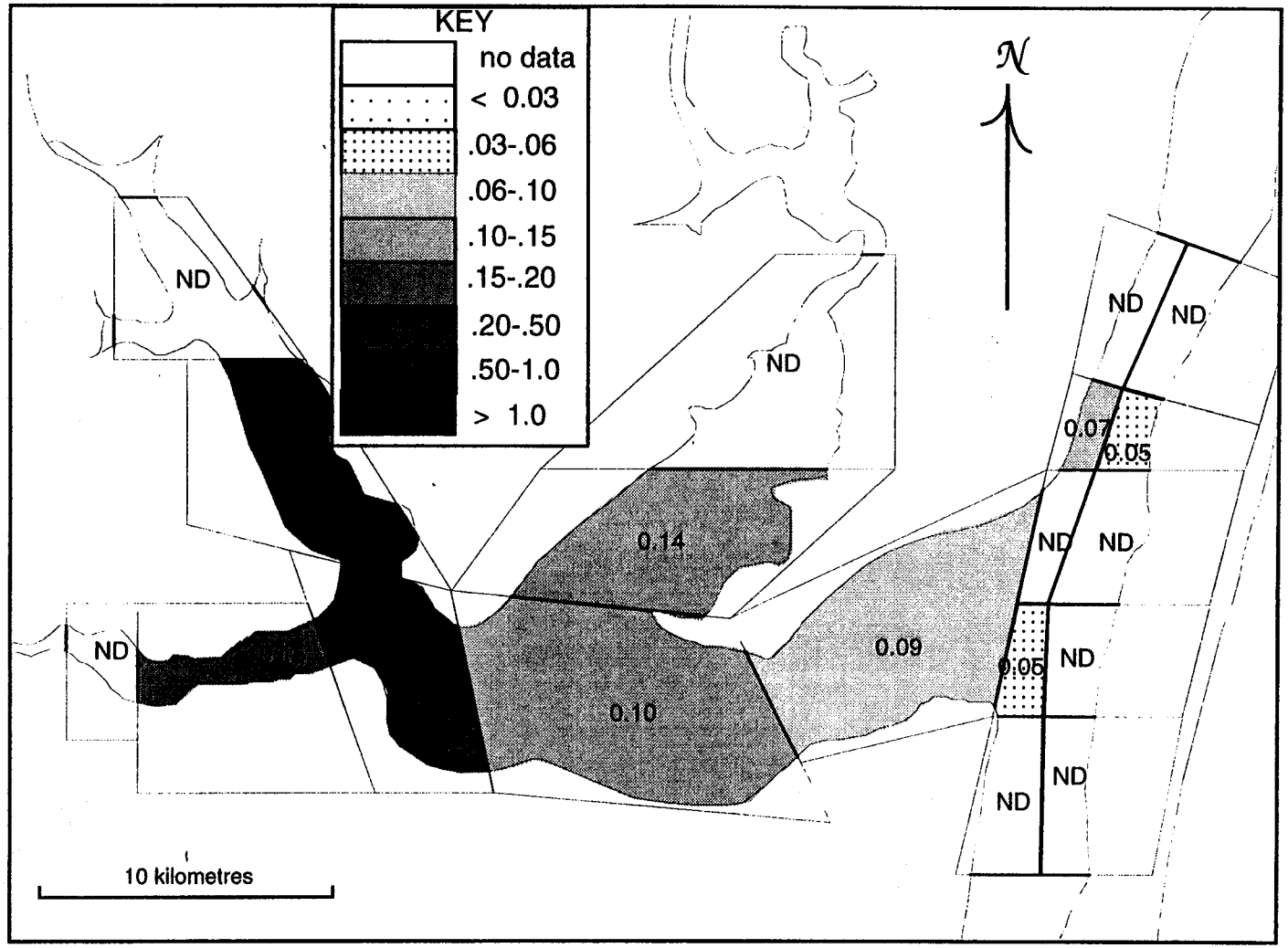


Figure 6-32. Period-of-record means of WQTOTP for Baffin Bay region

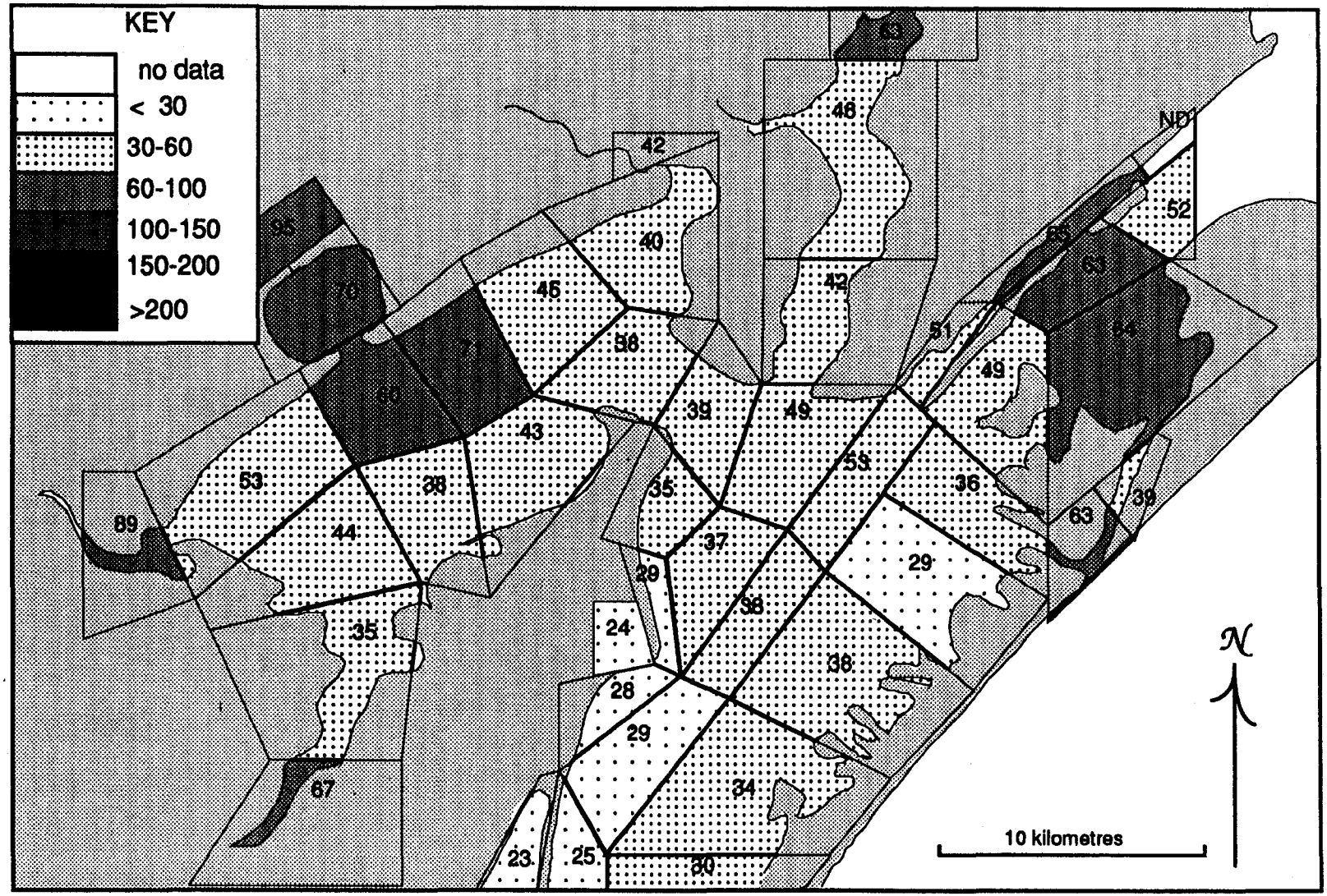


Figure 6-33. Period-of-record means of WQXTSS for Aransas-Copano system

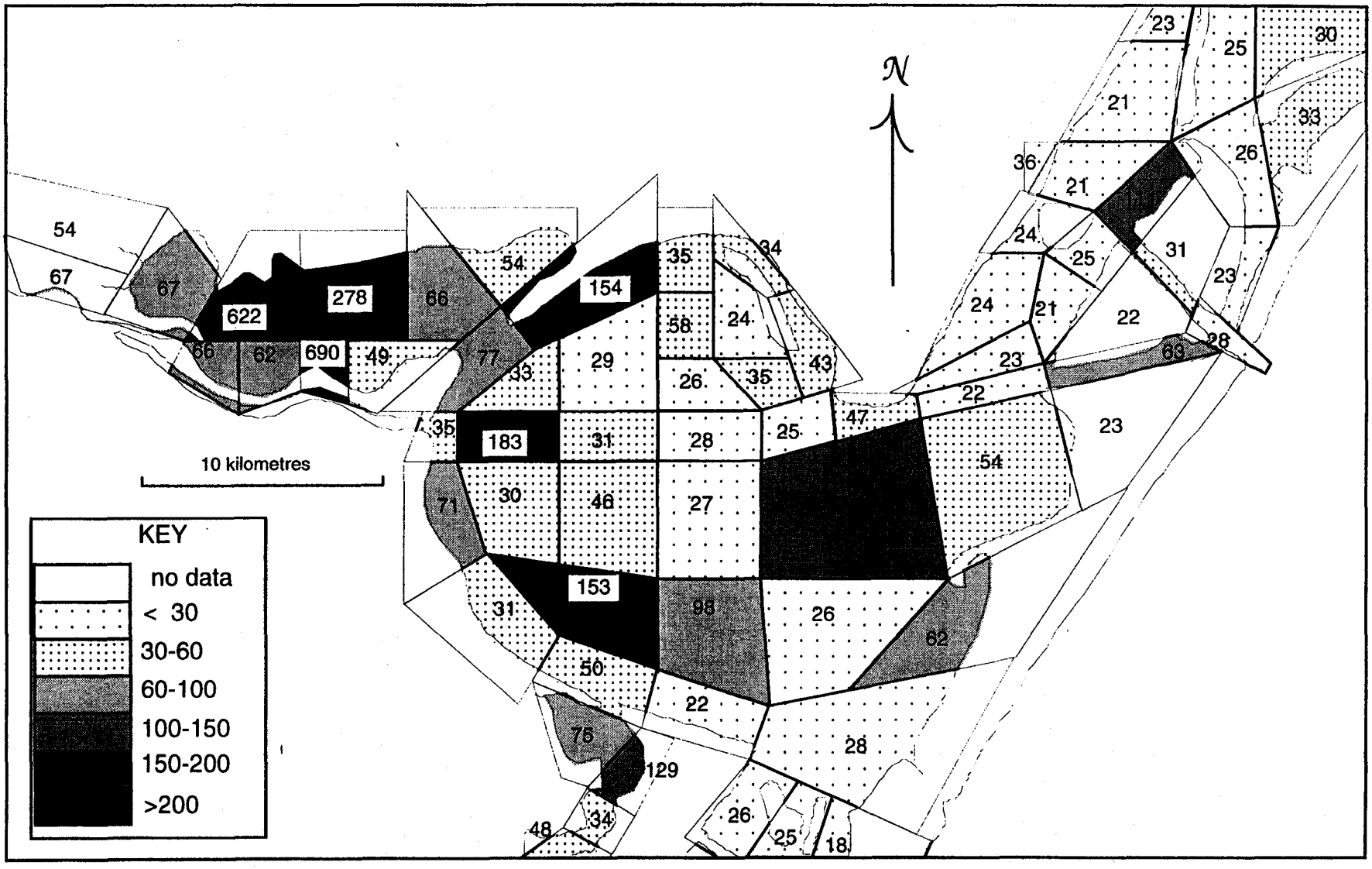


Figure 6-34. Period-of-record means of WQXTSS for Corpus Christi system

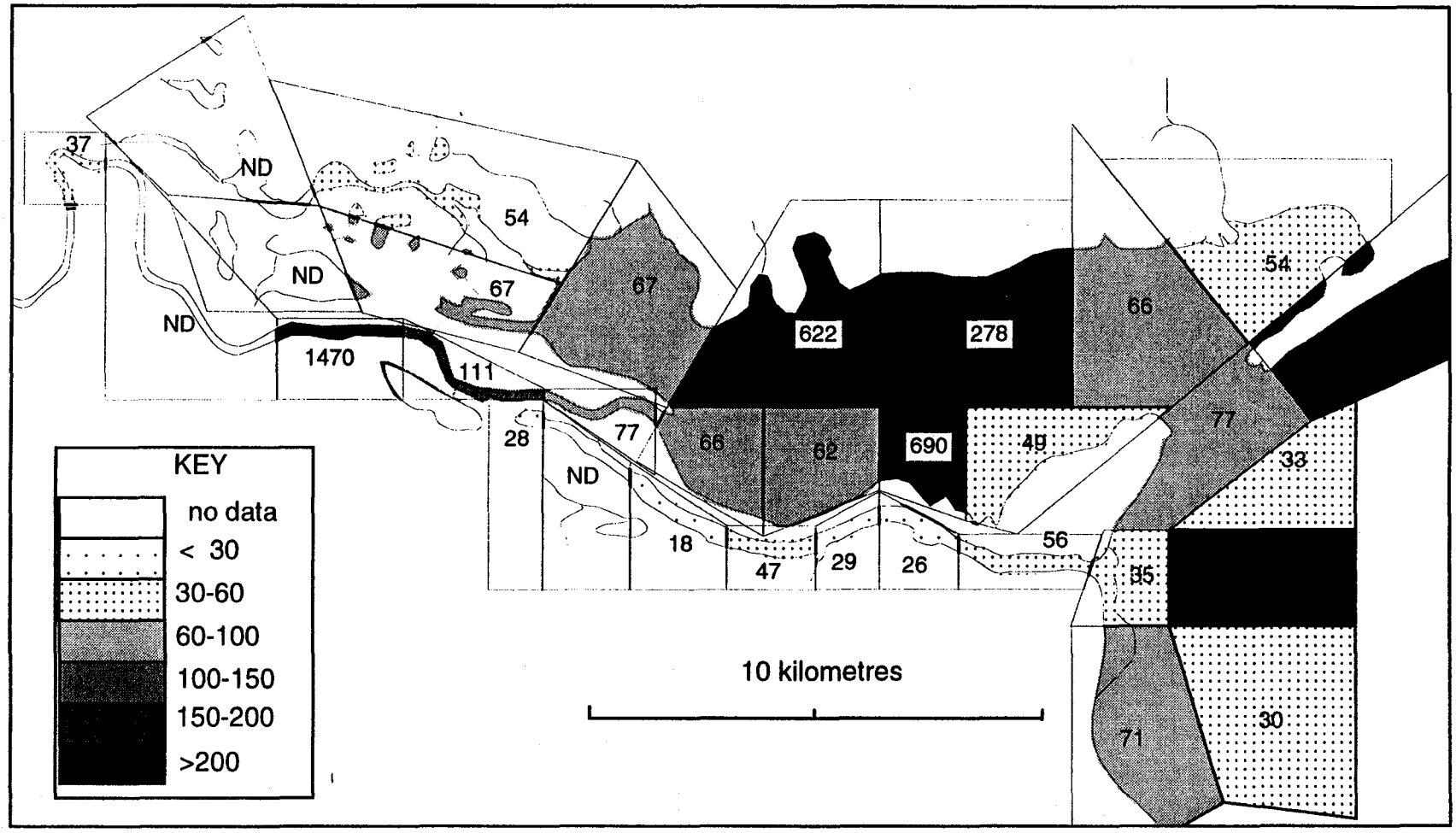


Figure 6-35. Period-of-record means of WQXTSS for Nueces Bay region, including Inner Harbor

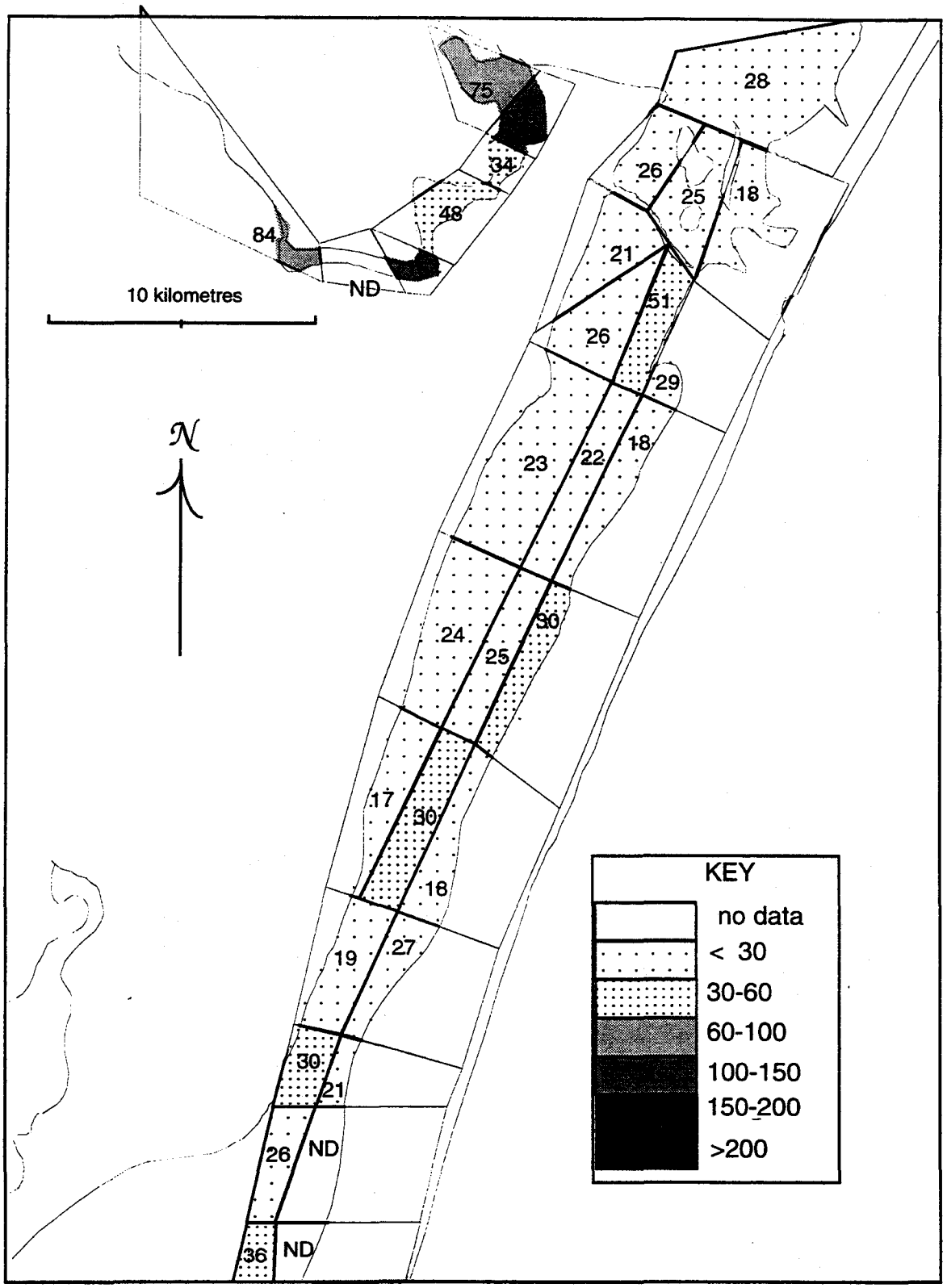


Figure 6-36. Period-of-record means of WQXTSS for Upper Laguna Madre and Oso Bay

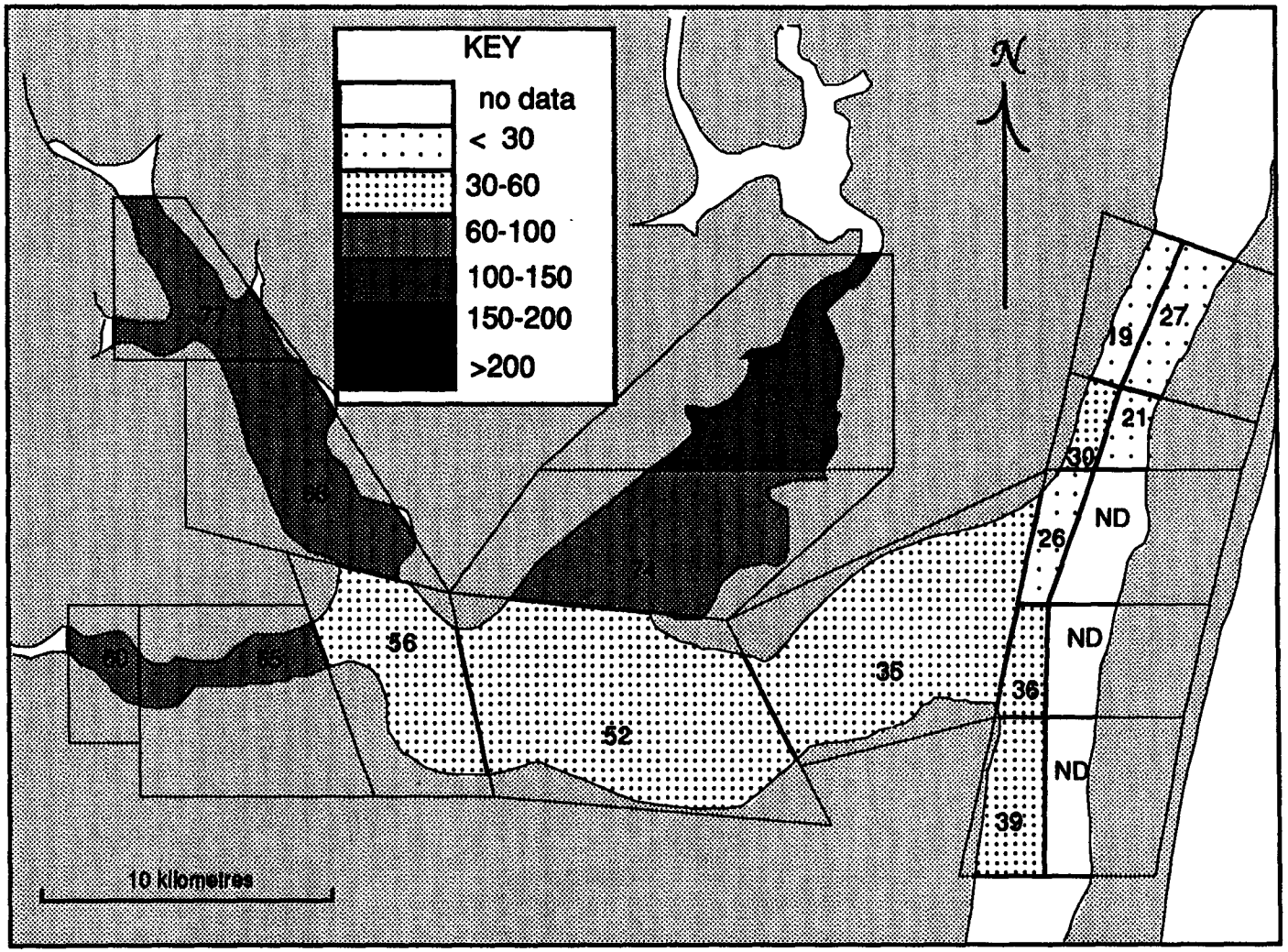


Figure 6-37. Period-of-record means of WQXTSS for Baffin Bay region

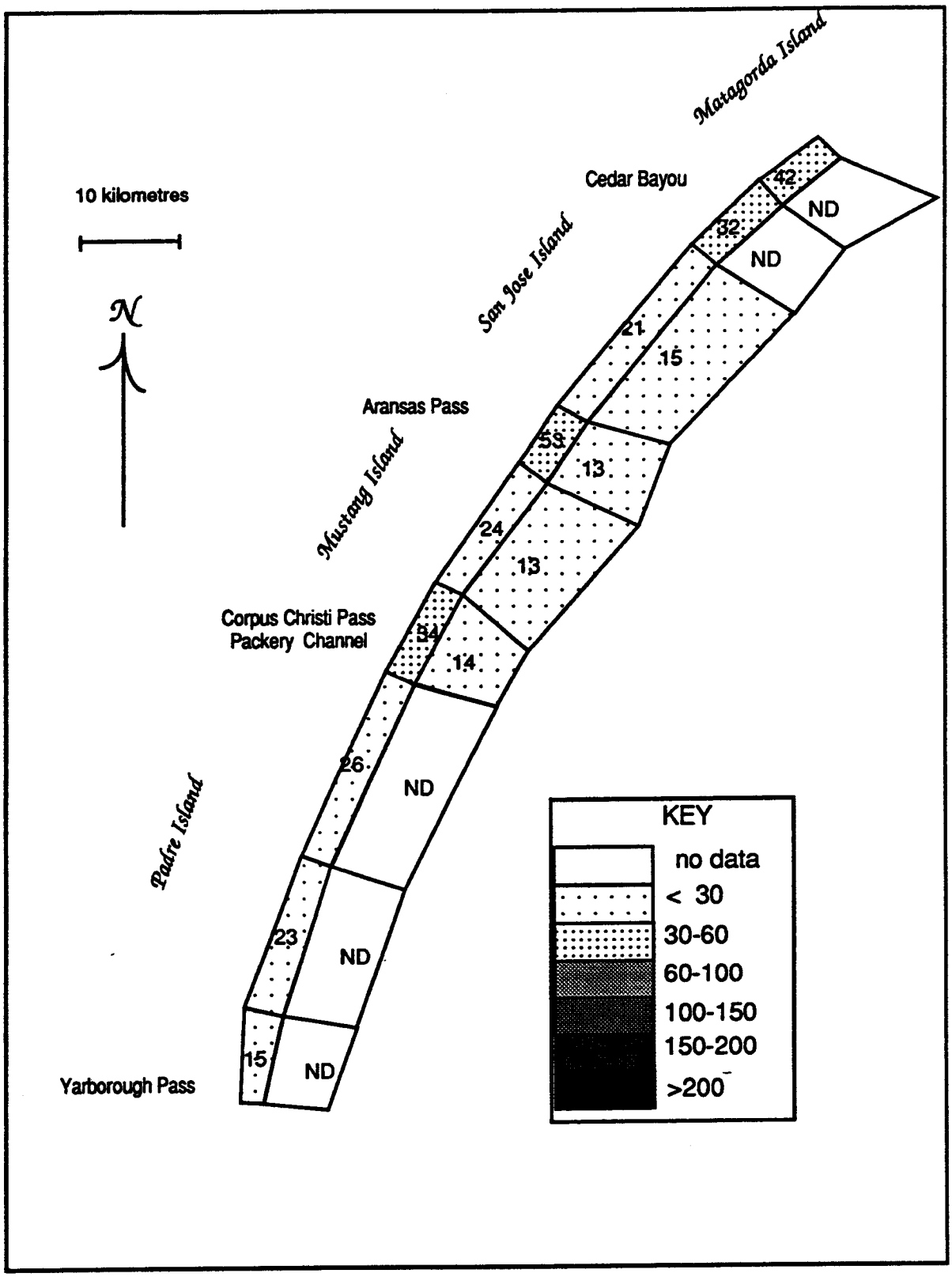


Figure 6-38. Period-of-record means of WQXTSS for Gulf of Mexico

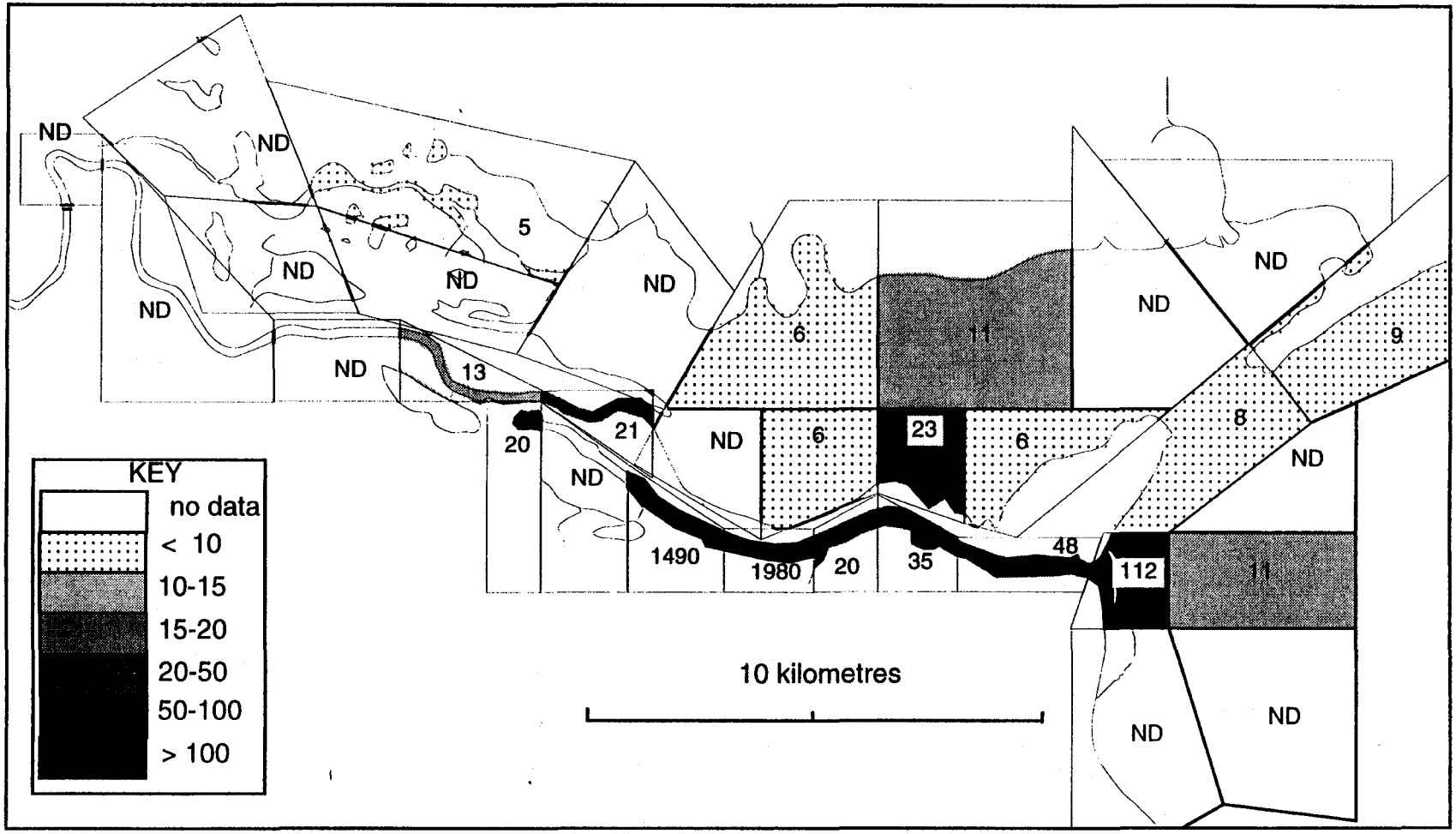


Figure 6-39. Period-of-record means of WQTOC for Nueces Bay region, including Inner Harbor

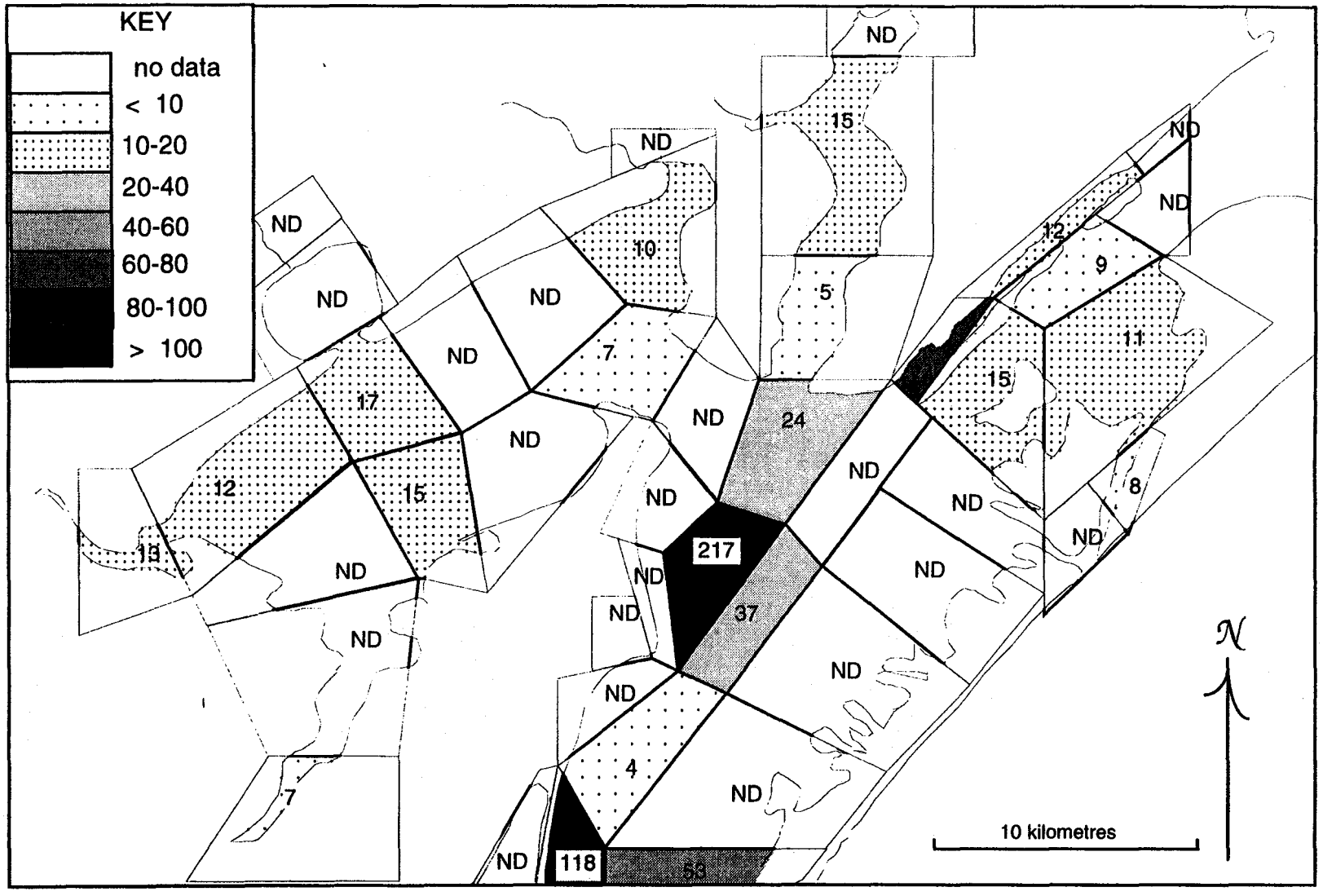


Figure 6-40. Period-of-record means of WQCHLA for Aransas-Copano system

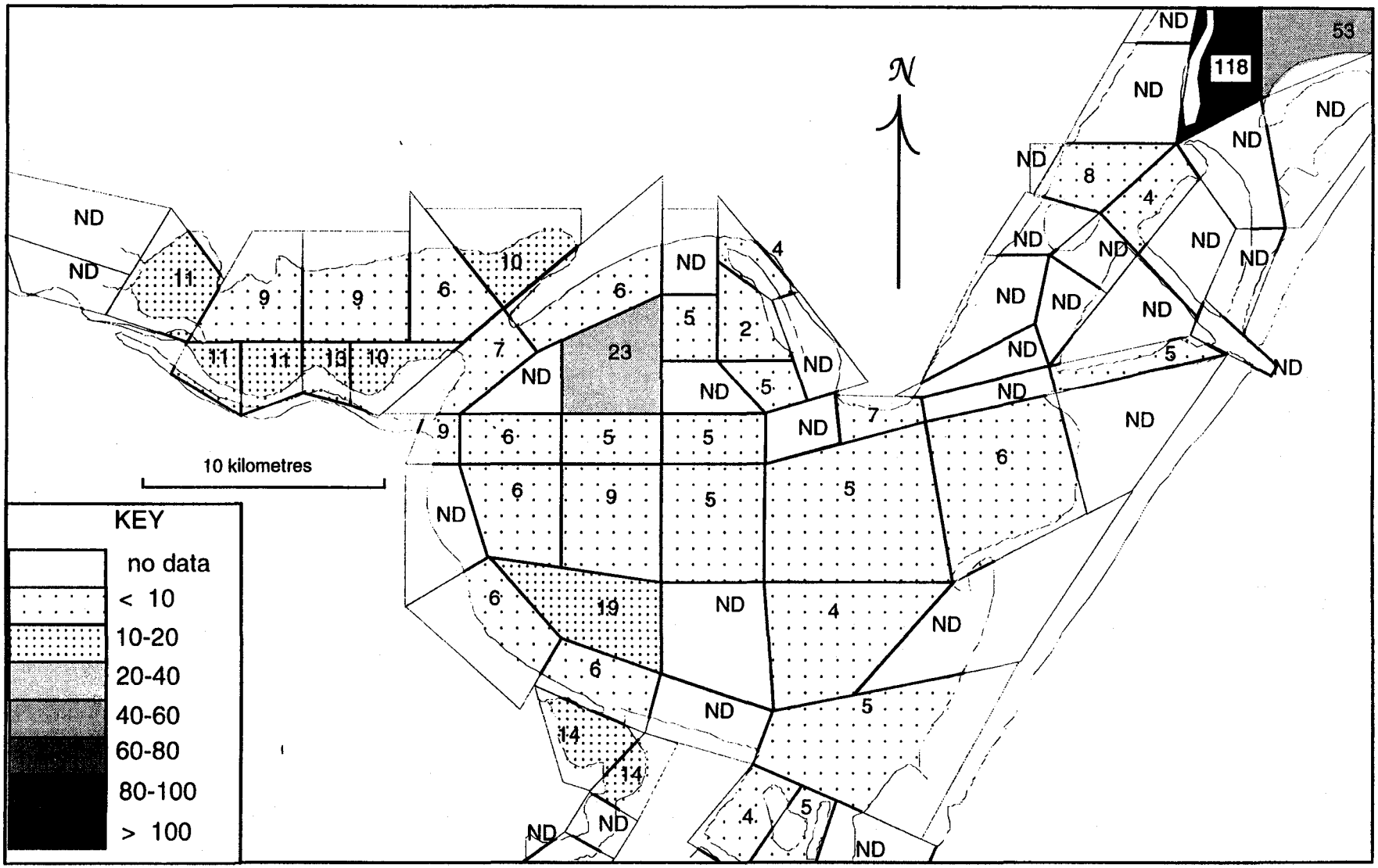


Figure 6-41. Period-of-record means of WQCHLA for Corpus Christi system

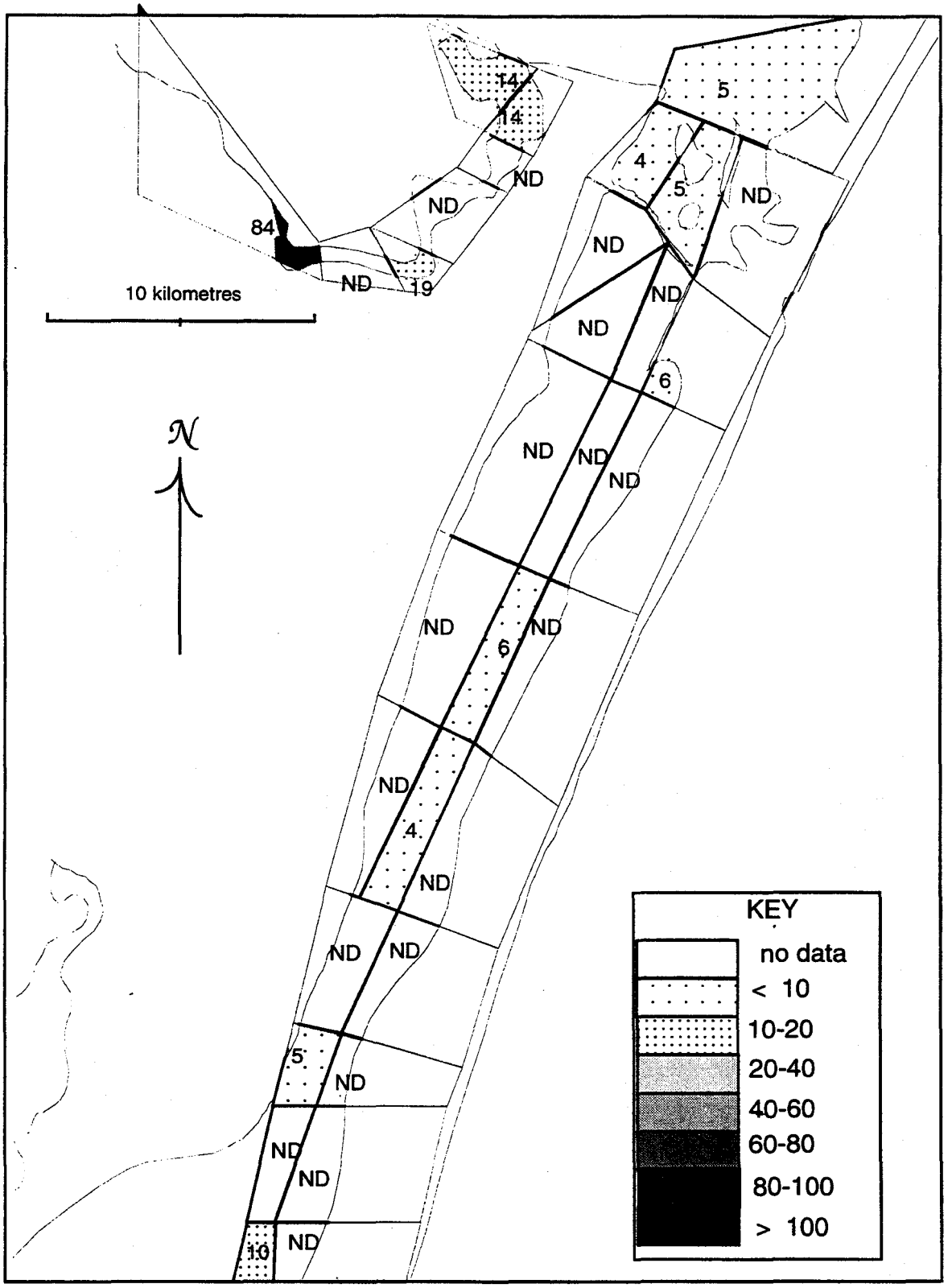


Figure 6-42. Period-of-record means of WQCHLA for Upper Laguna Madre and Oso Bay

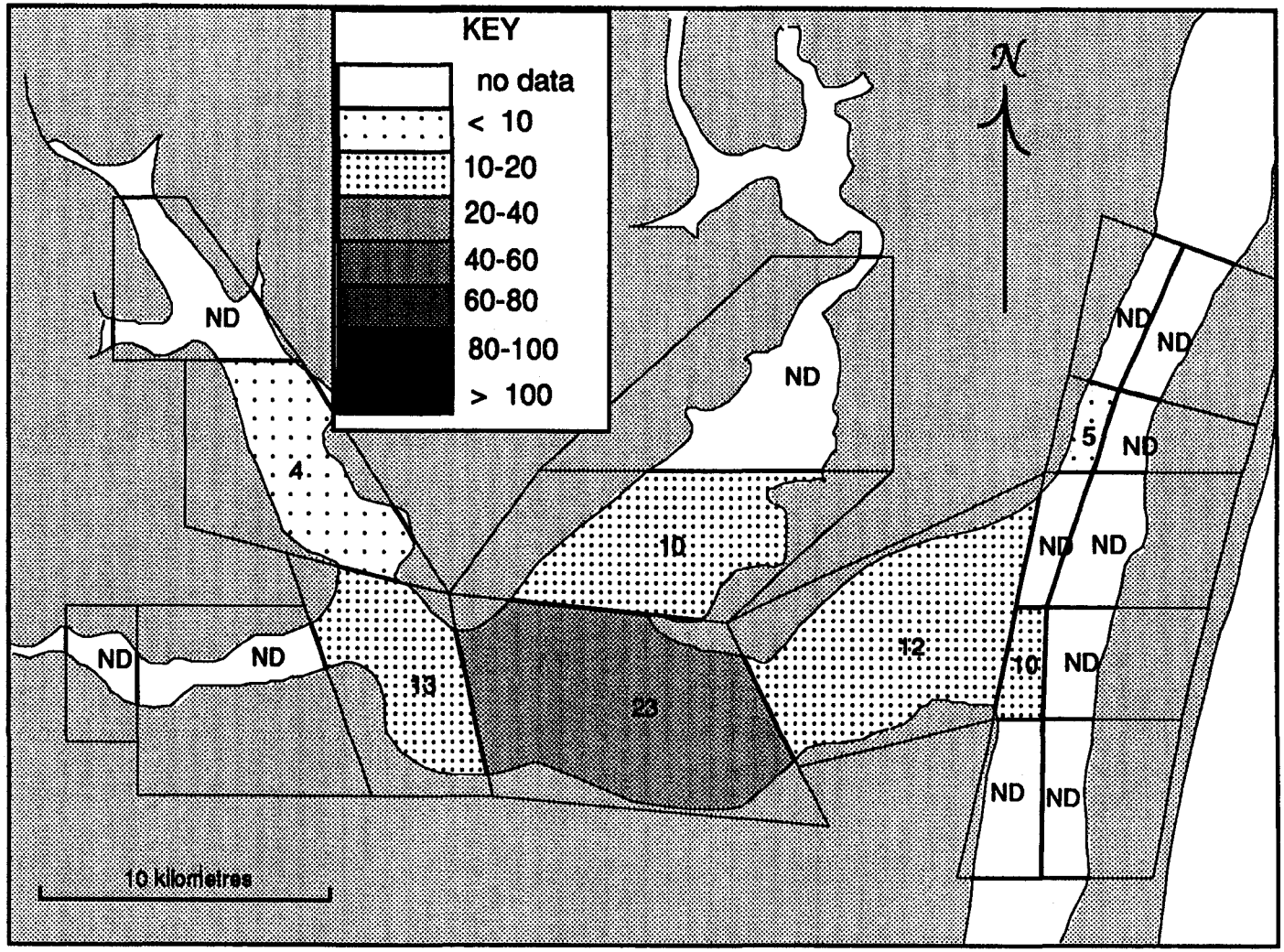


Figure 6-43. Period-of-record means of WQCHLA for Baffin Bay region

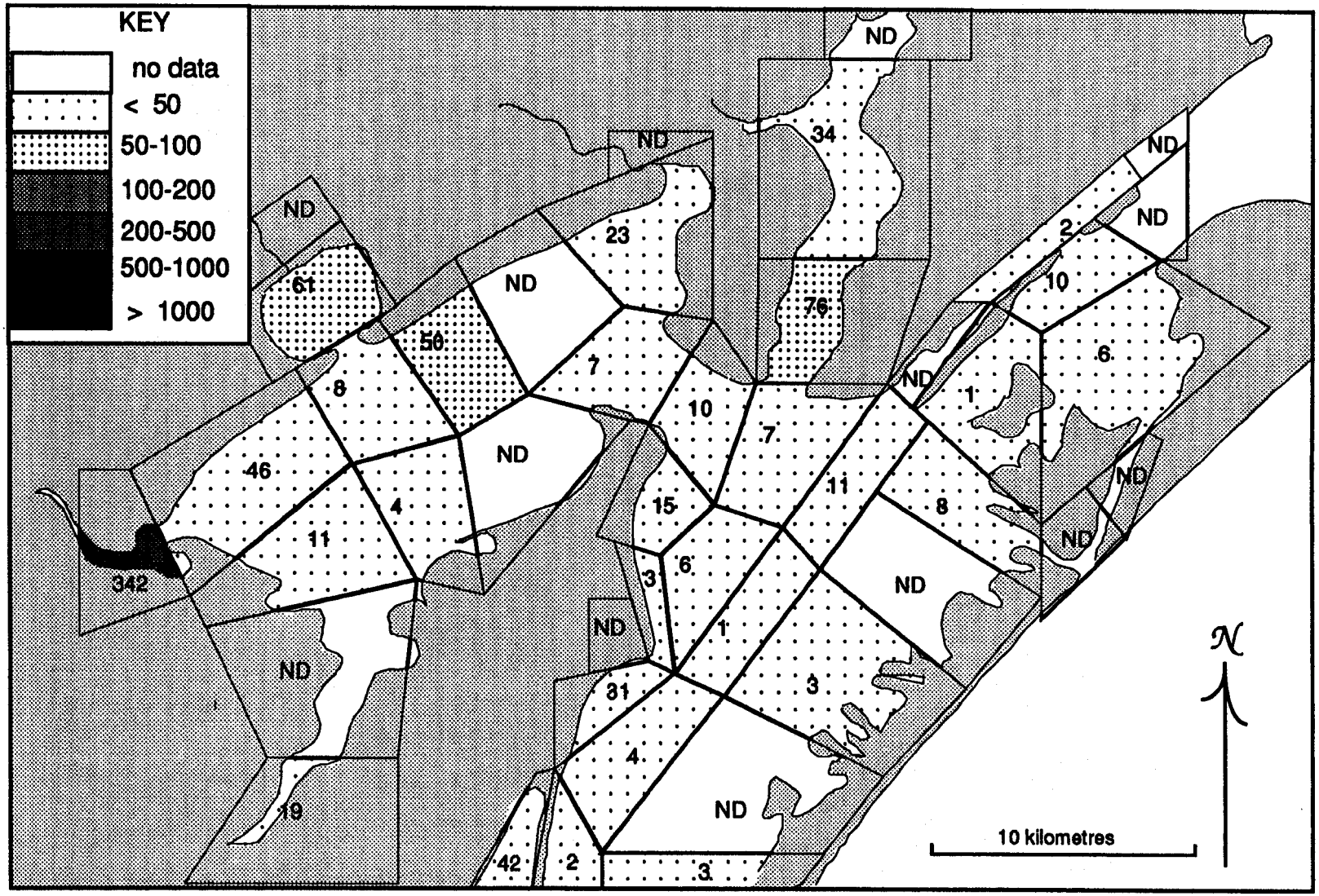


Figure 6-44. Period-of-record means of WQFCOLI for Aransas-Copano system

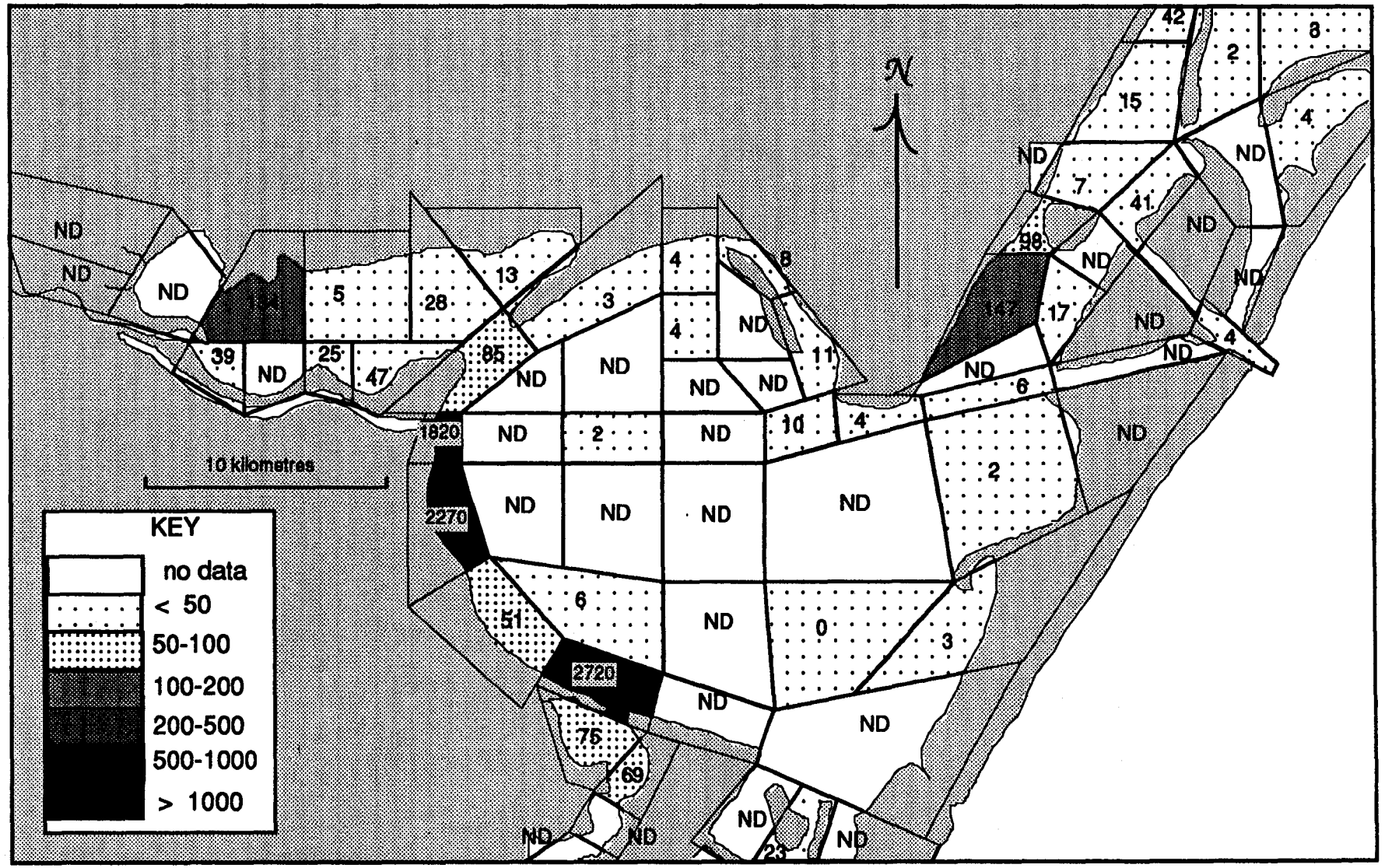


Figure 6-45. Period-of-record means of WQFCOLI for Corpus Christi system

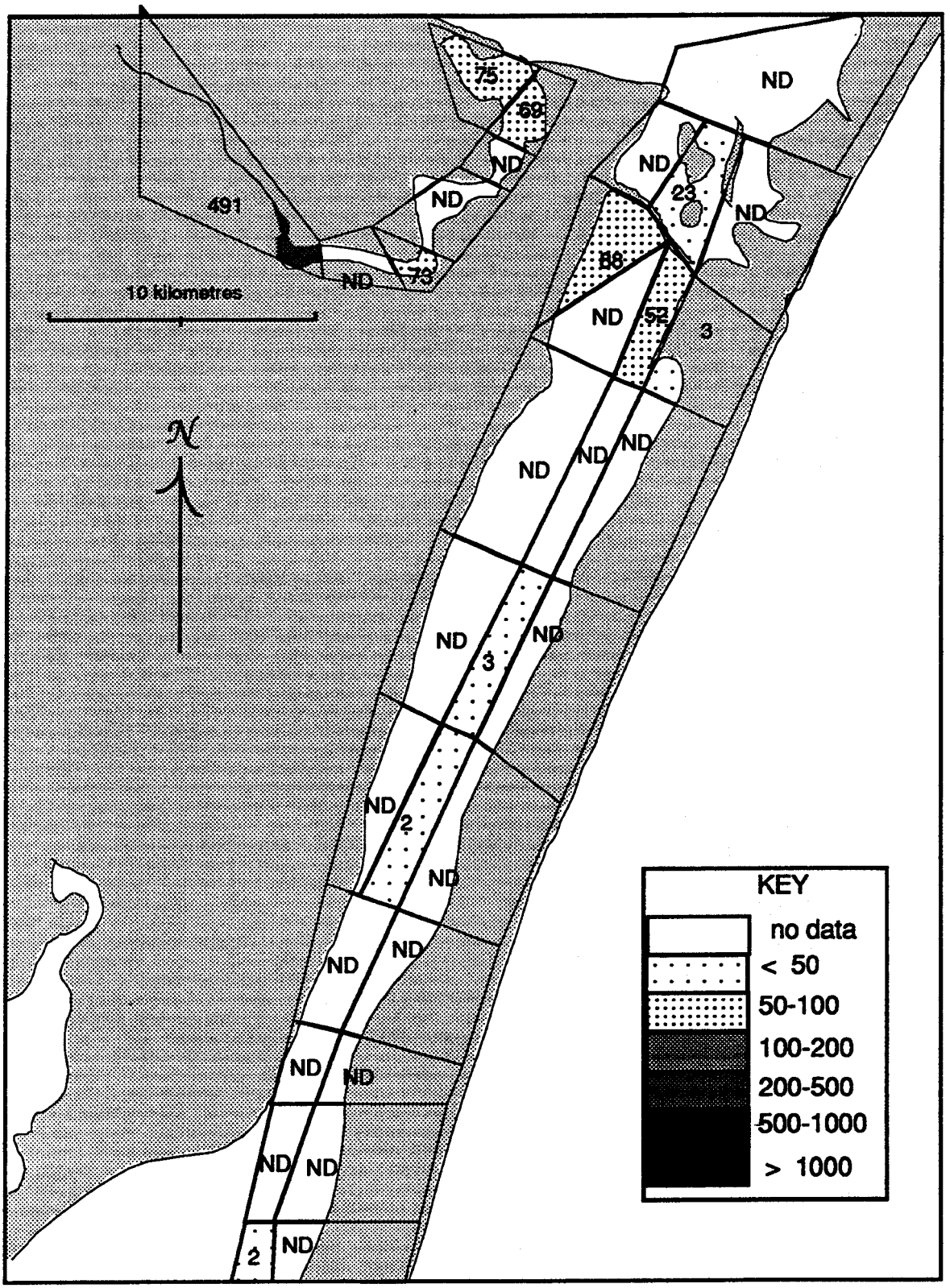


Figure 6-46. Period-of-record means of WQFCOLI for Upper Laguna Madre and Oso Bay

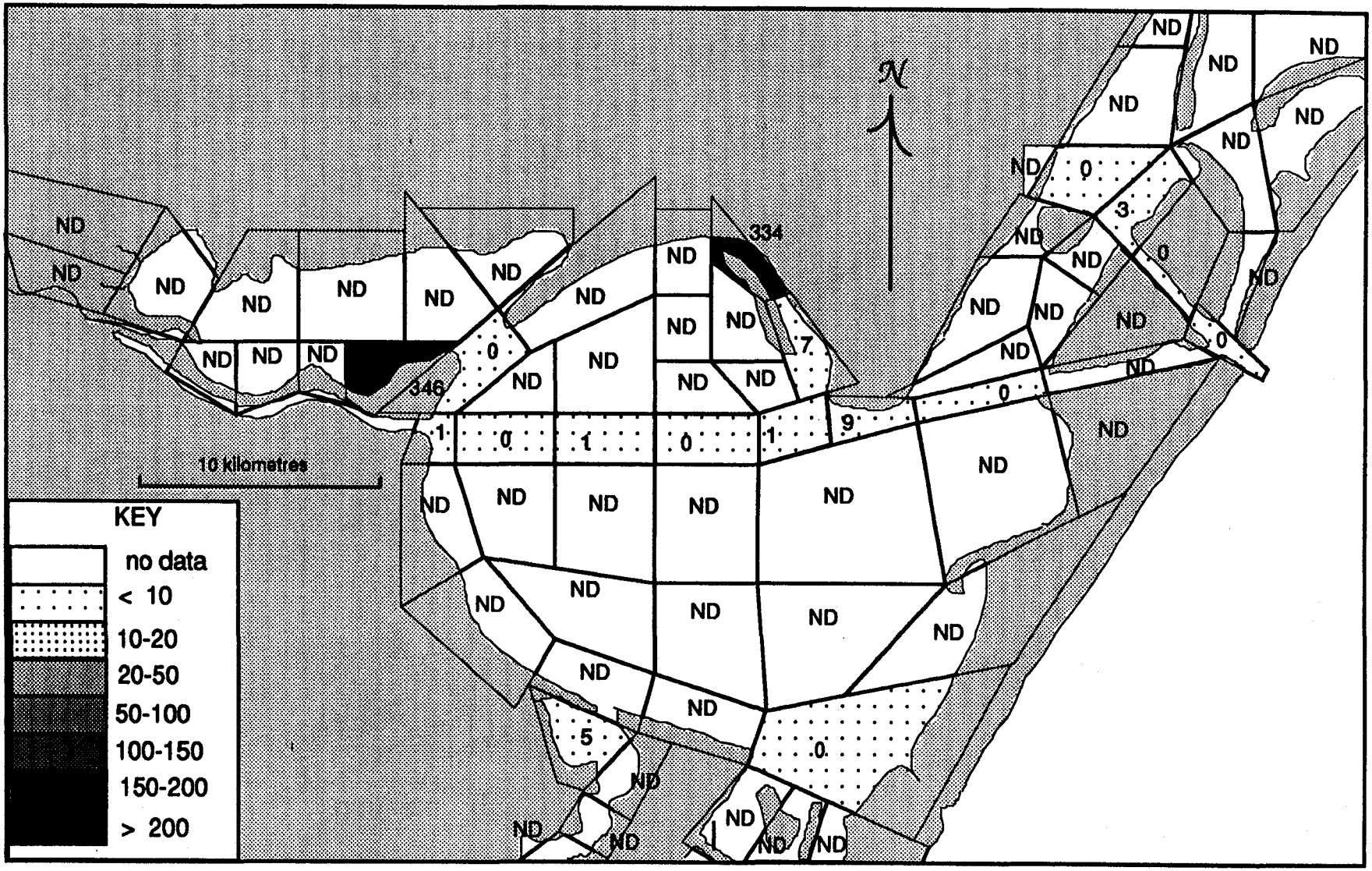


Figure 6-47. Period-of-record means of WQMETCDT for Corpus Christi system

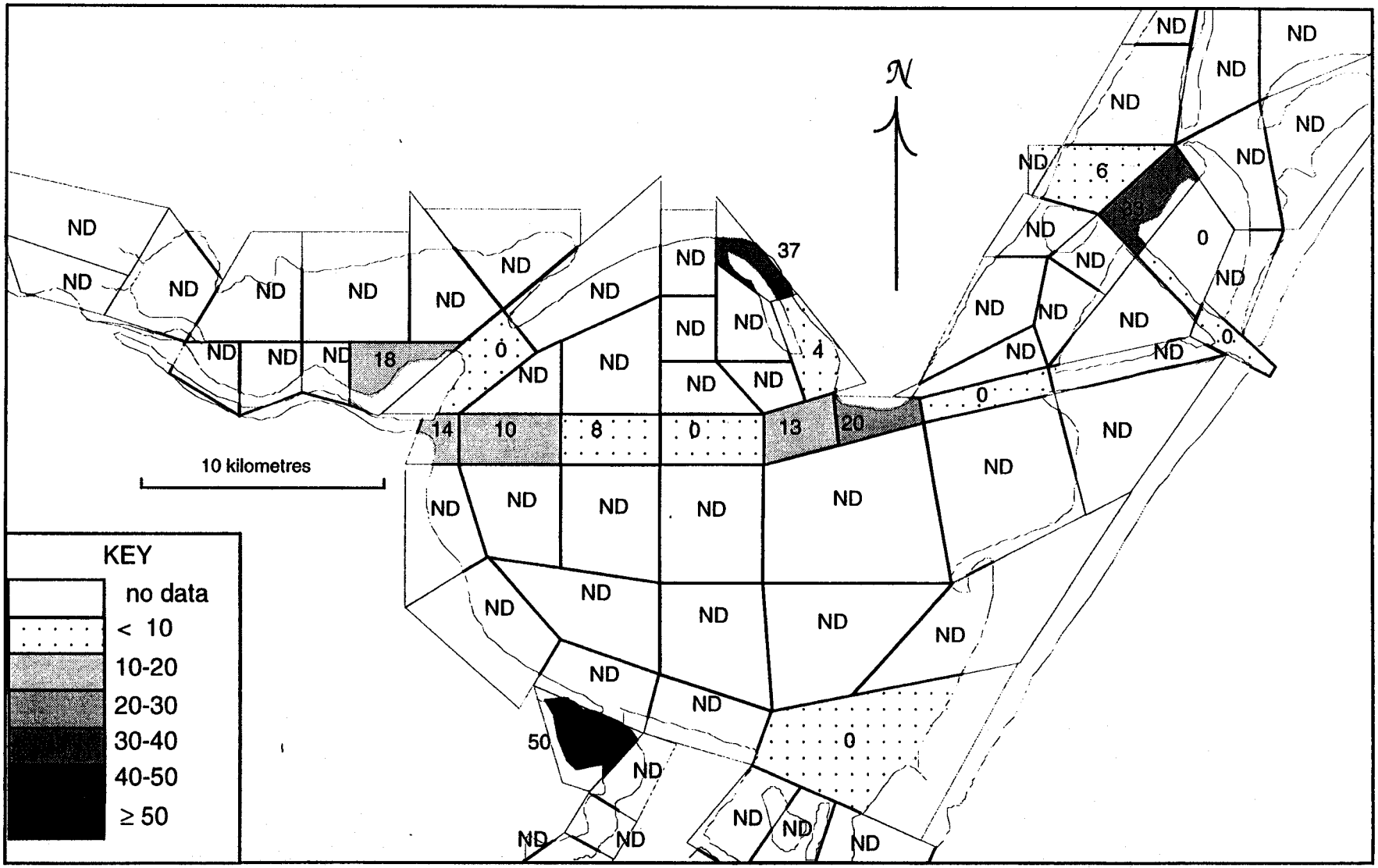


Figure 6-48. Period-of-record means of WQMETCUT for Corpus Christi system

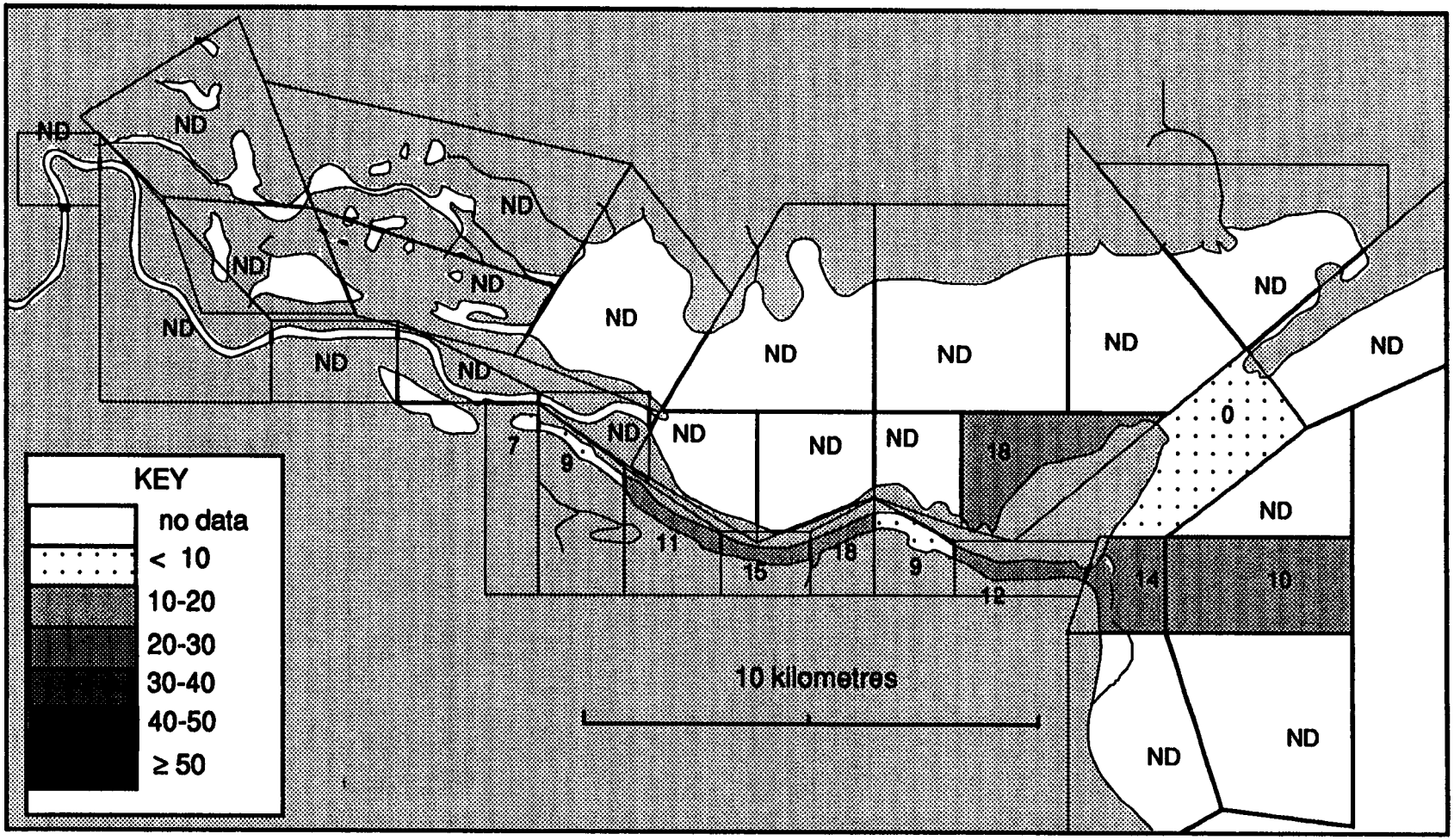


Figure 6-49. Period-of-record means of WQMETCUT for Nueces Bay region, including Inner Harbor

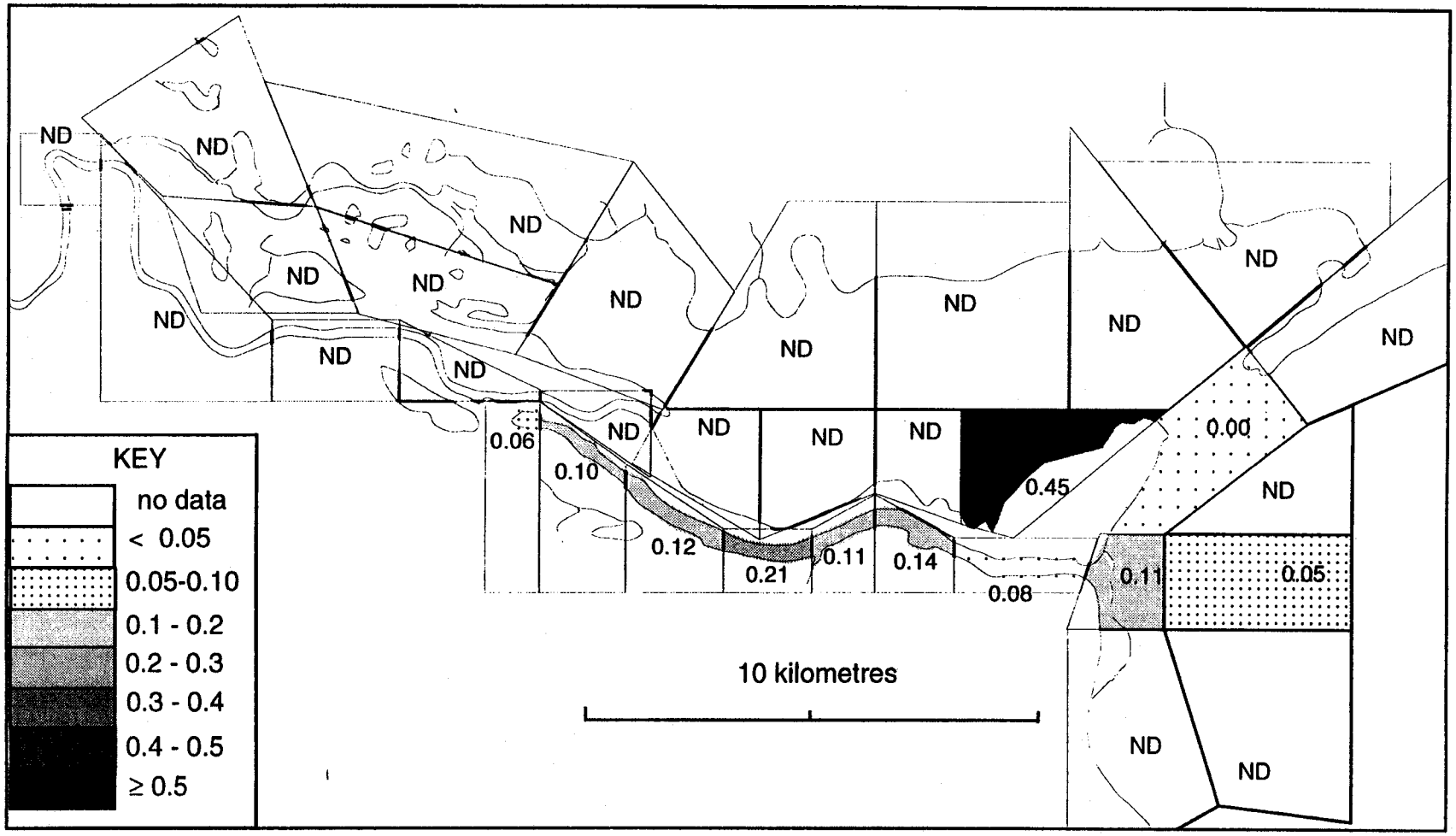


Figure 6-50. Period-of-record means of WQMETHGT for Nueces Bay region, including Inner Harbor

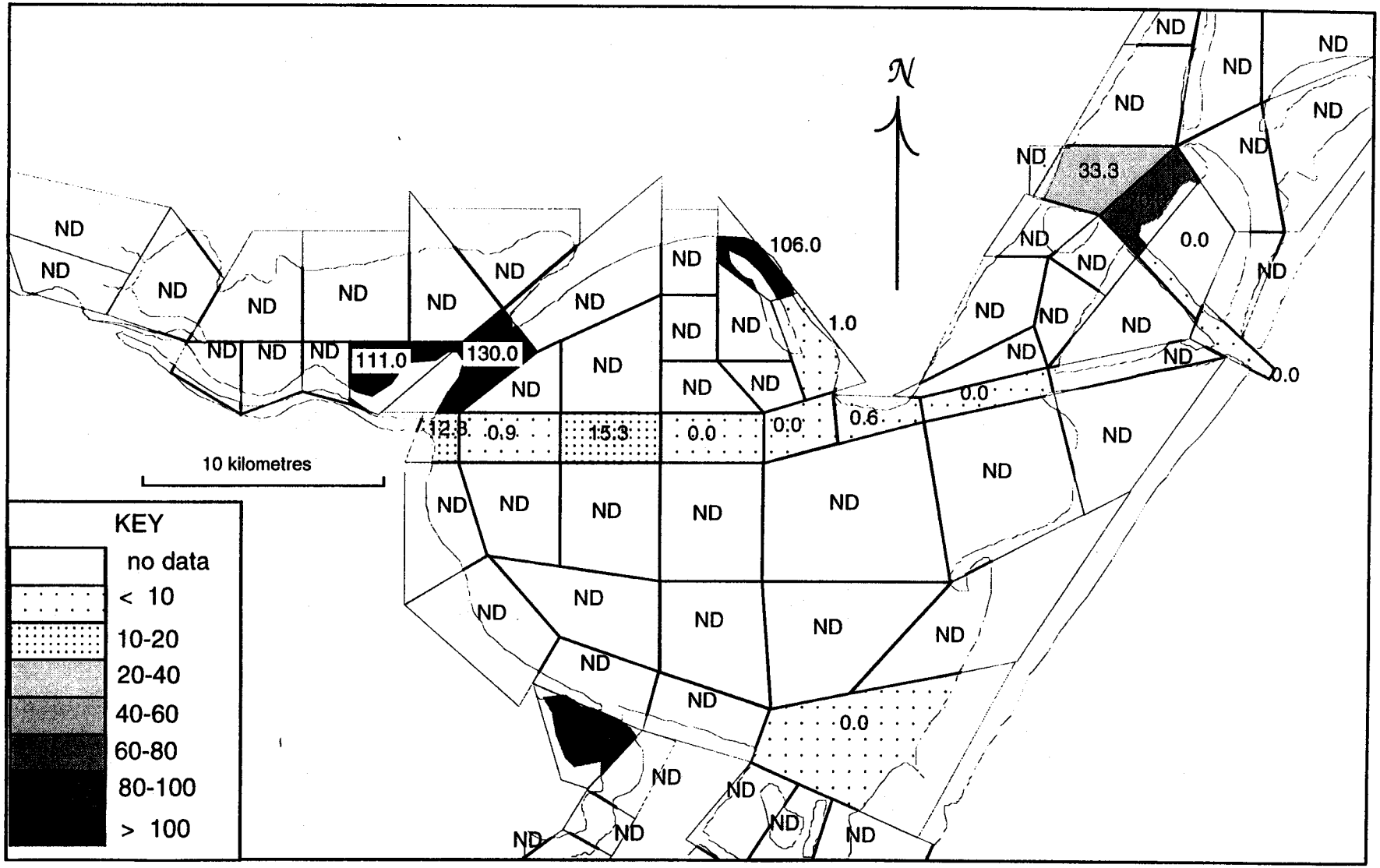


Figure 6-51. Period-of-record means of WQMETPBT for Corpus Christi system

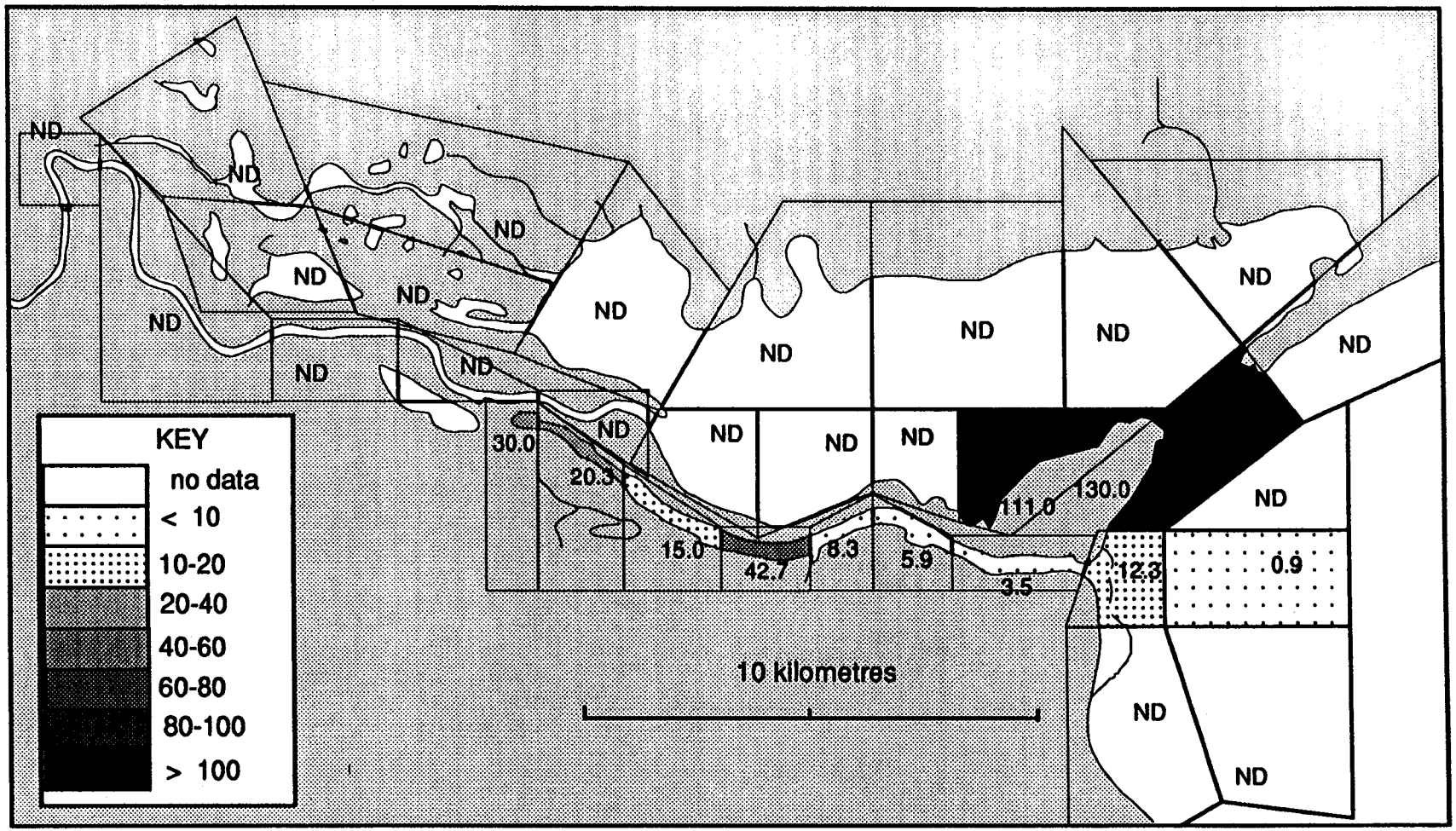


Figure 6-52. Period-of-record means of WQMETPBT for Nueces Bay region, including Inner Harbor

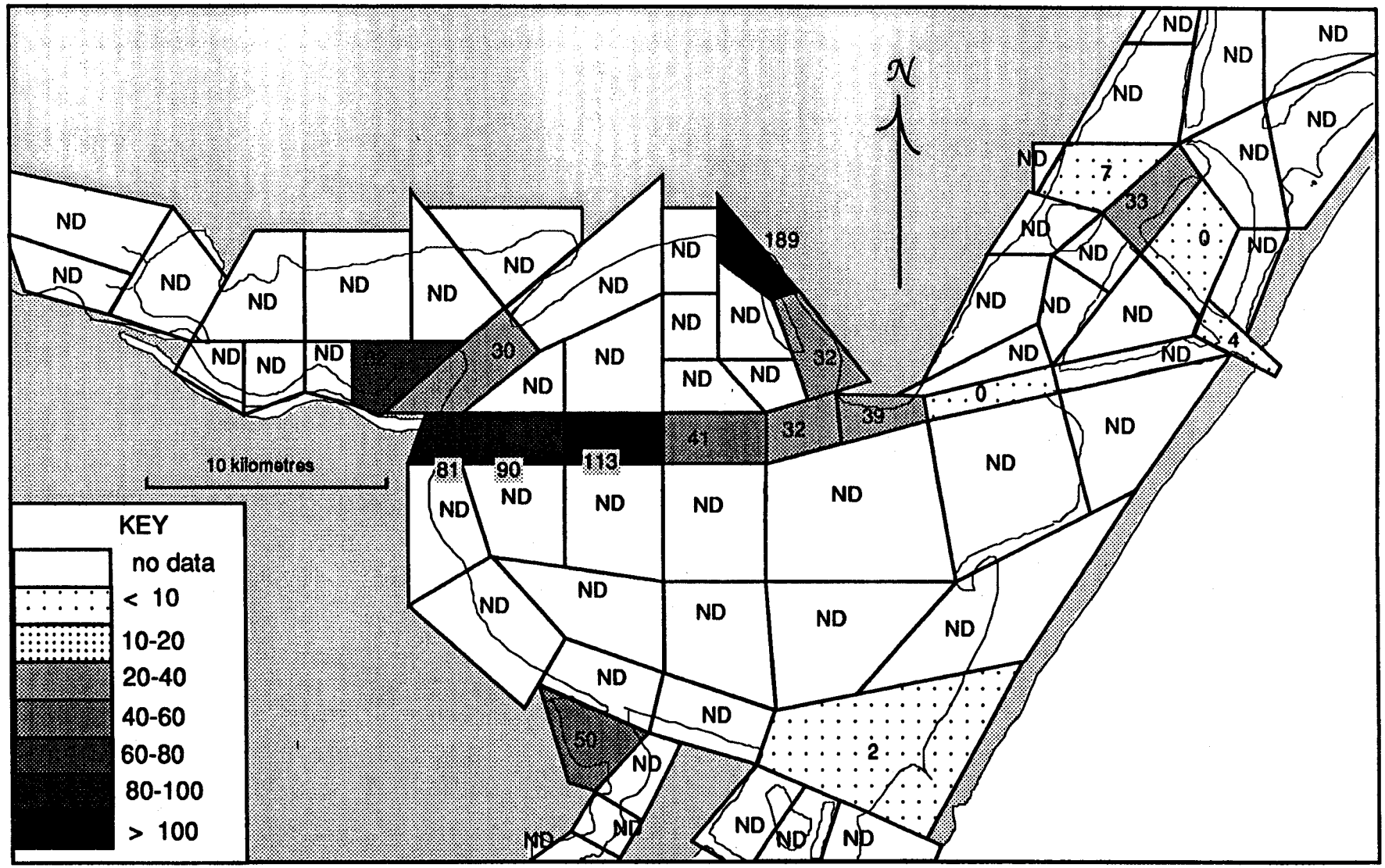


Figure 6-53. Period-of-record means of WQMETZNT for Corpus Christi system

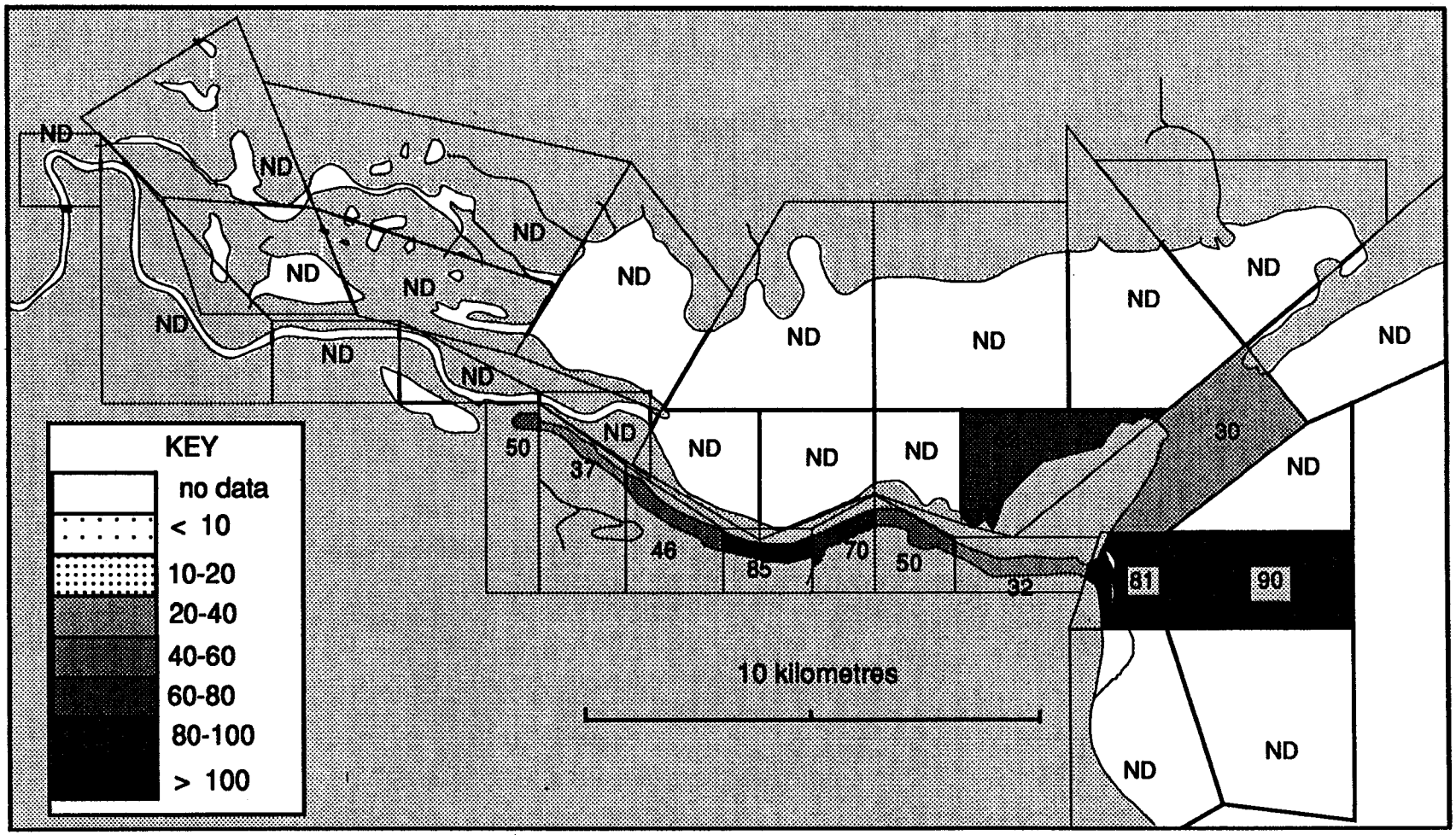


Figure 6-54. Period-of-record means of WQMETZNT for Nueces Bay region, including Inner Harbor

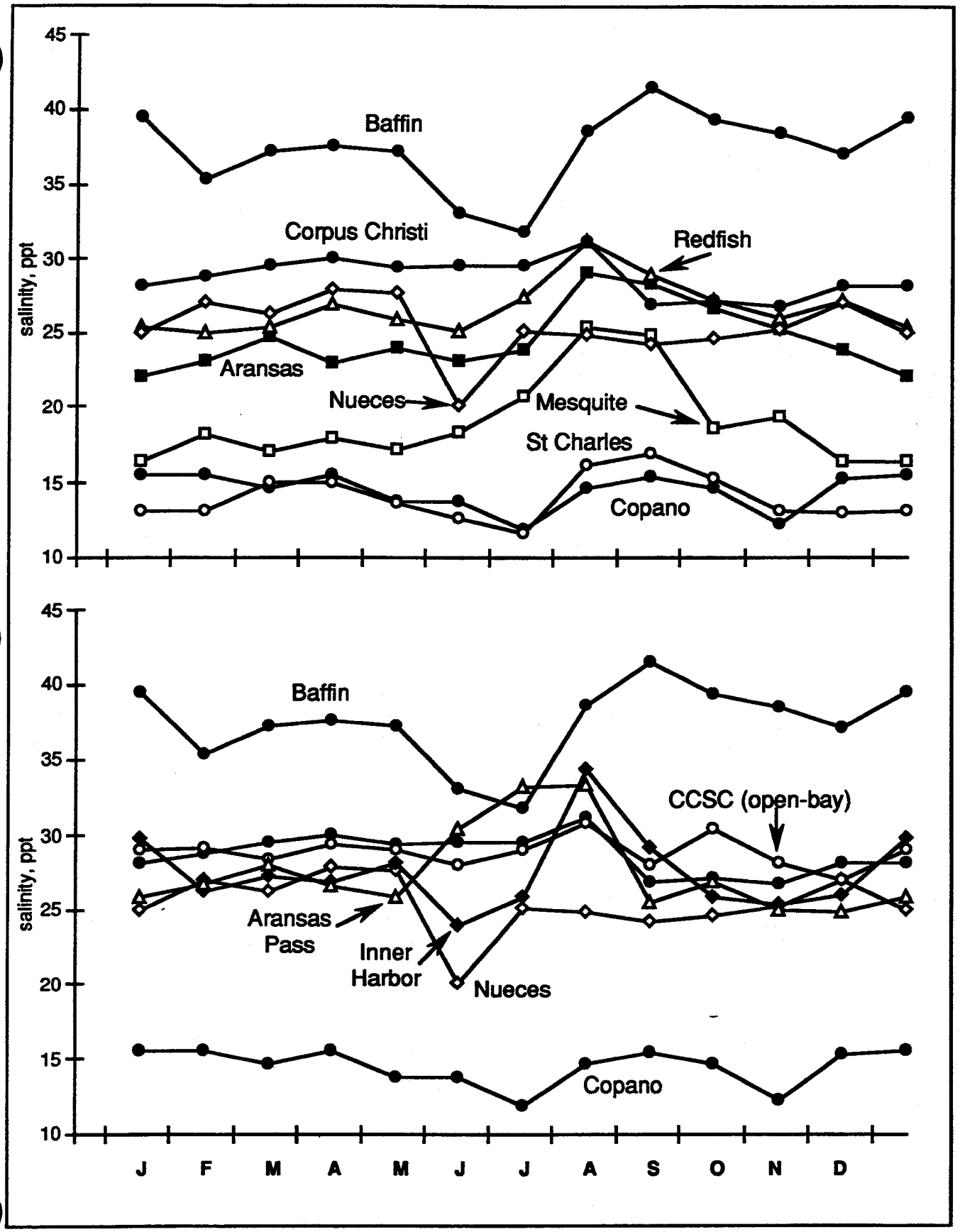


Figure 6-55. Period-of-record monthly-mean salinity (WQSAL), upper 1 m, principal bays (above) and Corpus Christi Bay region (below)

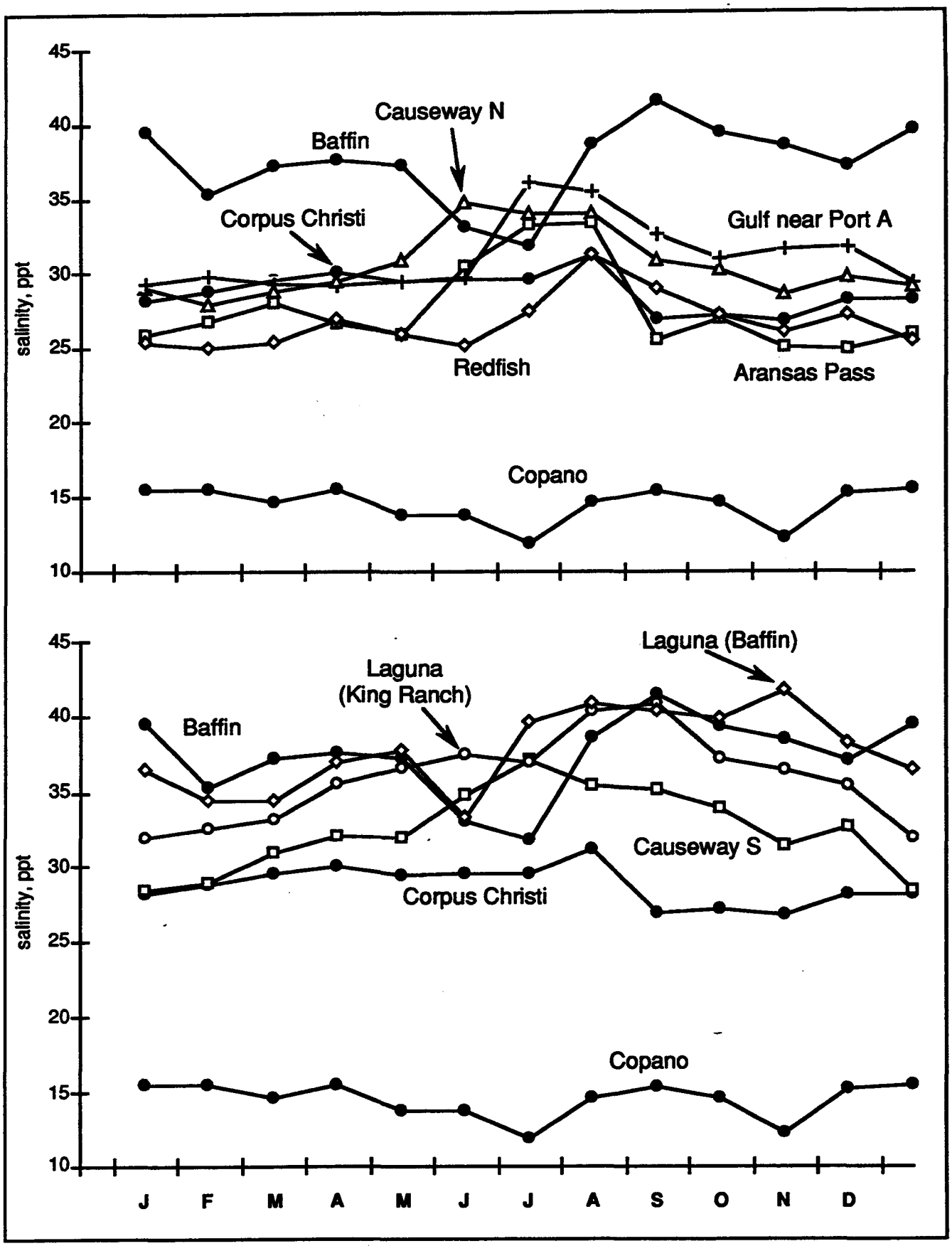


Figure 6-56. Period-of-record monthly-mean salinity (WQSAL), upper 1 m, barrier island region (above) and Upper Laguna region (below)

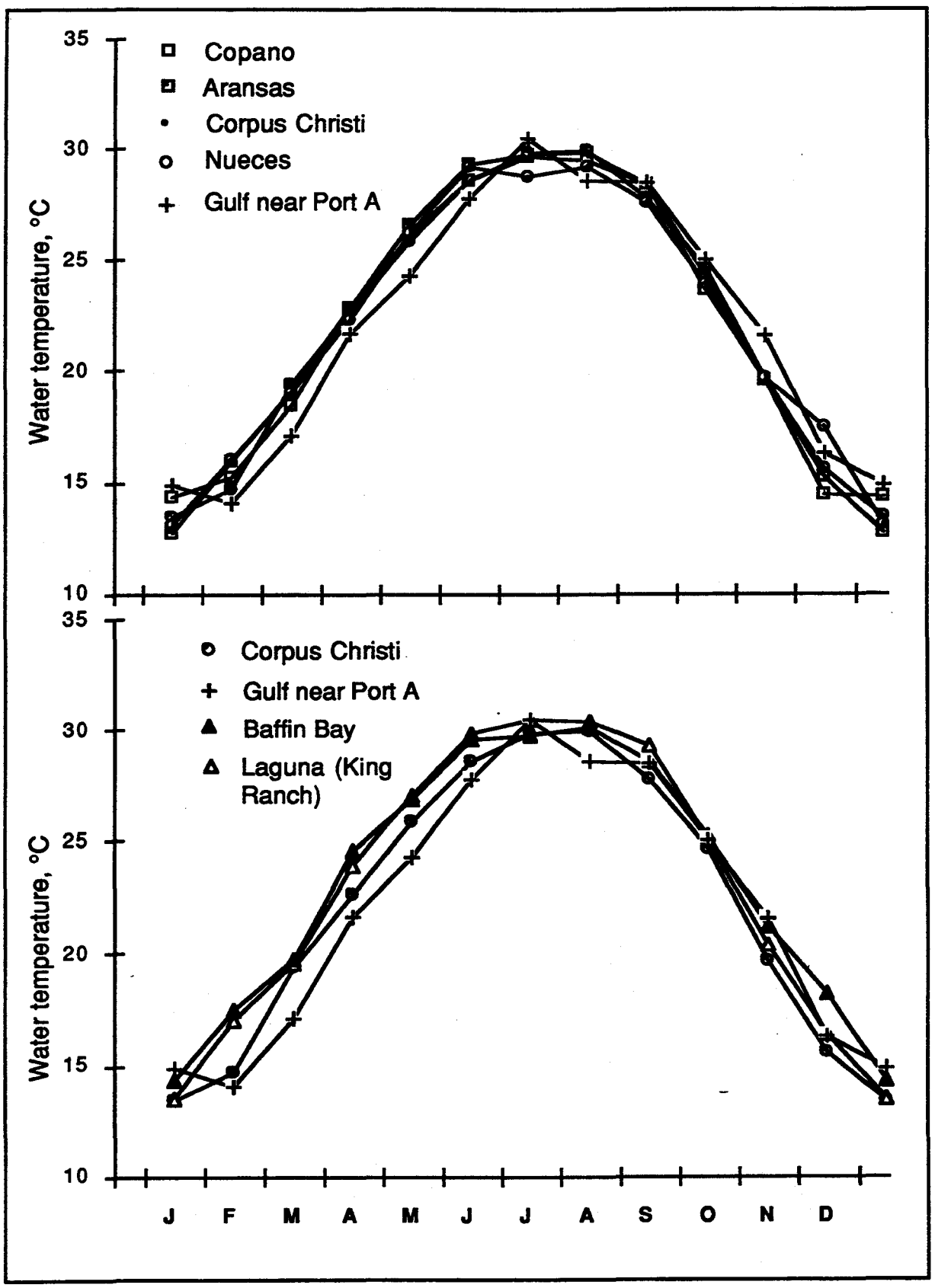


Figure 6-57. Period-of-record monthly-mean temperature (WQTEMP), upper 1 m, upper bays (above) and lower bays (below)

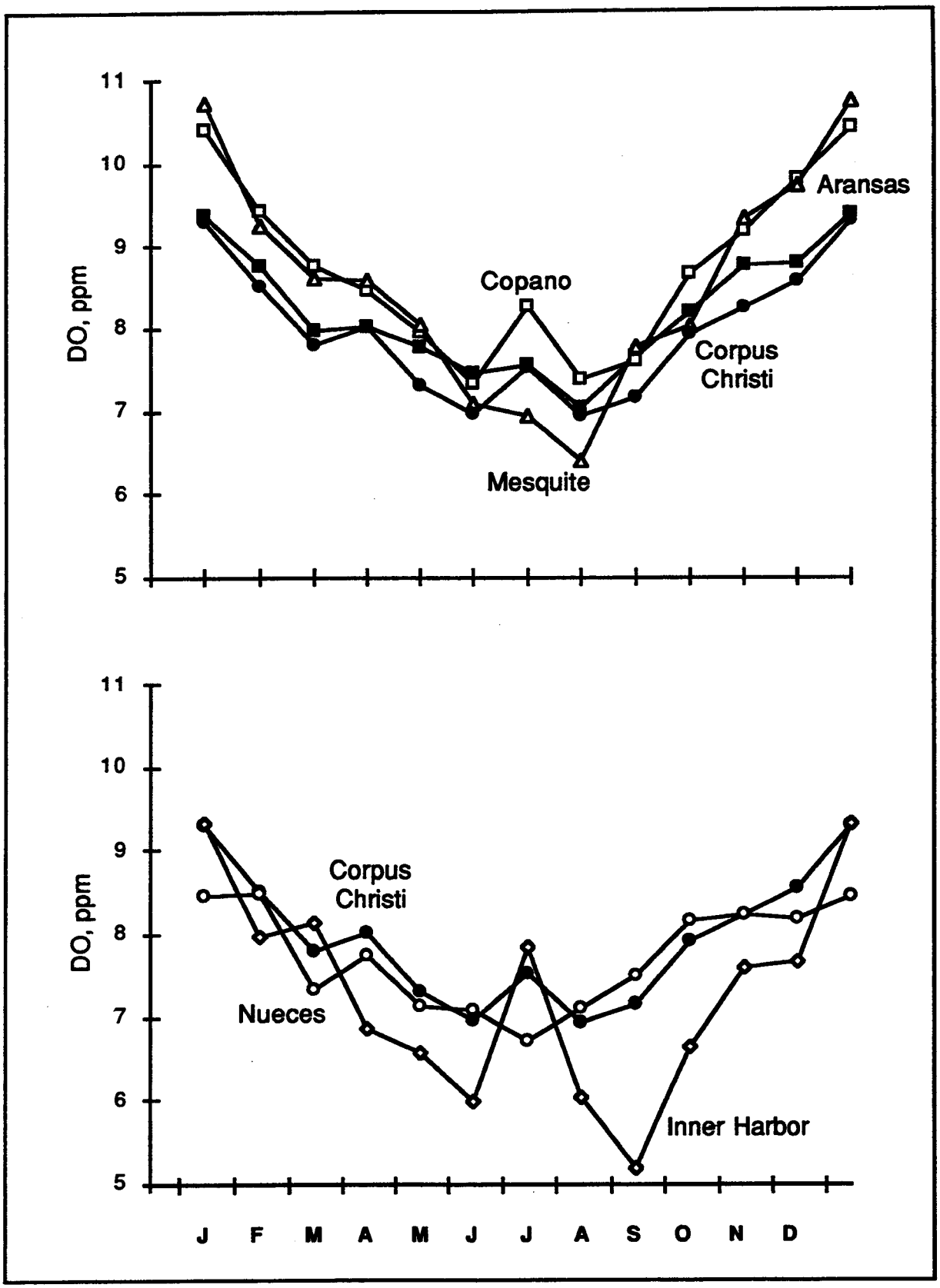


Figure 6-58. Period-of-record monthly-mean DO (WQDO) in upper 1 meter, upper bays (above), Nueces region (below)

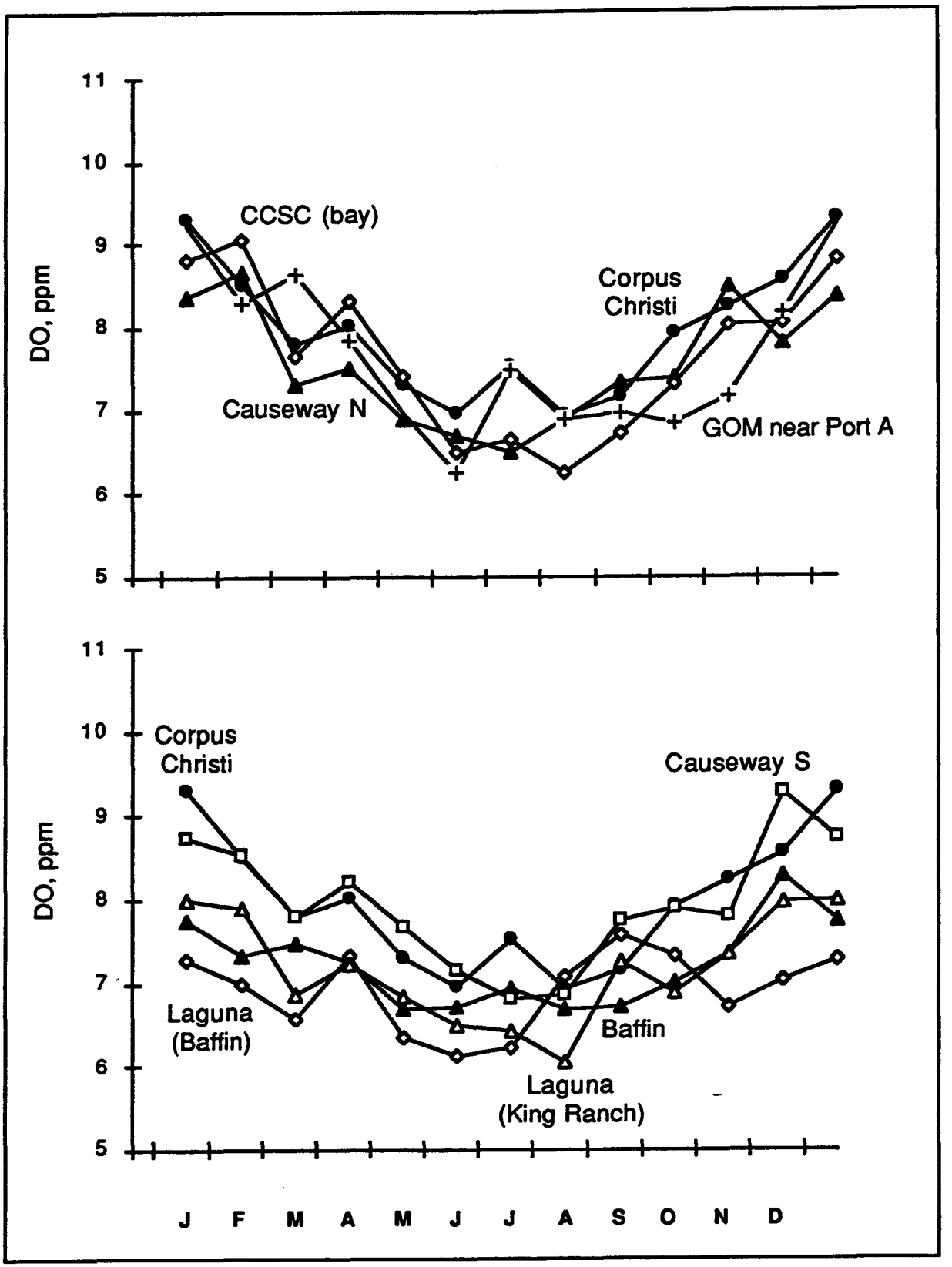


Figure 6-59. Period-of-record monthly-mean DO (WQDO) in upper 1 meter, Corpus Christi system (above), Laguna region (below)

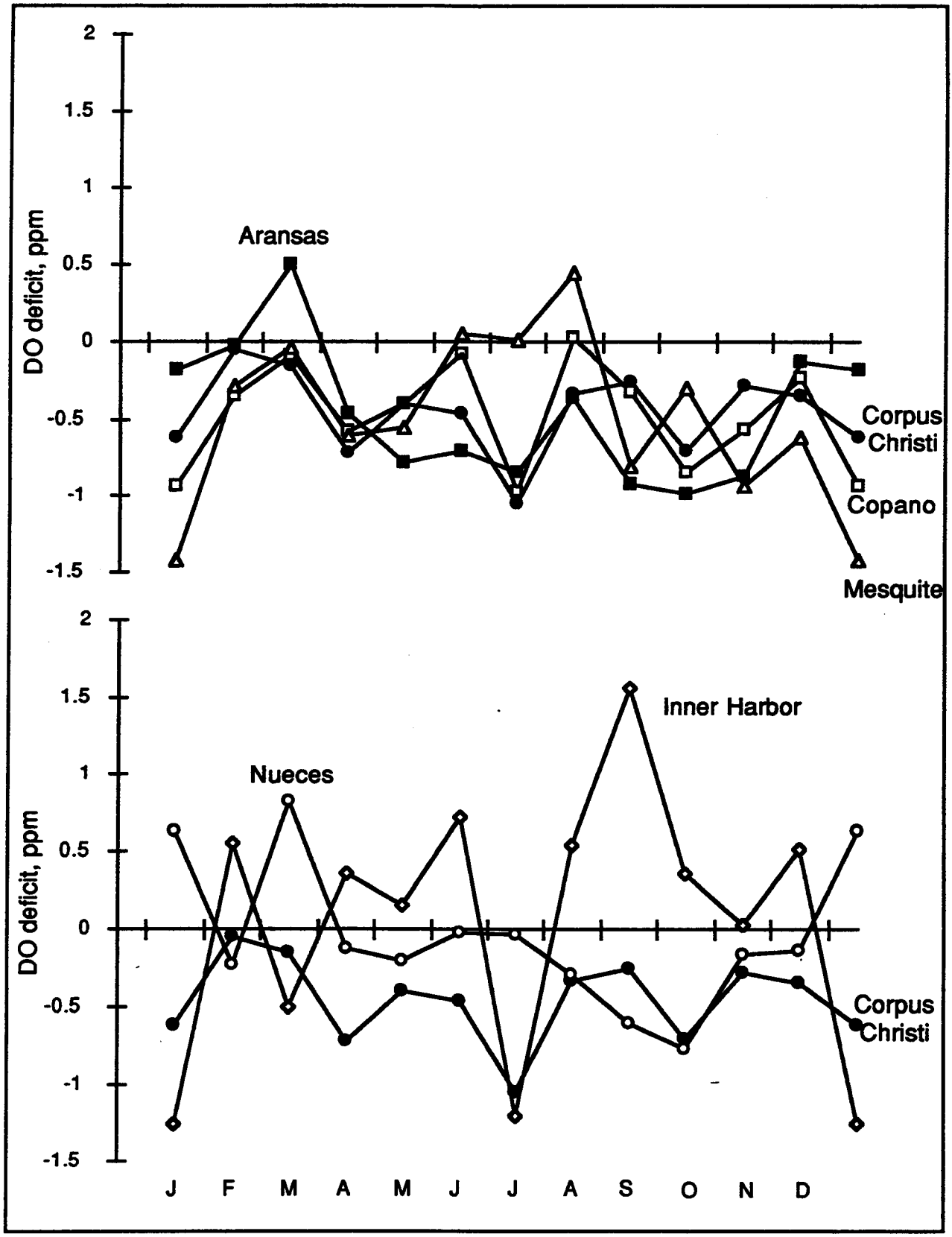


Figure 6-60. Period-of-record monthly-mean DO deficit (WQDODEF) in upper 1 meter, upper bays (above), Nueces region (below)

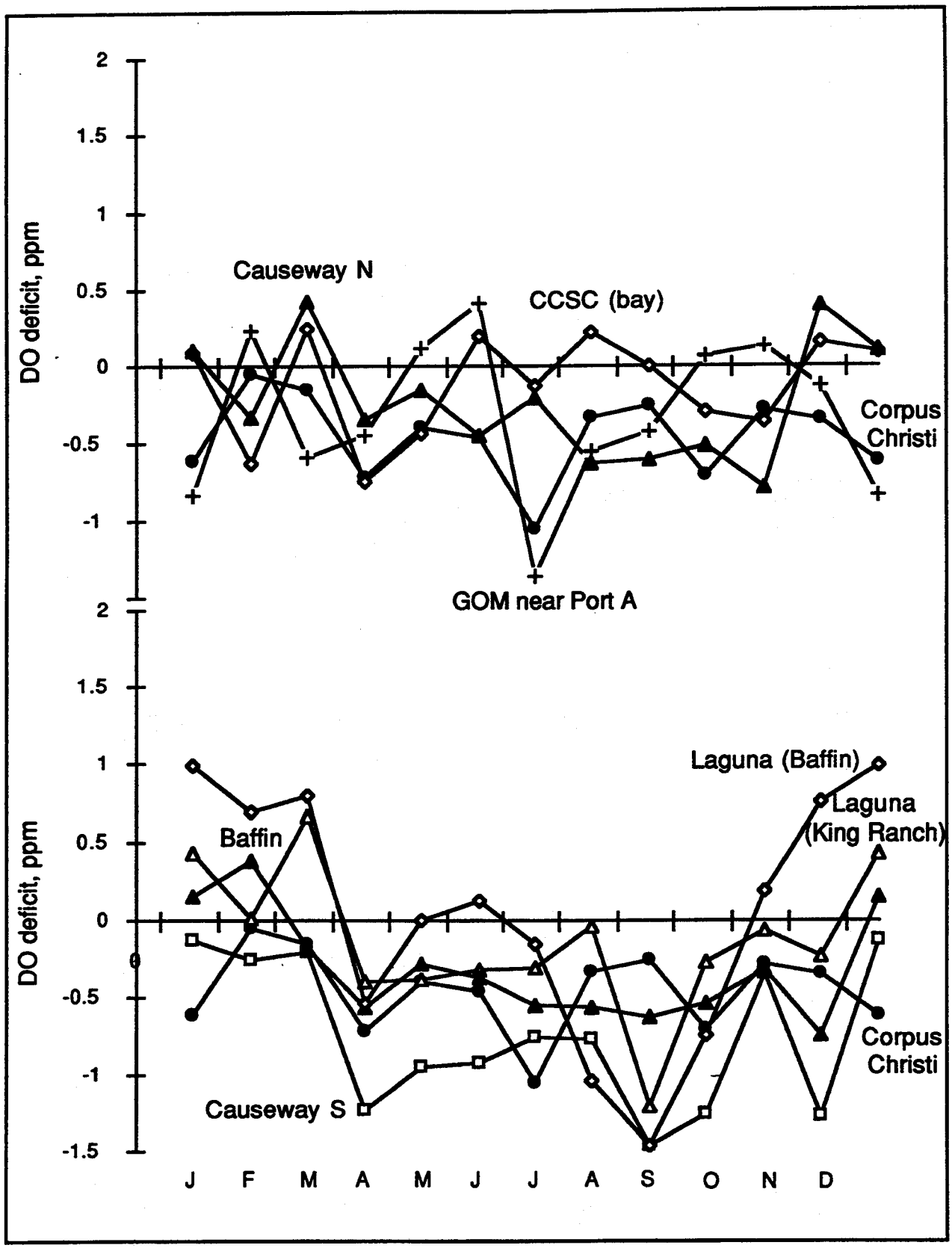


Figure 6-61. Period-of-record monthly-mean DO deficit (WQDODEF) in upper 1 meter, Corpus Christi system (above), Laguna region (below)

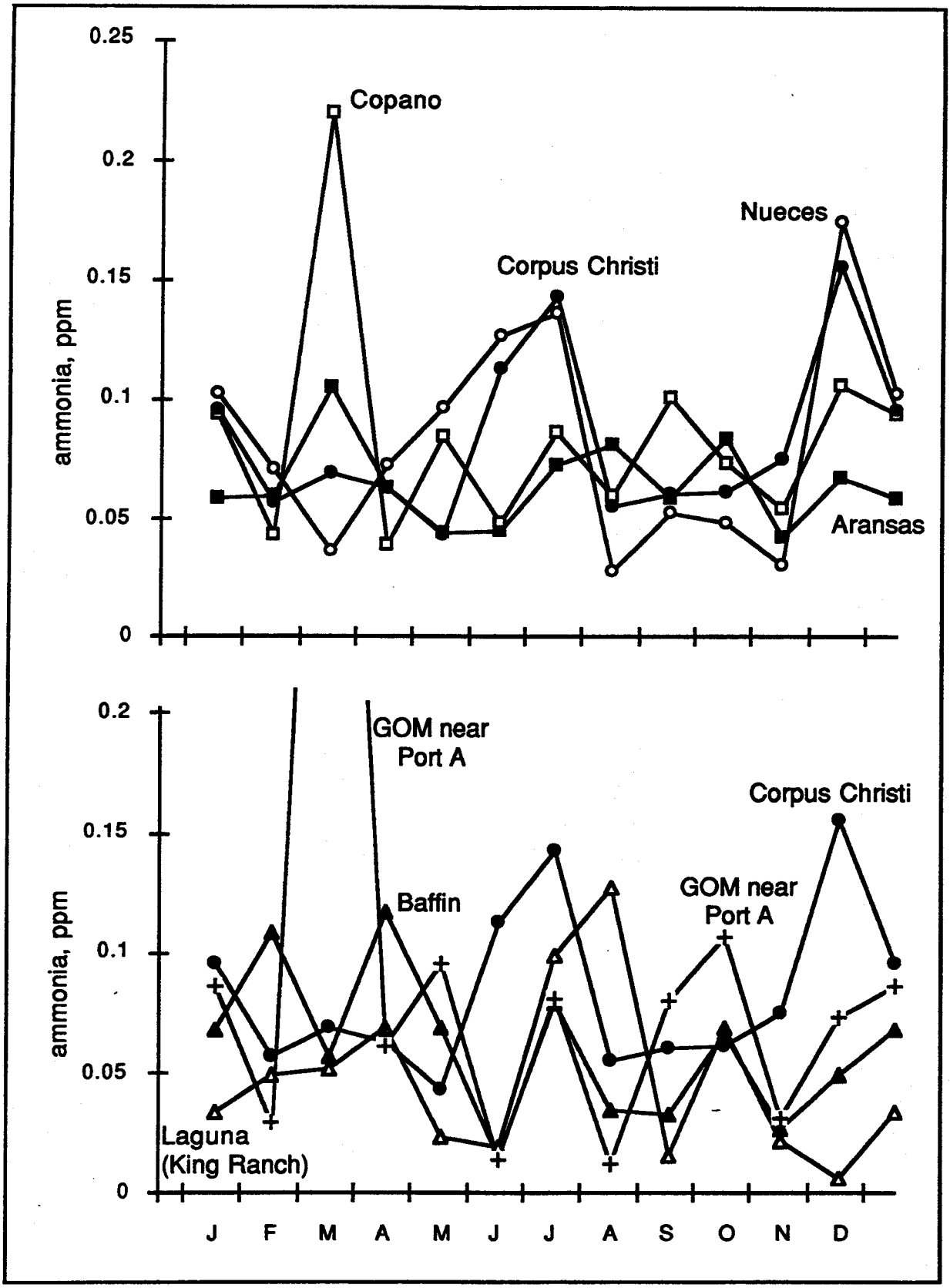


Figure 6-62. Period-of-record monthly-mean ammonia (WQAMMN) upper bays (above) and lower bays (below)

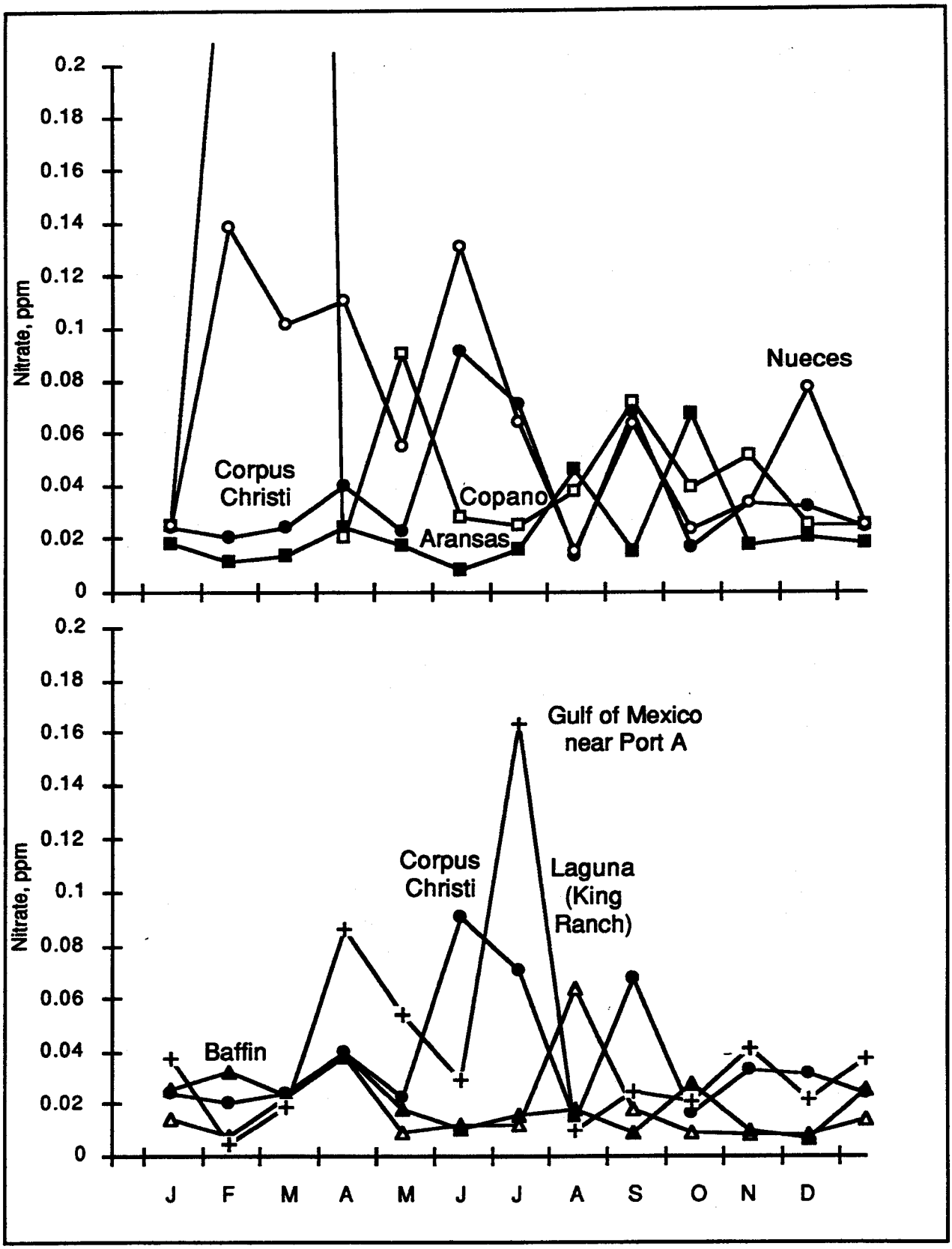


Figure 6-63. Period-of-record monthly-mean nitrate (WQNO3N), upper bays (above), lower bays (below)

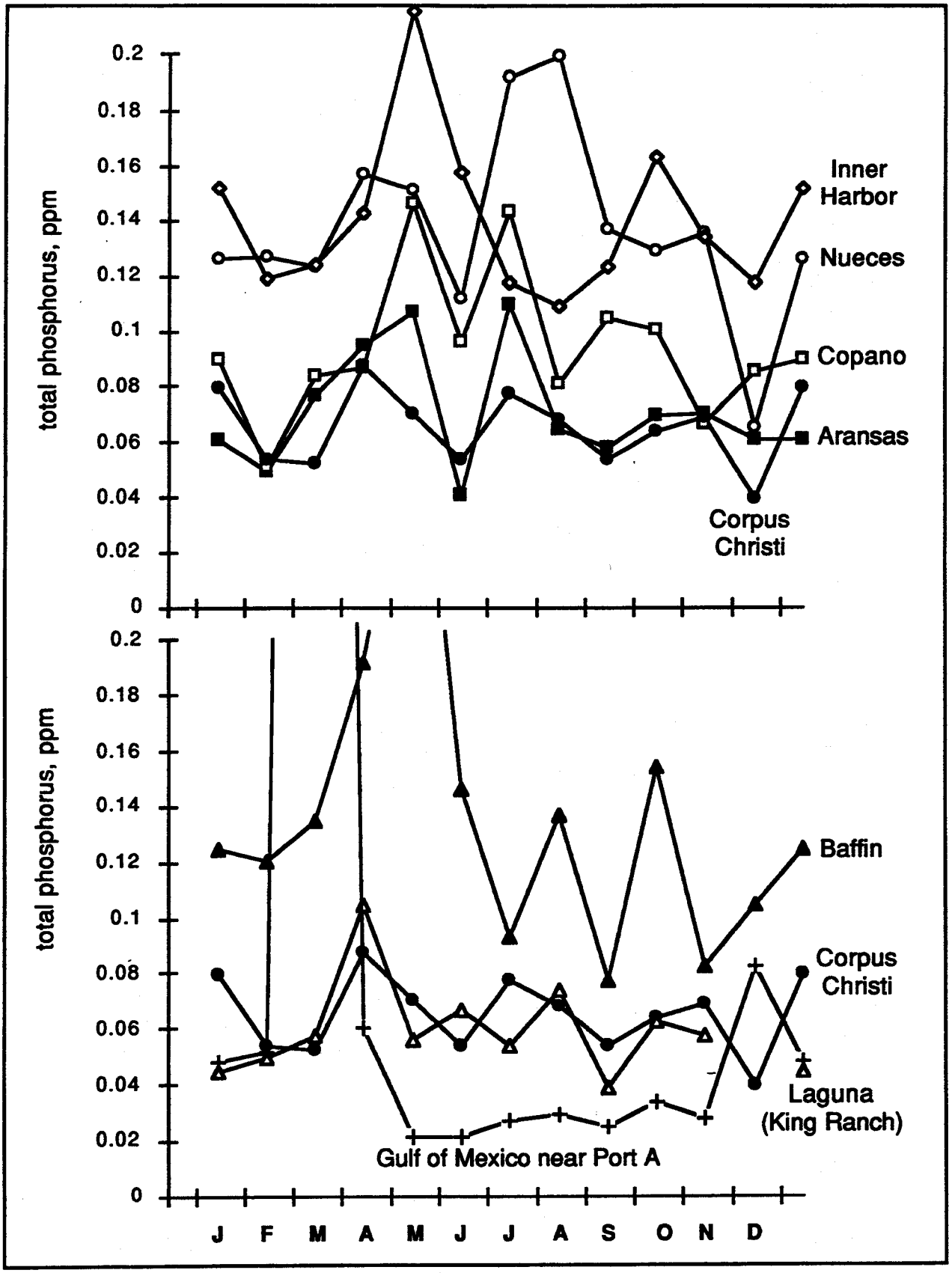


Figure 6-64. Period-of-record monthly-mean total phosphorus (WQTOTP), upper bays (above), lower bays (below)

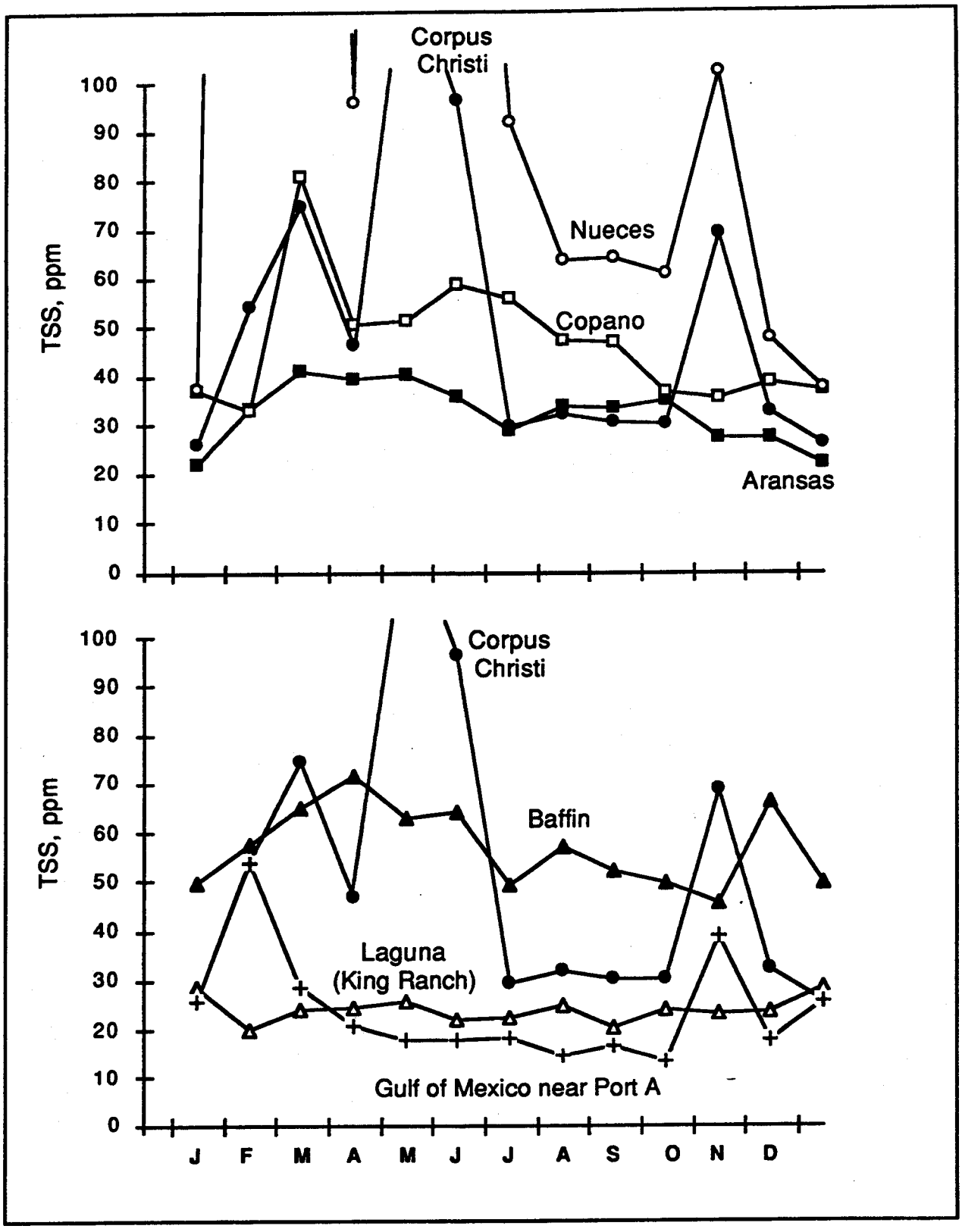


Figure 6-65. Period-of-record monthly-mean proxy TSS (WQXTSS), upper bays (above), lower bays (below)

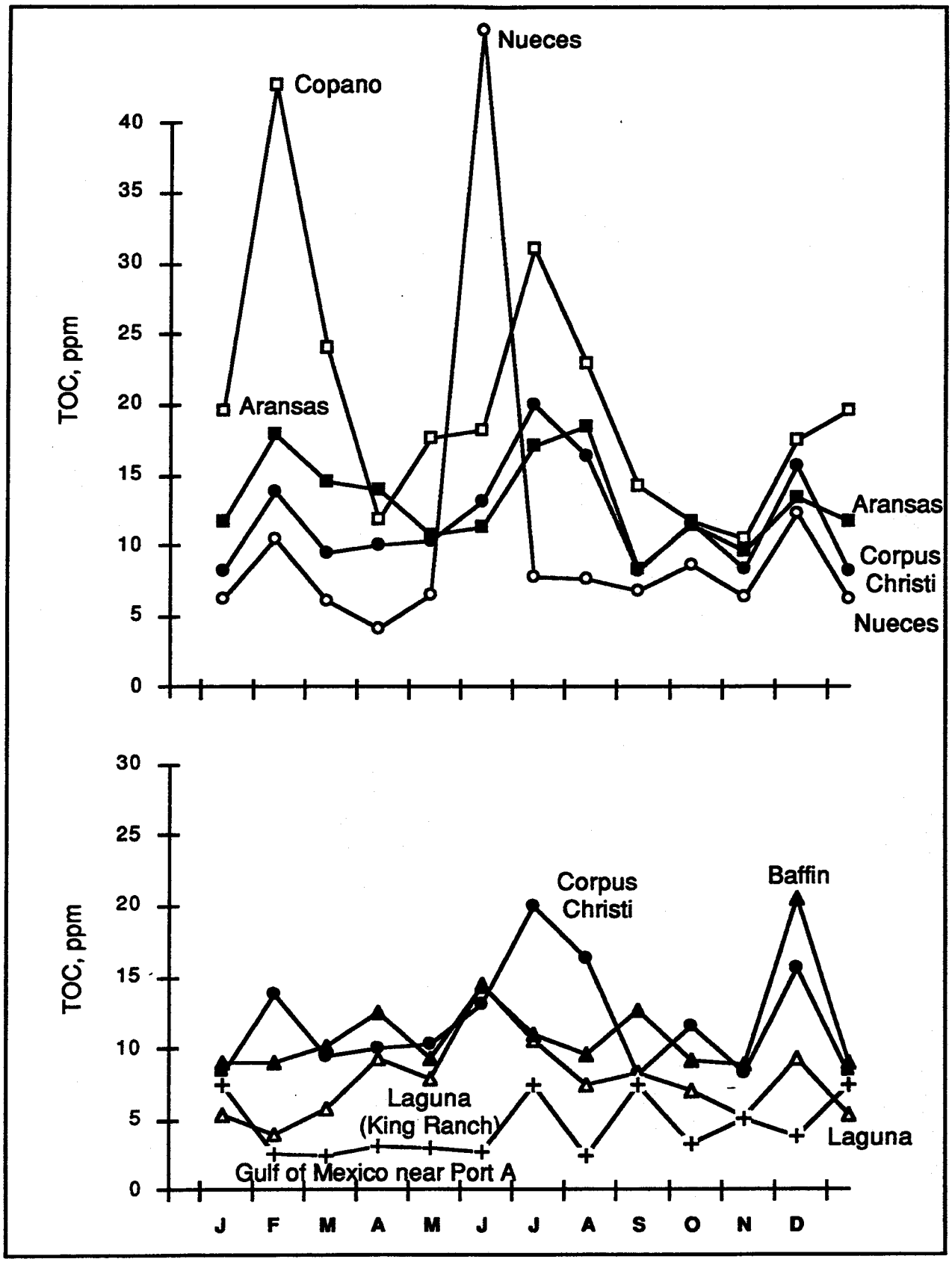


Figure 6-66. Period-of-record monthly-mean TOC (WQTOC), upper bays (above), lower bays (below)

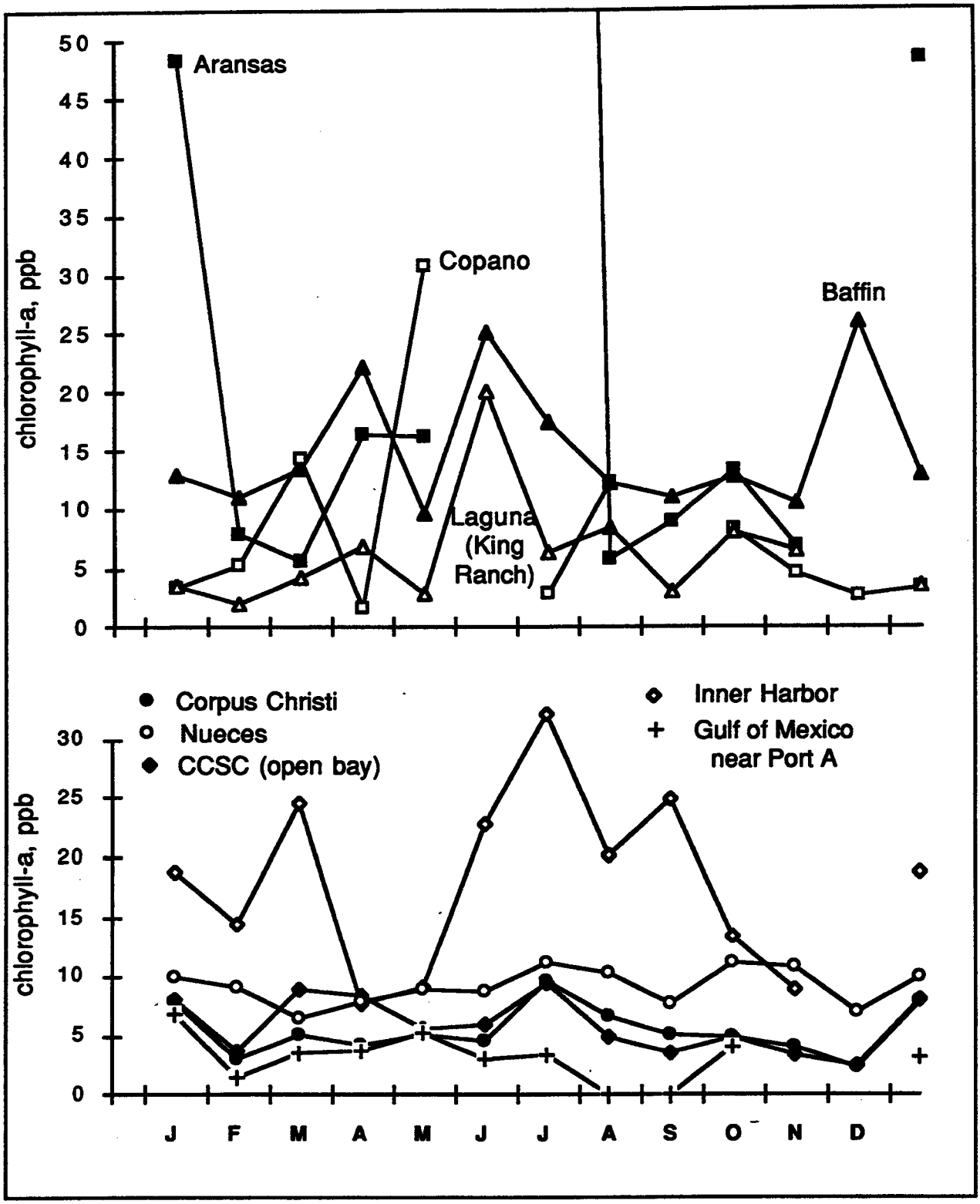


Figure 6-67. Period-of-record monthly-mean chlorophyll-a (WQCHLA), outer bays (above), Corpus Christi system (below)

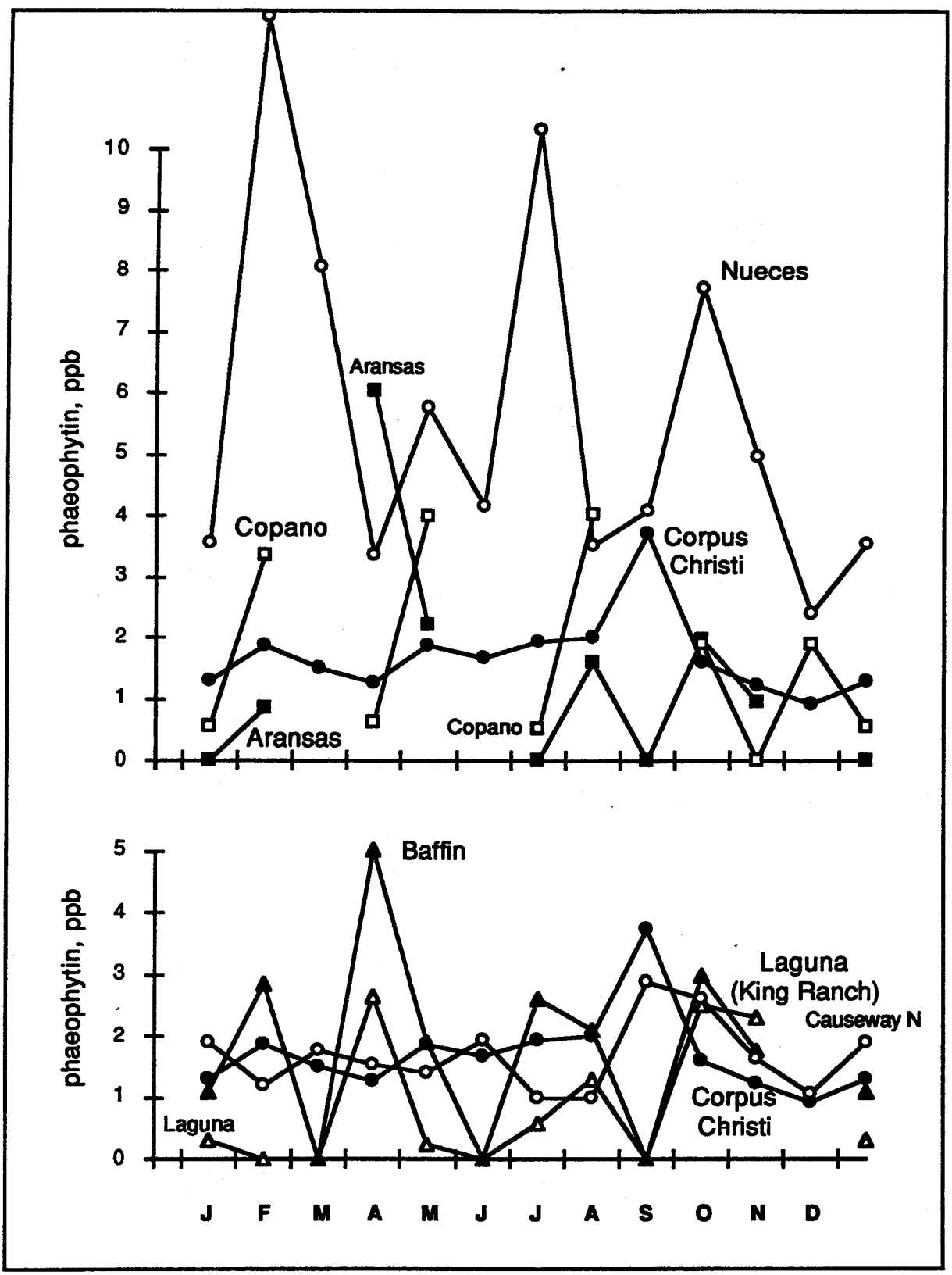


Figure 6-68. Period-of-record monthly-mean phaeophytin (WQPHEO), upper bays (above), lower bays (below)

6.2 Time Trends in Water Quality

As discussed in Section 6.1, the statistical analyses for each parameter are presented in a pair of tables, the second of which tabulates the Time Trend Analysis. Examples are Tables 6-36 and 6-37, which are the companions to Tables 6-2 and 6-3, for, respectively, ammonia (WQAMMN) and proxy TSS (WQXTSS). The only difference between these tables and those given in Appendix B for each of the water-phase analytes is that these show all of the hydrographic area segments, whereas those in the Appendix exclude those segments without data, to conserve space. As with the Period of Record statistics, special treatment is given temperature, salinity and dissolved oxygen deficit. Analyses of near-surface data, seasonally aggregated (in the case of temperature and salinity), are presented in Tables 6-38 through 6-40, the companion tables to Tables 6-8, 6-9 and 6-12.

Time trend analysis was approached by a linear least-squares regression of the (non-BDL) measurements versus time. The period of record, the period used for the time-trend analysis (which may differ from the former because BDL values are part of the measurement record but are excluded from the trend analysis), and the average observations per year entering the analysis, all provide an indication of the abscissa range and hence statistical validity of the trend analysis. Clearly, the shorter the period of time over which usable data are available, and the smaller the number of observations per year, the more limited the statistical validity of the trend analysis (though some of the other indicators, such as standard error and residual variance, may be misleadingly sanguine).

From the water-quality analysis viewpoint, the most important regression parameter is the slope of the trend line. This is the average (in the least-squares sense) rate of increase (if positive) or decrease (if negative) in the magnitude of the water quality variate, in units of the variate per year. It is the key indicator of a systematic change in that water-quality variate. The intercept is the average value (least-squares sense) of the trend at the beginning of the period of analysis. The trend line will pass through the centroid of the measured concentrations, the average >DL of the Period of Record Statistics (Tables 6-2 and 6-3, in the present examples). Finally, the standard error of the estimate (SEE, in units of the variate) and the residual variance (as a fraction ≤ 1) provide a measure of scatter about the trend line. The larger these two indicators are, the greater the scatter about the trend line indicated. This communicates both the extent of observed variability that may be systematic in time, and the uncertainty of the computed trend. It should also be noted, however, that a least-squares trend line is not judged by its explained variance (or linear correlation coefficient) because we are not seeking to *explain* the observed variability in a parameter only in terms of the passage of time. Indeed, considering the many sources of variation in the Corpus Christi system, we expect time to be a relatively minor contributor to variance in measured concentrations. Even if such a trend line "explains" only, say, 1 per cent of the variance of a constituent, it can still provide insight into long-term alterations in the water quality "climate" of the system.

Our concern with the scatter about the trend line is, rather, to be able to judge the "reality" of the computed trend. To this end, two additional parameters are

provided in the Time Trend tables, *viz.* the upper and lower 95% confidence bounds of the *slope* of the regression line, given by

$$m \pm t\{0.025,n-2\} \bullet \sqrt{[SEE^2/(varT)(n-2)]} \qquad (6\text{-}2)$$

where m denotes the slope of the trend line, n the number of data points, varT the variance of sample date, and t{p,N} is the critical point of Student's t-distribution for a one-sided probability < p with N degrees of freedom. We define a *probable trend* to be one for which *both* of the 95% confidence bounds have the same sign. In interpreting this analysis one must bear in mind that this entails a 1/40 failure rate (i.e., Type-I error, slope judged as significant when it is not), so this is a very stringent definition of "probable." We define a *possible* trend as one in which both of the 80% confidence bounds have the same sign, i.e. a 1/10 risk of misjudging the sign of the trend.

Confidence bounds for different levels of uncertainty can be constructed from the data of the Time Trend table, by backing out the value of $\xi \equiv \sqrt{[SEE^2/(varT)(n-2)]}$ in (6-2) above and selecting a different value of t from a table of t-distributions. The most important diagnostic is when both 95% confidence bounds have the *same* sign, indicating that the real trend has that sign (with a 97.5% probability), the circumstance we are referring to here as a "probable" trend. In many instances, the 95% confidence bounds have different signs, but one bound is of much greater absolute magnitude than the other, i.e. the confidence band is highly asymmetric about 0. To determine whether a different choice of confidence limit would have produced bounds of the same sign, it is simpler to merely compare the ratios of the magnitudes of the 95%-bounds as given, rather than to recompute the bounds with a different t-value. One need only specify the *ratio* $r \equiv t\{.025\}/t\{x\}$. If $|b_1|/|b_2| < (r-1)/(r+1)$, then the confidence bounds for the x-level have the same sign. For example, use t{.05}, corresponding to 90% confidence bounds; an inspection of a table of t-distributions discloses that $r \leq 1.25$ for more than 5 degrees of freedom, hence the 90% confidence bands will have the same sign if the magnitudes of the 95% bands (that are of different sign) exceed about a 10:1 ratio. Thus one can use the information in these Time Trend tables by quick inspection to estimate other confidence bounds on the slope.

As in any statistical inference, establishing the slope and intercept of a linear trend line is subject to the assumption that the available data are an adequate sampling of the population. The above equation measures some of this, in that the accuracy of the slope estimate degenerates, i.e., the confidence bounds become larger, as the scatter about the regression (SEE) increases, the number of data points n decreases, and the spread in time (varT) decreases. But a handful of data points spuriously clustered at both ends of the period of record can yield a high confidence in the slope, which one would dismiss as fictitious based upon his external knowledge about the normal variability of the water quality variate. A very small value of SEE can be just as indicative of a spurious correlation, as a high value is of no relationship. We note also that this analysis does not distinguish between a statistically unresolvable trend and a trend of zero.

In this respect, the behavior of the parameter in neighboring areas of the bay, and direct inspection of the data, should be used in determining whether to accept the statistical calculation of trend. The present analysis has a distinct advantage in statistical interpretation compared to the usual problem of interpreting a trend analysis of a set of data, namely that here we have sorted the data into separate geographical segments, each one of which represents an *independent* data set for trend analysis. This not only provides insight into spatial variation in water quality in Corpus Christi Bay, but also the regional coherence of trends is a strong indicator of whether the trends are real or are some statistical artifact (including the 1/40 chance of occurring by random variation).

In Figs. 6-69 *et seq.*, the distribution of positive and negative trends for key parameters is depicted graphically, by zones of "probable" and "possible" trends, as defined above. The depictions of these figures are based upon the time-trend tables given in Appendix B, except for the specially treated salinity, temperature, and DO deficit of Tables 6-38 *et seq.* (To conserve space, only selected regions of the study area or selected parameters are plotted in this way.) Consider the indicated trends of near-surface salinity in Copano Bay, Fig. 6-69. Each of segments CP02 through CP10 except CP06 displays an *increasing* trend in salinity, either possible or probable. The data set for each segment is drawn from different projects at different times, and an inspection of Table 6-38 discloses that the periods of analysis differ. We might be tempted to dismiss the fitted trend for any one of these segments as a statistical artifact. But taken together, the trends in these eight segments argue for the reality that salinity is increasing in Copano Bay, an inference that is further supported by the probable increasing trends in Port Bay (PB1 and PB2), inlet cove of the Aransas (AR1), and in St. Charles Bay (SC1-SC3). In other cases, the spatial distribution of trends has no obvious coherence, and one must carefully inspect the data base for each segment to determine which is probably more reliable. An example is near-surface salinity in Baffin Bay, Fig. 6-73, which trends upward in some segments, downward in others. For BF1-BF3, Table 6-36, the periods of record are long, dating back to the 1950's, and the number of samples per year are about equal. One is forced to the conclusion that either one or more of these trends is an artifact, improbable though that may be, or there are local or regional influences on salinity that affect areas of the bay in different ways. The most striking example of spatial coherence is the proxy TSS for the Upper Laguna Madre (Fig. 6-100) and Baffin Bay (Fig. 6-101), for which literally every segment (for which data exist) displays a *probable* declining trend.

In addition to the selected map displays of Figs. 6-69 et seq., Tables 6-42 through 6-51 show summary results of the trend analyses for significant parameters, based upon the principal component bay grouping introduced above, but without the individual segment information (which can be obtained from Appendix B).

Table 6-36
Time Trend Analysis for Hydrographic Area Segments: WQAMMN

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
A1	741017	750827	741017	750827	8.1	-6.44E-03	0.004	0.00294	0.705	-1.80E-02	5.00E-03	
A2	720330	790501	720330	790501	4.4	-1.38E-02	0.13	0.0728	0.875	-2.80E-02	8.30E-05	poss
A3	710608	820408	710608	820408	5.6	-4.27E-03	0.09	0.0718	0.975	-1.10E-02	2.60E-03	
A4	831117	890729	831117	890729	6.0	-9.36E-04	0.027	0.0145	0.988	-4.00E-03	2.10E-03	
A5	710608	750827	710608	750827	2.6	-3.88E-03	0.02	0.00593	0.507	-6.80E-03	-9.20E-04	prob
A10	710608	710608										
A12	710608	820408	710608	820408	7.5	4.14E-03	0.05	0.0656	0.977	-1.90E-03	1.00E-02	poss
A13	740723	740723										
AL1	840808	840808										
AL2	720928	890728	720928	890728	2.6	-3.05E-03	0.084	0.0463	0.857	-5.40E-03	-7.40E-04	prob
AR1	690520	930408	691029	920929	1.9	-3.16E-03	0.14	0.0895	0.935	-6.80E-03	5.30E-04	poss
BF1	680827	931015	680827	931015	10.0	-1.38E-02	0.35	0.197	0.896	-1.90E-02	-8.80E-03	prob
BF2	691105	931015	691105	931015	5.3	-6.87E-03	0.18	0.0772	0.687	-8.70E-03	-5.10E-03	prob
BF3	680827	931015	680827	931015	7.0	-4.88E-03	0.15	0.0652	0.851	-6.60E-03	-3.10E-03	prob
C02	701013	930512	701013	930106	3.1	-8.01E-04	0.081	0.0764	0.995	-3.60E-03	2.00E-03	
C03	701013	880810	701013	880810	3.0	-4.27E-03	0.18	0.132	0.958	-9.90E-03	1.30E-03	poss
C04	710506	880810	710506	880810	1.5	3.11E-03	0.026	0.0696	0.961	-3.40E-03	9.60E-03	poss
C05	720920	830628	720920	830628	6.2	2.34E-03	0.07	0.102	0.993	-4.60E-03	9.30E-03	poss
C06	701013	741212	701013	741212	8.6	2.12E-02	0.013	0.0332	0.677	1.10E-02	3.20E-02	prob
C07	711105	890729	711105	890729	5.5	-6.62E-03	0.12	0.0964	0.854	-9.90E-03	-3.40E-03	prob
C08	870923	880810	870923	880810	27.0	4.66E-02	0.07	0.082	0.975	-8.30E-02	1.80E-01	poss
C09	741024	830628	741024	830628	2.5	1.22E-02	0.023	0.164	0.949	-1.20E-02	3.70E-02	poss
C10	690326	890729	690326	890729	5.6	-2.38E-03	0.094	0.0671	0.952	-4.40E-03	-3.90E-04	prob
C11	690917	890729	690917	890729	9.2	-3.74E-03	0.1	0.0835	0.945	-6.00E-03	-1.50E-03	prob
C12	711105	890729	711105	890729	7.0	-2.87E-03	0.089	0.11	0.969	-5.80E-03	1.50E-05	poss
C14	690326	930715	690326	930715	16.0	-1.68E-03	0.076	0.0516	0.964	-2.50E-03	-8.10E-04	prob
C15	680530	930413	680530	930413	10.0	-6.40E-03	0.17	0.161	0.929	-9.30E-03	-3.50E-03	prob

(continued)

Table 6-36
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
C17	701013	890122	701013	890122	7.0	-7.91E-04	0.072	0.0969	0.998	-3.60E-03	2.00E-03	
C20	871020	880810	871020	880810	27.0	6.34E-02	0.046	0.0502	0.905	-2.80E-02	1.50E-01	poss
C21	711105	890729	711105	890729	3.4	-3.55E-03	0.1	0.0389	0.906	-6.40E-03	-7.00E-04	prob
C22	721219	741212	721219	741212	11.0	-3.68E-02	0.15	0.0404	0.782	-6.90E-02	-4.20E-03	prob
C23	870923	880810	870923	880810	27.0	8.03E-02	0.05	0.0896	0.941	-6.10E-02	2.20E-01	poss
C24	690916	890729	690916	890729	2.9	4.91E-03	-0.034	0.0712	0.965	-2.00E-03	1.20E-02	poss
CB	711111	820408	711111	820408	6.4	-4.22E-03	0.095	0.091	0.987	-1.30E-02	4.80E-03	
CBY1	870126	880707	870126	880707	8.3	1.08E-02	0.02	0.0197	0.935	-1.80E-02	4.00E-02	poss
CCC1	690326	890729	690326	890729	7.0	-3.84E-04	0.051	0.0418	0.996	-1.40E-03	6.50E-04	
CCC2	740723	810507	740723	810507	0.7	3.19E-02	0.1	0.179	0.74	-6.70E-02	1.30E-01	poss
CCC3	680326	890729	680326	890729	4.9	-8.44E-04	0.069	0.0594	0.989	-2.40E-03	7.00E-04	
CCC4	740723	850423	740723	801203	0.8	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
CCC5	711111	881107	711111	881107	3.3	6.31E-03	-0.035	0.0724	0.929	1.50E-04	1.20E-02	prob
CCC6	690717	930512	690717	930512	2.5	-5.93E-03	0.16	0.0719	0.69	-8.20E-03	-3.60E-03	prob
CCC7	690325	890729	690325	890729	15.0	-2.85E-03	0.091	0.0588	0.909	-3.90E-03	-1.80E-03	prob
CCC8	731024	930512	731024	930512	4.8	-2.56E-02	0.48	0.648	0.949	-4.90E-02	-2.70E-03	prob
CP02	711105	760819	711105	760819	5.2	-2.19E-03	0.032	0.0357	0.992	-1.30E-02	8.40E-03	
CP03	710609	760819	710609	760819	9.2	-1.61E-02	0.13	0.12	0.97	-4.30E-02	1.10E-02	
CP04	710915	710915										
CP05	710609	750827	710609	750827	9.7	-8.14E-03	0.097	0.0614	0.976	-2.50E-02	8.30E-03	
CP07	710609	820408	710609	820408	7.3	-3.95E-03	0.079	0.0739	0.982	-1.00E-02	2.60E-03	
CP09	770210	820408	770210	820408	1.9	2.79E-02	-0.0049	0.0941	0.785	-1.60E-02	7.10E-02	poss
CP10	690521	930428	690521	930428	5.3	-3.99E-03	0.13	0.151	0.969	-7.90E-03	-5.50E-05	prob
GR1	840808	840808										
GR2	690915	840808	690915	760211	3.0	2.79E-02	-0.024	0.1	0.866	-8.50E-03	6.40E-02	poss
HI2	770210	770210										
I2	690716	730606	690716	730606	3.1	-1.19E-01	0.47	0.268	0.784	-2.80E-01	4.10E-02	poss
I3	710608	840823	710608	820408	5.1	-3.64E-03	0.11	0.11	0.991	-1.40E-02	6.80E-03	
I4	840508	840823										

(continued)

Table 6-36
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
I5	710608	840823	710608	760419	8.0	-6.51E-03	0.06	0.0402	0.951	-1.60E-02	2.80E-03	poss
I6	690716	930429	690716	930429	2.5	-4.86E-03	0.18	0.168	0.948	-1.00E-02	5.30E-04	poss
I7	710608	890729	710608	890729	3.5	3.02E-04	0.045	0.114	1	-3.80E-03	4.40E-03	poss
I9	680828	890729	680828	890729	11.0	-4.51E-03	0.13	0.137	0.964	-7.60E-03	-1.50E-03	prob
I10	890315	930615	890315	930615	13.0	-5.51E-03	0.027	0.0133	0.78	-8.30E-03	-2.70E-03	prob
I11	680828	701008	680828	701008	2.8	-2.08E-01	0.38	0.139	0.377	-4.30E-01	1.70E-02	poss
I12	731023	930511	731023	930511	2.5	-8.53E-03	0.23	0.184	0.919	-1.70E-02	-1.40E-04	prob
I13	841202	931015	841202	931015	18.0	-1.50E-03	0.033	0.0336	0.991	-4.00E-03	1.00E-03	
I15	680827	930715	680827	930715	3.7	-6.02E-03	0.15	0.0678	0.729	-8.10E-03	-4.00E-03	prob
I17	720227	930715	720227	930715	5.4	-7.04E-03	0.19	0.151	0.914	-1.10E-02	-2.80E-03	prob
IH1	680530	930512	680530	930512	4.6	-2.33E-02	0.76	0.717	0.948	-4.20E-02	-4.70E-03	prob
IH2	770621	820810	770621	820810	0.6	-2.82E-02	0.3	0.0286	0.149	-1.80E-01	1.20E-01	
IH3	770621	820810	770621	820810	1.6	-2.37E-02	0.3	0.0451	0.423	-4.40E-02	-3.40E-03	prob
IH4	770621	820810	770621	820810	1.0	-8.27E-03	0.2	0.0426	0.863	-4.60E-02	3.00E-02	
IH5	680530	930512	680530	930512	5.0	-2.54E-02	0.74	0.646	0.922	-4.10E-02	-9.80E-03	prob
IH6	731024	930512	731024	930512	4.1	-2.13E-02	0.49	0.444	0.93	-3.90E-02	-3.90E-03	prob
IH7	680530	830628	680530	830628	6.3	1.57E-02	0.11	0.176	0.879	7.00E-03	2.40E-02	prob
INL	740723	840628	740723	820317	0.4	9.15E-02	0.1	1.83E-08	0	9.20E-02	9.20E-02	prob
LAC	710608	820408	710608	820408	4.2	5.53E-03	0.044	0.082	0.953	-1.90E-03	1.30E-02	poss
LQ1	801203	850423										
LQ2	731024	930512	731024	930512	2.5	-8.55E-03	0.23	0.462	0.981	-2.70E-02	9.60E-03	
LS1	840808	931015	890315	931015	12.0	8.84E-03	0.012	0.0599	0.964	-3.60E-03	2.10E-02	poss
LS2	690915	931015	690915	931015	2.8	-1.41E-03	0.051	0.0368	0.917	-2.60E-03	-2.70E-04	prob
MB1	730912	930506	730912	930506	2.7	-5.39E-03	0.15	0.147	0.952	-1.20E-02	1.20E-03	poss
MB2	870126	880707	870126	880707	16.0	7.67E-03	0.027	0.03	0.985	-2.00E-02	3.50E-02	poss
NB1	870923	880811	870923	880811	130.0	8.17E-02	0.06	0.0825	0.933	2.40E-02	1.40E-01	prob
NB2	870923	880811	870923	880811	27.0	3.99E-02	0.077	0.0724	0.977	-7.40E-02	1.50E-01	poss
NB3	831128	890729	831128	890729	10.0	1.21E-02	0.018	0.0558	0.909	2.00E-03	2.20E-02	prob
NB4	780613	930413	780613	930413	19.0	1.97E-02	-0.071	0.0876	0.933	1.10E-02	2.80E-02	prob

(continued)

Table 6-36
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
NB5	690326	930413	690326	930413	21.0	-4.50E-04	0.096	0.0793	0.999	-1.80E-03	9.00E-04	
NB6	690326	880811	690326	880811	3.4	-3.86E-03	0.15	0.12	0.951	-8.10E-03	3.50E-04	poss
NB7	731015	930413	731015	921123	2.1	2.87E-03	0.11	0.193	0.992	-7.50E-03	1.30E-02	poss
NB8	871021	880811	871021	880811	25.0	2.61E-02	0.058	0.0629	0.988	-9.00E-02	1.40E-01	poss
NB9	880324	880811	880324	880811	21.0	1.86E-01	0.02	0.0624	0.813	-2.00E-01	5.70E-01	poss
ND2	781017	790608	781017	790608	25.0	5.57E-02	0.078	0.0531	0.95	-8.30E-02	1.90E-01	poss
NR1	680530	730618	680530	730517	5.8	-6.22E-03	0.093	0.138	0.996	-4.50E-02	3.20E-02	
NR3	701012	731016	701012	731016	2.0	-1.99E-01	0.54	0.208	0.462	-4.50E-01	5.70E-02	poss
NR4	730917	920929	740531	920929	6.2	-1.63E-02	0.4	0.288	0.938	-2.80E-02	-4.40E-03	prob
NR5	680530	760830	680530	760830	4.0	2.13E-02	0.0091	0.114	0.915	-3.50E-03	4.60E-02	poss
OS1	720131	930427	720131	930427	2.3	-1.51E-01	8.1	6.61	0.973	-4.10E-01	1.10E-01	
OS3	720115	791101	720425	790828	2.6	-4.31E-02	0.68	0.682	0.981	-2.00E-01	1.20E-01	
OS6	810514	930427	810514	930427	2.8	6.07E-03	0.14	0.461	0.998	-4.30E-02	5.50E-02	poss
OS7	731003	910702	731003	910702	3.1	-4.47E-02	1.2	3.09	0.993	-1.90E-01	1.00E-01	
PB1	731029	930428	731029	930428	2.6	-8.70E-03	0.19	0.214	0.942	-1.90E-02	1.30E-03	poss
RB1	710608	730419	710608	730419	9.7	-2.44E-02	0.067	0.0343	0.846	-5.50E-02	6.00E-03	poss
RB3	690326	921013	690326	921013	2.4	3.86E-03	0.073	0.222	0.987	-5.20E-03	1.30E-02	poss
RB5	721220	741212	721220	741212	11.0	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
RB6	721215	741214	721215	741214	11.0	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
RB7	781017	790608	781017	790608	12.0	-5.02E-02	0.06	0.0276	0.864	-1.80E-01	7.60E-02	
RB8	710506	930427	710506	930427	4.5	-9.39E-04	0.087	0.114	0.997	-4.30E-03	2.50E-03	
RB9	740723	890729	740723	890729	0.4	-5.42E-03	0.1	0.000855	0.001	-5.60E-03	-5.20E-03	prob
SC2	711105	760819	711105	760819	5.4	-4.70E-02	0.19	0.234	0.908	-1.10E-01	1.50E-02	poss
SC3	710608	930428	710608	930428	4.0	-6.75E-03	0.18	0.301	0.981	-1.70E-02	3.60E-03	
UL03	690916	930715	690916	930715	2.2	-1.60E-03	0.058	0.0424	0.969	-4.10E-03	8.70E-04	
UL04	750106	930511	750106	930511	2.3	-1.97E-03	0.11	0.0749	0.981	-6.30E-03	2.40E-03	
UL11	690916	820330	690916	820330	1.2	1.56E-02	-0.058	0.0901	0.765	-1.30E-03	3.20E-02	
GMI4	731003	830926	731003	830810	2.5	-2.03E-02	0.26	0.332	0.965	-6.60E-02	2.60E-02	
GMI6	690326	930429	690326	930429	3.7	-3.51E-03	0.14	0.211	0.989	-1.10E-02	3.50E-03	
GMO6	720919	840628	720919	820317	1.2	6.50E-02	0.051	0.0877	0.079	5.10E-02	7.90E-02	prob

Table 6-37
Time Trend Analysis for Hydrographic Area Segments: WQXTSS

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
A1	660115	931118	660115	931118	9.4	-4.29E-01	46	34.4	0.99	-9.10E-01	5.40E-02	poss
A2	690501	931206	690501	931206	9.8	-5.95E-01	56	58.2	0.99	-1.50E+00	3.10E-01	poss
A3	660115	931206	660115	931206	9.7	-1.21E+00	50	37.4	0.94	-1.80E+00	-6.40E-01	prob
A4	710608	931108	710608	931108	8.2	-2.01E-01	40	44.1	1.00	-1.20E+00	8.00E-01	
A5	690501	931108	690501	931108	5.1	-3.09E-01	33	28.8	0.99	-9.10E-01	2.90E-01	
A6	660115	931207	660115	931207	4.7	-1.15E+00	50	18.6	0.79	-1.50E+00	-7.60E-01	prob
A8	751111	931102	751111	931102	3.3	-4.52E-01	41	40	1.00	-2.90E+00	2.00E+00	
A9	791127	931102	791127	931102	5.6	-1.40E+00	40	21.6	0.95	-2.80E+00	1.30E-02	poss
A10	690501	931206	690501	931206	9.4	-4.19E-02	39	73.5	1.00	-1.20E+00	1.10E+00	
A11	690501	931117	690501	931117	10.0	-5.15E-01	42	39.2	0.99	-1.20E+00	2.10E-01	poss
A12	710608	931216	710608	931216	16.0	3.34E-01	26	37.6	1.00	-2.00E-01	8.70E-01	poss
A13	740723	931216	740723	931216	5.7	5.81E-01	24	76.5	1.00	-3.30E+00	4.40E+00	poss
AL1	771014	931208	771014	931208	10.0	-9.83E+00	250	171	0.97	-1.80E+01	-1.30E+00	prob
AL2	730524	931208	730524	931208	14.0	-3.80E+00	130	93.6	0.97	-6.50E+00	-1.10E+00	prob
AR1	690520	930825	690520	930825	6.8	3.69E-01	84	85.9	1.00	-1.40E+00	2.20E+00	poss
AYB	690501	931105	690501	931105	1.6	5.98E-01	49	28.5	0.97	-5.20E-01	1.70E+00	poss
BF1	690915	931208	690915	931208	19.0	-1.47E+00	82	57.7	0.98	-2.50E+00	-4.50E-01	prob
BF2	690915	931208	690915	931208	19.0	-2.53E+00	98	74	0.97	-3.80E+00	-1.20E+00	prob
BF3	660315	931216	660315	931216	20.0	-1.08E+00	56	31	0.94	-1.40E+00	-7.30E-01	prob
C01	700619	931116	700619	931116	9.6	-3.32E+00	90	67.4	0.87	-4.40E+00	-2.20E+00	prob
C02	690918	931109	690918	931109	7.7	-1.48E+00	54	30.1	0.91	-2.20E+00	-8.00E-01	prob
C03	690115	931217	690115	931217	15.0	-1.96E+00	65	50.3	0.92	-2.70E+00	-1.30E+00	prob
C04	660115	931116	660115	931116	6.9	-7.29E-02	31	21.4	1.00	-4.10E-01	2.70E-01	
C05	701013	931217	701013	931217	9.5	-1.46E+00	170	944	1.00	-1.90E+01	1.60E+01	
C06	690115	931026	690115	931026	9.4	1.53E+00	79	498	1.00	-6.60E+00	9.60E+00	poss
C07	690917	931005	690917	931005	16.0	-1.93E+00	61	49.6	0.92	-2.60E+00	-1.30E+00	prob
C08	660115	931206	660115	931206	4.7	-5.78E-01	37	20.2	0.94	-9.70E-01	-1.90E-01	prob

(continued)

Table 6-37
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
C09	660115	931122	660115	931122	21.0	-3.98E-01	67	330	1.00	-3.50E+00	2.70E+00	
C10	690326	931206	690326	931206	17.0	-3.93E-01	31	40.6	1.00	-9.30E-01	1.40E-01	poss
C11	690326	940724	690326	940724	19.0	1.12E+00	90	605	1.00	-6.10E+00	8.30E+00	poss
C12	660115	931208	660115	931208	28.0	-6.31E-01	63	318	1.00	-3.20E+00	1.90E+00	
C13	710903	931217	710903	931217	4.3	-2.47E+00	64	25.5	0.88	-3.80E+00	-1.10E+00	prob
C14	660115	931217	660115	931217	31.0	-9.44E-01	42	26.9	0.91	-1.10E+00	-7.40E-01	prob
C15	660115	931217	660115	931217	25.0	-4.09E+00	120	76.4	0.85	-4.80E+00	-3.30E+00	prob
C16	830608	930817	830608	930817	6.6	-4.91E+00	58	36.8	0.85	-7.70E+00	-2.10E+00	prob
C17	701013	931217	701013	931217	12.0	-6.16E+00	240	1040	1.00	-2.60E+01	1.40E+01	
C18	660115	931206	660115	931206	4.1	-6.64E-01	40	30.4	0.96	-1.30E+00	-3.30E-02	prob
C19	771025	931208	771025	931208	4.8	-3.95E+00	75	48.6	0.92	-6.90E+00	-9.60E-01	prob
C20	700602	930921	700602	930921	12.0	-2.74E+00	75	65.2	0.90	-3.70E+00	-1.80E+00	prob
C21	660115	931217	660115	931217	7.9	-2.96E-01	28	23.3	0.99	-6.40E-01	4.90E-02	poss
C22	720328	931104	720328	931104	4.4	-3.26E-01	30	34	1.00	-1.30E+00	6.60E-01	
C23	781003	931102	781003	931102	4.0	-9.14E-01	44	42.4	1.00	-4.50E+00	2.60E+00	
C24	690326	931122	690326	931122	8.3	-7.86E-01	36	36.3	0.98	-1.50E+00	-1.00E-01	prob
C25	701008	931223	701008	931223	3.2	-1.01E+00	36	17.7	0.91	-1.80E+00	-2.60E-01	prob
CB	690501	931203	690501	931203	11.0	-1.28E+00	62	47	0.95	-2.00E+00	-5.80E-01	prob
CBH	690917	921202	690917	921202	0.8	-1.30E+00	50	27.7	0.88	-3.20E+00	6.10E-01	poss
CBY1	861014	931027	861014	931027	2.6	-7.58E+00	63	40.8	0.83	-1.70E+01	1.40E+00	poss
CBY2	660115	920113	660115	920113	1.0	-1.56E+00	74	44.1	0.93	-4.10E+00	9.70E-01	
CCC1	690917	931217	690917	931217	28.0	5.02E+00	36	296	0.99	1.50E+00	8.60E+00	prob
CCC2	690115	930504	690115	930504	2.6	-1.49E-01	24	12.5	0.99	-5.00E-01	2.00E-01	
CCC3	680326	940910	680326	940910	28.0	-6.74E-01	51	41.2	0.99	-1.10E+00	-2.10E-01	prob
CCC4	690615	931208	690615	931208	3.6	-2.68E-01	29	23.2	0.99	-8.30E-01	3.00E-01	
CCC5	711105	930921	711105	930921	6.3	-7.26E-01	38	41.6	0.99	-1.80E+00	3.20E-01	poss
CCC6	690115	931206	690115	931206	6.8	-4.60E-02	32	34.3	1.00	-7.00E-01	6.10E-01	
CCC7	690326	931217	690326	931217	8.3	2.40E+00	150	1090	1.00	-1.80E+01	2.30E+01	poss

(continued)

Table 6-37
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
CCC8	731024	931020	731024	931020	5.9	-2.08E+00	57	34.5	0.89	-3.20E+00	-9.80E-01	prob
CP01	800617	931223	800617	931223	2.4	1.22E+00	32	42	0.99	-3.00E+00	5.40E+00	poss
CP02	660215	931223	680115	931223	13.0	2.49E-01	37	41.5	1.00	-3.20E-01	8.20E-01	poss
CP03	680326	931217	680326	931217	13.0	-1.25E+00	76	54.1	0.98	-2.20E+00	-2.50E-01	prob
CP04	660115	931209	660115	931209	8.3	-9.05E-02	46	73.6	1.00	-1.20E+00	1.10E+00	
CP05	660215	931216	670315	931216	8.3	-1.84E-01	63	57.4	1.00	-1.10E+00	7.20E-01	
CP06	790525	931119	790525	931119	9.3	1.53E-01	69	71.1	1.00	-3.70E+00	4.00E+00	poss
CP07	710609	931216	710609	931216	10.0	-3.23E-01	41	45.3	1.00	-1.10E+00	5.00E-01	
CP08	660315	931119	670215	931119	11.0	-8.92E-01	58	50.8	0.98	-1.60E+00	-2.10E-01	prob
CP09	690501	931223	690501	931223	9.0	5.42E-01	38	50.8	0.99	-2.90E-01	1.40E+00	poss
CP10	660115	940818	660115	940818	13.0	-3.54E-01	44	44	1.00	-8.90E-01	1.90E-01	poss
EF	800404	930921	800404	930921	4.5	-1.38E-01	24	17.2	1.00	-1.40E+00	1.10E+00	
GR1	840808	930512	840808	930512	1.5	-2.99E+01	250	61.1	0.42	-4.70E+01	-1.30E+01	prob
GR2	690915	931116	690915	931116	14.0	-5.75E+00	170	82.4	0.91	-7.70E+00	-3.80E+00	prob
HI1	720919	931109	720919	931109	2.7	-2.43E-02	31	30.3	1.00	-1.00E+00	1.00E+00	
HI2	720919	931216	720919	931216	3.0	-5.77E-02	23	17	1.00	-1.20E+00	1.10E+00	
I1	660315	930405	930405	930405								
I2	660115	931203	660115	931203	3.1	-2.28E+00	96	57	0.87	-3.60E+00	-1.00E+00	prob
I3	660315	930921	660415	930921	5.8	-5.88E-01	59	54.6	1.00	-1.90E+00	7.30E-01	
I4	660115	931206	660115	931206	6.6	-8.43E-01	67	56.4	0.98	-1.70E+00	3.10E-02	poss
I5	710608	931206	710608	931206	9.8	-1.49E-01	39	40.9	1.00	-8.90E-01	6.00E-01	
I6	660115	931216	660115	931216	8.9	-6.49E-01	42	45.2	0.99	-1.50E+00	1.60E-01	poss
I7	660115	930616	660115	930616	13.0	-2.81E-01	29	21.6	0.99	-5.50E-01	-1.10E-02	prob
I8	690501	931123	690501	931123	3.9	-4.26E-01	32	25.5	0.98	-9.80E-01	1.20E-01	poss
I9	690522	931019	690522	931019	9.8	-7.32E-01	32	35.8	0.98	-1.40E+00	-8.50E-02	prob
I10	690615	930707	690615	930707	7.9	-1.93E+00	65	44	0.89	-2.70E+00	-1.10E+00	prob
I11	680828	931217	680828	931217	4.0	-2.25E-01	26	20.7	0.99	-8.00E-01	3.40E-01	
I12	731023	931111	731023	931111	8.1	-1.64E+00	46	25.2	0.90	-2.40E+00	-8.90E-01	prob

(continued)

Table 6-37
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
I13	660315	931216	660315	931216	12.0	-9.41E-01	45	20	0.82	-1.20E+00	-7.20E-01	prob
I14	811111	931119	811111	931119	8.8	-2.16E+00	34	15.4	0.84	-3.10E+00	-1.20E+00	prob
I15	680828	931028	680828	931028	6.1	-9.72E-01	46	35.8	0.97	-1.90E+00	-6.70E-02	prob
I16	800620	931118	800620	931118	4.0	-3.55E+00	58	19.9	0.75	-5.30E+00	-1.80E+00	prob
I17	720227	931025	720227	931025	6.1	-1.07E+00	52	29.9	0.95	-1.90E+00	-2.80E-01	prob
I18	660315	930413	660315	930413	3.5	-1.64E+00	57	19.8	0.62	-2.10E+00	-1.20E+00	prob
IH1	690918	930512	690918	930512	5.5	-1.50E-01	30	32.6	1.00	-1.00E+00	7.20E-01	
IH2	820810	820810										
IH3	701014	820810	701014	820810	1.9	1.43E+00	11	11	0.78	2.20E-01	2.60E+00	prob
IH4	791018	840531	791018	840531	1.9	-8.36E+00	70	22.9	0.85	-2.60E+01	9.40E+00	
IH5	690417	930512	690417	930512	6.9	-3.50E-01	32	31	0.99	-1.00E+00	3.40E-01	
IH6	690615	930512	690615	930512	4.7	-2.64E-01	29	20.5	0.99	-7.90E-01	2.60E-01	
IH7	690615	830628	690615	830628	42.0	6.42E+01	-120	289	0.82	5.30E+01	7.50E+01	prob
INL	740723	930809	740723	930809	1.5	-1.58E-01	30	28.8	1.00	-2.70E+00	2.40E+00	
LAC	710608	931109	710608	931109	6.0	7.11E-01	18	23.1	0.96	1.20E-01	1.30E+00	prob
LB	690501	930510	690501	930510	2.1	-1.75E-01	25	12.6	0.98	-5.70E-01	2.20E-01	
LQ1	660115	941203	660115	941203	21.0	-2.33E-01	44	31.6	1.00	-7.10E-01	2.50E-01	
LQ2	720328	941203	720328	941203	7.2	-6.39E-02	35	33.6	1.00	-8.00E-01	6.80E-01	
LS1	820526	931015	820526	931015	4.0	-9.00E-01	67	42.6	1.00	-5.10E+00	3.30E+00	
LS2	690915	931122	690915	931122	9.3	-2.36E+00	110	64.3	0.96	-3.90E+00	-8.00E-01	prob
M1	840924	931217	840924	931217	2.6	-7.14E+00	120	74.3	0.92	-1.80E+01	3.80E+00	poss
M2	790622	931217	790622	931217	4.8	1.93E+00	51	73.1	0.99	-2.90E+00	6.80E+00	poss
MB1	660115	931206	660115	931206	6.3	-6.24E-01	75	63.1	0.99	-1.90E+00	6.10E-01	
MB2	660115	931028	660115	931028	12.0	4.66E-01	56	77.6	1.00	-5.50E-01	1.50E+00	poss
NB1	760914	931207	760914	931207	9.7	-5.09E+00	130	50.4	0.90	-7.40E+00	-2.80E+00	prob
NB2	811112	931116	811112	931116	7.7	-5.90E+00	110	60.6	0.95	-1.10E+01	-8.10E-01	prob
NB3	830621	931207	830621	931207	9.9	-6.13E+00	97	56.8	0.93	-1.10E+01	-1.60E+00	prob
NB4	690326	931207	690326	931207	7.9	-1.53E+02	3400	4270	0.98	-3.00E+02	-2.10E+00	prob

(continued)

Table 6-37
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
NB5	680115	931117	680115	931117	19.0	1.50E+00	260	2170	1.00	-2.30E+01	2.60E+01	poss
NB6	690326	931117	690326	931117	5.4	1.82E+01	470	3570	1.00	-6.30E+01	9.90E+01	poss
NB7	731015	931207	731015	931207	9.3	-2.90E+00	87	58.2	0.94	-4.50E+00	-1.30E+00	prob
NB8	660115	931116	660115	931116	5.8	-1.28E+00	82	59.4	0.96	-2.20E+00	-3.50E-01	prob
NB9	660115	931207	660115	931207	4.8	-5.98E-01	65	47.8	0.99	-1.50E+00	3.30E-01	
ND2	781110	931005	781110	931005	1.2	-2.03E+00	69	34	0.92	-5.70E+00	1.60E+00	
ND4	850523	931005	850523	931005	0.6	3.78E+00	53	37.1	0.89	-1.60E+01	2.30E+01	poss
NR1	690325	730807	690325	730807	13.0	-4.65E+00	49	29.7	0.96	-1.10E+01	1.80E+00	poss
NR3	701012	830629	701012	830629	2.2	6.66E+02	-2100	2480	0.48	4.10E+02	9.20E+02	prob
NR4	730917	920929	730917	920929	8.7	1.60E-01	110	164	1.00	-5.00E+00	5.30E+00	poss
NR5	701012	760830	701012	760830	6.3	-4.85E+00	95	46.4	0.98	-1.60E+01	6.50E+00	
OS1	711021	930427	711021	930427	3.3	9.90E-01	78	197	1.00	-5.50E+00	7.40E+00	poss
OS3	711021	921123	711021	921123	2.8	-1.05E+01	220	195	0.91	-2.00E+01	-1.50E+00	prob
OS4	850403	931216	850403	931216	5.7	4.10E-02	48	39.5	1.00	-4.10E+00	4.20E+00	poss
OS5	860910	931216	860910	931216	3.9	1.05E+00	29	22.8	0.99	-3.40E+00	5.50E+00	poss
OS6	810514	931020	810514	931020	6.2	-1.69E+01	250	162	0.87	-2.70E+01	-6.90E+00	prob
OS7	660115	931104	660115	931104	6.1	-9.80E-01	91	81.6	0.99	-2.50E+00	5.20E-01	poss
PB1	730918	931209	730918	931209	7.7	-3.72E+00	110	113	0.96	-6.70E+00	-7.80E-01	prob
PB2	660215	931209	660215	931209	6.9	-3.67E-01	42	37.3	1.00	-1.20E+00	4.40E-01	
RB1	701014	931217	701014	931217	4.7	-8.34E-01	35	12.5	0.81	-1.20E+00	-5.10E-01	prob
RB2	790921	931123	790921	931123	6.8	-4.51E-01	25	20.3	1.00	-1.90E+00	9.50E-01	
RB3	660315	931217	660415	931217	6.6	-5.01E-01	30	18.2	0.96	-8.80E-01	-1.20E-01	prob
RB4	771122	931216	771122	931216	5.0	-2.92E-01	27	21.7	1.00	-1.50E+00	9.00E-01	
RB5	731017	931217	731017	931217	10.0	-6.18E-01	32	29.5	0.99	-1.40E+00	1.60E-01	poss
RB6	731017	931006	731017	931006	3.9	3.35E-01	21	39.9	1.00	-1.10E+00	1.70E+00	poss
RB7	660115	931217	660115	931217	4.1	-5.97E-01	32	10	0.77	-8.00E-01	-3.90E-01	prob
RB8	690326	931006	690326	931006	10.0	3.32E+00	73	543	1.00	-7.80E+00	1.40E+01	poss
RB9	660115	931102	660115	931102	7.1	-4.02E-01	29	14	0.94	-6.20E-01	-1.80E-01	prob

(continued)

Table 6-37
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
SC1	660215	931013	670315	931013	6.5	-1.64E+00	83	56.2	0.93	-2.50E+00	-7.50E-01	prob
SC2	660215	931203	660215	931203	14.0	-7.07E-01	57	47.3	0.98	-1.20E+00	-2.00E-01	prob
SC3	660215	931117	660215	931117	17.0	-1.37E-01	45	43.7	1.00	-6.20E-01	3.40E-01	
UL01	690615	931112	690615	931112	2.1	-1.28E+00	44	12.6	0.75	-1.90E+00	-6.60E-01	prob
UL02	670115	931217	670115	931217	5.3	-8.99E-01	39	16.4	0.79	-1.20E+00	-6.10E-01	prob
UL03	660315	931217	660515	931217	11.0	-1.08E+00	42	15.4	0.73	-1.30E+00	-8.80E-01	prob
UL04	750106	930914	750106	930914	4.3	-1.39E+00	43	20.2	0.88	-2.20E+00	-5.40E-01	prob
UL05	760611	931119	760611	931119	6.1	-1.88E+00	40	21.5	0.88	-2.90E+00	-8.80E-01	prob
UL06	660315	931217	660415	931217	8.1	-1.35E+00	48	20.5	0.74	-1.70E+00	-1.00E+00	prob
UL07	660315	931209	660415	931209	5.9	-1.42E+00	46	18.2	0.63	-1.70E+00	-1.10E+00	prob
UL08	790905	931026	790905	931026	6.9	-1.60E+00	30	9.05	0.73	-2.10E+00	-1.10E+00	prob
UL09	780516	930825	780516	930825	8.7	-1.71E+00	35	12.4	0.81	-2.30E+00	-1.10E+00	prob
UL10	660315	931209	660415	931209	5.6	-1.38E+00	49	18.8	0.66	-1.70E+00	-1.10E+00	prob
UL11	690916	930525	690916	930525	1.3	-1.19E+00	38	9.48	0.59	-1.70E+00	-6.40E-01	prob
UL14	871006	880802	871006	880802	2.4							
GMI1	890105	931123	890105	931123	7.4	3.36E-01	14	9.49	0.997	-1.70E+00	2.40E+00	poss
GMI2	871021	931112	871021	931112	23	-2.80E-01	23	15.1	0.999	-1.60E+00	1.00E+00	
GMI3	871021	931112	871021	931112	30	2.25E+00	21	23.1	0.97	3.50E-01	4.10E+00	prob
GMI4	730917	931216	730917	931216	9.4	-9.17E-01	46	36.3	0.978	-1.80E+00	-3.30E-02	prob
GMI5	850225	931122	850225	931122	24	2.54E+00	11	26.6	0.961	8.20E-01	4.30E+00	prob
GMI6	690326	931122	690326	931122	12	-5.87E-01	61	309	1	-5.00E+00	3.80E+00	
GMI7	850212	931202	850212	931202	52	-1.01E+00	25	21.8	0.994	-2.20E+00	1.80E-01	poss
GMI8	850626	931022	850626	931022	20	2.24E-01	31	30.1	1	-2.50E+00	2.90E+00	poss
GMI9	871022	931116	871022	931116	15	1.34E+00	39	30	0.993	-1.90E+00	4.60E+00	poss
GMO2	791106	801028	791106	801028								
GMO4	850317	931122	850317	931122	7.1	-1.17E+00	18	15.5	0.969	-2.80E+00	5.00E-01	poss
GMO5	850212	931216	850212	931216	41	-1.04E+00	18	13.6	0.963	-1.60E+00	-4.90E-01	prob
GMO6	720919	931216	720919	931216	9.7	3.13E-01	8.1	16.4	0.99	-1.10E-01	7.40E-01	poss
GMO7	850212	931202	850212	931202	42	2.20E-01	14	19.7	0.999	-5.90E-01	1.00E+00	poss

Table 6-38
Trend analyses for salinity (WQSAL), upper 1 metre,
for hydrographic area segments

Segment	*period of record*		*avg obs/yr*	*slope ppt/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
A1	581123	940329	13	-3.30E-02	17	7.8	-1.00E-01	3.80E-02	
A2	590129	940418	7.7	-5.09E-02	18	7.06	-1.50E-01	4.50E-02	
A3	610926	940317	11	3.19E-02	16	7.29	-4.90E-02	1.10E-01	poss
A4	590602	940317	5.1	-1.26E-01	22	7.59	-2.60E-01	3.20E-03	poss
A5	641130	940317	5.7	3.74E-02	17	6.81	-8.30E-02	1.60E-01	poss
A6	610926	940317	5.8	1.02E-01	17	7.09	-1.70E-02	2.20E-01	poss
A8	590111	940317	3.1	-3.24E-02	20	8.19	-2.50E-01	1.80E-01	
A9	641130	931102	2	-3.20E-02	21	7.94	-3.70E-01	3.10E-01	
A10	590428	940317	7.7	-7.24E-03	19	7.13	-1.10E-01	9.60E-02	
A11	690501	931117	5.9	5.61E-02	22	7.19	-9.20E-02	2.00E-01	poss
A12	700324	940317	13	2.97E-01	18	6.76	1.90E-01	4.10E-01	prob
A13	740618	940317	6.7	6.31E-02	23	7.6	-2.10E-01	3.40E-01	poss
AL1	771014	931110	10	-1.23E+00	52	16.3	-2.00E+00	-5.00E-01	prob
AL2	720928	931208	12	-2.00E-01	41	15.1	-6.50E-01	2.50E-01	
AR1	690520	930825	7.2	2.60E-01	7.9	8.62	7.80E-02	4.40E-01	prob
AYB	690501	910718	1.5	1.08E-01	21	6.02	-2.50E-01	4.70E-01	poss
BF1	680827	931208	16	2.33E-01	33	14.7	-3.30E-02	5.00E-01	poss
BF2	680827	931208	12	4.59E-01	30	13.1	2.00E-01	7.10E-01	prob
BF3	580515	931216	15	-8.36E-02	40	10.5	-1.70E-01	7.50E-03	poss
C01	520217	940330	4.9	-3.13E-01	36	10.5	-4.50E-01	-1.80E-01	prob
C02	520217	940330	7.6	-2.57E-01	37	9.95	-3.70E-01	-1.50E-01	prob
C03	600926	940330	9.5	-1.00E-01	31	9.16	-2.10E-01	1.40E-02	poss
C04	520217	930519	4.8	1.02E-01	24	9.95	-1.10E-01	3.10E-01	poss
C05	520217	930519	3.6	-3.08E-02	27	8.16	-1.80E-01	1.20E-01	
C06	520217	901106	3.8	-9.13E-02	29	7.58	-2.50E-01	6.40E-02	
C07	520324	931005	4.5	2.06E-02	28	6.95	-9.40E-02	1.40E-01	poss
C08	520217	931005	3	-8.09E-02	33	5.75	-1.80E-01	1.70E-02	poss
C09	520324	940330	14	3.48E-02	29	5.58	-1.40E-02	8.30E-02	poss
C10	520324	931026	5.9	1.65E-01	24	6.9	5.80E-02	2.70E-01	prob
C11	520407	940724	9.5	3.74E-01	18	7.06	2.80E-01	4.70E-01	prob
C12	520324	940330	16	2.12E-02	29	6.03	-2.40E-02	6.70E-02	poss
C13	520324	930928	1.2	3.27E-01	18	7.57	1.00E-01	5.50E-01	prob
C14	520324	931122	21	6.66E-02	28	6.73	1.90E-02	1.10E-01	prob
C15	520217	940330	23	1.32E-01	22	10.7	5.60E-02	2.10E-01	prob
C16	520217	920206	0.5	-7.33E-02	29	11.2	-4.30E-01	2.80E-01	
C17	520217	940330	9.8	6.21E-02	26	7.59	-1.00E-02	1.30E-01	poss
C18	520217	930908	2.4	-1.86E-01	34	6.75	-3.20E-01	-4.70E-02	prob
C19	520216	940330	2.8	-1.83E-01	35	5.58	-2.60E-01	-1.00E-01	prob

(continued)

Table 6-38
Trend analyses for salinity (WQSAL), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppt/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
C20	520216	940330	3.8	-1.10E-01	31	7.15	-2.00E-01	-2.20E-02	prob
C21	520216	931208	6	-2.59E-02	31	5.47	-8.80E-02	3.60E-02	
C22	520216	921202	1.3	-1.17E-01	30	5.09	-2.70E-01	3.50E-02	poss
C23	520324	931102	1.1	-1.14E-01	35	4.32	-2.70E-01	4.60E-02	poss
C24	670929	931122	8.5	4.80E-01	23	6.94	3.40E-01	6.20E-01	prob
C25	670929	931223	5	3.30E-01	25	6.75	1.70E-01	4.90E-01	prob
CB	650101	931203	11	-9.00E-03	17	7.5	-1.10E-01	9.40E-02	
CBH	671003	921202	0.52	1.67E-01	22	6.89	-3.70E-01	7.10E-01	poss
CBY1	861014	931027	2.6	2.48E-01	18	9.69	-1.90E+00	2.40E+00	poss
CBY2	650101	920113	1.7	-2.46E-01	28	6.24	-5.40E-01	5.20E-02	poss
CCC1	520216	931217	8.3	3.87E-02	28	9.75	-6.40E-02	1.40E-01	poss
CCC2	520216	930309	2.5	-5.89E-02	30	5.2	-1.60E-01	4.10E-02	
CCC3	520216	950317	8.6	9.18E-03	29	6.13	-5.40E-02	7.30E-02	poss
CCC4	600926	940330	3.2	-7.72E-02	30	5.43	-1.80E-01	2.90E-02	poss
CCC5	520216	930519	2.5	-1.27E-01	33	6.79	-2.30E-01	-2.80E-02	prob
CCC6	520324	931005	3.9	1.29E-01	26	5.5	2.50E-02	2.30E-01	prob
CCC7	520217	930916	7	3.48E-01	18	7.03	2.50E-01	4.50E-01	prob
CCC8	600926	940330	8.5	-2.38E-01	34	9.84	-3.60E-01	-1.10E-01	prob
CP01	800617	931223	2.4	-2.01E-01	19	8.86	-1.10E+00	6.80E-01	
CP02	650101	940329	12	7.07E-02	15	8	-2.50E-02	1.70E-01	poss
CP03	640401	940329	16	7.87E-02	12	8.97	-2.10E-02	1.80E-01	poss
CP04	630805	940329	11	1.32E-02	15	8.55	-8.80E-02	1.10E-01	poss
CP05	641201	940329	9.9	7.34E-02	12	8.82	-4.70E-02	1.90E-01	poss
CP06	641201	930922	3.6	-3.20E-01	23	9.04	-5.00E-01	-1.40E-01	prob
CP07	610926	931108	5.8	4.02E-01	5.8	7.46	2.50E-01	5.60E-01	prob
CP08	660315	930928	8.8	1.55E-01	13	7.73	4.70E-02	2.60E-01	prob
CP09	610926	931223	4.9	2.87E-02	12	6.93	-1.10E-01	1.70E-01	poss
CP10	590216	940818	14	1.73E-01	11	7.51	9.50E-02	2.50E-01	prob
EF	790221	930921	5	2.66E-01	29	4.19	1.20E-02	5.20E-01	prob
GR1	840808	930512	1.5	-3.43E+00	66	17.2	-8.20E+00	1.30E+00	poss
GR2	680827	931116	11	-4.97E-02	38	15.8	-4.20E-01	3.20E-01	
HI1	670930	931109	2.3	5.22E-01	19	5.95	3.20E-01	7.20E-01	prob
HI2	670930	931216	3.5	4.35E-01	20	5.31	2.50E-01	6.20E-01	prob
I1	660415	950406	1.7	-5.97E-02	15	6.69	-3.90E-01	2.70E-01	
I2	660215	931203	3.4	5.30E-02	19	7.16	-1.10E-01	2.10E-01	poss
I3	660415	930921	6	1.46E-01	15	7.3	-2.00E-02	3.10E-01	poss
I4	581124	940317	5.7	-7.23E-02	20	7.55	-1.70E-01	2.30E-02	poss
I5	650101	930719	4.3	-3.84E-01	24	6.48	-5.40E-01	-2.30E-01	prob

(continued)

Table 6-38
Trend analyses for salinity (WQSAL), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppt/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
I6	581124	940317	9.2	-1.10E-01	24	9.15	-2.10E-01	-6.70E-03	prob
I7	650101	930428	12	-5.44E-02	24	6.86	-1.50E-01	4.30E-02	
I8	650101	931005	2.9	-5.30E-02	29	6.11	-1.80E-01	7.60E-02	
I9	580715	931019	6.3	3.14E-01	23	7.45	1.80E-01	4.50E-01	prob
I10	690615	930707	4.9	2.69E-02	31	8.46	-1.60E-01	2.10E-01	poss
I11	580415	931217	3.5	5.04E-02	33	7.24	-6.70E-02	1.70E-01	poss
I12	580715	931111	4	1.52E-02	34	8.37	-2.00E-01	2.30E-01	poss
I13	580615	931209	13	-1.53E-01	41	9.39	-2.30E-01	-7.80E-02	prob
I14	580715	931119	3.1	-1.96E-02	39	7.35	-2.80E-01	2.40E-01	
I15	680827	931028	5.7	9.98E-02	35	8.84	-1.60E-01	3.60E-01	poss
I16	580715	931118	1.8	-1.91E-01	43	8.61	-5.20E-01	1.40E-01	
I17	580715	931025	4.4	2.45E-01	29	10	2.40E-02	4.70E-01	prob
I18	580515	921020	4.9	-5.78E-02	40	9.9	-2.10E-01	9.50E-02	
IH1	670118	930512	6.1	1.63E-01	26	7.98	-1.20E-02	3.40E-01	poss
IH2	820810	820810	4						
IH3	701014	820810	2.9	1.08E+00	21	4.59	7.30E-01	1.40E+00	prob
IH4	670118	840531	1.7	-3.99E-01	34	10.4	-1.00E+00	2.10E-01	poss
IH5	670118	930512	7.6	2.19E-01	25	7.39	7.60E-02	3.60E-01	prob
IH6	690615	930916	5.9	2.33E-01	26	5.57	1.10E-01	3.60E-01	prob
IH7	600926	850731	11	-5.63E-01	34	9.56	-8.00E-01	-3.30E-01	prob
INL	700324	930809	2	2.84E-01	25	5.67	-1.20E-02	5.80E-01	poss
LAC	660115	931109	3.6	1.61E-01	23	6.9	-2.60E-02	3.50E-01	poss
LB	690501	930510	2.5	-1.67E-01	23	6.41	-3.60E-01	3.00E-02	poss
LQ1	630115	950317	8.2	8.21E-05	29	5.56	-7.50E-02	7.50E-02	poss
LQ2	520217	950317	4.2	-2.15E-02	30	5.06	-9.70E-02	5.40E-02	
LS1	820311	931015	6.6	-2.14E+00	56	16.8	-3.40E+00	-8.90E-01	prob
LS2	680827	931122	10	3.34E-01	30	15.3	-6.90E-05	6.70E-01	poss
M1	840924	931217	2.6	-7.67E-01	16	8.67	-2.00E+00	5.10E-01	
M2	640609	940329	3.4	-2.83E-01	22	11.3	-7.20E-01	1.60E-01	
MB1	581123	940428	8.3	-8.29E-02	20	8.39	-1.80E-01	1.50E-02	poss
MB2	581123	940428	9.5	-2.10E-01	24	8.16	-2.90E-01	-1.30E-01	prob
NB1	760914	931207	12	-1.04E-01	26	11.1	-5.70E-01	3.60E-01	
NB2	590713	940506	4.3	-9.10E-02	27	11.1	-3.00E-01	1.20E-01	
NB3	590713	931118	3	3.68E-02	24	10.2	-1.80E-01	2.60E-01	poss
NB4	671206	931117	14	6.40E-01	14	8.55	4.20E-01	8.60E-01	prob
NB5	671206	931117	29	6.22E-01	17	8.33	5.40E-01	7.00E-01	prob
NB6	590713	940506	13	3.06E-01	17	8.23	2.30E-01	3.80E-01	prob
NB7	590713	940506	16	5.44E-02	24	8.19	-1.60E-02	1.20E-01	poss

(continued)

Table 6-38
Trend analyses for salinity (WQSAL), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppt/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
NB8	590713	940506	9	-1.77E-02	27	9.36	-1.10E-01	7.60E-02	
NB9	590713	940506	7.6	1.49E-01	23	8.38	4.70E-02	2.50E-01	prob
ND2	771112	931005	1.9	1.17E-01	19	10.9	-7.90E-01	1.00E+00	poss
ND4	780805	960129	19	-9.49E-02	23	9.01	-5.80E-01	3.90E-01	
NR1	670927	780907	7.3	1.81E-01	0.2	1.6	-2.80E-02	3.90E-01	poss
NR3	680530	830629	3.2	-1.20E-01	7	9.17	-7.70E-01	5.30E-01	
NR4	730917	920929	9.3	3.37E-01	7.5	10.1	3.20E-02	6.40E-01	prob
NR5	680530	760830	12	-1.93E-01	11	10.2	-1.70E+00	1.30E+00	
OS1	711021	930427	3.4	-3.27E-01	7.4	6.39	-5.30E-01	-1.30E-01	prob
OS3	711021	921123	2.6	9.69E-01	18	10.9	4.60E-01	1.50E+00	prob
OS4	850403	931216	5.7	-1.42E+00	40	10.4	-2.50E+00	-3.40E-01	prob
OS5	860910	931216	3.9	-1.25E+00	41	7.29	-2.70E+00	1.80E-01	poss
OS6	780724	931020	5.8	-4.53E-01	36	9.6	-9.40E-01	3.70E-02	poss
OS7	630115	931104	7	-1.00E-01	32	8.6	-2.20E-01	1.60E-02	poss
PB1	640401	931209	5.5	3.67E-01	5.3	8.47	1.60E-01	5.70E-01	prob
PB2	660315	931209	7.2	3.37E-01	8.1	8.58	1.60E-01	5.20E-01	prob
RB1	660115	931217	5.2	2.93E-01	17	7.16	1.10E-01	4.80E-01	prob
RB2	740618	931019	5.1	2.28E-01	22	7.99	-1.20E-01	5.80E-01	poss
RB3	660415	931217	6.8	1.54E-01	23	7.14	1.50E-02	2.90E-01	prob
RB4	690917	931216	6.3	1.88E-01	23	6.06	2.30E-02	3.50E-01	prob
RB5	700324	931217	12	2.89E-01	23	5.58	1.80E-01	4.00E-01	prob
RB6	721017	931006	5.7	2.78E-01	23	6.16	1.30E-01	4.20E-01	prob
RB7	630115	931217	5.3	-1.33E-01	31	5.04	-2.10E-01	-5.90E-02	prob
RB8	670930	931006	11	3.93E-01	20	5.93	2.70E-01	5.10E-01	prob
RB9	630115	931102	7.1	3.30E-02	28	6.49	-5.60E-02	1.20E-01	poss
SC1	660315	931013	6.8	3.04E-01	7.4	7.44	1.90E-01	4.20E-01	prob
SC2	660315	940418	16	2.36E-01	9.6	9.14	1.50E-01	3.20E-01	prob
SC3	660315	931117	20	2.87E-01	12	6.89	2.10E-01	3.60E-01	prob
UL01	690615	931112	2.8	-1.53E-01	36	5.76	-3.80E-01	7.60E-02	poss
UL02	670115	931217	6.7	3.02E-02	33	6.77	-8.80E-02	1.50E-01	poss
UL03	580415	931217	9.5	-8.29E-02	38	8.18	-1.70E-01	-6.90E-04	prob
UL04	750106	930914	4.6	-1.23E-01	34	6.59	-3.80E-01	1.30E-01	
UL05	580715	931119	3	6.33E-02	34	8.18	-1.90E-01	3.20E-01	poss
UL06	580615	931216	6.6	-3.50E-02	38	8.56	-1.30E-01	6.30E-02	
UL07	580615	931209	7	-1.37E-01	39	9.21	-2.50E-01	-2.30E-02	prob
UL08	771107	931026	6.1	2.02E-01	35	7.9	-1.70E-01	5.80E-01	poss
UL09	780516	930825	6.8	3.25E-02	36	7.24	-3.10E-01	3.70E-01	poss
UL10	580615	931119	5.7	-1.83E-01	42	8.9	-3.00E-01	-7.10E-02	prob

(continued)

Table 6-38
Trend analyses for salinity (WQSAL), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppt/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
UL11	680827	921209	1.2	-3.04E-02	36	7.22	-4.40E-01	3.80E-01	
UL14	580515	880802	1.2	2.44E-01	35	10	-2.60E-01	7.50E-01	poss
GMI1	890105	931123	7.4	-6.54E-01	34	2.92	-1.30E+00	-2.50E-02	prob
GMI2	871021	931112	23	-5.02E-01	34	3.66	-8.20E-01	-1.80E-01	prob
GMI3	871021	931112	30	-1.48E-01	33	3.07	-4.00E-01	1.00E-01	
GMI4	730917	931122	8.8	2.73E-01	28	4.49	1.60E-01	3.80E-01	prob
GMI5	860818	931122	21	-3.48E-01	34	4.03	-7.00E-01	-4.20E-04	prob
GMI6	671208	930730	8.3	1.95E-01	27	5.21	1.10E-01	2.80E-01	prob
GMI7	850212	930503	42	-5.62E-01	35	3.75	-8.50E-01	-2.70E-01	prob
GMI8	650101	931022	6.3	1.60E-02	31	5.2	-8.90E-02	1.20E-01	poss
GMI9	871022	931116	15	-1.08E+00	34	3.92	-1.50E+00	-6.50E-01	prob
GMO2	791106	801028	2						
GMO4	850416	931122	1.2	5.23E-02	30	3.4	-1.10E+00	1.20E+00	poss
GMO5	850212	920817	6.3	2.34E-01	31	3.01	-1.80E-01	6.50E-01	poss
GMO6	720919	931025	1.7	1.72E-01	28	3.96	-4.90E-02	3.90E-01	poss
GMO7	850212	930503	9.1	6.25E-01	29	3.04	3.20E-01	9.30E-01	prob

Summary by component bay
Fraction (percent) of segments with data exhibiting indicated trend

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	0	7.7	53.8	23.1	15.4		4.17E-02
Copano Bay	11.1	0	0	55.6	33.3	-3.56E-02	8.11E-02
St Charles	0	0	0	0	100		2.62E-01
Mesquite	25	25	25	25	0	-5.25E-02	
Redfish	12.5	0	0	25	62.5	-1.66E-02	1.63E-01
Corpus Christi	25	20	20	15	20	-5.25E-02	4.66E-02
CCSC (bay)	20	20	0	20	40	-2.54E-02	9.54E-02
Inner Harbor	14.3	14.3	0	14.3	42.9	-8.04E-02	2.19E-01
Nueces Bay	0	0	40	20	40		2.52E-01
Aransas Pass	0	0	0	75	25		1.31E-01
Causeway N	0	0	0	0	100		3.75E-01
Causeway S	0	25	25	50	0		
Laguna (King)	30.8	0	23.1	46.2	0	-4.28E-02	
Laguna (Baffin)	0	0	66.7	0	33.3		4.08E-02
Baffin Bay	0	20	40	20	20		9.18E-02
GOM inlet	33.3	0	0	33.3	33.3	-1.52E-01	1.37E-01

Table 6-39
Trend analyses for water temperature (WQTEMP), upper 1 metre, for hydrographic area segments

Segment	*period of record*		*avg obs/yr*	*slope °C/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
A1	581123	940329	13	-1.44E-01	24	5.7	-2.00E-01	-9.30E-02	prob
A2	590129	940418	7.8	-1.52E-01	25	6.3	-2.40E-01	-6.60E-02	prob
A3	610926	940317	11	-1.34E-01	24	5.9	-2.00E-01	-6.90E-02	prob
A4	590602	940317	5.2	-1.80E-01	25	6.1	-2.80E-01	-7.80E-02	prob
A5	641130	940317	5.9	-1.90E-01	25	5.5	-2.90E-01	-9.40E-02	prob
A6	610926	940317	5.9	-1.26E-01	24	6.2	-2.30E-01	-2.30E-02	prob
A8	590111	940317	3.1	-9.14E-02	24	6.1	-2.40E-01	6.10E-02	
A9	641130	931102	2.1	6.86E-02	21	6.5	-1.80E-01	3.10E-01	poss
A10	590428	940317	7.9	-1.27E-01	24	6.1	-2.10E-01	-4.00E-02	prob
A11	690501	931117	5.9	1.08E-01	22	6.2	-1.80E-02	2.30E-01	poss
A12	700324	940317	13	-1.90E-02	22	6.3	-1.20E-01	8.20E-02	
A13	740618	940317	6.7	-2.60E-01	26	6.5	-4.90E-01	-2.70E-02	prob
AL1	771014	931110	10	-2.26E-01	28	5.3	-4.60E-01	1.40E-02	poss
AL2	720928	931208	12	-7.58E-02	26	5.3	-2.30E-01	7.90E-02	
AR1	690520	930825	7.3	1.10E-01	22	6.1	-1.70E-02	2.40E-01	poss
AYB	690501	910718	1.5	2.33E-01	23	5.9	-1.20E-01	5.90E-01	poss
BF1	680827	931208	16	-1.53E-01	26	5.6	-2.60E-01	-5.10E-02	prob
BF2	680827	931208	12	-5.02E-02	24	6.1	-1.70E-01	6.80E-02	
BF3	630114	931216	16	-4.49E-03	24	5.9	-6.30E-02	5.40E-02	
C01	600926	940330	6	-1.78E-01	26	5.6	-2.60E-01	-9.90E-02	prob
C02	600926	940330	9.5	-1.73E-01	26	5.5	-2.40E-01	-1.10E-01	prob
C03	600926	940330	9.6	-1.51E-01	25	5.9	-2.20E-01	-7.70E-02	prob
C04	630115	930519	6.5	-9.18E-02	25	5.5	-2.10E-01	2.80E-02	poss
C05	670930	930519	5.3	-3.30E-01	26	5.5	-5.00E-01	-1.60E-01	prob
C06	670929	901106	5.8	-1.48E-01	24	5.6	-3.20E-01	2.90E-02	poss
C07	690917	931005	7.3	-1.65E-01	24	6.0	-3.00E-01	-3.10E-02	prob
C08	630115	931005	3.9	-1.07E-01	24	6.2	-2.30E-01	1.90E-02	poss
C09	600926	940330	17	-1.02E-02	24	5.8	-6.30E-02	4.30E-02	
C10	670929	931026	9.2	-1.34E-01	24	5.9	-2.40E-01	-2.50E-02	prob
C11	670929	940724	15	-1.06E-01	24	5.7	-1.90E-01	-2.50E-02	prob
C12	600926	940330	21	-6.20E-02	24	6.1	-1.10E-01	-1.40E-02	prob
C13	670929	930928	1.9	-4.73E-02	25	5.7	-2.60E-01	1.70E-01	
C14	630115	931122	27	-2.87E-03	23	6.0	-4.70E-02	4.20E-02	
C15	600926	940330	29	-1.33E-01	25	5.9	-1.80E-01	-8.90E-02	prob
C16	670930	920206	0.57	-2.86E-01	25	5.5	-7.00E-01	1.30E-01	poss
C17	600926	940330	12	-1.15E-01	26	5.7	-1.90E-01	-4.10E-02	prob
C18	630115	930908	2.7	-8.89E-02	24	6.5	-2.70E-01	9.60E-02	
C19	600926	940330	3.2	-1.56E-01	26	5.8	-2.80E-01	-2.90E-02	prob

(continued)

Table 6-39
Trend analyses for water temperature (WQTEMP), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope °C/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
C20	600926	940330	4.2	-2.55E-01	27	5.2	-3.40E-01	-1.70E-01	prob
C21	630115	931208	7.6	1.62E-02	23	5.9	-6.50E-02	9.70E-02	poss
C22	720328	921202	2.4	-1.42E-01	22	6.3	-4.70E-01	1.90E-01	
C23	781003	931102	2.9	-3.53E-03	23	5.6	-5.60E-01	5.50E-01	
C24	670929	931122	8.5	3.63E-02	23	6.0	-8.30E-02	1.60E-01	poss
C25	670929	931223	5.1	-1.03E-02	24	6.0	-1.50E-01	1.30E-01	
CB	650101	931203	11	3.96E-02	22	5.8	-4.10E-02	1.20E-01	poss
CBH	671003	921202	0.56	-2.03E-01	29	3.5	-4.70E-01	6.00E-02	poss
CBY1	861014	931027	2.6	-2.32E-01	21	6.1	-1.60E+00	1.10E+00	
CBY2	650101	920113	1.7	-8.79E-02	22	7.2	-4.30E-01	2.60E-01	
CCC1	520114	931217	7.6	-3.71E-02	24	5.6	-1.20E-01	4.20E-02	
CCC2	690115	930309	3.8	-1.71E-02	23	6.4	-2.10E-01	1.70E-01	
CCC3	600926	950317	10	-8.01E-02	25	5.9	-1.50E-01	-7.00E-03	prob
CCC4	600926	940330	3.3	-2.06E-01	26	5.4	-3.10E-01	-1.00E-01	prob
CCC5	520114	930519	2.1	-9.25E-02	24	6.3	-2.80E-01	9.50E-02	
CCC6	690115	931005	6.3	7.43E-03	22	6.3	-1.30E-01	1.50E-01	poss
CCC7	670930	930916	11	-2.05E-01	25	5.8	-3.00E-01	-1.10E-01	prob
CCC8	600926	940330	8.2	-1.87E-01	26	5.7	-2.60E-01	-1.10E-01	prob
CP01	800617	931223	2.4	-6.26E-01	29	6.3	-1.30E+00	3.70E-03	poss
CP02	650101	940329	12	-3.40E-02	23	6.1	-1.10E-01	4.00E-02	
CP03	641201	940329	16	-6.64E-02	22	6.1	-1.30E-01	1.90E-03	poss
CP04	630805	940329	11	-1.10E-01	24	5.9	-1.80E-01	-4.00E-02	prob
CP05	641201	940329	9.8	-1.24E-01	23	6.1	-2.10E-01	-3.90E-02	prob
CP06	641201	930922	3.6	6.46E-02	22	6.3	-6.30E-02	1.90E-01	poss
CP07	610926	931108	5.9	9.93E-03	22	6.1	-1.20E-01	1.40E-01	poss
CP08	660315	930928	8.8	-8.96E-03	23	5.9	-9.20E-02	7.40E-02	
CP09	610926	931223	5	-9.76E-02	24	6.0	-2.10E-01	1.90E-02	poss
CP10	590216	940818	14	-6.60E-02	23	6.2	-1.30E-01	-8.80E-04	prob
EF	790221	930921	5	1.40E-01	23	6.1	-2.30E-01	5.10E-01	poss
GR1	840808	930512	1.5	-2.18E-01	29	2.1	-7.90E-01	3.60E-01	
GR2	680827	931116	11	-6.58E-02	27	5.5	-1.90E-01	6.30E-02	
HI1	670930	931109	2.3	1.21E-02	23	6.0	-1.90E-01	2.10E-01	poss
HI2	670930	931216	3.5	-2.03E-02	23	6.3	-2.40E-01	2.00E-01	
I1	660415	930405	0.11	-8.00E-02	25	0.3	-3.80E-01	2.20E-01	poss
I2	660215	931203	3.4	4.35E-02	23	5.9	-8.70E-02	1.70E-01	poss
I3	660415	930921	6	8.95E-02	22	6.0	-4.80E-02	2.30E-01	poss
I4	581124	940317	5.7	-3.17E-02	22	6.4	-1.10E-01	4.80E-02	
I5	650101	930719	4.3	-5.47E-02	22	6.6	-2.10E-01	1.00E-01	

(continued)

Table 6-39
Trend analyses for water temperature (WQTEMP), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope °C/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
I6	581124	940317	9.1	-8.30E-02	23	6.1	-1.50E-01	-1.40E-02	prob
I7	650101	930428	12	-6.32E-02	23	6.3	-1.50E-01	2.70E-02	poss
I8	650101	931005	2.8	1.23E-01	22	6.1	-6.20E-03	2.50E-01	poss
I9	670929	931019	8.3	-3.72E-02	23	6.1	-1.50E-01	7.60E-02	
I10	690615	930707	4.9	-4.68E-02	25	6.2	-1.80E-01	8.80E-02	
I11	680828	931217	4.3	1.96E-02	24	5.9	-1.60E-01	2.00E-01	poss
I12	731023	931111	6.7	1.15E-01	22	5.4	-5.00E-02	2.80E-01	poss
I13	630114	931209	13	5.43E-03	23	6.4	-5.20E-02	6.30E-02	poss
I14	781109	931119	7.1	2.51E-01	22	6.2	-6.30E-02	5.60E-01	poss
I15	680827	931028	5.6	6.25E-03	24	6.1	-1.70E-01	1.80E-01	poss
I16	790822	931118	4.3	-2.20E-01	27	6.2	-6.20E-01	1.80E-01	
I17	720227	931025	6.8	-5.37E-03	24	5.7	-1.50E-01	1.40E-01	
I18	630114	921020	4	1.07E-01	22	6.1	-1.40E-02	2.30E-01	poss
IH1	670118	930512	5.7	1.12E-01	23	5.8	-2.40E-02	2.50E-01	poss
IH2	820810	820810	3						
IH3	701014	820810	2.6	4.33E-01	23	4.3	5.50E-02	8.10E-01	prob
IH4	670118	840531	1.4	4.87E-01	21	5.2	1.30E-01	8.40E-01	prob
IH5	670118	930512	7	-4.16E-03	24	5.9	-1.30E-01	1.20E-01	
IH6	690615	930916	5.5	8.69E-02	23	5.7	-4.50E-02	2.20E-01	poss
IH7	600926	850731	10	5.00E-02	23	5.7	-9.60E-02	2.00E-01	poss
INL	700324	930809	2	8.89E-02	22	6.4	-2.50E-01	4.20E-01	poss
LAC	660115	931109	3.2	4.22E-02	21	6.1	-1.40E-01	2.20E-01	poss
LB	690501	930510	2.5	-5.40E-02	23	6.5	-2.50E-01	1.50E-01	
LQ1	630115	950317	8.2	-2.53E-02	24	5.9	-1.10E-01	5.50E-02	
LQ2	720126	950317	7.5	1.12E-02	23	5.9	-1.20E-01	1.40E-01	poss
LS1	820311	931015	6.6	-3.79E-01	27	5.2	-7.70E-01	7.40E-03	poss
LS2	680827	931122	10	-8.42E-02	26	5.7	-2.10E-01	4.00E-02	poss
M1	840924	931217	2.6	3.05E-01	25	5.0	-4.40E-01	1.00E+00	poss
M2	640519	940329	3.5	-1.46E-01	26	5.6	-3.20E-01	2.40E-02	poss
MB1	581123	940428	8.4	-2.98E-02	22	6.6	-1.10E-01	4.70E-02	
MB2	581123	940428	9.9	-1.25E-02	22	6.4	-7.70E-02	5.20E-02	
NB1	760914	931207	12	-2.65E-01	26	5.4	-4.90E-01	-3.80E-02	prob
NB2	590713	940506	4.2	-1.14E-01	26	5.6	-2.20E-01	-5.60E-03	prob
NB3	590713	931118	4.3	-1.28E-02	24	6.0	-1.30E-01	1.00E-01	
NB4	671206	931117	13	-3.88E-02	23	5.4	-1.80E-01	1.00E-01	
NB5	671206	931117	29	-7.45E-02	24	5.6	-1.30E-01	-2.20E-02	prob
NB6	590713	940506	14	2.06E-01	21	6.1	1.50E-01	2.60E-01	prob
NB7	590713	940506	17	7.56E-02	23	6.3	2.30E-02	1.30E-01	prob

(continued)

Table 6-39
Trend analyses for water temperature (WQTEMP), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope °C/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
NB8	590713	940506	8.9	-1.11E-01	25	5.8	-1.70E-01	-5.20E-02	prob
NB9	590713	940506	7.6	-1.28E-01	26	6.0	-2.00E-01	-5.60E-02	prob
ND2	771112	931005	1.9	5.47E-01	20	4.3	1.90E-01	9.00E-01	prob
ND4	780805	960129	19	-8.12E-02	24	6.0	-4.00E-01	2.40E-01	
NR1	671205	730807	14	3.78E-01	23	6.1	-6.30E-01	1.40E+00	poss
NR3	680530	830629	3.2	-1.14E-01	26	3.7	-3.70E-01	1.50E-01	
NR4	730917	920929	9	6.94E-02	23	6.2	-1.20E-01	2.60E-01	poss
NR5	680530	760830	12	-4.93E-01	27	5.3	-1.30E+00	2.80E-01	
OS1	711021	930427	3.5	2.40E-02	23	6.2	-1.80E-01	2.20E-01	poss
OS3	720115	921123	2.8	6.88E-02	24	7.0	-2.50E-01	3.90E-01	poss
OS4	850403	931216	5.7	-2.76E-01	26	6.6	-9.70E-01	4.10E-01	
OS5	860910	931216	3.9	1.06E-01	24	6.6	-1.20E+00	1.40E+00	poss
OS6	780724	931020	5.6	-9.92E-02	26	6.2	-4.30E-01	2.30E-01	
OS7	630115	931104	7	4.68E-02	24	6.1	-3.60E-02	1.30E-01	poss
PB1	700323	931209	6.9	6.17E-02	22	5.6	-7.90E-02	2.00E-01	poss
PB2	660315	931209	7.2	1.10E-02	23	5.8	-1.10E-01	1.30E-01	poss
RB1	660115	931217	5.3	1.22E-02	24	5.9	-1.30E-01	1.60E-01	poss
RB2	700324	931019	4.2	8.46E-02	24	5.5	-1.40E-01	3.10E-01	poss
RB3	660415	931217	6.8	2.10E-04	24	5.7	-1.10E-01	1.10E-01	poss
RB4	690917	931216	6.5	-3.68E-02	25	5.9	-1.90E-01	1.10E-01	
RB5	700324	931217	12	1.93E-02	24	5.7	-9.00E-02	1.30E-01	poss
RB6	721017	931006	5.7	1.33E-01	21	6.6	-2.10E-02	2.90E-01	poss
RB7	630115	931217	5.3	2.81E-03	24	5.7	-8.00E-02	8.60E-02	poss
RB8	670930	931006	11	-7.38E-02	24	6.0	-1.90E-01	4.70E-02	
RB9	630115	931102	7.1	-1.14E-02	24	6.4	-9.90E-02	7.60E-02	
SC1	660315	931013	6.7	7.32E-02	23	5.7	-1.60E-02	1.60E-01	poss
SC2	660315	940418	16	-8.10E-02	24	6.3	-1.40E-01	-1.90E-02	prob
SC3	680115	931117	21	1.04E-01	22	6.0	3.70E-02	1.70E-01	prob
UL01	690615	931112	2.8	-2.03E-01	28	5.9	-4.40E-01	3.00E-02	poss
UL02	670115	931217	6.7	1.35E-01	23	5.5	3.90E-02	2.30E-01	prob
UL03	630114	931217	10	5.91E-02	22	6.3	-1.20E-02	1.30E-01	poss
UL04	750106	930914	4.4	-3.44E-02	24	5.8	-2.70E-01	2.00E-01	
UL05	760611	931119	6	2.66E-01	23	6.2	1.50E-02	5.20E-01	prob
UL06	630114	931216	6.9	8.24E-02	22	6.1	4.50E-03	1.60E-01	prob
UL07	630315	931209	7.5	4.44E-02	24	6.2	-3.80E-02	1.30E-01	poss
UL08	771107	931026	6.1	1.70E-01	24	5.1	-7.10E-02	4.10E-01	poss
UL09	780516	930825	6.8	1.51E-01	23	5.6	-1.10E-01	4.10E-01	poss
UL10	630114	931119	6	4.64E-02	23	6.4	-4.30E-02	1.40E-01	poss

(continued)

Table 6-39
Trend analyses for water temperature (WQTEMP), upper 1 metre
(continued)

Segment	period of record		avg obs/yr	slope °C/yr	intcp	SEE	95% conf on slope lower	upper	trend
UL11	680827	921209	1.2	-2.60E-01	28	5.7	-5.80E-01	6.40E-02	poss
UL14	871006	880802	2.4						
GMI1	890105	931123	7.4	-9.80E-01	27	3.7	-1.80E+00	-1.80E-01	prob
GMI2	871021	931112	23	4.95E-01	23	4.3	1.20E-01	8.70E-01	prob
GMI3	871021	931112	30	5.46E-01	23	4.7	1.60E-01	9.30E-01	prob
GMI4	730917	931122	8.8	1.91E-01	22	6.0	4.20E-02	3.40E-01	prob
GMI5	860818	931122	21	5.57E-01	22	5.0	1.20E-01	9.90E-01	prob
GMI6	690326	930730	8.8	1.47E-01	22	5.4	5.40E-02	2.40E-01	prob
GMI7	850212	930503	42	1.20E+00	18	5.5	7.70E-01	1.60E+00	prob
GMI8	650101	931022	6.3	1.30E-01	22	5.9	1.20E-02	2.50E-01	prob
GMI9	871022	931116	15	5.78E-01	23	5.2	8.50E-03	1.10E+00	prob
GMO2	791106	801028	2						
GMO4	850416	931122	1.2	-9.17E-01	24	3.8	-2.20E+00	3.30E-01	poss
GMO5	850212	920817	6.3	5.92E-01	17	4.9	-9.00E-02	1.30E+00	poss
GMO6	720919	931025	1.7	-2.44E-01	24	4.5	-4.80E-01	-3.80E-03	prob
GMO7	850212	930503	9.1	3.06E-01	19	5.1	-2.00E-01	8.20E-01	poss

Summary by component bay
Fraction (percent) of segments with data exhibiting indicated trend

component bay	prob <0	poss <0	none	poss >0	prob >0	mean prob<0	mean prob>0
Aransas Bay	38.5	0.0	30.8	30.8	0.0	-5.67E-02	
Copano Bay	33.3	22.2	22.2	22.2	0.0	-3.33E-02	
St Charles	50.0	0.0	0.0	0.0	50.0	-4.05E-02	5.20E-02
Mesquite	0.0	0.0	50.0	50.0	0.0		
Redfish	0.0	0.0	37.5	62.5	0.0		
Corpus Christi	50.0	20.0	25.0	5.0	0.0	-8.82E-02	
CCSC (bay)	60.0	0.0	20.0	20.0	0.0	-9.82E-02	
Inner Harbor	0.0	0.0	14.3	42.9	28.6	-	1.31E-01
Nueces Bay	60.0	0.0	40.0	0.0	0.0	-5.99E-02	
Aransas Pass	0.0	0.0	25.0	75.0	0.0		
Causeway N	0.0	0.0	66.7	33.3	0.0		
Causeway S	0.0	25.0	50.0	0.0	25.0		3.38E-02
Laguna (King)	0.0	7.7	0.0	76.9	15.4		2.68E-02
Laguna (Baffin)	0.0	0.0	66.7	33.3	0.0		
Baffin Bay	20.0	0.0	80.0	0.0	0.0	-3.06E-02	
GOM inlet	16.7	0.0	0.0	33.3	50.0	-4.07E-02	3.17E-01

Table 6-40
Trend analyses for dissolved oxygen (WQDO), upper 1 metre,
for hydrographic area segments

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
A1	581123	940329	13	-3.30E-02	17	7.8	-1.00E-01	3.80E-02	
A2	590129	940418	7.7	-5.09E-02	18	7.06	-1.50E-01	4.50E-02	
A1	690501	931118	7.8	1.80E-02	8.3	1.58	-1.20E-02	4.80E-02	poss
A2	690501	931014	7.9	7.32E-02	8.2	2.17	2.90E-02	1.20E-01	prob
A3	690501	930825	8.1	-2.70E-03	8.8	1.58	-3.60E-02	3.00E-02	
A4	700323	930928	4.3	-6.75E-02	9.3	1.63	-1.20E-01	-1.50E-02	prob
A5	690501	930511	4.8	3.13E-02	8.5	2.04	-1.70E-02	8.00E-02	poss
A6	700324	931117	4.5	2.05E-04	9.2	2.86	-1.00E-01	1.00E-01	poss
A8	700324	931102	2.4	3.62E-02	8.5	3.00	-1.10E-01	1.80E-01	poss
A9	700324	931102	2.4	-2.43E-02	9.7	2.10	-1.20E-01	7.60E-02	
A10	690501	931117	6.2	3.69E-02	8.1	1.91	7.30E-05	7.40E-02	prob
A11	690501	931117	5.2	4.97E-02	7.5	1.76	1.20E-02	8.70E-02	prob
A12	700324	931109	10	6.64E-03	8.6	2.24	-3.60E-02	4.90E-02	poss
A13	740723	931005	4.5	-2.22E-02	9.0	2.16	-1.20E-01	7.30E-02	
AL1	771014	931110	10	1.36E-01	5.8	1.96	4.80E-02	2.20E-01	prob
AL2	720928	931208	12	8.30E-02	6.0	1.89	2.70E-02	1.40E-01	prob
AR1	690520	930825	7.2	-1.18E-03	8.6	2.04	-4.40E-02	4.10E-02	
AYB	690501	910718	1.5	-7.20E-02	7.4	1.20	-1.40E-01	-9.10E-05	prob
BF1	680827	931208	12	-5.26E-03	7.3	1.87	-4.40E-02	3.30E-02	
BF2	680827	931208	9.8	2.74E-03	7.0	2.02	-3.90E-02	4.50E-02	poss
BF3	680827	931216	15	-1.92E-02	7.3	2.20	-5.50E-02	1.70E-02	
C01	520217	931109	3	6.45E-03	8.0	1.56	-2.30E-02	3.60E-02	poss
C02	610426	931109	5.7	-7.82E-03	7.9	1.54	-3.40E-02	1.80E-02	
C03	610426	930908	6.9	3.21E-02	7.5	2.00	-4.00E-03	6.80E-02	poss
C04	520406	930519	3.1	4.24E-02	6.2	2.10	-1.80E-02	1.00E-01	poss
C05	520217	930519	3.3	3.03E-02	7.0	1.63	-5.90E-03	6.70E-02	poss
C06	520217	901106	3.4	-4.96E-04	7.2	1.77	-4.90E-02	4.80E-02	
C07	690917	931005	6.7	-7.21E-02	8.5	1.47	-1.10E-01	-3.90E-02	prob
C08	690917	931005	1.7	-8.66E-02	8.9	1.52	-1.50E-01	-2.60E-02	prob
C09	700610	931122	18	-1.96E-02	8.3	1.71	-4.20E-02	2.90E-03	poss
C10	520324	931026	5	-2.09E-02	8.3	1.52	-4.90E-02	7.20E-03	poss
C11	520629	940724	8.7	-1.79E-02	8.2	1.53	-3.90E-02	3.60E-03	poss
C12	700506	931208	21	-9.65E-03	8.0	1.75	-2.90E-02	1.00E-02	
C13	670929	930928	1.8	7.79E-03	7.9	2.00	-6.80E-02	8.40E-02	poss
C14	520324	931122	14	1.73E-02	7.4	1.79	-8.50E-04	3.50E-02	poss
C15	520112	931104	18	2.38E-02	7.0	1.53	9.40E-03	3.80E-02	prob
C16	520217	920206	0.4	3.10E-02	6.4	1.53	-3.00E-02	9.20E-02	poss
C17	520112	931207	8	2.46E-02	7.3	1.85	-1.40E-03	5.10E-02	poss

(continued)

Table 6-40
Trend analyses for dissolved oxygen (WQDO), upper 1 metre
(continued)

Segment	period of record		avg obs/yr	slope ppm/yr	intcp	SEE	95% conf on slope lower	upper	trend
C18	520217	930908	0.7	2.67E-02	6.1	1.65	-1.90E-02	7.30E-02	poss
C19	520216	931208	1.2	3.30E-02	7.4	1.92	-1.80E-02	8.40E-02	poss
C20	520216	930317	2.3	-1.51E-03	8.1	1.33	-3.70E-02	3.40E-02	
C21	520114	931208	3.6	1.00E-02	7.7	1.75	-2.10E-02	4.10E-02	poss
C22	520405	921202	1.2	-4.33E-02	8.8	1.79	-1.20E-01	3.80E-02	
C23	781003	931102	2.7	-1.11E-01	9.3	1.73	-2.80E-01	6.10E-02	
C24	670929	931122	8.1	-3.23E-02	8.2	2.24	-7.80E-02	1.30E-02	poss
C25	670929	931223	4.9	4.72E-02	6.9	2.38	-1.40E-02	1.10E-01	poss
CB	690501	931203	12	5.14E-02	8.1	2.18	1.90E-02	8.40E-02	prob
CBH	671003	921202	0.52	3.79E-02	7.7	1.84	-1.10E-01	1.80E-01	poss
CBY1	861014	931027	2.4	-2.61E-01	10.0	1.81	-6.70E-01	1.50E-01	poss
CBY2	841003	920113	0.55	2.89E-01	8.1	2.05	-1.60E+00	2.20E+00	poss
CCC1	520216	931217	7	-1.87E-02	8.3	1.73	-4.40E-02	6.30E-03	poss
CCC2	520112	930309	1.2	1.54E-02	7.2	1.64	-4.10E-02	7.20E-02	poss
CCC3	520114	950317	6.7	3.65E-03	7.9	1.76	-2.00E-02	2.80E-02	poss
CCC4	520114	931208	1.6	1.25E-01	3.4	1.75	8.10E-02	1.70E-01	prob
CCC5	520216	930519	1.6	8.59E-04	7.5	1.40	-3.70E-02	3.80E-02	poss
CCC6	690717	931005	4.7	1.20E-02	7.2	1.53	-2.80E-02	5.30E-02	poss
CCC7	520406	930916	6.2	5.33E-02	6.7	1.66	2.70E-02	7.90E-02	prob
CCC8	610426	931020	5.7	-1.61E-02	7.9	1.63	-4.60E-02	1.40E-02	
CP01	800617	931223	2.4	5.04E-02	8.3	2.09	-1.60E-01	2.60E-01	poss
CP02	690501	931223	11	3.33E-02	8.1	2.04	-6.90E-04	6.70E-02	poss
CP03	700323	931217	13	3.76E-02	8.2	2.08	4.40E-03	7.10E-02	prob
CP04	690501	931209	8.1	2.44E-02	8.4	1.72	-8.20E-03	5.70E-02	poss
CP05	690501	930928	7.7	9.18E-03	8.2	1.76	-3.10E-02	5.00E-02	poss
CP06	700323	930922	2.6	-1.24E-01	11.0	1.82	-2.10E-01	-3.90E-02	prob
CP07	700323	931108	7.5	-4.47E-03	8.5	1.82	-4.50E-02	3.60E-02	
CP08	690501	930928	8.3	-1.35E-02	8.8	2.14	-5.10E-02	2.40E-02	
CP09	690501	931223	6.2	5.83E-02	8.1	1.72	2.30E-02	9.40E-02	prob
CP10	690521	940818	13	2.06E-02	8.3	1.81	-7.80E-03	4.90E-02	poss
EF	790221	930921	5	-1.35E-01	9.5	2.14	-2.70E-01	-5.50E-03	prob
GR1	840808	930512	1.5	4.68E-01	4.7	2.50	-2.20E-01	1.20E+00	poss
GR2	680827	931116	11	5.45E-02	6.2	2.20	3.20E-03	1.10E-01	prob
HI1	670930	931109	1.6	-6.61E-02	9.4	2.09	-1.40E-01	1.00E-02	poss
HI2	670930	931216	3.5	-6.05E-02	9.4	1.84	-1.30E-01	4.20E-03	poss
I1	870825	930405	0.36						
I2	690501	931203	3.7	5.31E-02	7.3	1.53	1.80E-02	8.80E-02	prob
I3	710608	930921	7	2.07E-02	8.5	2.40	-3.60E-02	7.80E-02	poss

(continued)

Table 6-40
Trend analyses for dissolved oxygen (WQDO), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
I4	690501	931203	3.7	3.15E-02	7.7	1.45	-3.40E-03	6.60E-02	poss
I5	710608	930719	3.2	-5.91E-02	9.2	1.69	-1.20E-01	5.50E-03	poss
I6	691209	930720	6.3	-2.31E-02	8.5	1.74	-6.50E-02	1.90E-02	
I7	690501	930428	10	8.55E-02	7.3	1.93	5.30E-02	1.20E-01	prob
I8	690501	931005	2.6	7.31E-02	7.2	2.08	2.00E-02	1.30E-01	prob
I9	670929	931019	7.5	-9.32E-04	7.1	2.17	-4.30E-02	4.10E-02	
I10	690615	930707	3	6.93E-03	7.6	2.01	-5.50E-02	6.80E-02	poss
I11	680828	931217	4.3	7.25E-02	6.4	2.15	5.80E-03	1.40E-01	prob
I12	731023	931111	6.7	1.00E-02	7.6	1.80	-4.50E-02	6.50E-02	poss
I13	680828	931209	6.8	4.37E-02	6.8	4.93	-5.40E-02	1.40E-01	poss
I14	781109	931119	7.1	1.15E-02	6.7	2.38	-1.10E-01	1.30E-01	poss
I15	680827	931028	4.5	-1.54E-02	6.9	1.92	-7.80E-02	4.80E-02	
I16	790822	931118	4.3	2.13E-02	6.5	1.86	-1.00E-01	1.40E-01	poss
I17	720227	931025	5.2	-3.25E-02	7.6	1.45	-7.40E-02	8.80E-03	poss
I18	690715	921020	2.3	2.63E-02	6.5	1.87	-3.80E-02	9.10E-02	poss
IH1	670118	930512	5.5	-5.92E-02	8.0	2.61	-1.20E-01	3.30E-03	poss
IH2	720424	820810	1.3	-1.46E-01	7.0	1.43	-3.60E-01	7.30E-02	poss
IH3	701014	820810	3.6	-2.27E-01	7.7	2.12	-3.90E-01	-6.50E-02	prob
IH4	670118	840531	1.5	-7.63E-02	7.6	2.09	-2.10E-01	6.10E-02	
IH5	670118	930512	7.1	-1.42E-02	7.5	2.57	-6.80E-02	4.00E-02	
IH6	690615	930916	5.5	5.24E-02	6.0	2.35	-1.60E-03	1.10E-01	poss
IH7	520511	840213	7	-2.08E-03	6.7	1.68	-5.00E-02	4.60E-02	
INL	700324	930809	1.8	-3.53E-02	8.6	1.51	-1.20E-01	4.90E-02	
LAC	710608	931109	3.8	4.96E-02	7.6	1.86	-7.00E-03	1.10E-01	poss
LB	690501	930510	2.5	1.81E-01	7.1	1.97	1.20E-01	2.40E-01	prob
LQ1	700619	950317	6.7	6.72E-03	7.9	1.46	-2.10E-02	3.40E-02	poss
LQ2	520217	950317	3.7	1.70E-02	7.4	1.94	-2.00E-02	5.40E-02	poss
LS1	820311	930526	2	2.17E-01	5.8	2.43	-7.30E-02	5.10E-01	poss
LS2	680827	931122	9	2.58E-02	6.9	2.12	-2.40E-02	7.50E-02	poss
M1	840924	931217	2.6	-2.91E-01	9.2	1.80	-5.60E-01	-2.60E-02	prob
M2	790622	931217	5	-6.21E-02	8.9	2.10	-2.10E-01	8.30E-02	
MB1	691202	931117	7.9	-3.52E-02	9.3	2.01	-8.80E-02	1.70E-02	poss
MB2	690501	931028	8.9	3.20E-02	8.0	1.89	2.80E-03	6.10E-02	prob
NB1	760914	931207	11	4.74E-03	7.8	2.23	-8.90E-02	9.90E-02	poss
NB2	670118	931116	3.4	5.29E-03	7.7	2.03	-6.00E-02	7.00E-02	poss
NB3	710620	931118	5.7	-4.94E-02	8.3	1.77	-1.10E-01	1.20E-02	poss
NB4	671206	931117	12	2.42E-02	7.5	1.63	-1.90E-02	6.70E-02	poss
NB5	671206	931117	25	3.49E-02	7.4	1.70	1.70E-02	5.30E-02	prob

(continued)

Table 6-40
Trend analyses for dissolved oxygen (WQDO), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
NB6	671206	931117	15	-6.40E-02	8.2	1.45	-7.90E-02	-4.90E-02	prob
NB7	670118	931207	15	-5.43E-02	8.3	1.89	-7.90E-02	-3.00E-02	prob
NB8	671002	931116	3.7	-1.80E-02	7.8	1.49	-6.70E-02	3.10E-02	
NB9	720405	931207	5.5	4.65E-02	7.5	2.04	-3.20E-02	1.30E-01	poss
ND2	771112	931005	1.9	9.98E-03	8.0	1.37	-1.00E-01	1.20E-01	poss
ND4	780805	960129	19	-5.76E-02	8.5	1.86	-1.60E-01	4.30E-02	
NR1	671205	730807	14	4.35E-01	6.4	1.65	1.60E-01	7.10E-01	prob
NR3	680530	830629	3.2	-1.14E-01	8.7	2.37	-2.80E-01	5.50E-02	poss
NR4	730917	920929	8.9	-2.00E-02	9.7	2.89	-1.10E-01	7.00E-02	
NR5	680530	760830	12	1.27E-01	7.3	2.19	-1.90E-01	4.50E-01	poss
OS1	711021	930427	3.5	-8.87E-02	10.0	4.95	-2.50E-01	7.10E-02	
OS3	711021	921123	2.8	-7.32E-02	8.4	2.22	-1.80E-01	2.90E-02	poss
OS4	850403	931216	5.7	1.40E-01	7.6	2.37	-1.10E-01	3.90E-01	poss
OS5	860910	931216	3.9	-1.91E-01	9.3	1.74	-5.30E-01	1.50E-01	
OS6	780724	931020	5.5	-1.64E-02	7.8	2.03	-1.20E-01	9.10E-02	
OS7	730917	931104	7.7	2.05E-02	8.0	2.02	-3.40E-02	7.50E-02	poss
PB1	730918	931209	7.8	-3.30E-03	8.4	1.76	-4.90E-02	4.20E-02	
PB2	770513	931209	11	-1.18E-01	10.0	2.56	-2.10E-01	-3.10E-02	prob
RB1	700324	931217	5.8	-1.01E-02	9.3	2.52	-7.60E-02	5.60E-02	
RB2	700324	931019	4	-4.26E-02	9.9	3.21	-1.80E-01	9.90E-02	
RB3	670930	931217	6.9	5.57E-02	7.7	2.17	8.60E-03	1.00E-01	prob
RB4	690917	931216	6	2.77E-02	8.2	5.23	-1.10E-01	1.70E-01	poss
RB5	700324	931217	12	2.08E-02	8.2	1.95	-1.80E-02	5.90E-02	poss
RB6	721017	931006	5.7	1.32E-02	8.2	1.83	-2.90E-02	5.60E-02	poss
RB7	761110	931217	5.6	3.27E-02	8.0	2.17	-6.50E-02	1.30E-01	poss
RB8	670930	931006	10	-3.09E-02	8.2	1.53	-6.20E-02	9.90E-05	poss
RB9	670930	931102	5.3	5.24E-02	7.6	2.25	-1.40E-03	1.10E-01	poss
SC1	690501	931013	6.7	7.04E-02	7.2	1.60	4.30E-02	9.80E-02	prob
SC2	690501	931203	13	9.82E-02	7.2	2.28	6.80E-02	1.30E-01	prob
SC3	690501	931117	21	8.50E-02	7.6	2.39	5.80E-02	1.10E-01	prob
UL01	690615	931112	2.8	7.04E-02	6.6	1.99	-8.60E-03	1.50E-01	poss
UL02	690615	931217	6.2	9.27E-02	6.3	2.13	4.20E-02	1.40E-01	prob
UL03	680828	931217	8.9	-8.34E-02	7.8	2.38	-1.30E-01	-4.00E-02	prob
UL04	750106	930914	4.3	3.40E-03	7.9	1.59	-6.20E-02	6.90E-02	poss
UL05	760611	931119	6	1.83E-02	7.7	2.17	-7.00E-02	1.10E-01	poss
UL06	690715	931216	6.1	-5.96E-02	7.2	2.20	-1.10E-01	-7.80E-03	prob
UL07	690715	931209	5.5	3.83E-02	7.0	1.67	2.40E-03	7.40E-02	prob
UL08	771107	931026	6.1	-5.73E-02	7.1	2.17	-1.60E-01	4.60E-02	
UL09	780516	930825	6.8	8.70E-02	6.2	1.61	1.10E-02	1.60E-01	prob

(continued)

Table 6-40
Trend analyses for dissolved oxygen (WQDO), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
UL10	690415	931119	4.8	1.27E-02	6.9	1.56	-2.60E-02	5.10E-02	poss
UL11	680827	921209	1.2	-7.35E-02	7.5	2.19	-2.00E-01	5.00E-02	
UL14	871006	880802	2.4						
GMI1	890105	931123	7.4	4.95E-01	5.0	0.92	3.00E-01	6.90E-01	prob
GMI2	871021	931112	23	-9.78E-03	6.4	1.09	-1.10E-01	8.60E-02	
GMI3	871021	931112	30	-1.17E-01	6.7	1.05	-2.00E-01	-3.10E-02	prob
GMI4	730917	931122	8.8	-1.11E-01	8.4	1.46	-1.50E-01	-7.50E-02	prob
GMI5	860818	931122	21	-1.32E-01	7.0	1.16	-2.30E-01	-3.10E-02	prob
GMI6	690326	930730	8.7	-1.68E-03	7.1	1.36	-2.50E-02	2.20E-02	
GMI7	850212	930503	42	-2.93E-01	8.6	1.40	-4.00E-01	-1.80E-01	prob
GMI8	850626	931022	20	-1.88E-01	8.2	1.45	-3.20E-01	-5.80E-02	prob
GMI9	871022	931116	15	-1.05E-01	8.1	2.16	-3.40E-01	1.30E-01	
GMO2	791106	801028	2						
GMO4	850416	931122	1.2	-2.69E-01	8.9	1.12	-6.40E-01	1.00E-01	poss
GMO5	850212	920817	6.3	1.49E-01	7.7	2.28	-1.70E-01	4.60E-01	poss
GMO6	720919	931025	1.7	3.01E-02	7.4	1.11	-2.90E-02	9.00E-02	poss
GMO7	850212	930503	9.1	-9.37E-02	8.6	1.51	-2.40E-01	5.60E-02	

Summary by component bay
Fraction (percent) of segments with data exhibiting indicated trend

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	7.7	7.7	23.1	38.5	23.1	-5.19E-03	1.23E-02
Copano Bay	11.1	0.0	22.2	44.4	22.2	-1.38E-02	1.07E-02
St Charles	0.0	0.0	0.0	0.0	100.0		9.16E-02
Mesquite	25.0	25.0	0.0	0.0	50.0	-1.80E-02	2.09E-02
Redfish	0.0	12.5	12.5	62.5	12.5		6.96E-03
Corpus Christi	10.0	10.0	25.0	55.0	0.0	-7.94E-03	
CCSC (bay)	0.0	0.0	0.0	60.0	40.0	-	3.57E-02
Inner Harbor	14.3	28.6	42.9	14.3	0.0	-3.24E-02	
Nueces Bay	0.0	20.0	20.0	40.0	20.0		6.98E-03
Aransas Pass	0.0	50.0	25.0	25.0	0.0		
Causeway N	0.0	33.3	33.3	33.3	0.0		
Causeway S	0.0	0.0	0.0	75.0	25.0		2.32E-02
Laguna (King)	15.4	0.0	23.1	38.5	23.1	-1.10E-02	1.52E-02
Laguna (Baffin)	0.0	33.3	0.0	66.7	0.0		
Baffin Bay	0.0	0.0	40.0	20.0	40.0		2.75E-02
GOM inlet	33.3	0.0	33.3	33.3	0.0	-7.08E-02	

Table 6-41
Trend analyses for dissolved oxygen deficit (WQDODEF), upper 1 metre, for hydrographic area segments

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
A1	581123	940329	13	-3.30E-02	17	7.8	-1.00E-01	3.80E-02	
A2	590129	940418	7.7	-5.09E-02	18	7.06	-1.50E-01	4.50E-02	
A1	690501	931118	7.5	-3.30E-02	-0.1	1.53	-6.30E-02	-2.90E-03	prob
A2	690501	931014	7.9	-6.99E-02	-0.1	1.93	-1.10E-01	-3.00E-02	prob
A3	690501	930825	7.8	-2.14E-02	-0.5	1.34	-5.00E-02	7.10E-03	poss
A4	710608	930928	4.4	5.27E-02	-1.0	1.23	1.10E-02	9.40E-02	prob
A5	690501	930511	4.7	-4.43E-02	-0.5	1.88	-9.00E-02	1.10E-03	poss
A6	741119	931117	5.5	-5.75E-02	-0.7	2.79	-1.70E-01	5.30E-02	
A8	741119	931102	2.9	-1.12E-01	-0.1	2.89	-2.70E-01	4.90E-02	poss
A9	741119	931102	2.8	1.21E-02	-1.5	1.97	-9.90E-02	1.20E-01	poss
A10	690501	931117	6	-5.04E-02	-0.1	1.64	-8.30E-02	-1.80E-02	prob
A11	690501	931117	5.2	-6.18E-02	0.2	1.56	-9.50E-02	-2.90E-02	prob
A12	710608	931109	11	-4.49E-02	-0.5	2.08	-8.50E-02	-5.10E-03	prob
A13	740723	931005	4.5	6.95E-03	-1.5	2.08	-8.50E-02	9.90E-02	poss
AL1	771014	931110	10	-5.31E-02	-0.2	1.77	-1.30E-01	2.60E-02	poss
AL2	720928	931208	12	-6.50E-02	0.4	1.68	-1.10E-01	-1.50E-02	prob
AR1	690520	930825	7	-2.62E-02	-0.1	1.89	-6.70E-02	1.40E-02	
AYB	690501	910718	1.5	3.43E-02	0.3	0.77	-1.20E-02	8.10E-02	poss
BF1	680827	931208	12	-3.43E-03	-0.2	1.67	-3.80E-02	3.10E-02	
BF2	680827	931208	9.8	-2.31E-02	0.2	1.99	-6.50E-02	1.80E-02	
BF3	680827	931216	15	1.44E-02	-0.5	2.09	-2.00E-02	4.90E-02	poss
C01	700619	931109	4.4	3.75E-02	-1.1	1.28	5.80E-03	6.90E-02	prob
C02	670930	931109	6	1.60E-02	-0.6	1.38	-1.50E-02	4.70E-02	poss
C03	670930	930908	7.6	-3.36E-02	-0.3	1.95	-7.30E-02	5.70E-03	poss
C04	670930	930519	5	-3.53E-02	0.4	2.18	-1.00E-01	3.20E-02	
C05	670930	930519	5.1	1.12E-02	-0.4	1.37	-3.10E-02	5.40E-02	poss
C06	670929	901106	5.6	6.40E-03	0.2	1.60	-4.50E-02	5.80E-02	poss
C07	690917	931005	6.5	7.25E-02	-1.0	1.23	4.40E-02	1.00E-01	prob
C08	690917	931005	1.5	9.44E-02	-1.6	1.70	2.20E-02	1.70E-01	prob
C09	700610	931122	18	-7.85E-03	-0.8	1.68	-3.00E-02	1.50E-02	
C10	670929	931026	7.8	2.80E-02	-0.6	1.24	4.10E-03	5.20E-02	prob
C11	670929	940724	14	1.48E-02	-0.5	1.26	-3.20E-03	3.30E-02	poss
C12	700506	931208	21	-8.19E-03	-0.5	1.67	-2.70E-02	1.10E-02	
C13	670929	930928	1.7	-3.66E-02	-0.2	1.85	-1.10E-01	3.50E-02	
C14	670929	931122	23	-3.48E-02	-0.2	1.70	-5.20E-02	-1.70E-02	prob
C15	671002	931104	27	-4.01E-02	0.3	1.22	-5.30E-02	-2.70E-02	prob
C16	670930	920206	0.53	-1.07E-01	2.2	1.44	-2.20E-01	3.60E-03	poss
C17	670930	931207	12	-4.67E-02	0.0	1.83	-7.60E-02	-1.70E-02	prob

(continued)

Table 6-41
Trend analyses for dissolved oxygen deficit (WQDODEF), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
C18	670930	930908	0.81	-2.22E-02	0.8	1.58	-1.10E-01	6.70E-02	
C19	741016	931208	2.4	-6.99E-02	-0.5	2.03	-1.90E-01	4.70E-02	
C20	700610	930317	3.9	4.27E-02	-0.7	1.17	5.70E-03	8.00E-02	prob
C21	711105	931208	6.5	-3.69E-02	-0.3	1.63	-7.20E-02	-1.50E-03	prob
C22	720328	921202	2.3	7.99E-02	-0.5	1.53	-1.90E-03	1.60E-01	poss
C23	781003	931102	2.7	9.38E-02	-1.8	1.83	-8.90E-02	2.80E-01	poss
C24	670929	931122	8	6.77E-03	-0.7	2.27	-4.00E-02	5.30E-02	poss
C25	670929	931223	4.9	-5.85E-02	0.5	2.29	-1.20E-01	6.30E-04	poss
CB	690501	931203	12	-6.05E-02	-0.1	1.90	-8.90E-02	-3.20E-02	prob
CBH	671003	921202	0.52	-1.93E-02	-0.9	1.55	-1.40E-01	1.00E-01	
CBY1	861014	931027	2.4	2.55E-01	-1.7	1.44	-6.90E-02	5.80E-01	poss
CBY2	841003	920113	0.55	4.43E-02	-1.4	1.77	-1.60E+00	1.70E+00	poss
CCC1	670930	931217	11	1.94E-02	-0.6	1.66	-5.70E-03	4.40E-02	poss
CCC2	720321	930309	2.1	-2.70E-02	0.0	1.60	-1.10E-01	6.10E-02	
CCC3	670929	950317	10	-1.41E-02	-0.5	1.74	-4.00E-02	1.20E-02	
CCC4	690615	931208	2.7	-1.40E-01	2.0	1.56	-1.80E-01	-9.70E-02	prob
CCC5	711105	930519	2.8	4.49E-02	-0.5	1.25	-2.40E-03	9.20E-02	poss
CCC6	690717	931005	4.6	-2.19E-02	0.3	1.25	-5.60E-02	1.20E-02	
CCC7	670930	930916	9.6	-4.86E-02	-0.1	1.34	-7.20E-02	-2.60E-02	prob
CCC8	710506	931020	7.2	1.34E-02	-0.2	1.22	-1.70E-02	4.40E-02	poss
CP01	800617	931223	2.4	6.42E-02	-1.4	1.74	-1.10E-01	2.40E-01	poss
CP02	690501	931223	11	-4.34E-02	0.0	2.05	-7.80E-02	-9.00E-03	prob
CP03	710609	931217	13	-7.19E-02	0.4	1.75	-1.00E-01	-4.40E-02	prob
CP04	690501	931209	8	-4.66E-02	-0.2	1.66	-7.90E-02	-1.50E-02	prob
CP05	690501	930928	7.7	-2.86E-02	0.2	1.28	-5.80E-02	1.10E-03	poss
CP06	741119	930922	3	4.77E-02	-1.2	2.00	-6.40E-02	1.60E-01	poss
CP07	710609	931108	7.9	-1.56E-02	-0.2	1.44	-4.80E-02	1.70E-02	
CP08	690501	930928	8.3	5.93E-03	-0.8	2.00	-2.90E-02	4.10E-02	poss
CP09	690501	931223	6.2	-4.70E-02	0.0	1.49	-7.80E-02	-1.60E-02	prob
CP10	690521	940818	13	-4.25E-02	0.0	1.56	-6.70E-02	-1.80E-02	prob
EF	790221	930921	5	1.00E-01	-2.2	2.22	-3.50E-02	2.40E-01	poss
GR1	840808	930512	1.5	-2.90E-01	0.2	1.96	-8.30E-01	2.50E-01	
GR2	680827	931116	11	-4.32E-02	0.3	2.09	-9.20E-02	5.50E-03	poss
HI1	670930	931109	1.6	4.30E-02	-1.7	1.73	-2.00E-02	1.10E-01	poss
HI2	670930	931216	3.5	4.40E-02	-1.7	1.95	-2.50E-02	1.10E-01	poss
I1	930405	930405	1						
I2	690501	931203	3.7	-5.97E-02	0.4	1.43	-9.20E-02	-2.70E-02	prob
I3	710608	930921	7	-4.91E-02	-0.4	2.09	-9.90E-02	6.30E-04	poss

(continued)

Table 6-41
Trend analyses for dissolved oxygen deficit (WQDODEF), upper 1 metre
(continued)

Segment	period of record		avg obs/yr	slope ppm/yr	intcp	SEE	95% conf on slope lower	upper	trend
I4	690501	931203	3.6	-5.73E-02	0.3	1.42	-9.20E-02	-2.30E-02	prob
I5	710608	930719	3.2	7.30E-02	-1.3	1.54	1.40E-02	1.30E-01	prob
I6	691209	930720	6.1	-2.33E-03	-0.3	1.44	-3.90E-02	3.40E-02	
I7	690501	930428	9.8	-8.26E-02	0.3	1.75	-1.10E-01	-5.30E-02	prob
I8	690501	931005	2.6	-8.91E-02	0.3	1.86	-1.40E-01	-4.10E-02	prob
I9	670929	931019	7.3	1.67E-03	0.2	2.11	-4.10E-02	4.40E-02	poss
I10	690615	930707	2.9	-2.00E-03	-0.8	1.91	-6.10E-02	5.70E-02	
I11	680828	931217	4.3	-8.10E-02	0.7	2.14	-1.50E-01	-1.50E-02	prob
I12	731023	931111	6.7	-3.48E-02	-0.3	1.68	-8.60E-02	1.60E-02	poss
I13	680828	931209	6.7	-3.34E-02	-0.1	4.91	-1.30E-01	6.40E-02	
I14	781109	931119	7.1	-5.87E-02	0.5	2.58	-1.90E-01	7.20E-02	
I15	680827	931028	4.5	4.01E-03	0.1	1.85	-5.70E-02	6.50E-02	poss
I16	790822	931118	4.3	-5.95E-03	0.0	2.07	-1.40E-01	1.30E-01	
I17	720227	931025	5.1	4.67E-03	-0.4	1.13	-2.80E-02	3.70E-02	poss
I18	690715	921020	2.3	-3.27E-02	0.3	2.01	-1.00E-01	3.60E-02	
IH1	680530	930512	5.5	4.05E-02	-0.5	2.35	-2.00E-02	1.00E-01	poss
IH2	820810	820810	3						
IH3	701014	820810	2.6	1.90E-01	-0.8	2.11	6.40E-03	3.70E-01	prob
IH4	741016	840531	1.6	-1.41E-01	1.2	1.69	-5.40E-01	2.50E-01	
IH5	680530	930512	6.7	-1.22E-02	0.1	2.39	-6.60E-02	4.20E-02	
IH6	690615	930916	5.4	-7.82E-02	1.5	1.97	-1.20E-01	-3.20E-02	prob
IH7	680530	840213	12	-6.89E-03	0.8	1.52	-6.00E-02	4.70E-02	
INL	740723	930809	2.2	-1.88E-02	-0.5	1.22	-9.50E-02	5.70E-02	
LAC	710608	931109	3.8	-5.45E-02	0.1	1.56	-1.00E-01	-7.20E-03	prob
LB	690501	930510	2.5	-1.64E-01	0.5	1.77	-2.20E-01	-1.10E-01	prob
LQ1	700619	950317	6.6	-1.44E-02	-0.5	1.46	-4.20E-02	1.30E-02	
LQ2	720126	950317	6.4	-1.39E-02	-0.4	1.76	-5.80E-02	3.00E-02	
LS1	820311	930526	2	-2.27E-01	0.6	1.89	-4.50E-01	-2.30E-03	prob
LS2	680827	931122	9	-4.38E-02	0.2	1.98	-9.00E-02	2.30E-03	poss
M1	840924	931217	2.6	2.80E-01	-1.5	1.58	4.80E-02	5.10E-01	prob
M2	790622	931217	5	8.89E-02	-1.4	1.92	-4.40E-02	2.20E-01	poss
MB1	730822	931117	9.1	7.70E-03	-0.8	1.57	-3.60E-02	5.10E-02	poss
MB2	690501	931028	8.8	-3.22E-02	-0.2	1.55	-5.70E-02	-7.70E-03	prob
NB1	760914	931207	10	4.03E-02	-0.6	2.41	-6.20E-02	1.40E-01	poss
NB2	741016	931116	4.2	-5.20E-02	0.3	2.11	-1.80E-01	7.20E-02	
NB3	710720	931118	3.7	2.29E-03	-0.1	1.83	-8.00E-02	8.50E-02	poss
NB4	671206	931117	11	-4.23E-02	0.5	1.45	-8.00E-02	-4.20E-03	prob
NB5	671206	931117	25	-5.12E-02	0.5	1.45	-6.70E-02	-3.60E-02	prob

(continued)

Table 6-41
Trend analyses for dissolved oxygen deficit (WQDODEF), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
NB6	671206	931117	15	6.26E-03	0.0	1.25	-7.20E-03	2.00E-02	poss
NB7	690326	931207	15	5.39E-03	-0.2	1.76	-1.90E-02	3.00E-02	poss
NB8	671002	931116	3.4	-8.46E-03	0.1	1.63	-6.60E-02	4.90E-02	
NB9	751001	931207	6.4	-7.76E-02	-0.1	1.96	-1.60E-01	1.70E-03	poss
ND2	771112	931005	1.9	-8.84E-02	0.1	1.63	-2.30E-01	4.80E-02	poss
ND4	780805	960129	19	7.28E-02	-1.0	1.60	-1.40E-02	1.60E-01	poss
NR1	671205	730807	13	-5.09E-01	2.3	1.70	-8.00E-01	-2.20E-01	prob
NR3	680530	830629	3.2	1.34E-01	-0.8	2.22	-2.40E-02	2.90E-01	poss
NR4	730917	920929	8.8	-9.55E-03	-1.3	2.77	-9.60E-02	7.70E-02	
NR5	680530	760830	12	-5.87E-02	0.3	2.01	-3.50E-01	2.40E-01	
OS1	711021	930427	3.3	1.41E-01	-2.8	5.30	-3.70E-02	3.20E-01	poss
OS3	720115	921123	2.6	3.28E-02	-0.8	2.00	-6.10E-02	1.30E-01	poss
OS4	850403	931216	5.7	-3.85E-02	-1.1	2.10	-2.60E-01	1.80E-01	
OS5	860910	931216	3.9	2.43E-01	-2.7	1.68	-8.70E-02	5.70E-01	poss
OS6	780724	931020	5.5	5.24E-02	-1.1	1.89	-4.80E-02	1.50E-01	poss
OS7	730917	931104	7.7	-4.10E-02	-0.6	1.89	-9.20E-02	1.00E-02	poss
PB1	730918	931209	7.8	-3.32E-02	0.1	1.49	-7.20E-02	5.30E-03	poss
PB2	770513	931209	11	1.09E-01	-2.4	2.45	2.50E-02	1.90E-01	prob
RB1	701014	931217	5.8	3.99E-04	-1.6	2.54	-7.00E-02	7.10E-02	poss
RB2	750722	931019	5.1	2.13E-02	-2.3	3.23	-1.30E-01	1.80E-01	poss
RB3	670930	931217	6.9	-7.33E-02	-0.1	2.18	-1.20E-01	-2.60E-02	prob
RB4	690917	931216	5.9	-4.64E-02	-0.6	5.30	-1.90E-01	1.00E-01	
RB5	721017	931217	13	-4.74E-02	-0.6	1.91	-8.60E-02	-8.70E-03	prob
RB6	721017	931006	5.7	-4.49E-02	-0.4	1.59	-8.20E-02	-7.70E-03	prob
RB7	761110	931217	5.6	-3.34E-02	-0.8	2.17	-1.30E-01	6.40E-02	
RB8	670930	931006	10	2.03E-02	-0.6	1.28	-6.50E-03	4.70E-02	poss
RB9	670930	931102	5.3	-6.07E-02	-0.2	2.42	-1.20E-01	-2.70E-03	prob
SC1	690501	931013	6.7	-9.60E-02	1.1	1.40	-1.20E-01	-7.20E-02	prob
SC2	690501	931203	13	-1.14E-01	1.0	2.20	-1.40E-01	-8.50E-02	prob
SC3	690501	931117	21	-1.14E-01	0.6	2.14	-1.40E-01	-8.90E-02	prob
UL01	690615	931112	2.8	-4.15E-02	-0.2	1.99	-1.20E-01	3.70E-02	
UL02	690615	931217	6.2	-9.91E-02	0.6	2.21	-1.50E-01	-4.70E-02	prob
UL03	680828	931217	8.9	7.66E-02	-0.7	2.34	3.40E-02	1.20E-01	prob
UL04	750106	930914	4.3	2.73E-04	-0.9	1.52	-6.20E-02	6.30E-02	poss
UL05	760611	931119	6	-6.47E-02	-0.4	2.31	-1.60E-01	2.90E-02	poss
UL06	690715	931216	6.1	5.56E-02	-0.4	2.03	8.00E-03	1.00E-01	prob
UL07	690715	931209	5.5	-4.54E-02	0.0	1.77	-8.40E-02	-7.10E-03	prob
UL08	771107	931026	6.1	2.52E-02	-0.2	2.05	-7.20E-02	1.20E-01	poss
UL09	780516	930825	6.8	-1.08E-01	0.8	1.60	-1.80E-01	-3.30E-02	prob

(continued)

Table 6-41
Trend analyses for dissolved oxygen deficit (WQDODEF), upper 1 metre
(continued)

Segment	*period of record*		*avg obs/yr*	*slope ppm/yr*	*intcp*	*SEE*	*95% conf on slope lower*	*upper*	*trend*
UL10	690415	931119	4.8	-7.72E-03	-0.2	1.68	-4.90E-02	3.40E-02	
UL11	680827	921209	1.2	1.05E-01	-1.1	2.23	-2.00E-02	2.30E-01	poss
UL14	871006	880802	2.4						
GMI1	890105	931123	7.4	-3.45E-01	1.5	0.62	-4.80E-01	-2.10E-01	prob
GMI2	871021	931112	23	-3.41E-02	0.6	0.67	-9.30E-02	2.50E-02	
GMI3	871021	931112	30	4.52E-02	0.4	0.60	-4.50E-03	9.50E-02	poss
GMI4	730917	931122	8.6	7.19E-02	-0.9	1.05	4.60E-02	9.80E-02	prob
GMI5	860818	931122	21	6.74E-02	0.2	0.82	-3.00E-03	1.40E-01	poss
GMI6	690326	930730	8.5	-2.55E-02	0.5	1.10	-4.50E-02	-6.20E-03	prob
GMI7	850212	930503	42	1.69E-01	-1.0	1.27	6.80E-02	2.70E-01	prob
GMI8	850626	931022	20	1.00E-01	-0.8	1.25	-1.20E-02	2.10E-01	poss
GMI9	871022	931116	15	8.19E-02	-1.1	2.07	-1.40E-01	3.10E-01	poss
GMO2	791106	801028	2						
GMO4	850416	931122	1.2	3.94E-01	-1.9	0.69	1.70E-01	6.20E-01	prob
GMO5	850212	920817	6.3	-2.48E-01	0.4	2.39	-5.80E-01	8.20E-02	poss
GMO6	720919	931025	1.6	-3.50E-02	0.2	0.94	-8.80E-02	1.80E-02	poss
GMO7	850212	930503	9.1	2.78E-02	-0.8	1.43	-1.10E-01	1.70E-01	poss

Summary by component bay
Fraction (percent) of segments with data exhibiting indicated trend

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	38.5	15.4	15.4	23.1	7.7	-2.00E-02	4.05E-03
Copano Bay	55.6	11.1	11.1	22.2	0.0	-2.79E-02	
St Charles	100	0	0	0	0.0	-1.14E-01	
Mesquite	50	0	0	50	0.0	-2.32E-02	
Redfish	50	0	25	25	0.0	-2.83E-02	
Corpus Christi	15	10	20	30	25.0	-5.92E-03	1.38E-02
CCSC (bay)	40	0	40	20	0.0	-3.77E-02	
Inner Harbor	14.3	0	42.9	14.3	14.3	-1.12E-02	2.71E-02
Nueces Bay	40	0	40	20	0.0	-1.87E-02	
Aransas Pass	25	0	25	50	0.0	-1.36E-02	
Causeway N	0	33.3	0	66.7	0.0		
Causeway S	25	0	50	25	0.0	-2.48E-02	
Laguna (King)	23.1	15.4	23.1	23.1	15.4	-1.80E-02	1.02E-02
Laguna (Baffin)	0	0	66.7	33.3	0.0		
Baffin Bay	20	20	40	20	0.0	-1.30E-02	
GOM inlet	16.7	33.3	0	33.3	16.7	-4.25E-03	2.82E-02

Table 6-42
Summary of trend analysis by component bay for WQALK
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	100	0	0	0	0	-1.25E-01	
Copano Bay	0	0	0	100	0		
St Charles	0	0	100	0	0		
Mesquite	100	0	0	0	0	-3.95E-01	
Redfish	100	0	0	0	0	-3.04E-01	
Corpus Christi	100	0	0	0	0	-9.85E-02	
CCSC (bay)	100	0	0	0	0	-2.56E-01	
Inner Harbor	100	0	0	0	0	-6.64E-01	
Nueces Bay	50	0	50	0	0	-2.85E-01	
Aransas Pass							
Causeway N							
Causeway S	100	0	0	0	0	-4.60E-01	
Laguna (King)	100	0	0	0	0	-2.48E-01	
Laguna (Baffin)	100	0	0	0	0	-2.70E-01	
Baffin Bay	50	50	0	0	0	-6.38E-01	
GOM inlet	100	0	0	0	0	-1.85E-01	

Table 6-43
Summary of trend analysis by component bay for WQPH
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (pH/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	0	9.1	27.3	0	63.6		1.00E-02
Copano Bay	0	0	11.1	11.1	77.8		8.50E-03
St Charles	0	0	0	100	0		
Mesquite	0	0	0	75	25		2.02E-03
Redfish	37.5	25	37.5	0	0	-1.28E-02	
Corpus Christi	41.2	17.6	11.8	29.4	0	-1.62E-02	
CCSC (bay)	20	40	20	20	0	-3.72E-03	
Inner Harbor	28.6	0	14.3	57.1	0	-4.47E-02	
Nueces Bay	0	20	0	60	20		7.28E-03
Aransas Pass	0	0	75	25	0		
Causeway N	100	0	0	0	0	-3.55E-02	
Causeway S	0	0	0	66.7	33.3		9.98E-03
Laguna (King)	33.3	33.3	11.1	11.1	11.1	-8.38E-03	6.80E-04
Laguna (Baffin)	0	0	100	0	0		
Baffin Bay	40	60	0	0	0	-1.26E-02	
GOM inlet	0	0	50	50	0		

Table 6-44
Summary of trend analysis by component bay for WQAMMN
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	28.6	14.3	42.9	14.3	0	-1.00E-03	
Copano Bay	16.7	0	66.7	16.7	0	-4.43E-04	
St Charles	0	50	50	0	0		
Mesquite	0	33.3	33.3	33.3	0		
Redfish	16.7	0	66.7	16.7	0	-6.78E-04	
Corpus Christi	40	6.7	13.3	33.3	6.7	-2.74E-03	1.06E-03
CCSC (bay)	40	0	40	0	20	-1.76E-03	1.26E-03
Inner Harbor	57.1	0	28.6	0	14.3	-1.34E-02	2.24E-03
Nueces Bay	0	0	20	40	40		6.36E-03
Aransas Pass	0	0	33.3	33.3	33.3		2.29E-02
Causeway N	50	0	0	50	0	-1.50E-03	
Causeway S	50	0	50	0	0	-1.38E-03	
Laguna (King)	33.3	16.7	33.3	16.7	0	-1.12E-03	
Laguna (Baffin)	100	0	0	0	0	-1.17E-03	
Baffin Bay	80	0	0	20	0	-5.72E-03	
GOM inlet	0	0	50	0	50		1.08E-02

Table 6-45
Summary of trend analysis by component bay for WQNO3N
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	28.6	14.3	28.6	14.3	14.3	-8.60E-04	7.13E-04
Copano Bay	66.7	16.7	16.7	0	0	-7.80E-02	
St Charles	50	0	50	0	0	-1.31E-02	
Mesquite	0	33.3	33.3	33.3	0		
Redfish	42.9	0	28.6	14.3	14.3	-1.17E-02	5.96E-03
Corpus Christi	12.5	25	25	18.8	18.8	-1.69E-04	5.44E-04
CCSC (bay)	40	0	20	0	40	-3.45E-03	1.50E-03
Inner Harbor	0	0	60	40	0		
Nueces Bay	20	0	0	40	40	-2.36E-03	4.34E-03
Aransas Pass	50	0	50	0	0	-5.08E-03	
Causeway N	33.3	0	0	33.3	33.3	-6.07E-03	1.75E-03
Causeway S	0	0	50	50	0		
Laguna (King)	50	0	16.7	33.3	0	-5.86E-03	
Laguna (Baffin)	100	0	0	0	0	-1.11E-03	
Baffin Bay	60	0	20	20	0	-3.45E-03	
GOM inlet	0	0	50	0	50		8.90E-04

Table 6-46
Summary of trend analysis by component bay for WQTOTP
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	0	0	57.1	28.6	14.3		1.05E-04
Copano Bay	0	16.7	66.7	0	16.7		2.50E-04
St Charles	0	50	0	50	0		
Mesquite	0	0	50	50	0		
Redfish	0	16.7	16.7	16.7	50		1.85E-03
Corpus Christi	0	9.1	9.1	63.6	18.2		1.77E-04
CCSC (bay)	0	0	50	50	0		
Inner Harbor	25	25	25	25	0	-1.59E-03	
Nueces Bay	0	0	0	100	0		
Aransas Pass	0	0	100	0	0		
Causeway N	0	0	50	50	0		
Causeway S	0	0	0	100	0		
Laguna (King)	0	0	50	50	0		
Laguna (Baffin)	0	0	0	0	100		2.28E-04
Baffin Bay	20	20	40	20	0	-6.92E-04	
GOM inlet	0	0	0	100	0		

Table 6-47
Summary of trend analysis by component bay for WQTPO4
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	0	0	0	0	100		3.93E+00
Copano Bay	0	0	50	50	0		
St Charles	0	0	100	0	0		
Mesquite	0	0	0	100	0		
Redfish	0	0	0	100	0		
Corpus Christi	0	0	33.3	66.7	0		
CCSC (bay)	0	0	0	100	0		
Inner Harbor	0	75	25	0	0		
Nueces Bay	0	0	0	100	0		
Aransas Pass	0	0	0	100	0		
Causeway N	0	0	100	0	0		
Causeway S	0	0	0	100	0		
Laguna (King)	0	0	0	100	0		
Laguna (Baffin)	0	0	0	0	100		7.62E-04
Baffin Bay	0	33.3	66.7	0	0		
GOM inlet	0	0	100	0	0		

Table 6-48
Summary of trend analysis by component bay for WQCHLA
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	0	28.6	42.9	28.6	0		
Copano Bay	40	40	0	20	0	-3.17E+00	
St Charles	50	0	0	0	50	-5.25E+00	8.35E-01
Mesquite	33.3	33.3	33.3	0	0	-3.58E+00	
Redfish	0	0	66.7	33.3	0		
Corpus Christi	21.4	14.3	14.3	21.4	28.6	-5.11E-01	6.10E-01
CCSC (bay)	40	0	20	40	0	-7.88E-01	
Inner Harbor	100	0	0	0	0	-2.50E+00	
Nueces Bay	20	0	20	40	20	-2.34E-01	4.30E-02
Aransas Pass	50	50	0	0	0	-2.73E-01	
Causeway N	50	50	0	0	0	-1.81E-01	
Causeway S	0	0	0	100	0		
Laguna (King)	33.3	0	33.3	33.3	0	-8.08E-02	
Laguna (Baffin)	0	0	100	0	0		
Baffin Bay	20	0	40	20	20	-2.36E+00	4.02E-01
GOM inlet	0	0	100	0	0		

Table 6-49
Summary of trend analysis by component bay for WQBOD5
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	33.3	33.3	33.3	0	0	-1.70E-01	
Copano Bay	60	0	20	20	0	-7.36E-02	
St Charles	0	0	100	0	0		
Mesquite	0	0	100	0	0		
Redfish	0	50	0	50	0		
Corpus Christi	40	40	0	20	0	-5.15E-02	
CCSC (bay)	25	25	0	50	0	-4.62E-02	
Inner Harbor	0	42.9	57.1	0	0		
Nueces Bay	0	0	0	100	0		
Aransas Pass	0	0	0	0	100		1.43E-01
Causeway N	100	0	0	0	0	-5.63E-02	
Causeway S							
Laguna (King)	0	66.7	0	33.3	0		
Laguna (Baffin)	0	100	0	0	0		
Baffin Bay	20	40	0	0	40	-2.78E-01	1.40E+00
GOM inlet	0	0	100	0	0		

Table 6-50
Summary of trend analysis by component bay for WQXTSS
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	38.5	30.8	23.1	7.7	0	-6.89E-01	
Copano Bay	22.2	11.1	33.3	33.3	0	-2.38E-01	
St Charles	50	0	50	0	0	-3.54E-01	
Mesquite	25	0	25	50	0	-3.20E-01	
Redfish	37.5	12.5	25	25	0	-1.88E-01	
Corpus Christi	55	10	25	10	0	-1.25E+00	
CCSC (bay)	20	20	40	20	0	-1.35E-01	
Inner Harbor	0	0	66.7	0	33.3		9.38E+00
Nueces Bay	80	0	0	20	0	-3.33E+01	
Aransas Pass	0	0	50	0	50		1.43E+00
Causeway N	100	0	0	0	0	-8.43E-01	
Causeway S	100	0	0	0	0	-1.37E+00	
Laguna (King)	92.3	0	7.7	0	0	-1.33E+00	
Laguna (Baffin)	100	0	0	0	0	-1.04E+00	
Baffin Bay	100	0	0	0	0	-2.93E+00	
GOM inlet	16.7	16.7	16.7	33.3	16.7	-1.73E-01	4.23E-01

Table 6-51
Summary of trend analysis by component bay for WQTOC
Fraction (percent) of segments with data, exhibiting indicated trend
and average of probable trends (ppm/yr)

component bay	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	15.4	7.7	23.1	7.7	7.7	-3.73E-01	2.44E-01
Copano Bay	11.1	22.2	33.3	0.0	0.0	-8.83E-02	
St Charles	100.0	0.0	0.0	0.0	0.0	-3.45E+00	
Mesquite	25.0	0.0	25.0	0.0	0.0	-6.63E-01	
Redfish	25.0	12.5	37.5	0.0	0.0	-1.09E-01	
Corpus Christi	40.0	0.0	10.0	5.0	0.0	-4.03E-01	
CCSC (bay)	60.0	0.0	0.0	20.0	20.0	-4.52E-01	1.89E-01
Inner Harbor	0.0	0.0	0.0	0.0	85.7		2.03E+02
Nueces Bay	20.0	20.0	0.0	20.0	0.0	-2.56E-01	
Aransas Pass	25.0	25.0	0.0	25.0	0.0	-1.12E-01	
Causeway N	33.3	0.0	0.0	33.3	0.0	-2.04E-01	
Causeway S	25.0	0.0	0.0	0.0	0.0	-1.09E-01	
Laguna (King)	15.4	0.0	7.7	7.7	7.7	-1.31E-01	2.65E-02
Laguna (Baffin)	0.0	16.7	0.0	0.0	33.3		1.26E+00
Baffin Bay	60.0	0.0	20.0	20.0	0.0	-2.69E-01	
GOM inlet	16.7	0.0	0.0	0.0	0.0	-6.72E-02	

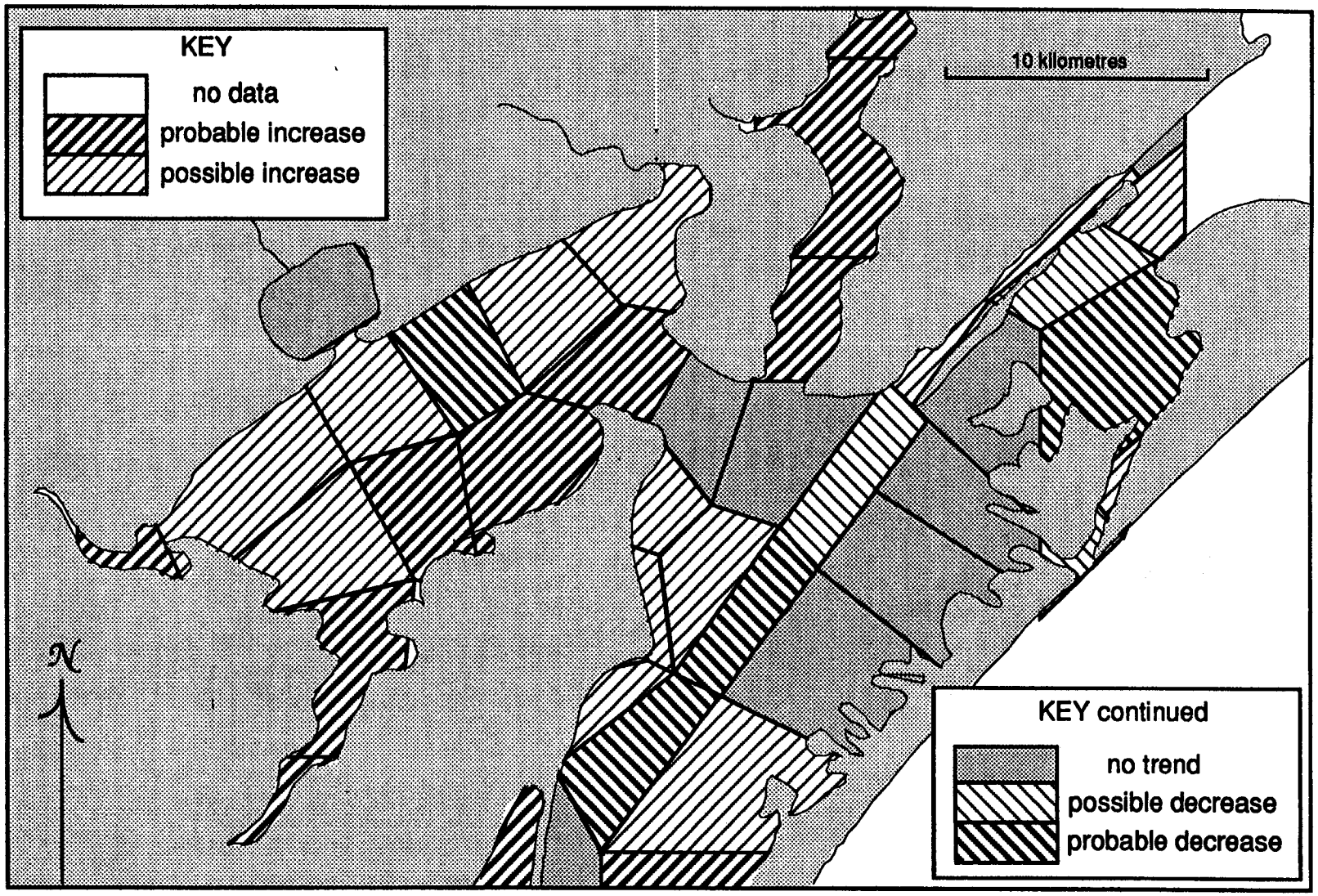


Figure 6-69. WQSAL in upper 1 m period-of-record time trends for Aransas-Copano system

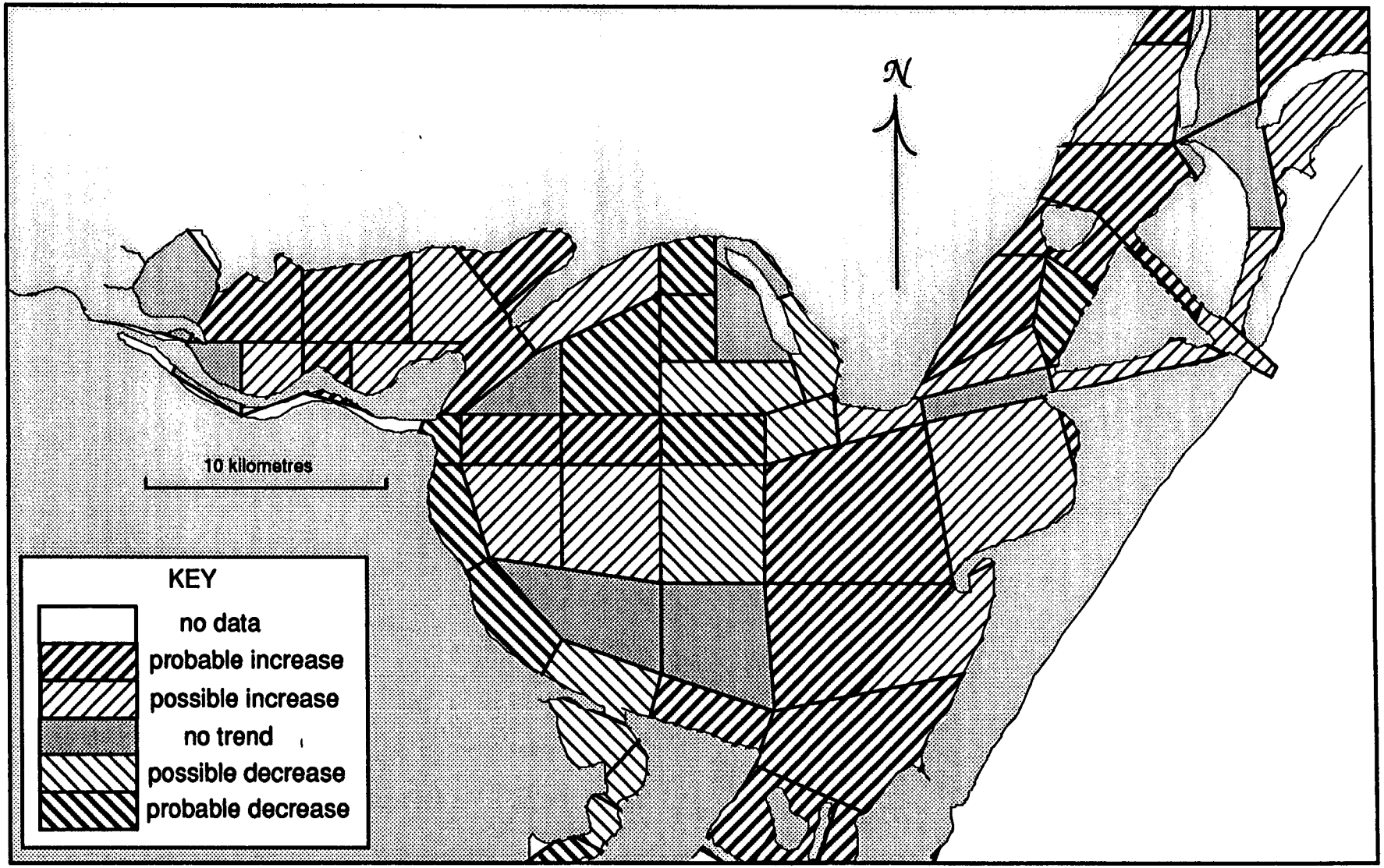


Figure 6-70. WQSAL in upper 1 m period-of-record time trends for Corpus Christi system

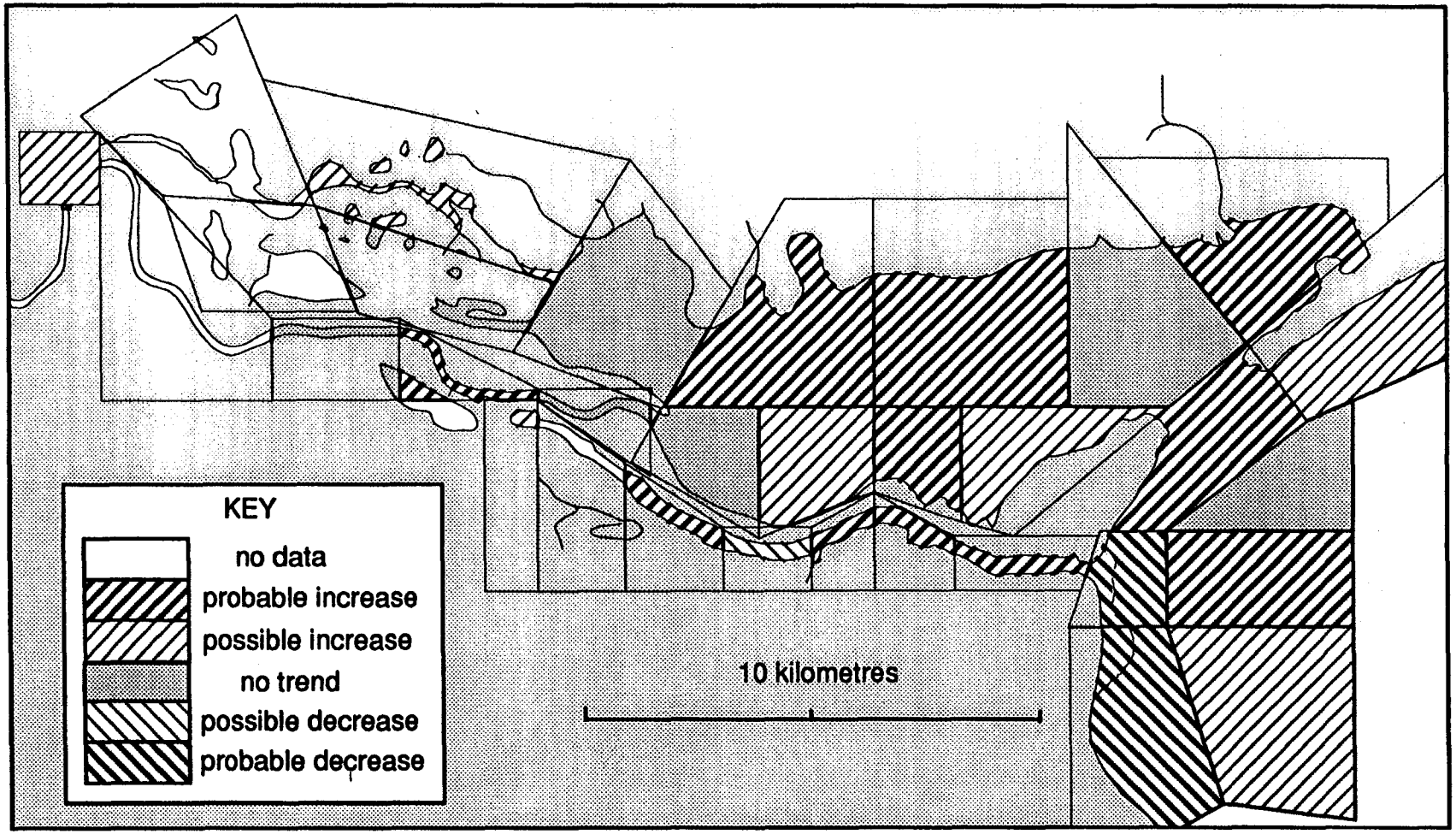


Figure 6-71. WQSAL in upper 1 m period-of-record time trends for Nueces Bay region, including Inner Harbor

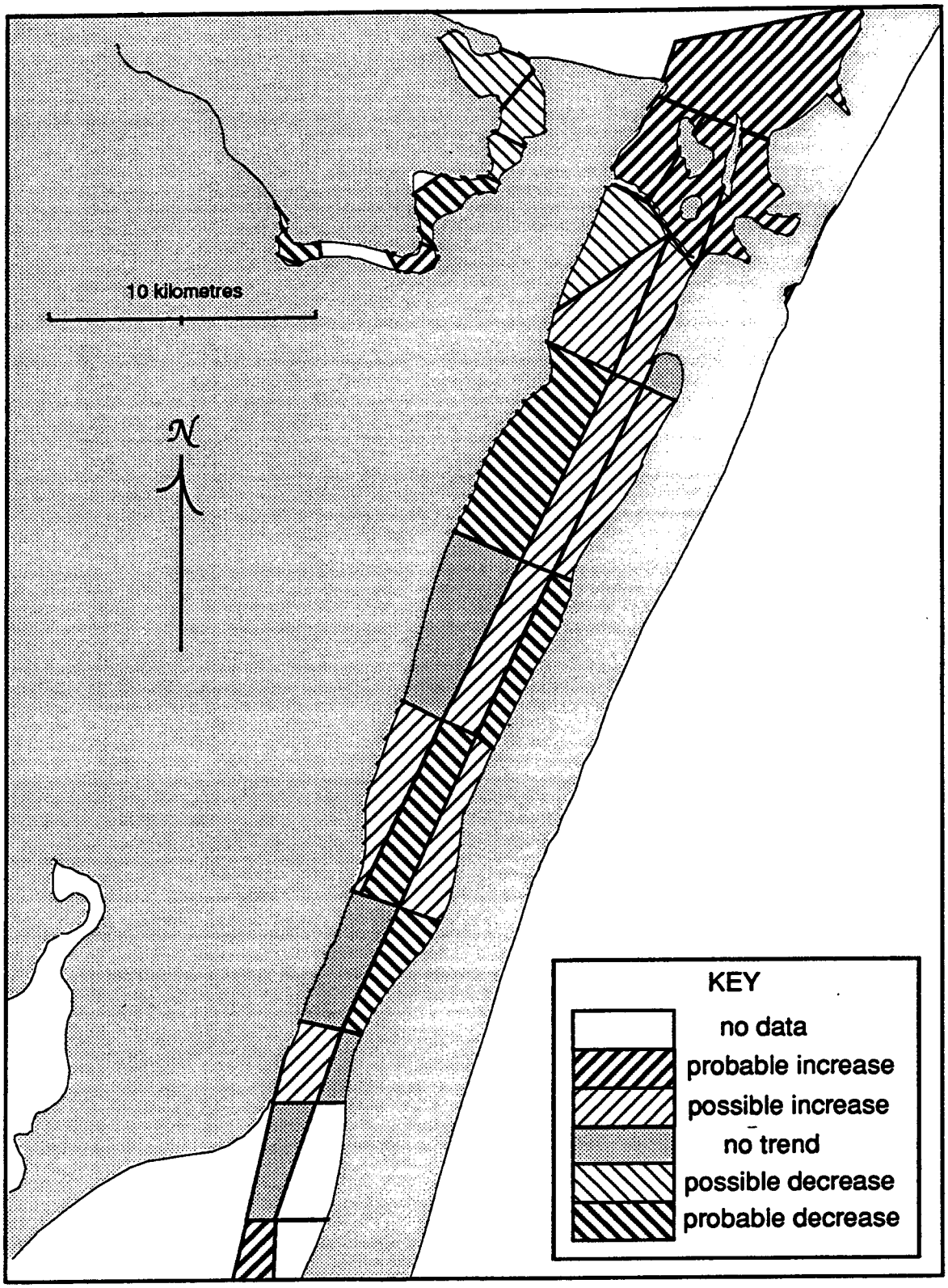


Figure 6-72. WQSAL in upper 1 m period-of-record trends for Upper Laguna Madre

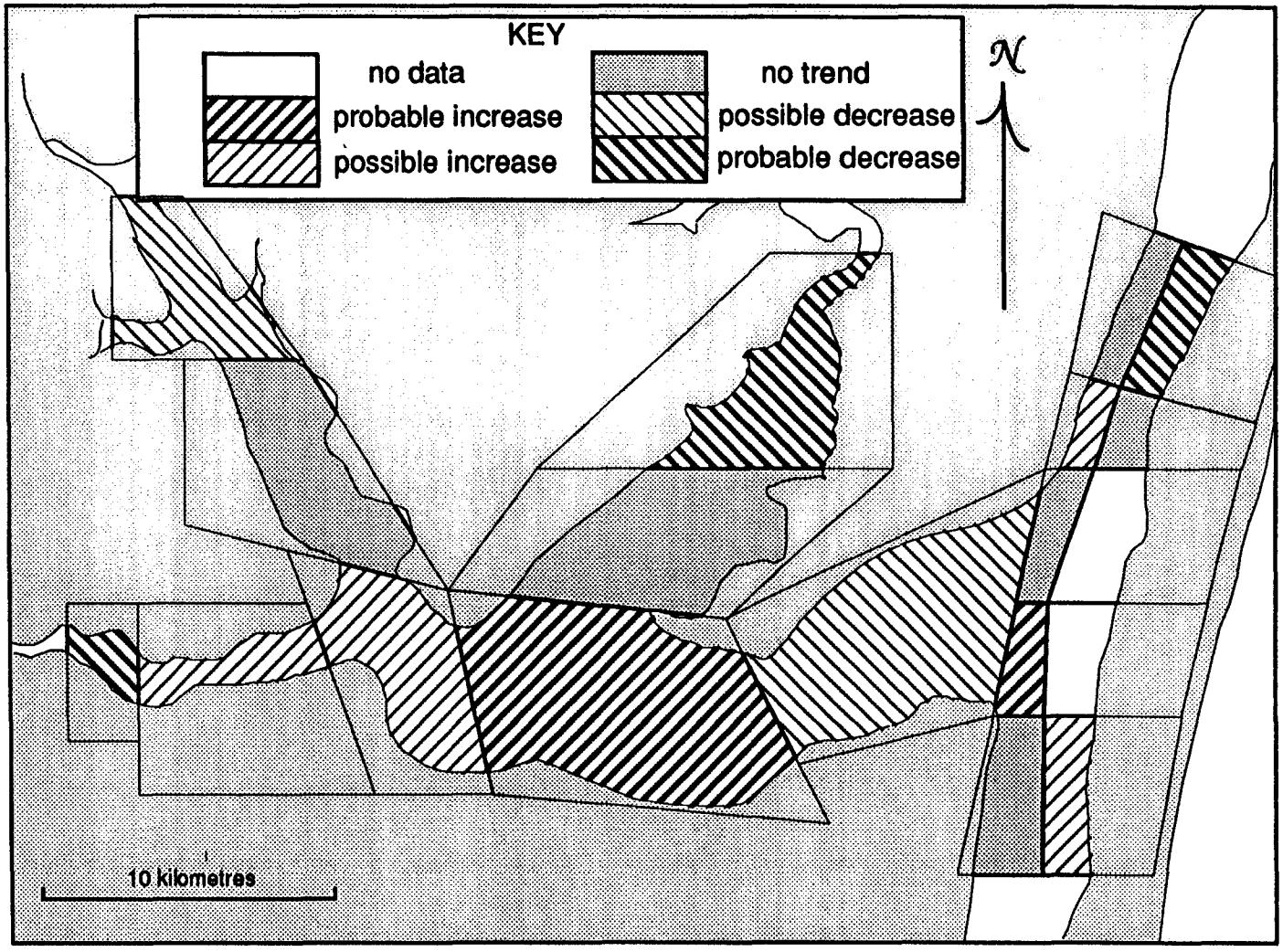


Figure 6-73. WQSAL in upper 1 m period-of-record time trends for Baffin Bay region

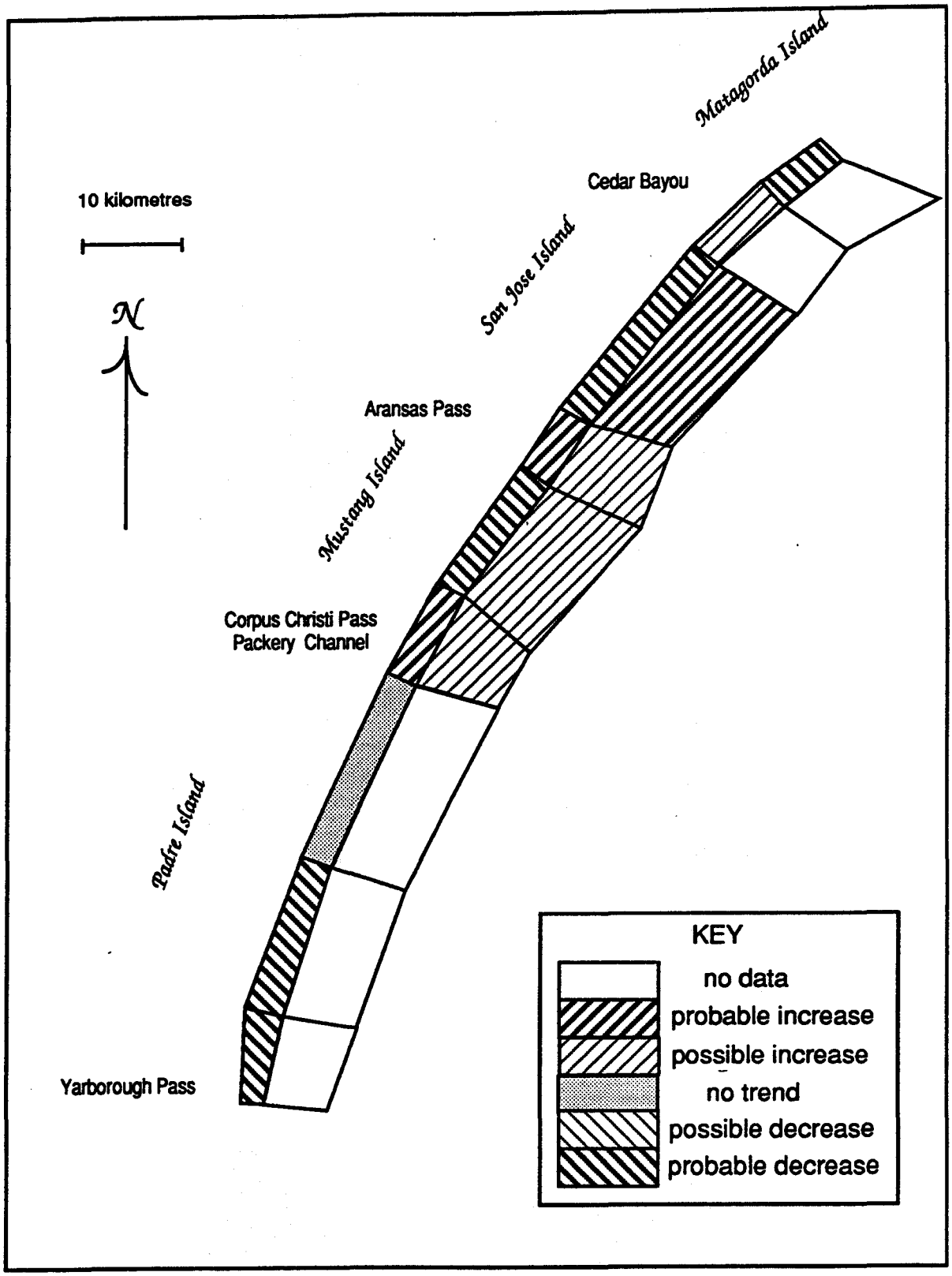


Figure 6-74. WQSAL in upper 1 m period-of-record trends for Gulf of Mexico

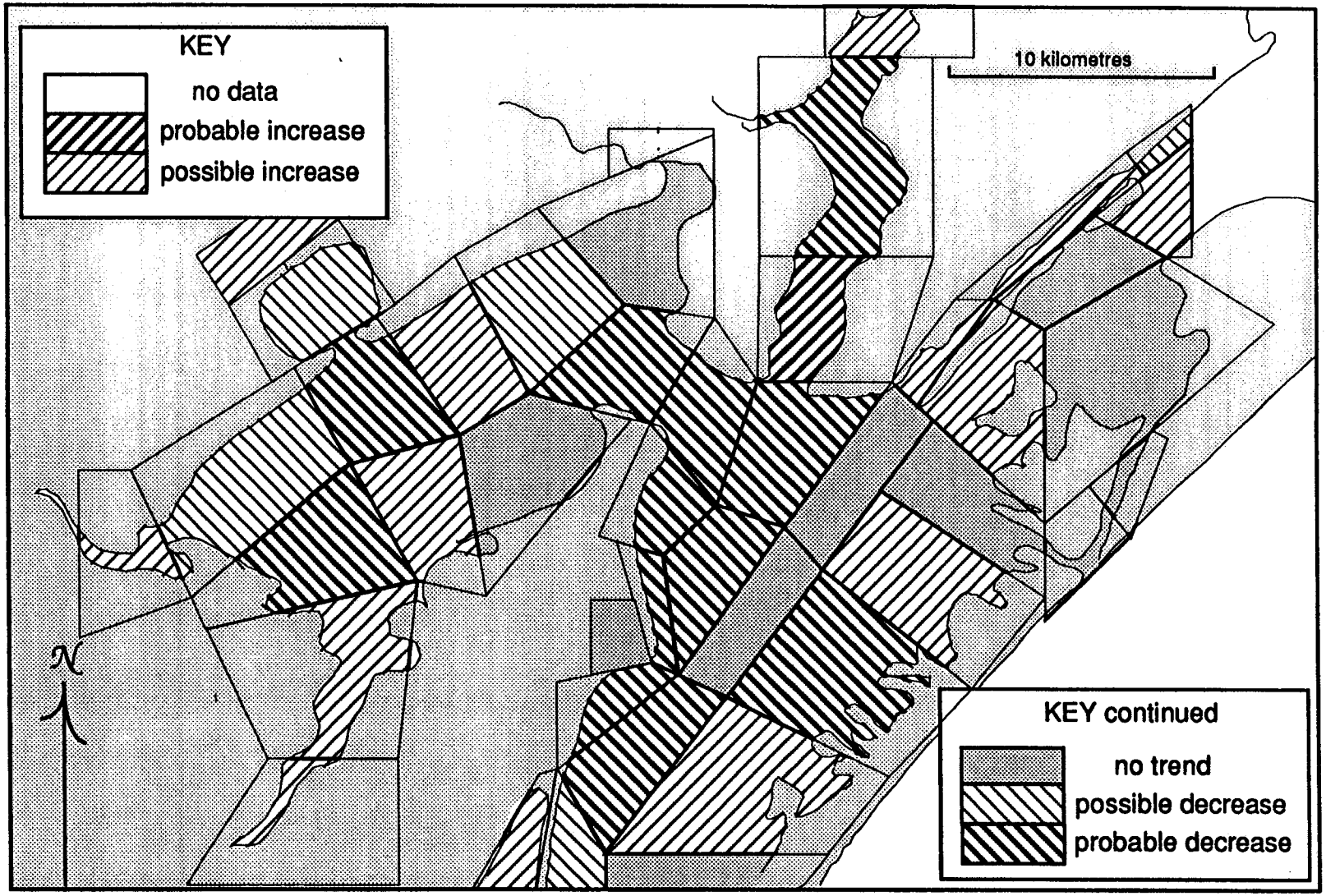


Figure 6-75. WQTEMP in upper 1 m period-of-record time trends for Aransas-Copano system

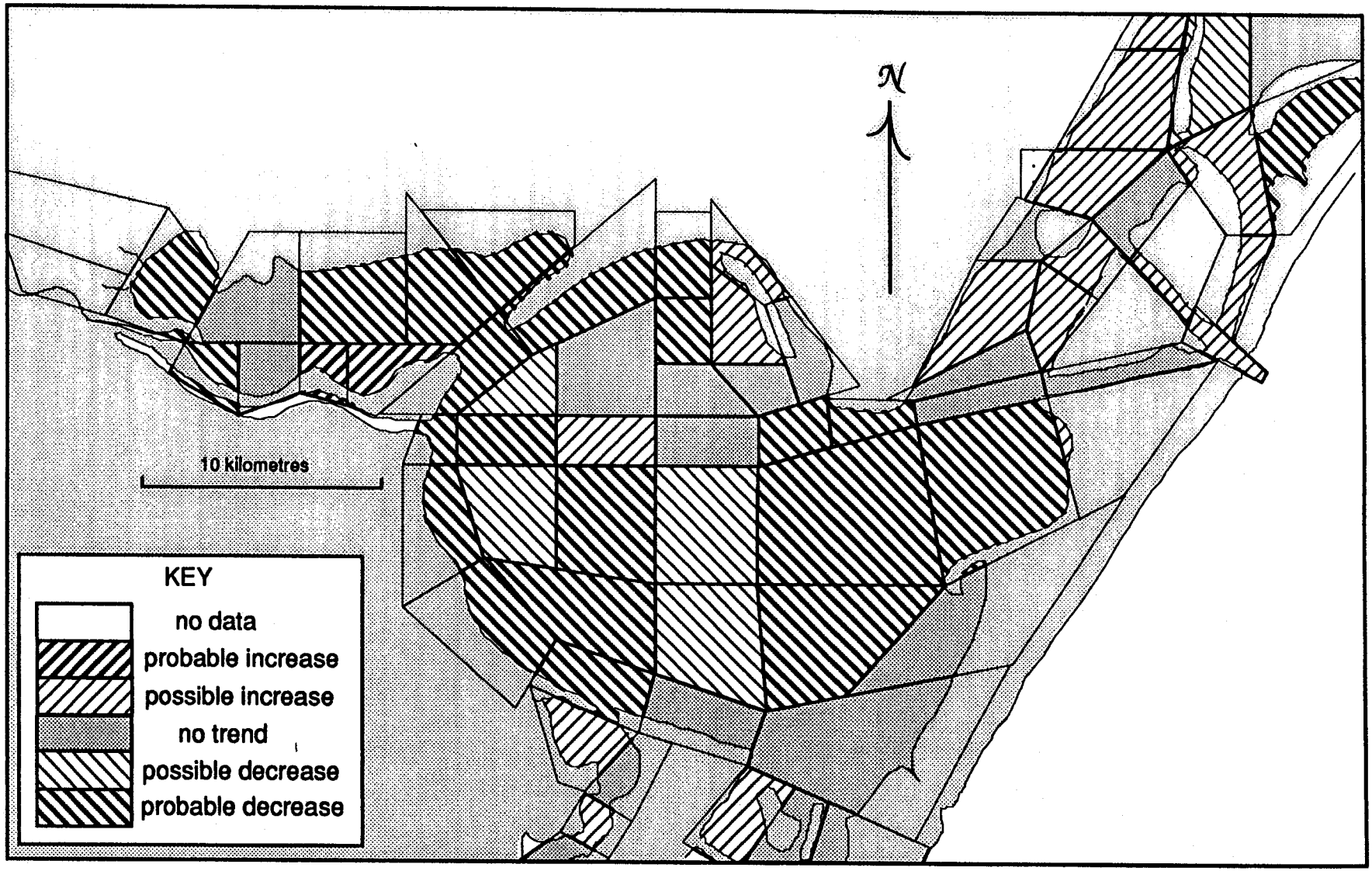


Figure 6-76. WQTEMP in upper 1 m period-of-record trends for Corpus Christi system

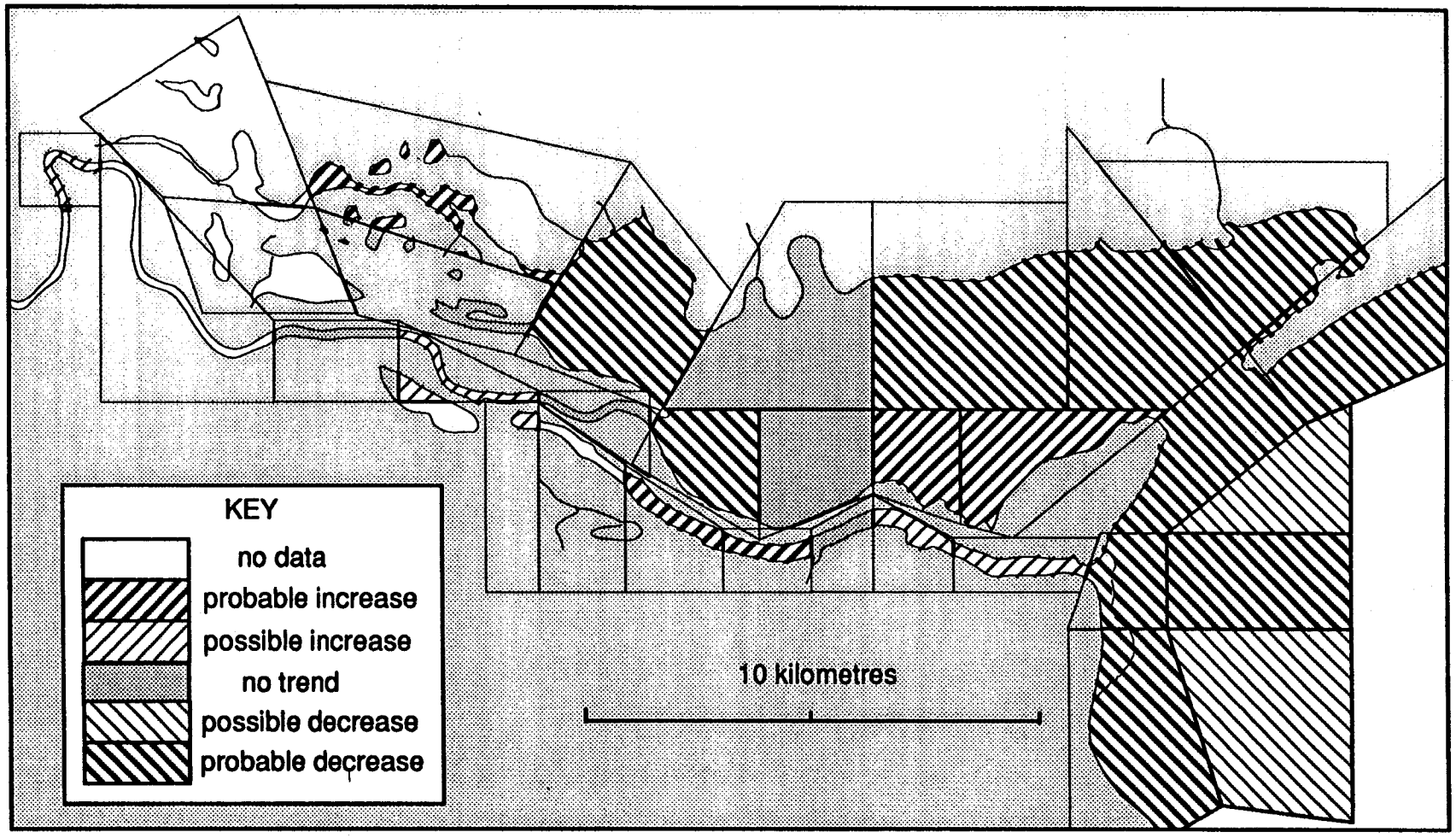


Figure 6-77. WQTEMP in upper 1 m period-of-record time trends for Nueces Bay region, including Inner Harbor

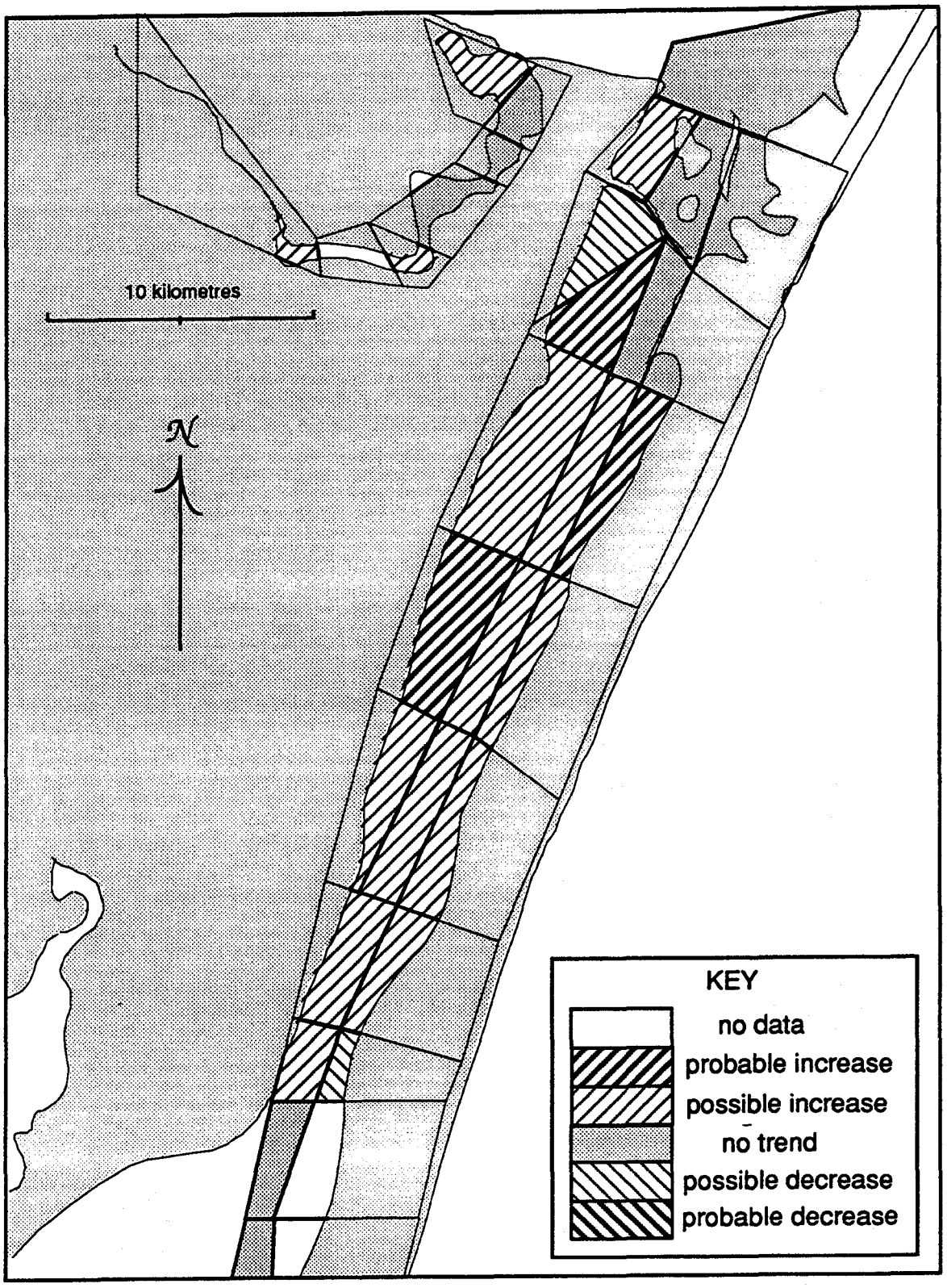


Figure 6-78. WQTEMP in upper 1 m period-of-record trends for Upper Laguna Madre

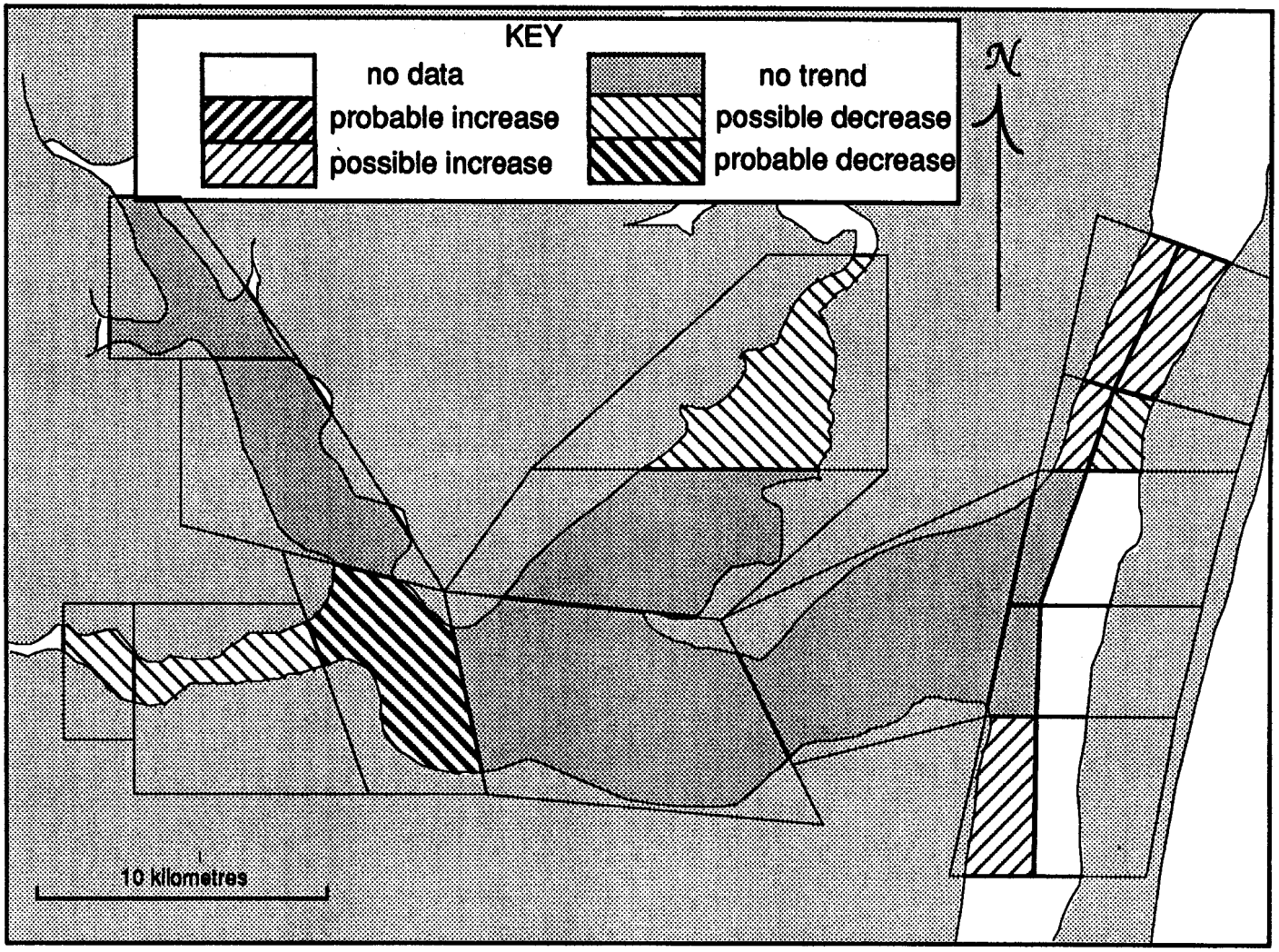


Figure 6-79. WQTEMP in upper 1 m period-of-record time trends for Baffin Bay region

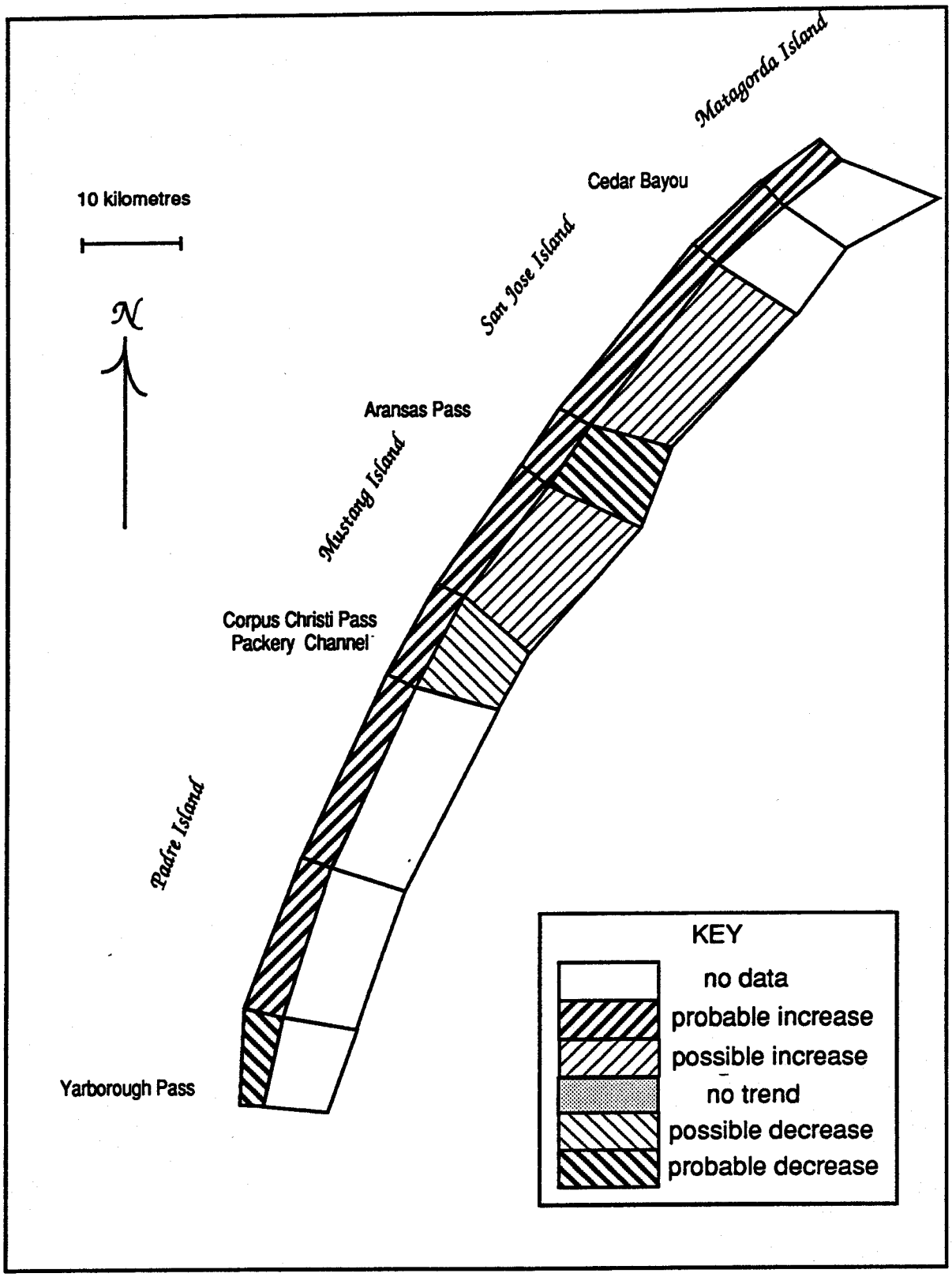


Figure 6-80. WQTEMP in upper 1 m period-of-record trends for Gulf of Mexico

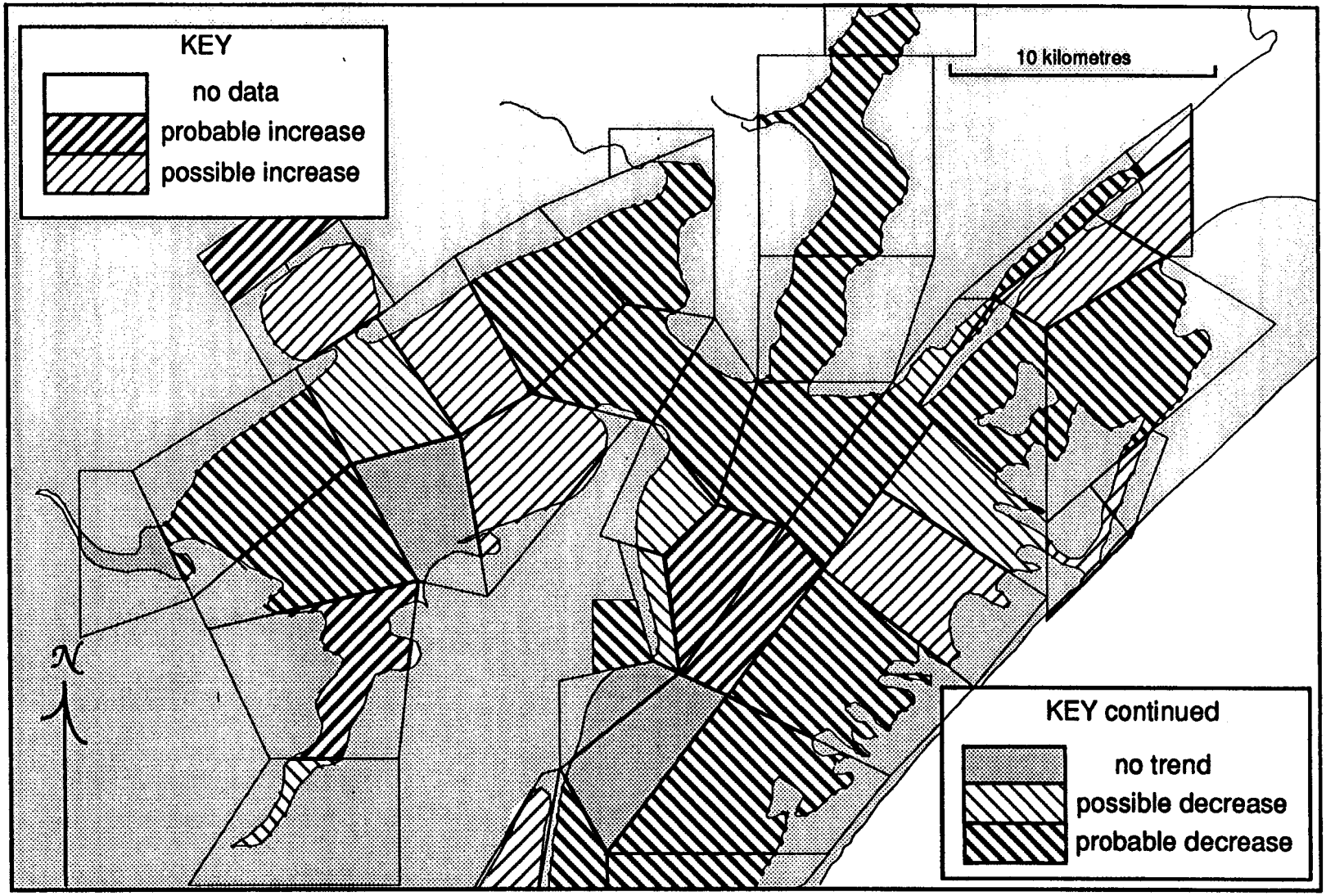


Figure 6-81. WQDODEF in upper 1 m period-of-record time trends for Aransas-Copano system

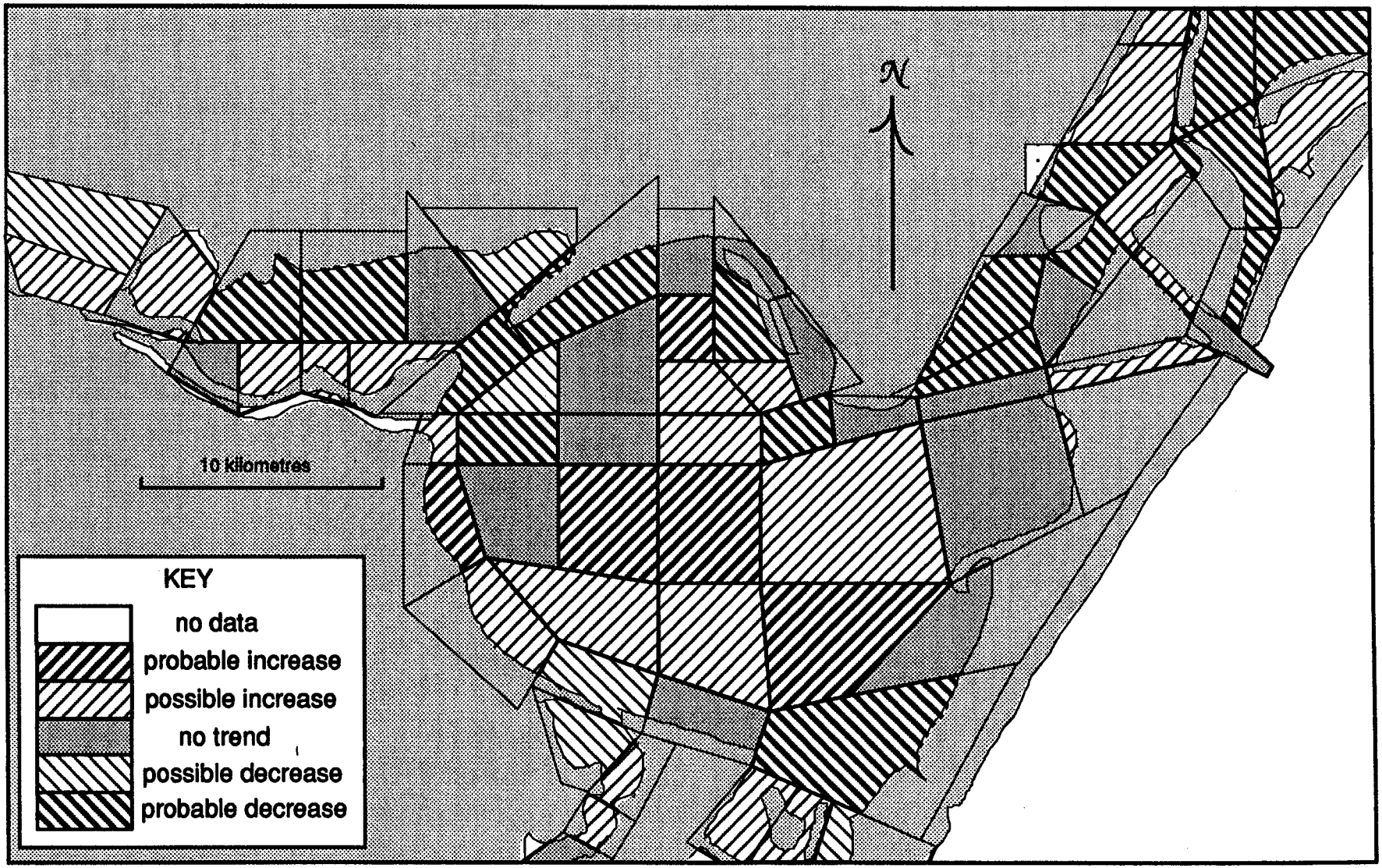


Figure 6-82. WQDODEF in upper 1 m period-of-record trends for Corpus Christi system

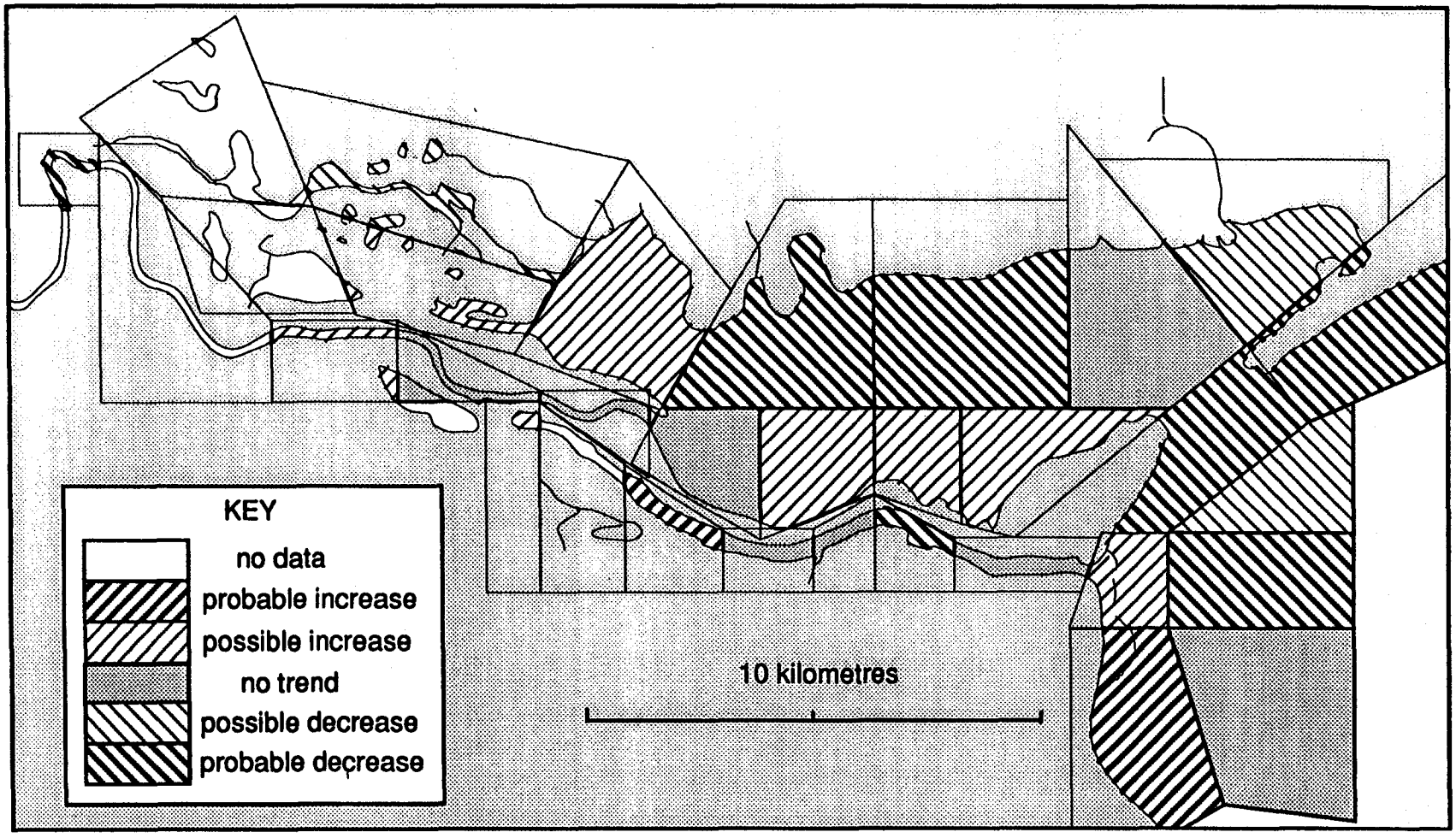


Figure 6-83. WQDODEF in upper 1 m period-of-record time trends for Nueces Bay region, including Inner Harbor

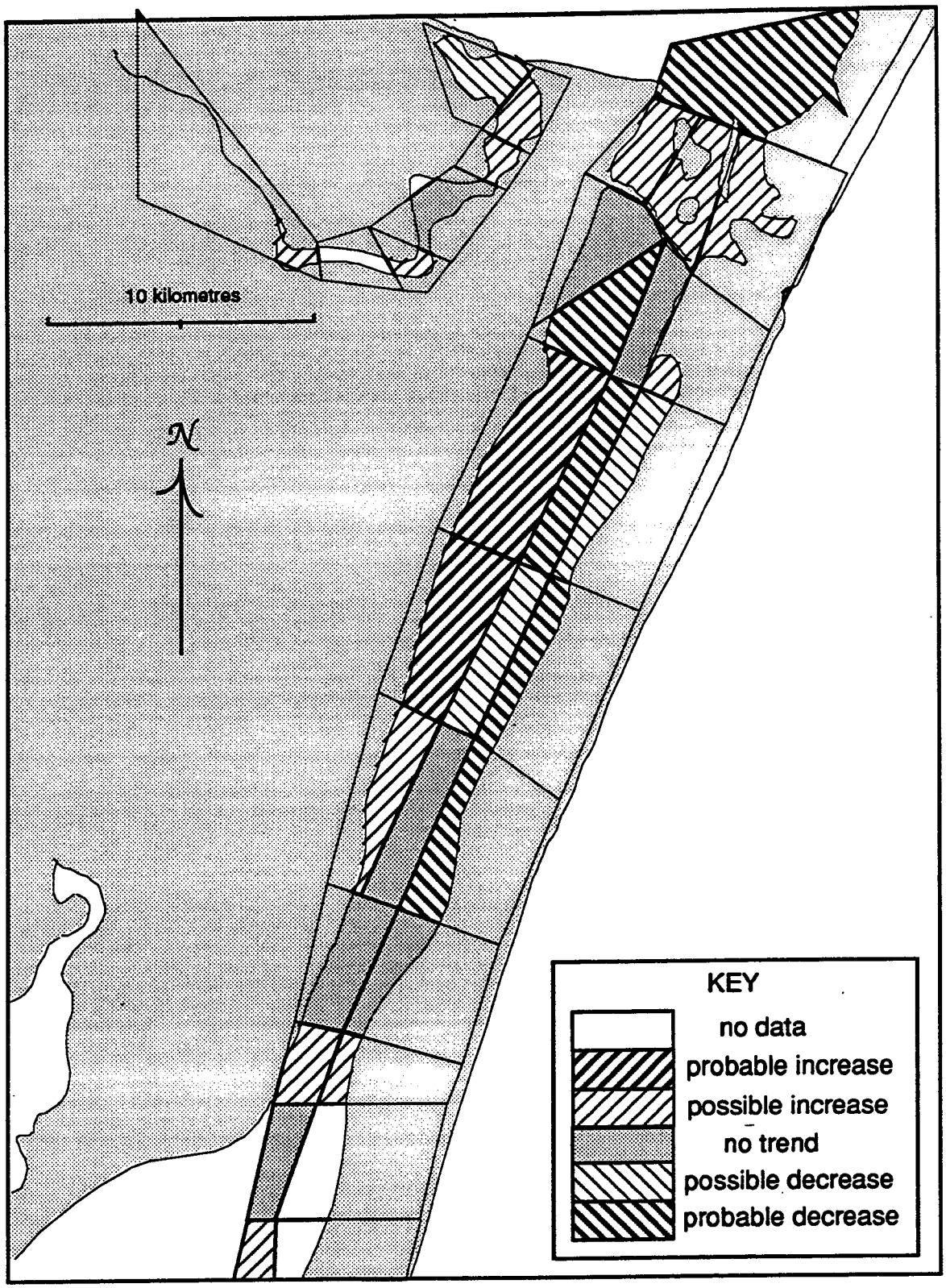


Figure 6-84. WQDODEF in upper 1 m period-of-record trends for Upper Laguna Madre

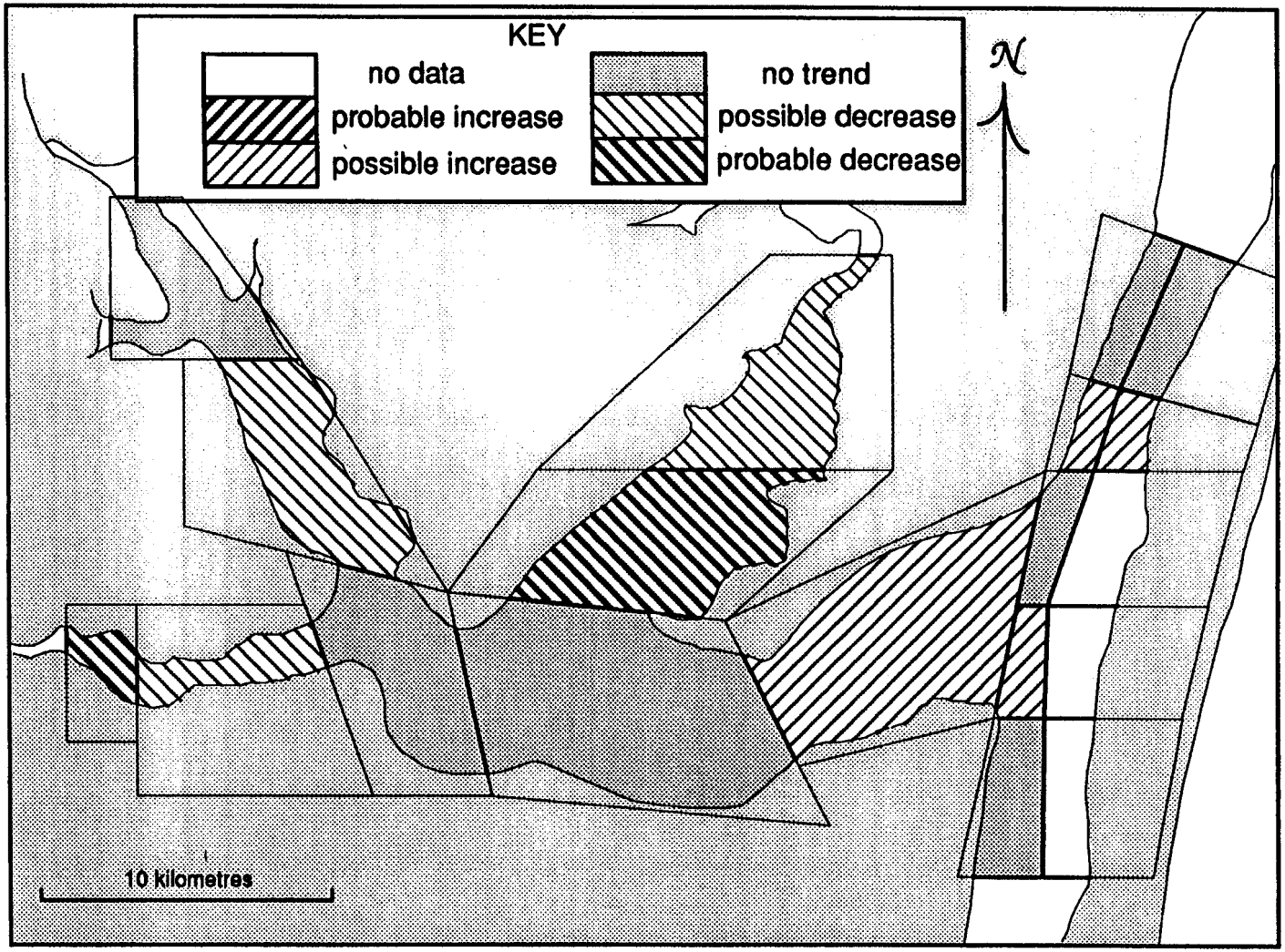


Figure 6-85. WQDODEF in upper 1 m period-of-record time trends for Baffin Bay region

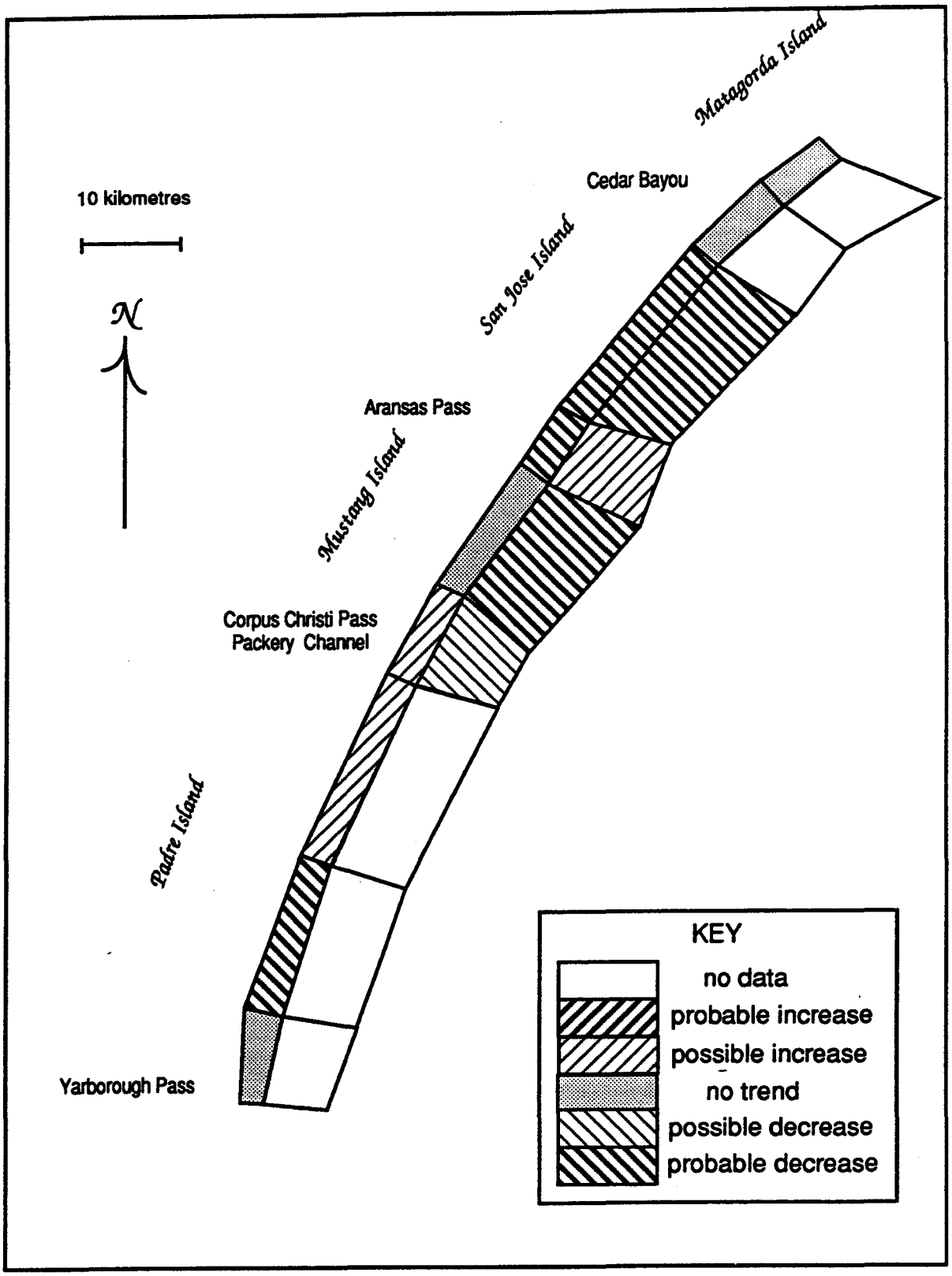


Figure 6-86. WQDODEF in upper 1 m period-of-record trends for Gulf of Mexico

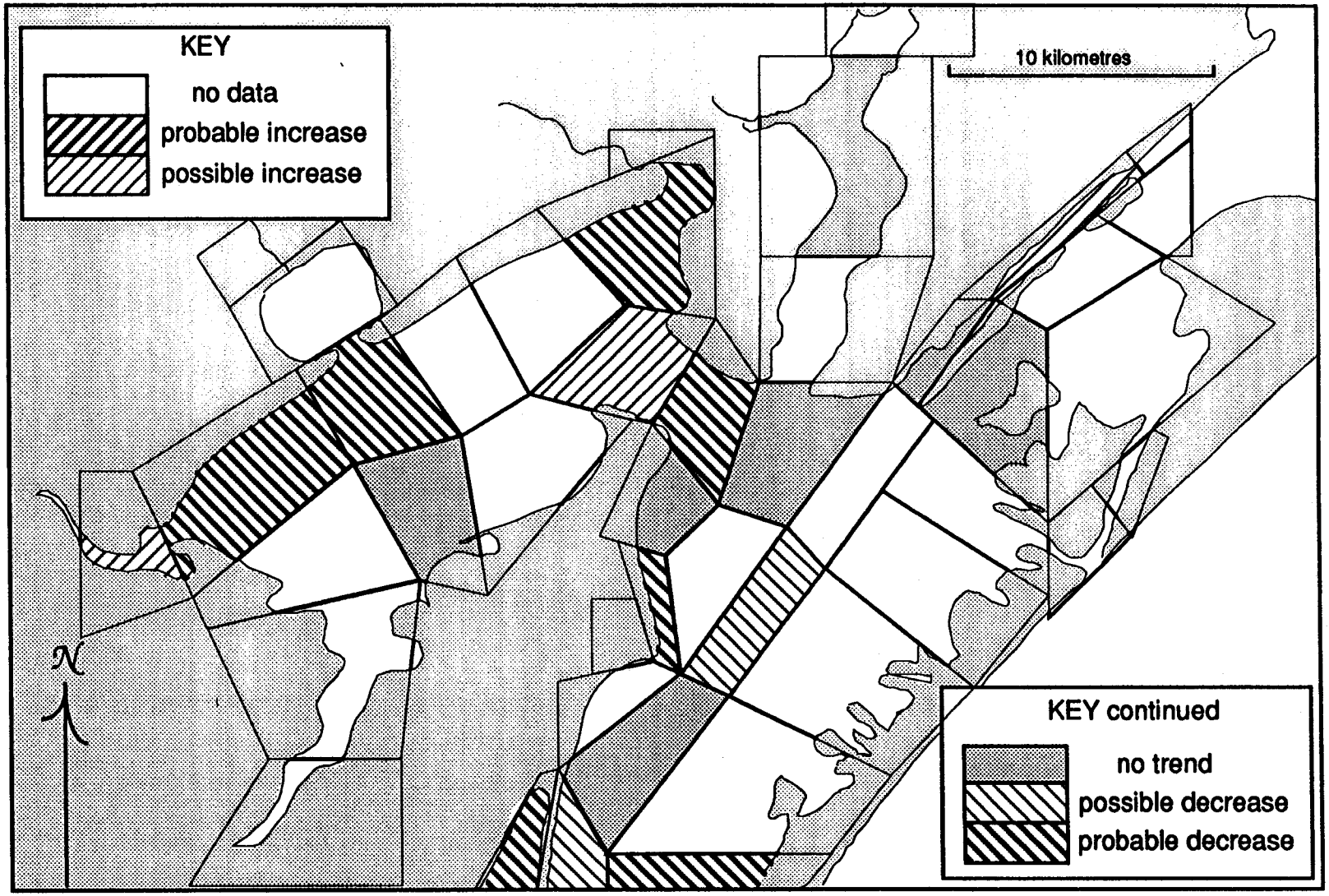


Figure 6-87. WQBOD5 period-of-record time trends for Aransas-Copano system

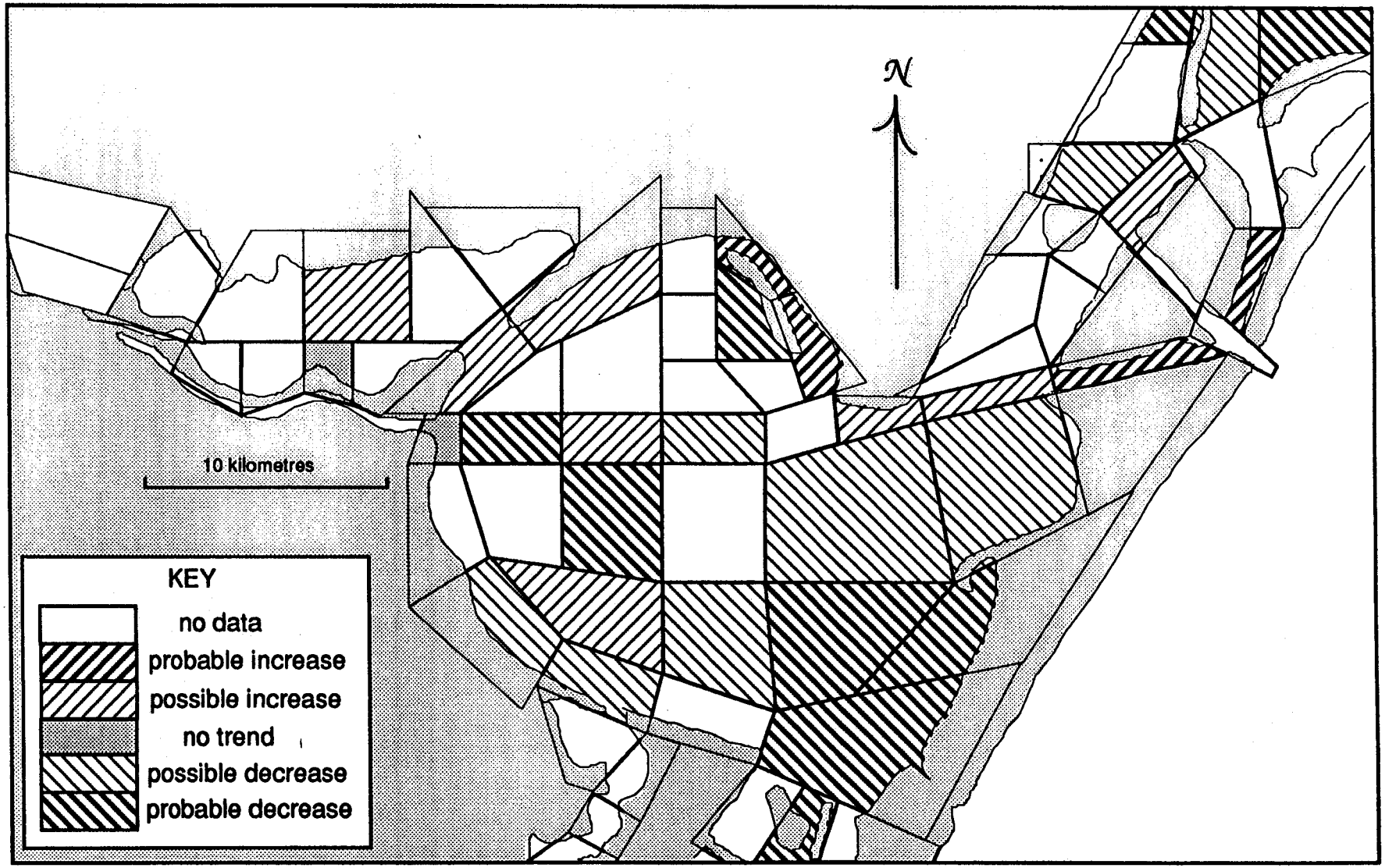


Figure 6-88. WQBOD5 period-of-record trends for Corpus Christi system

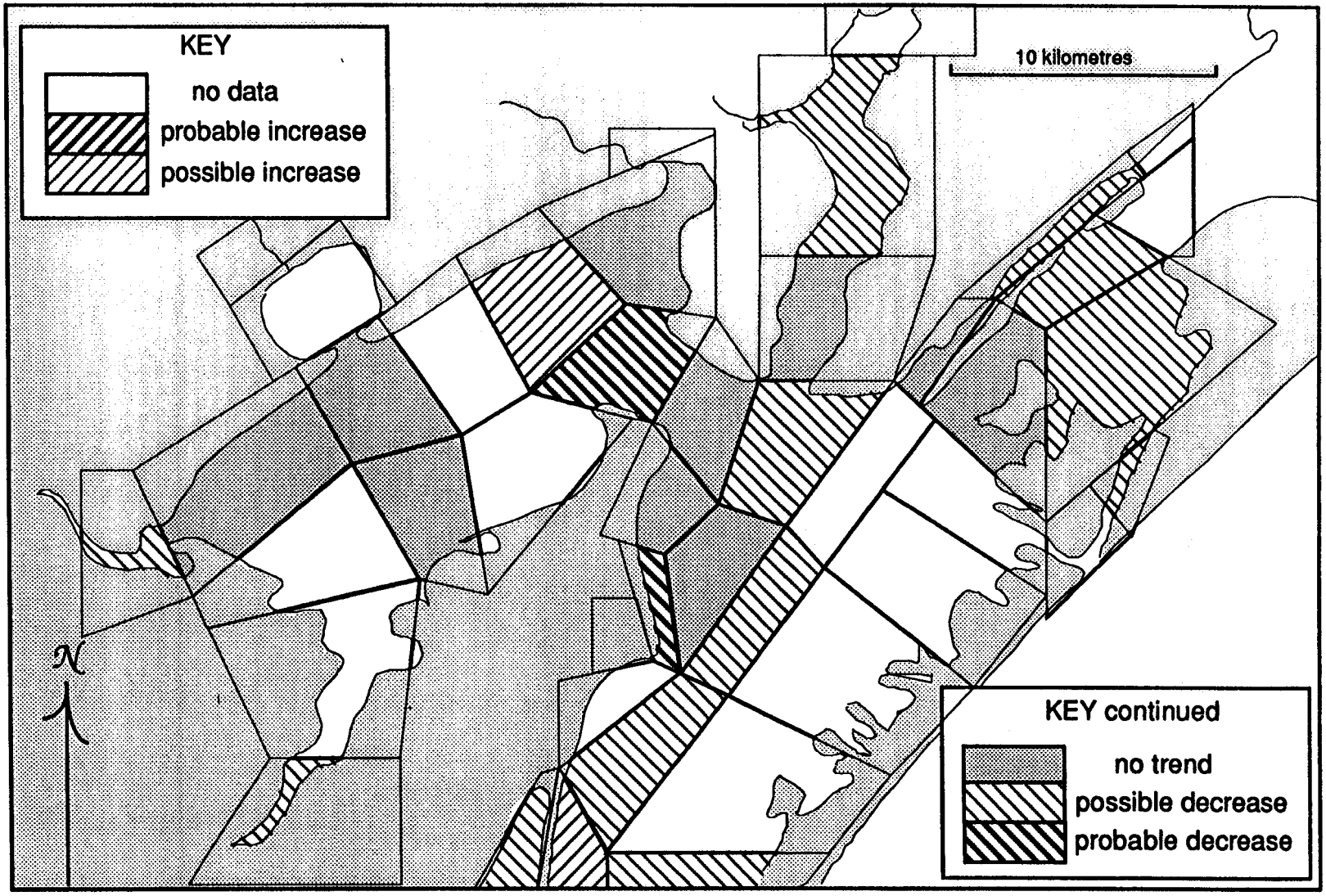


Figure 6-89. WQAMMN period-of-record time trends for Aransas-Copano system

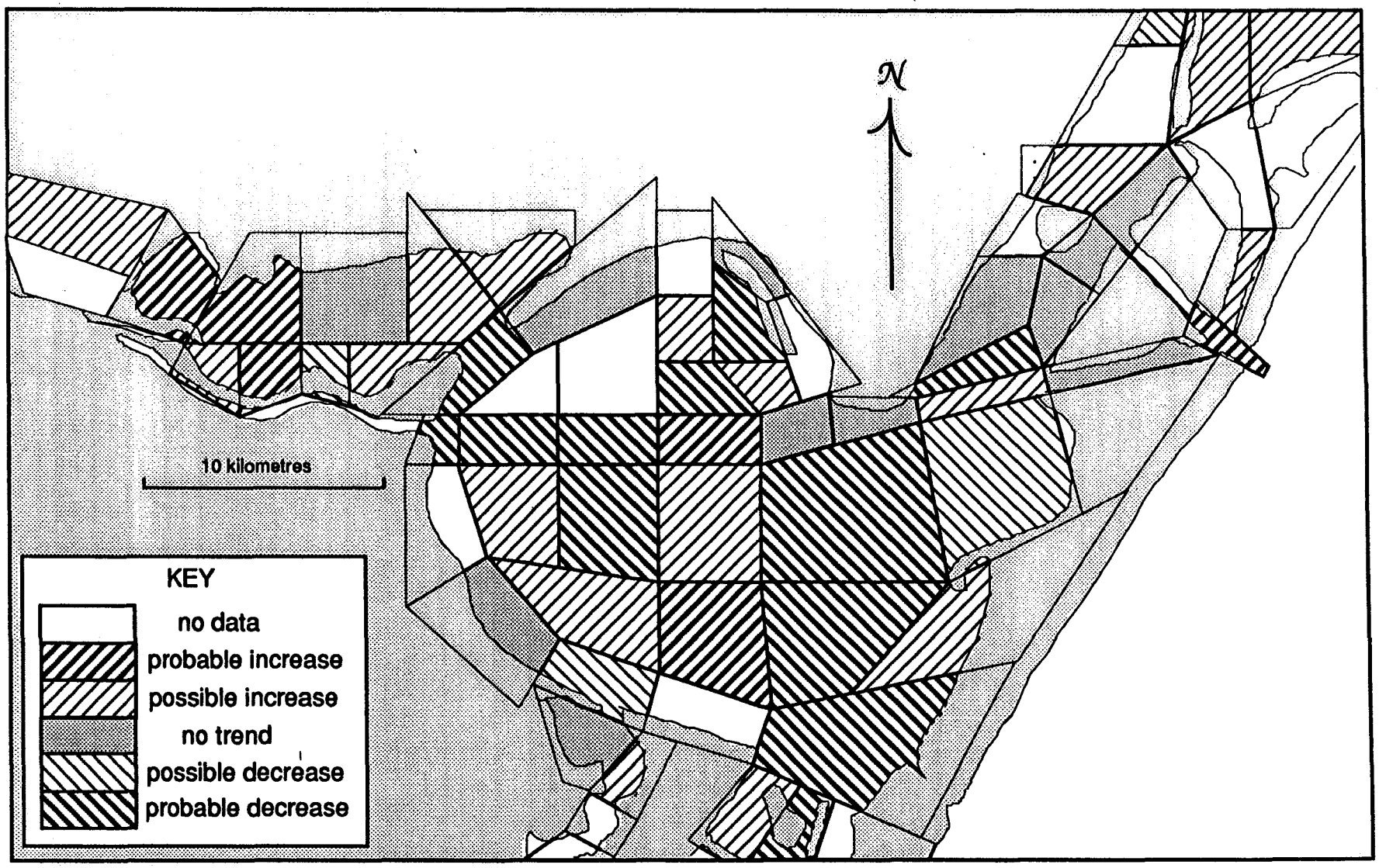


Figure 6-90. WQAMMN period-of-record trends for Corpus Christi system

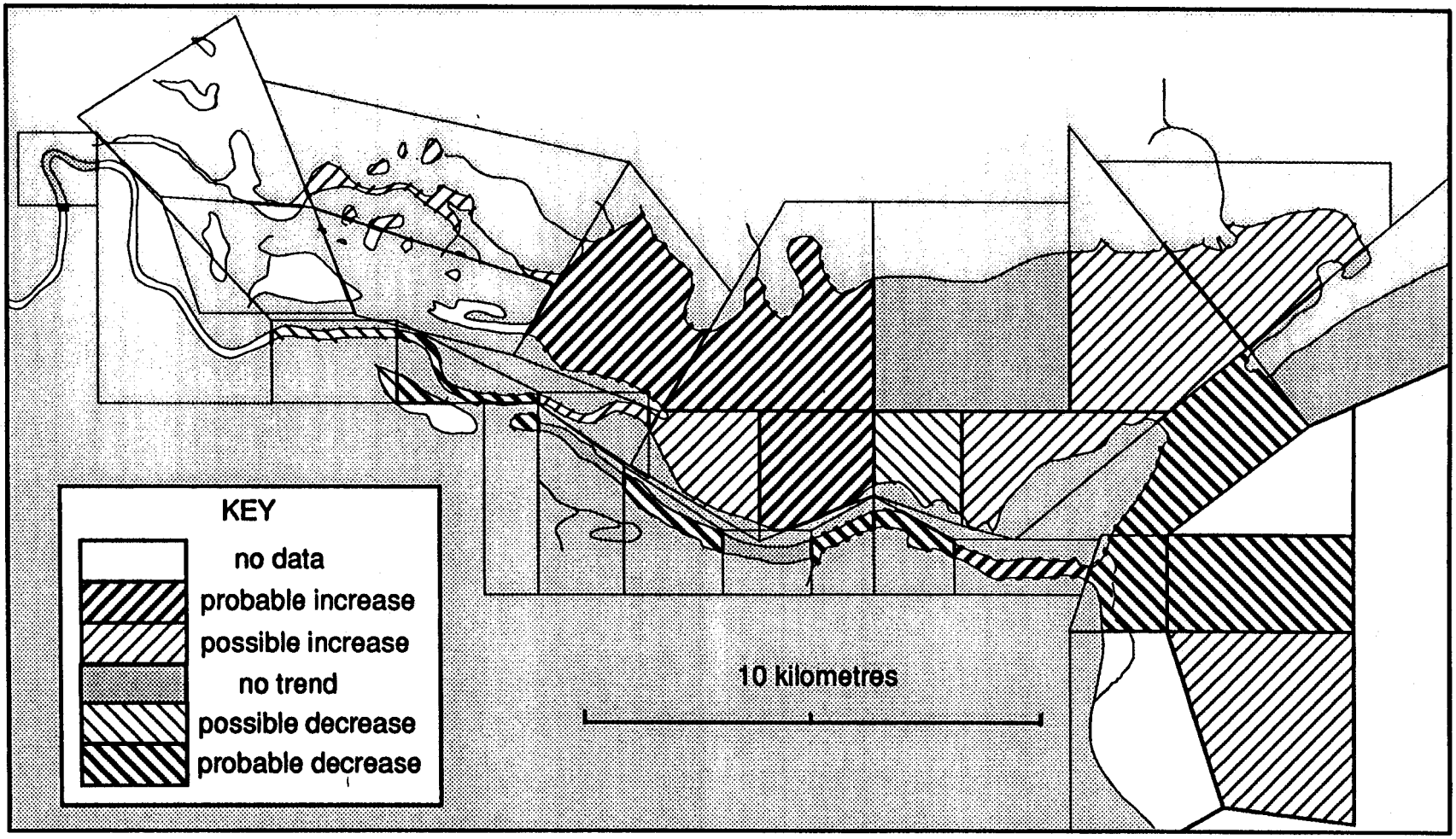


Figure 6-91. WQAMMN period-of-record time trends for Nueces Bay region, including Inner Harbor

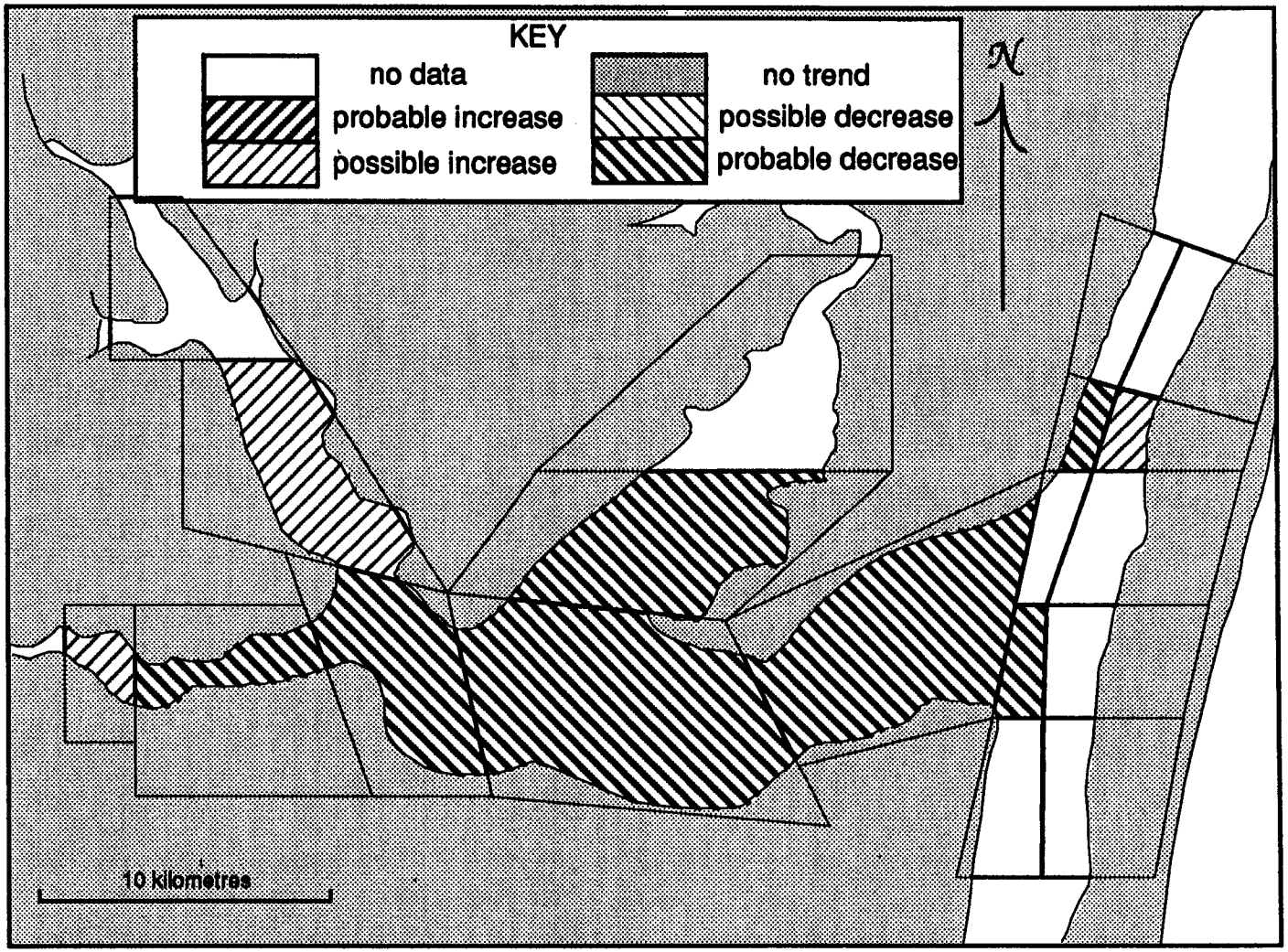


Figure 6-92. WQAMMN period-of-record time trends for Baffin Bay region

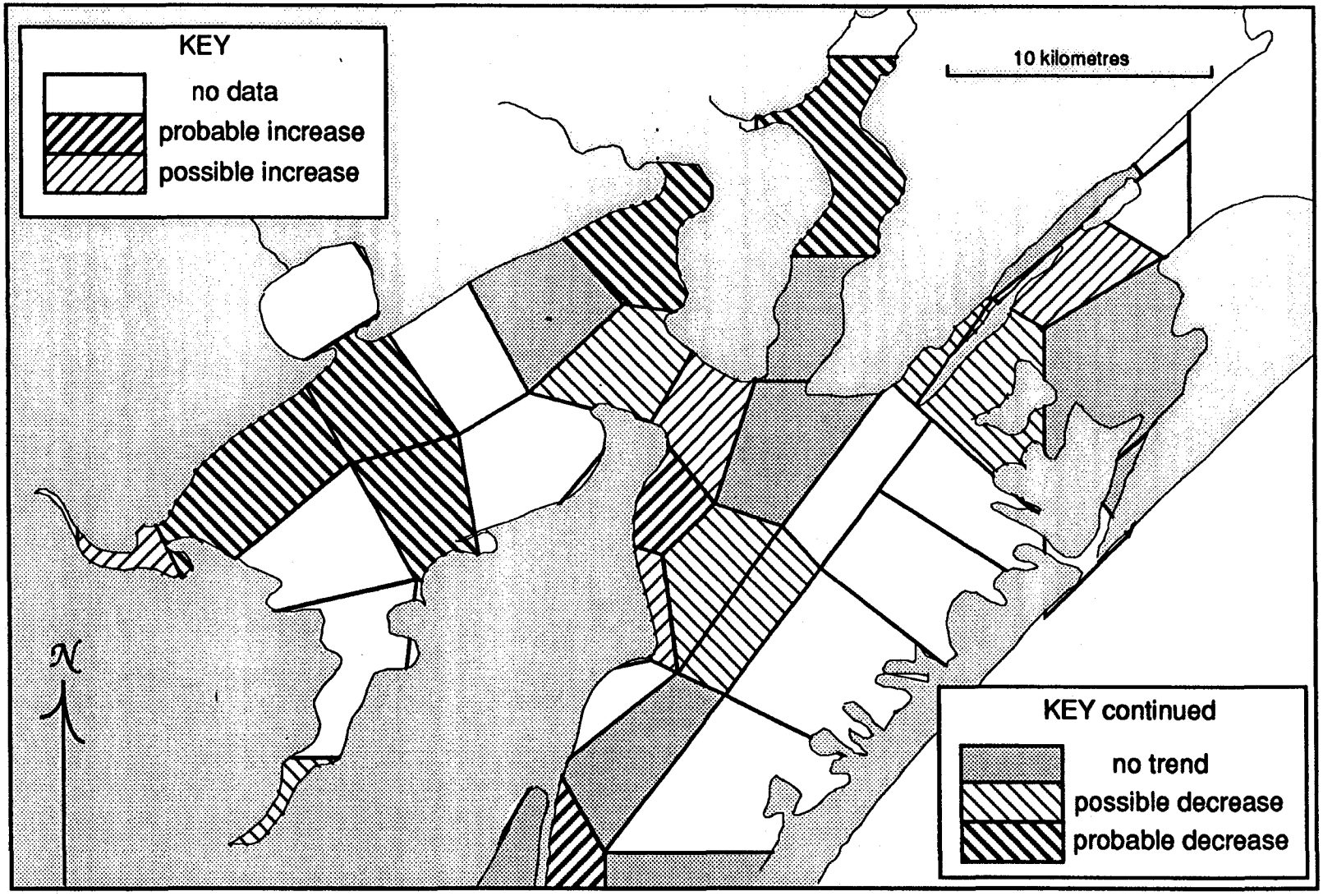


Figure 6-93. WQNO3N period-of-record time trends for Aransas-Copano system

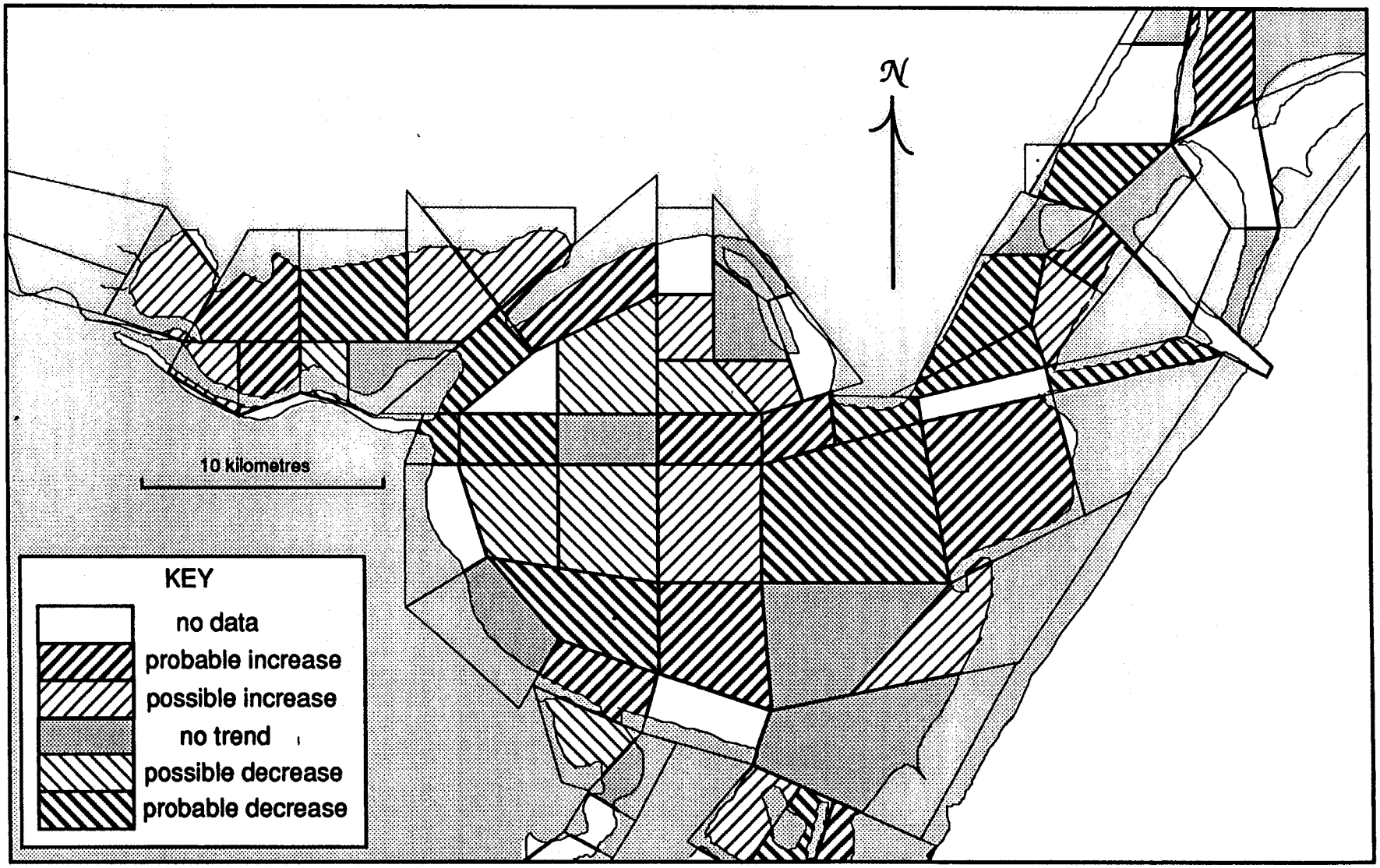


Figure 6-94. WQNO3N period-of-record trends for Corpus Christi system

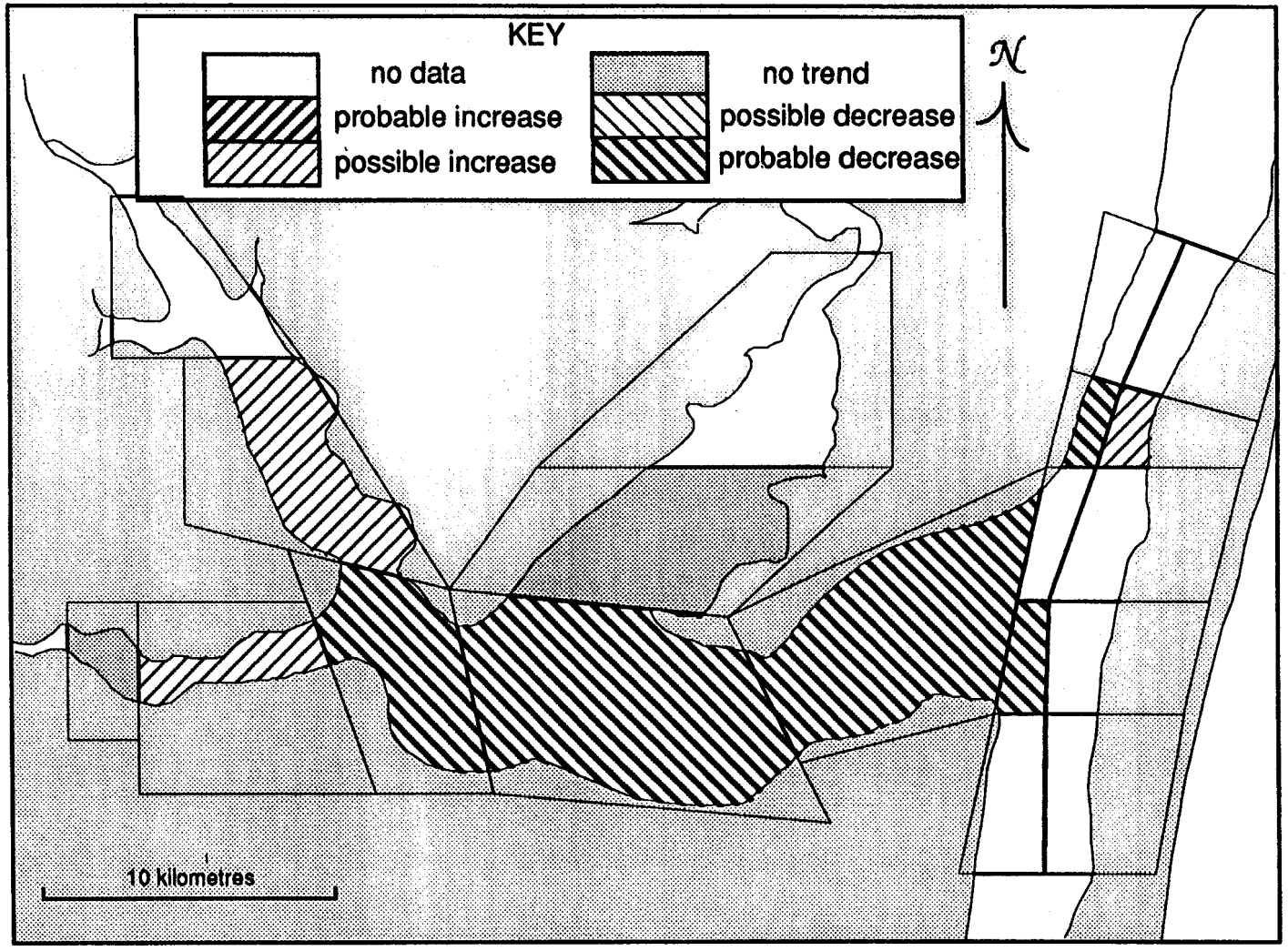


Figure 6-95. WQNO3N period-of-record time trends for Baffin Bay region

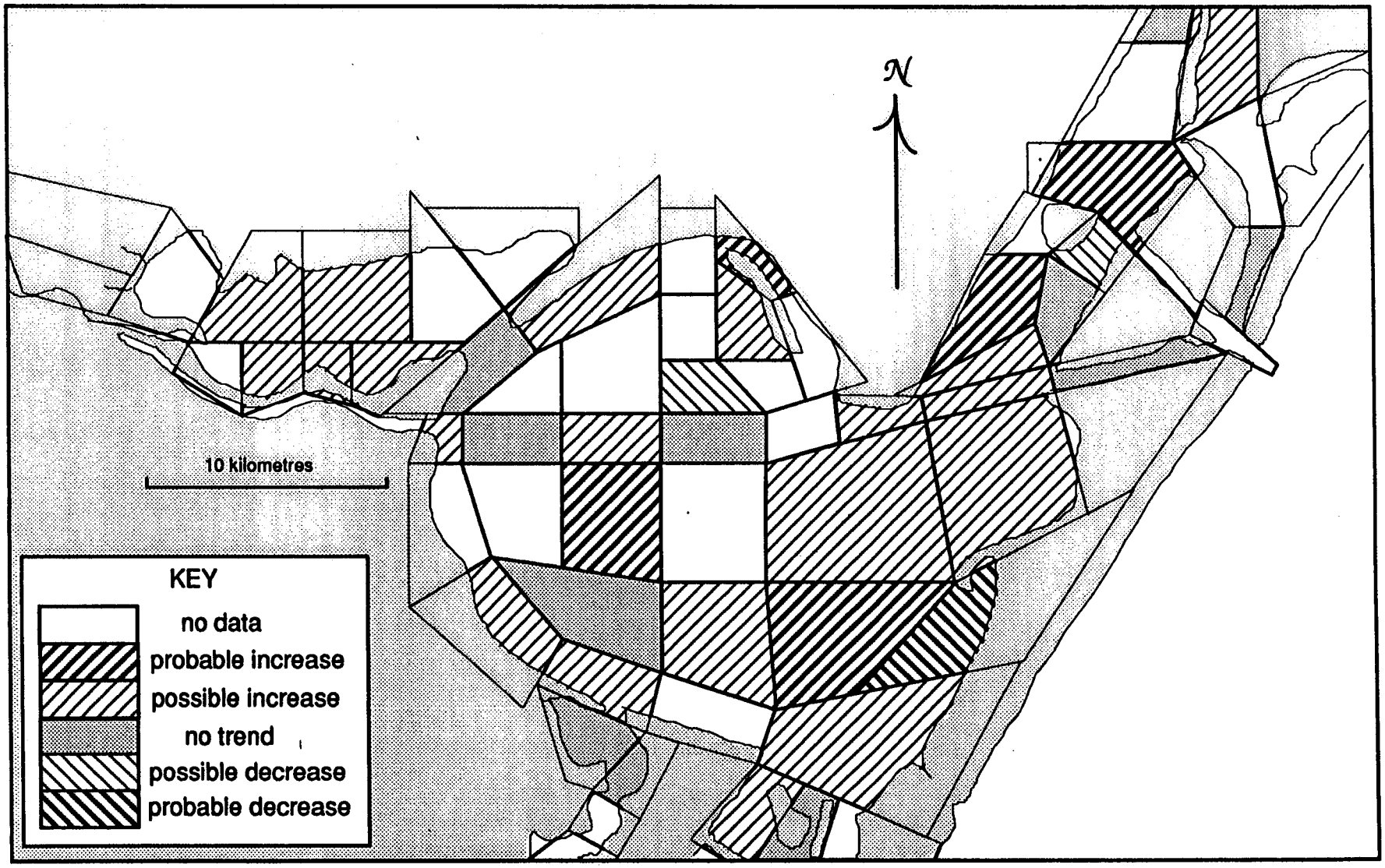


Figure 6-96. WQTOTP period-of-record trends for Corpus Christi system

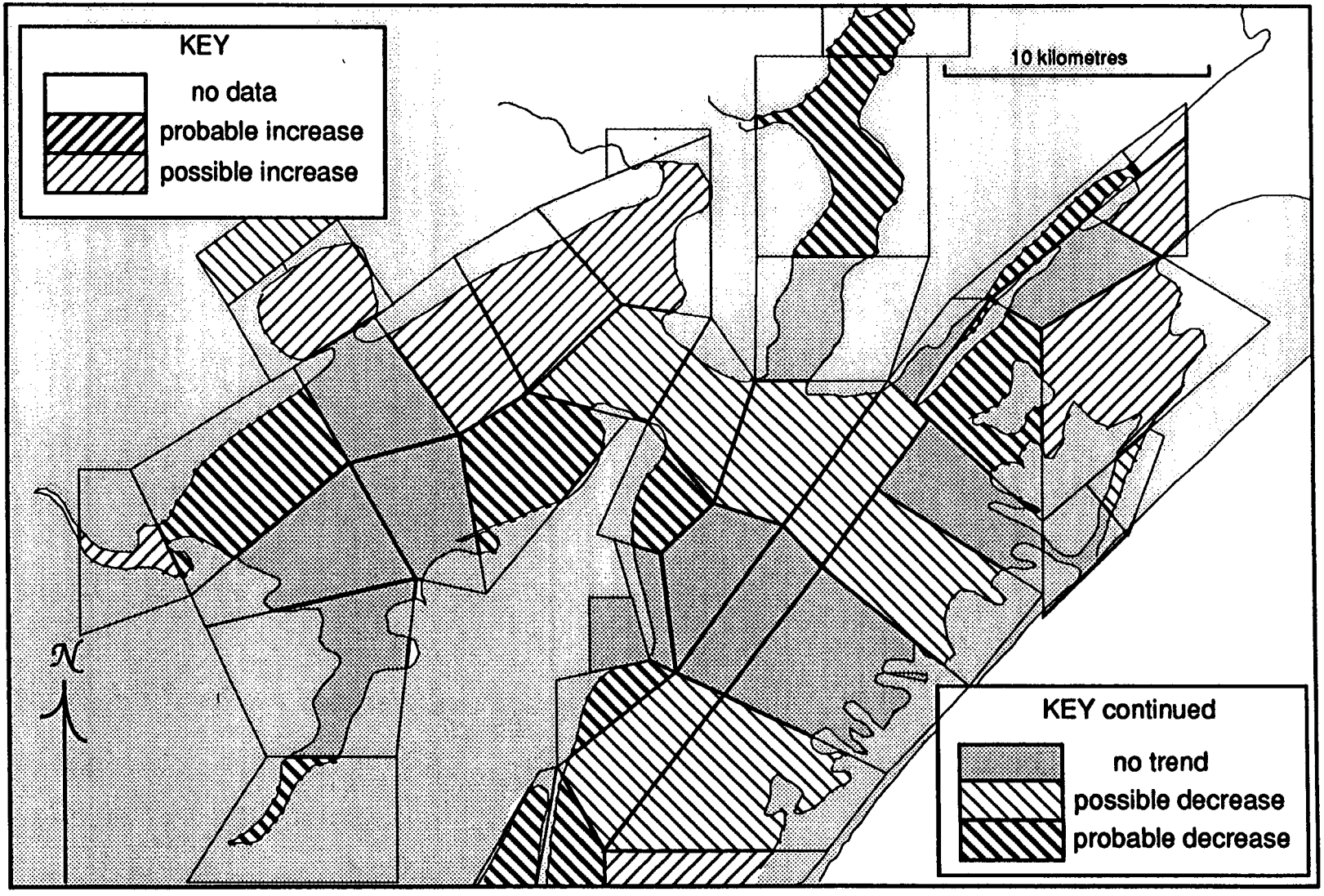


Figure 6-97. WQXTSS period-of-record time trends for Aransas-Copano system

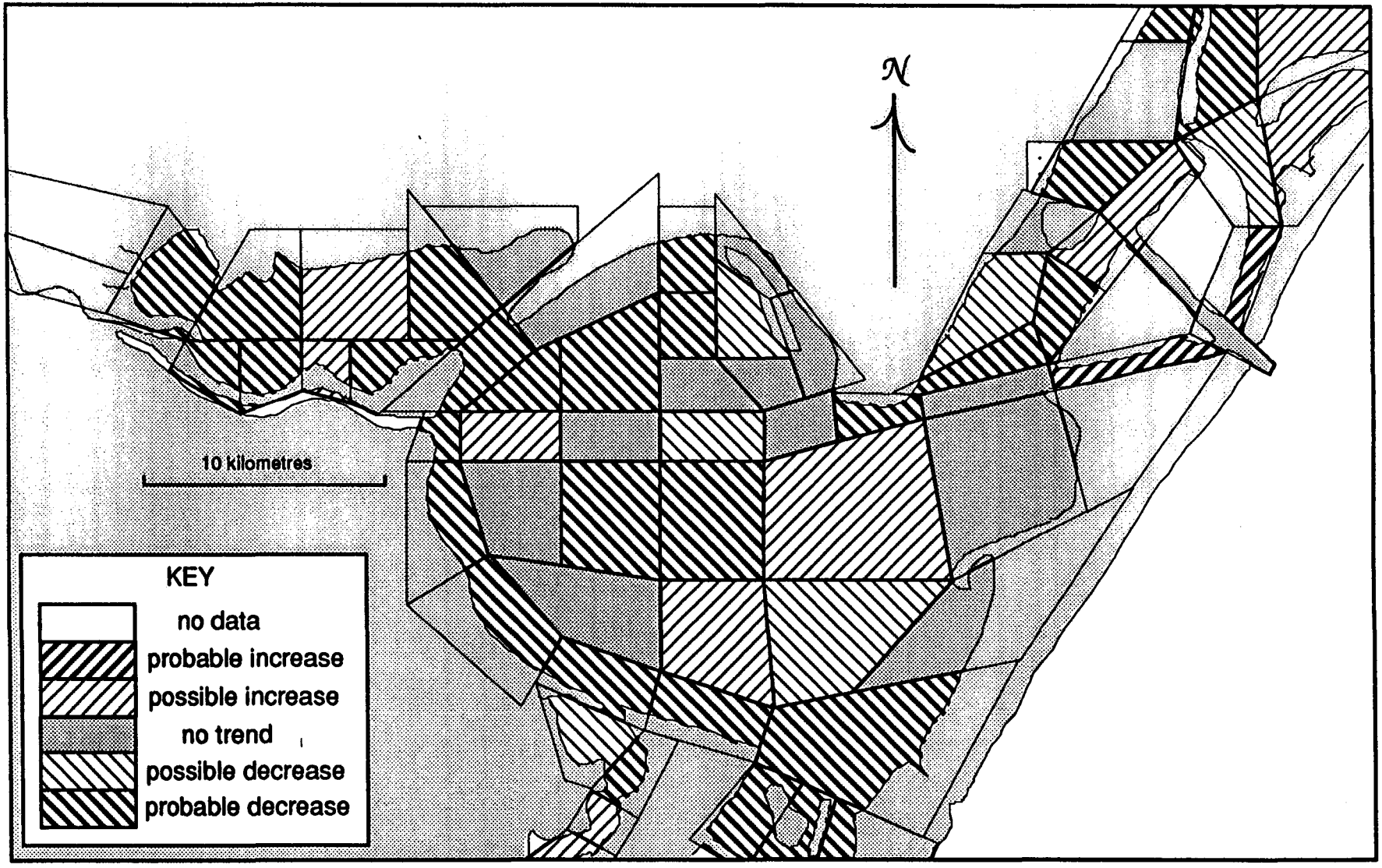


Figure 6-98. WQXTSS period-of-record trends for Corpus Christi system

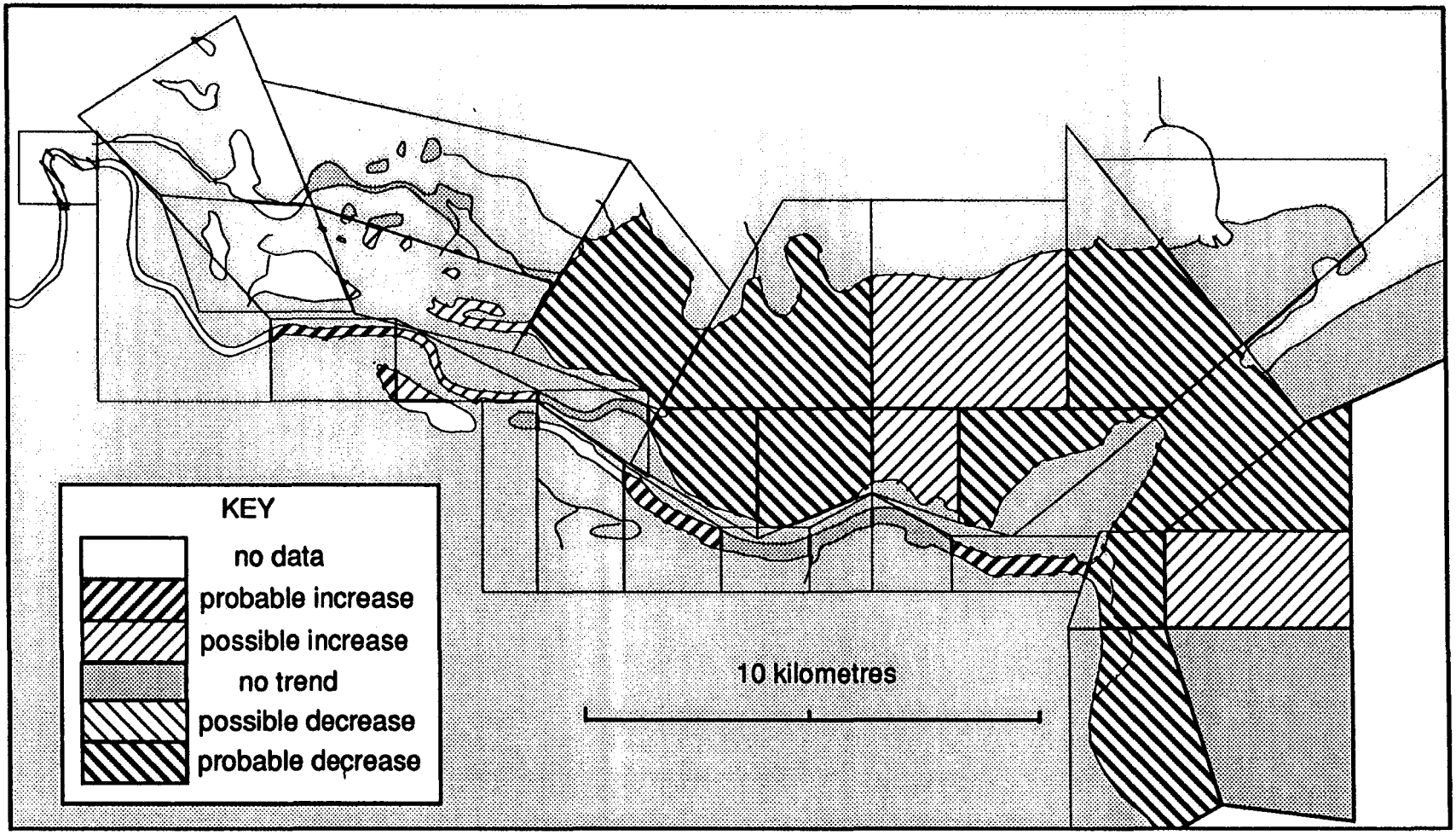


Figure 6-99. WQXTSS period-of-record time trends for Nueces Bay region, including Inner Harbor

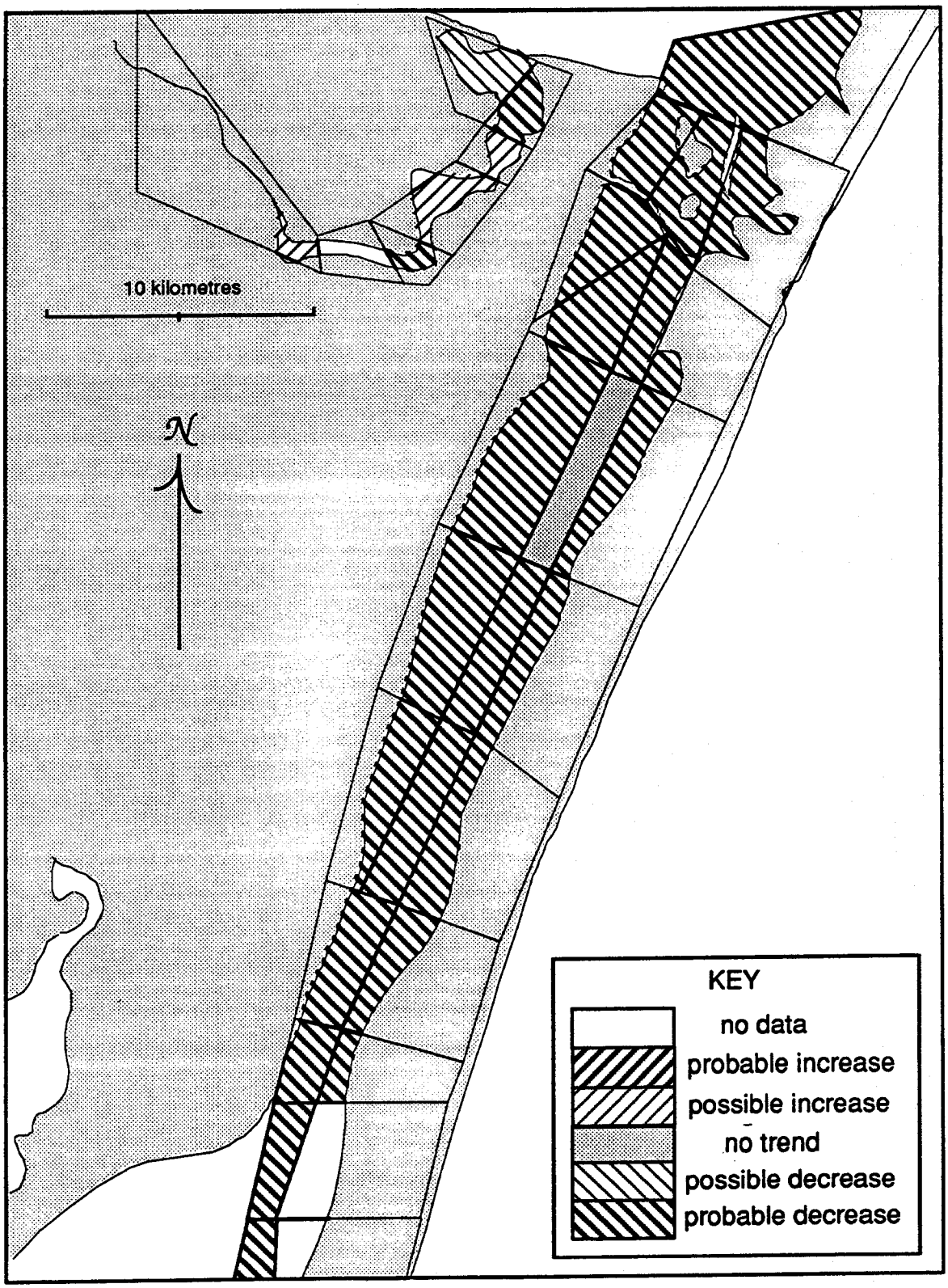


Figure 6-100. WQXTSS period-of-record trends for Upper Laguna Madre and Oso Bay

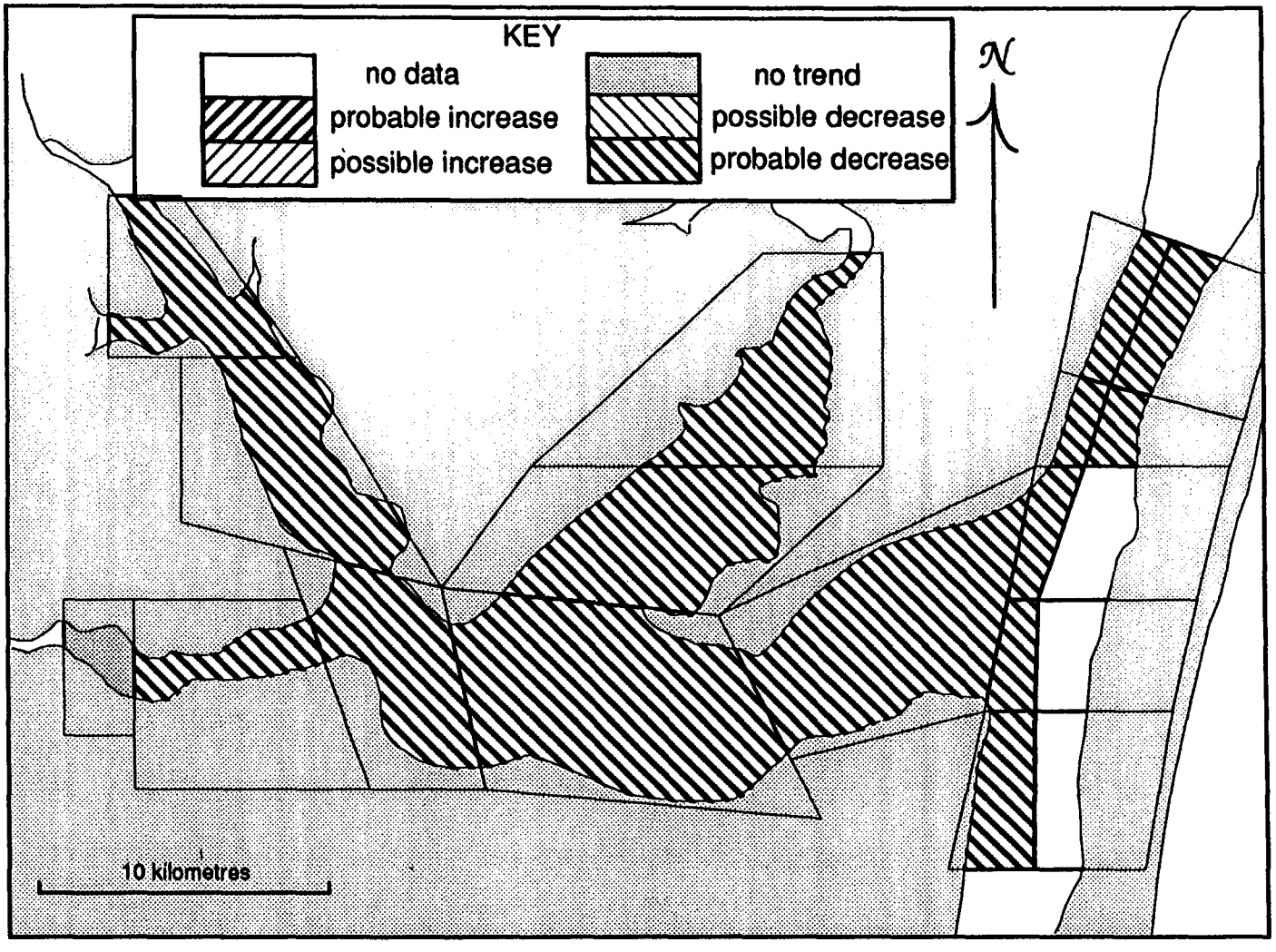


Figure 6-101. WQXTSS period-of-record time trends for Baffin Bay region

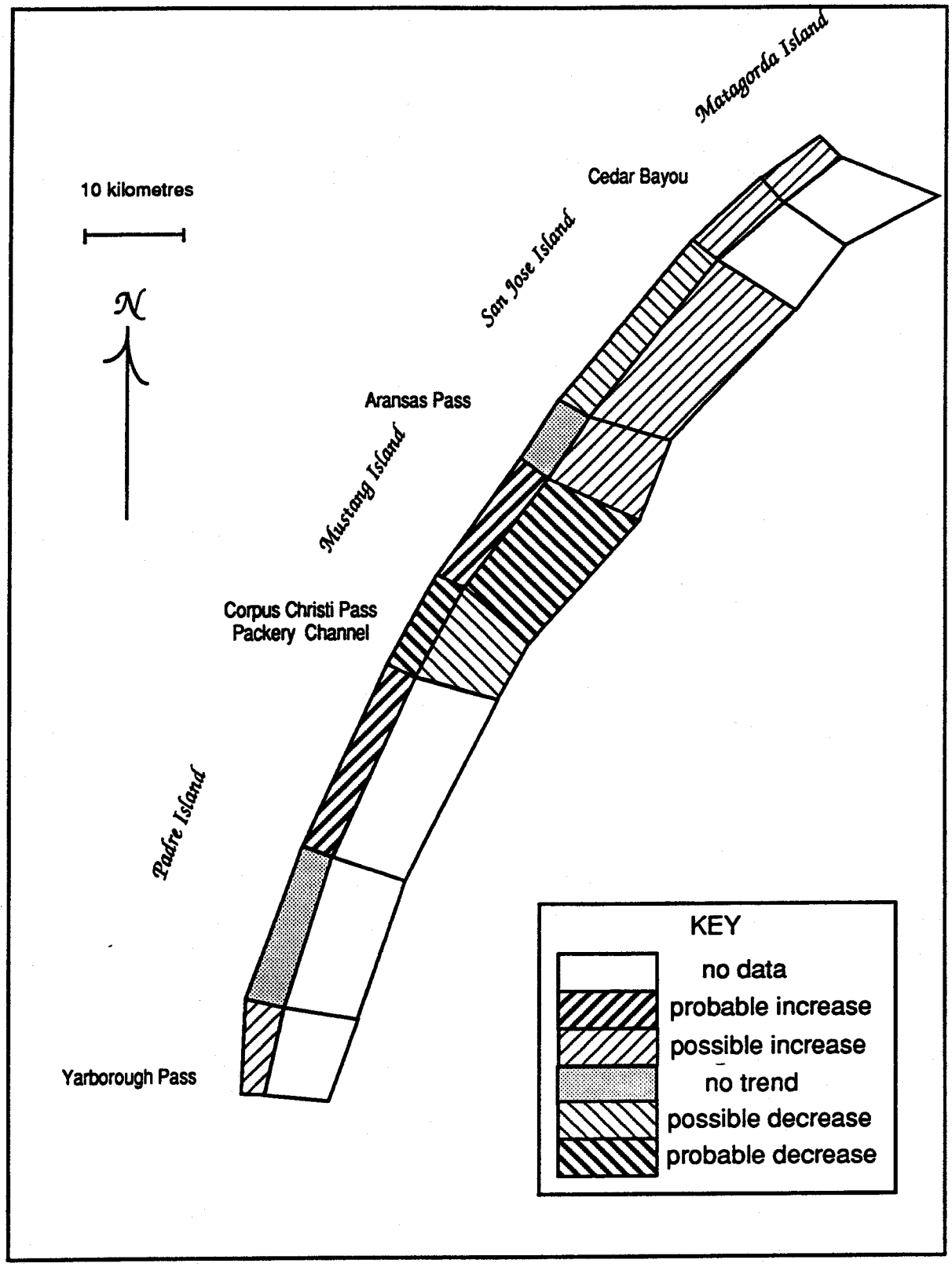


Figure 6-102. WQXTSS period-of-record trends for Gulf of Mexico

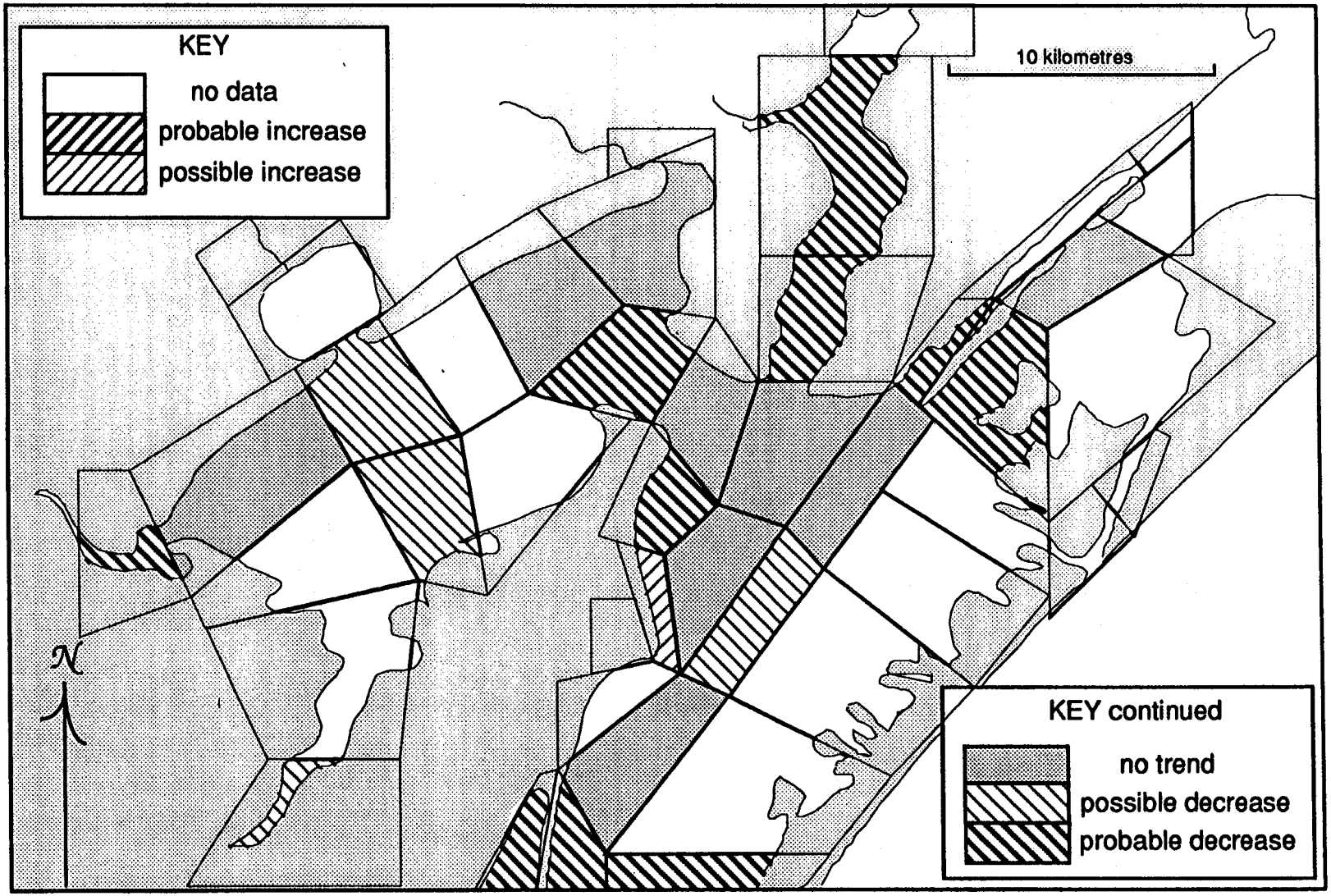


Figure 6-103. WQTOC period-of-record time trends for Aransas-Copano system

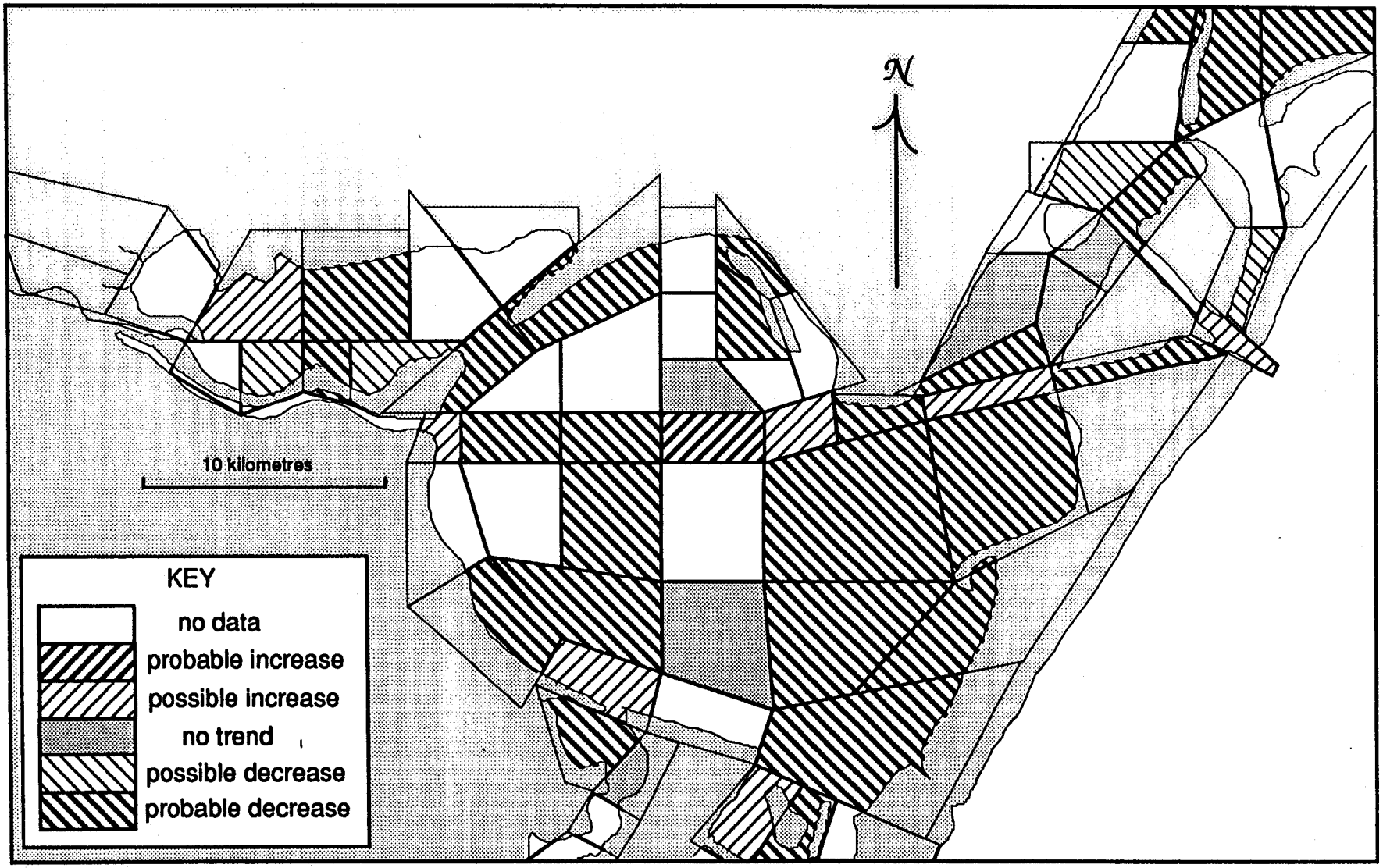


Figure 6-104. WQTOC period-of-record trends for Corpus Christi system

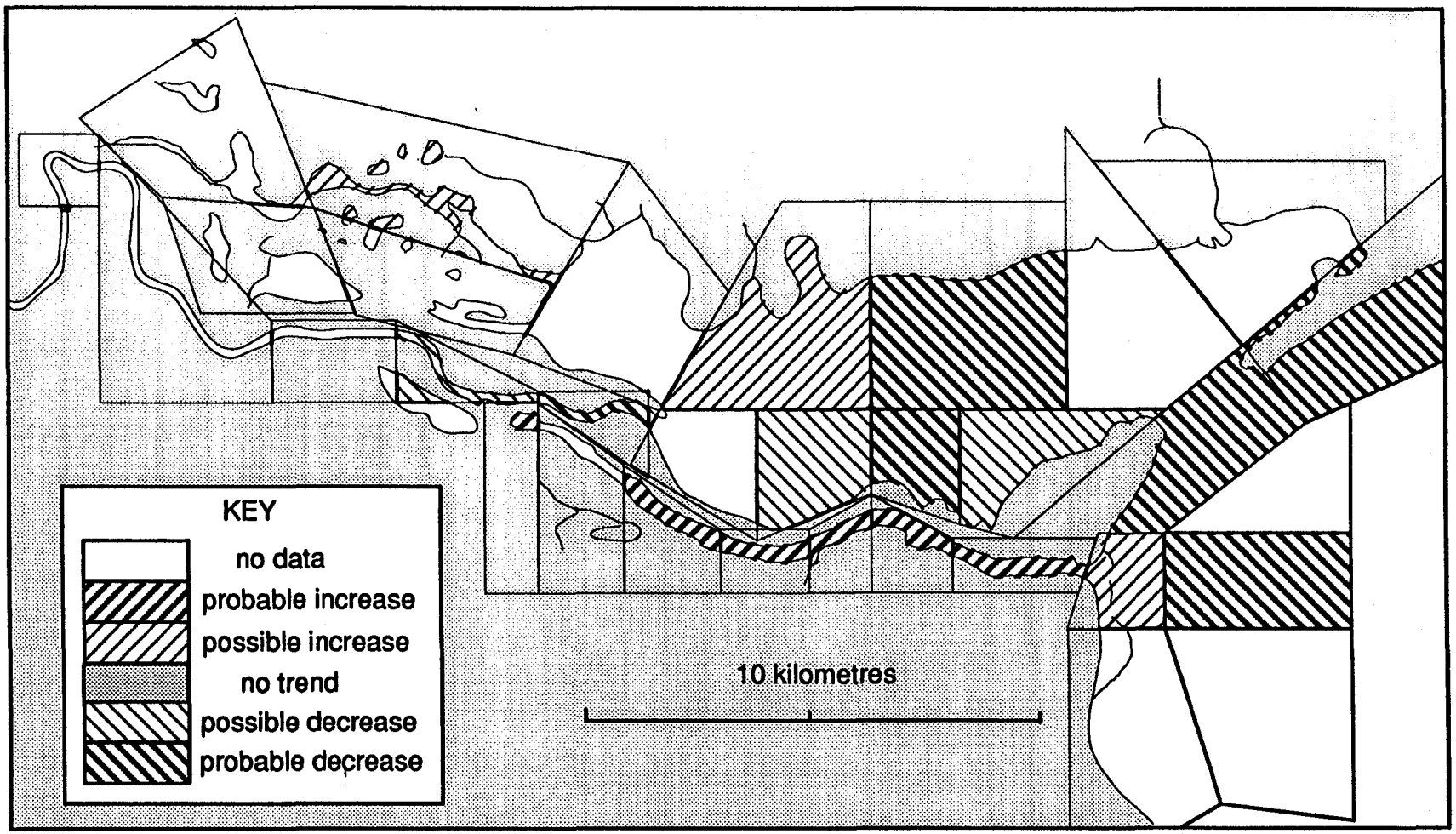


Figure 6-105. WQTOC period-of-record time trends for Nueces Bay region, including Inner Harbor

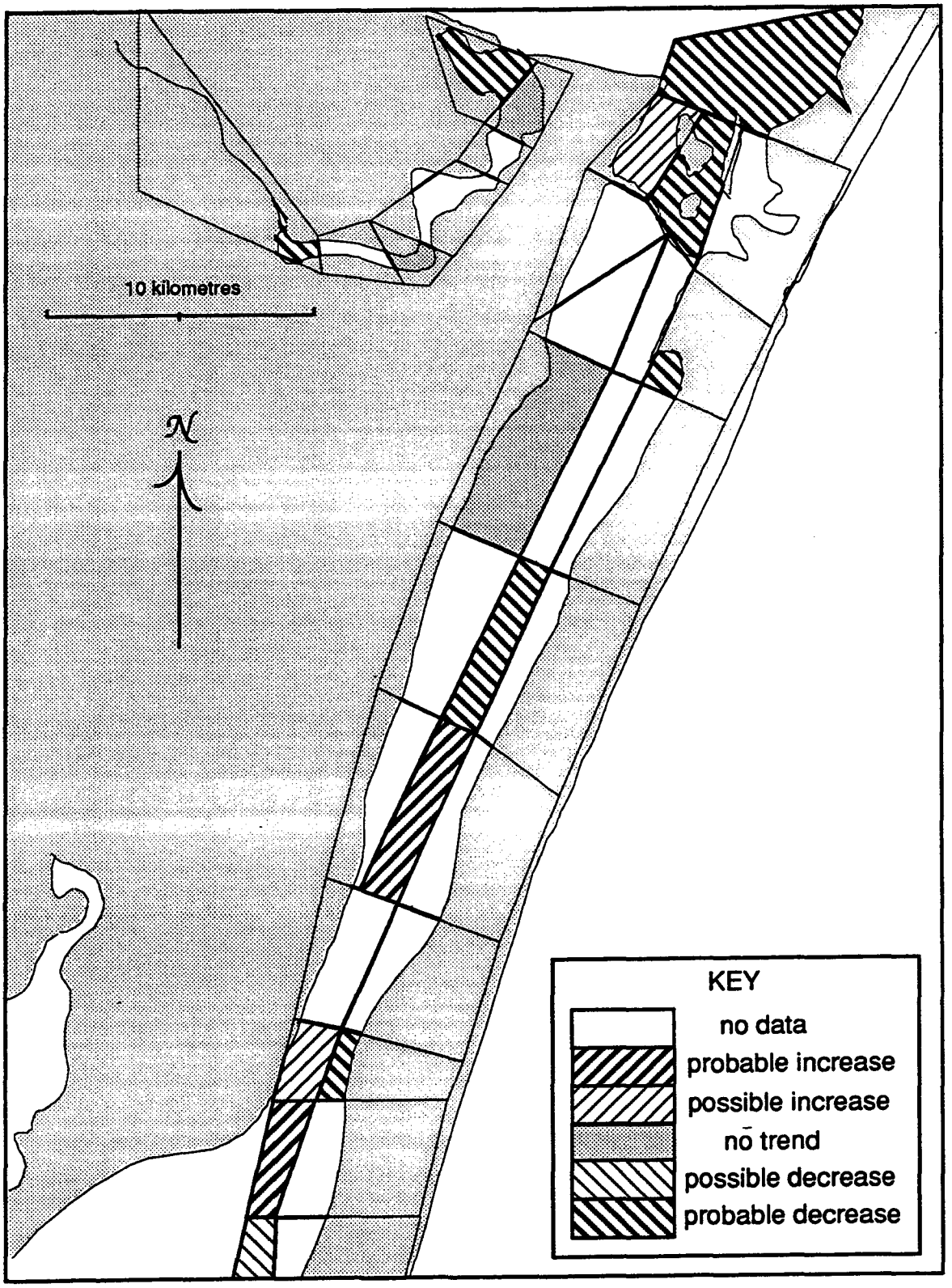


Figure 6-106. WQTOC period-of-record trends for Upper Laguna Madre and Oso Bay

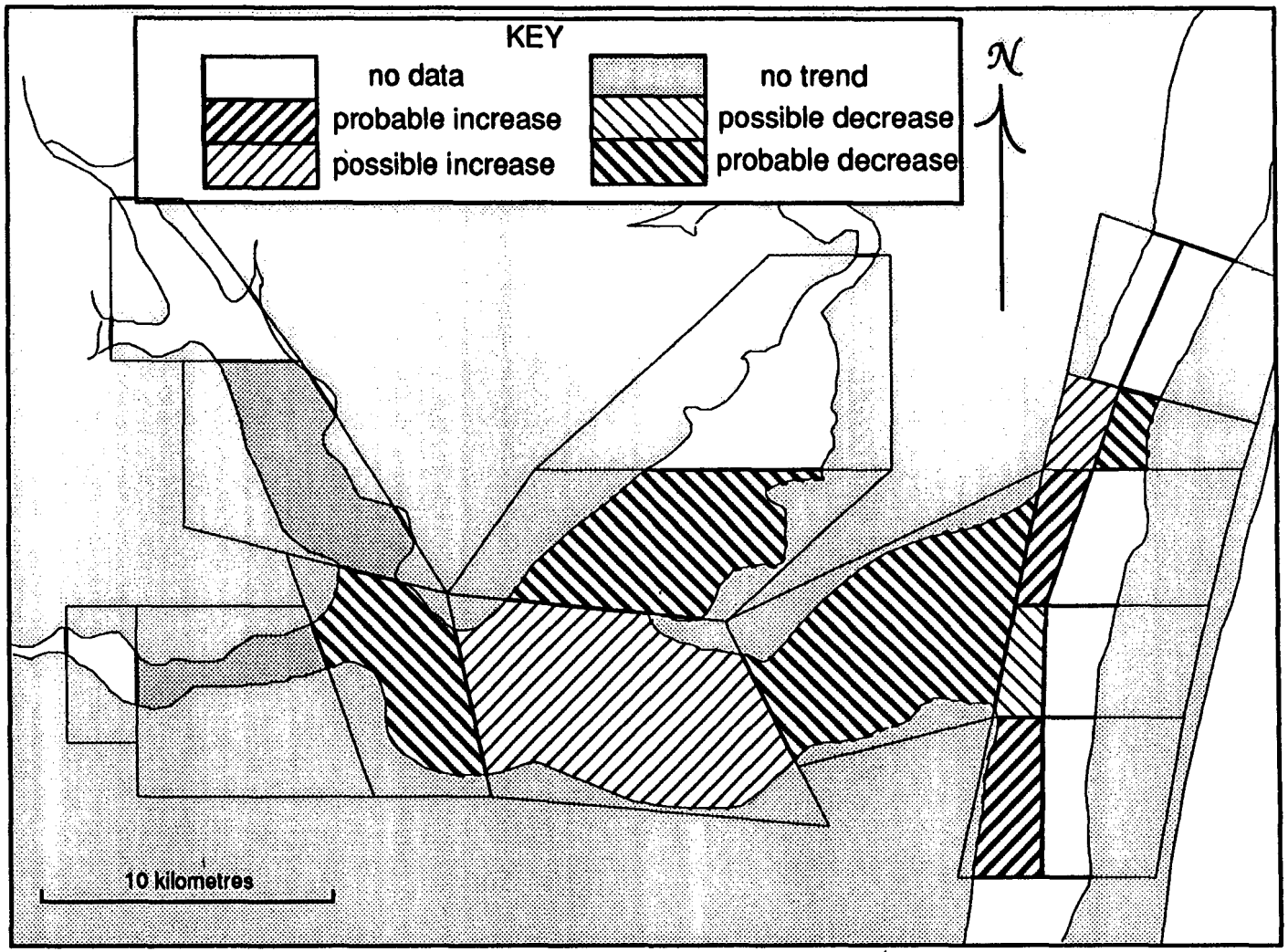


Figure 6-107. WQTOC period-of-record time trends for Baffin Bay region

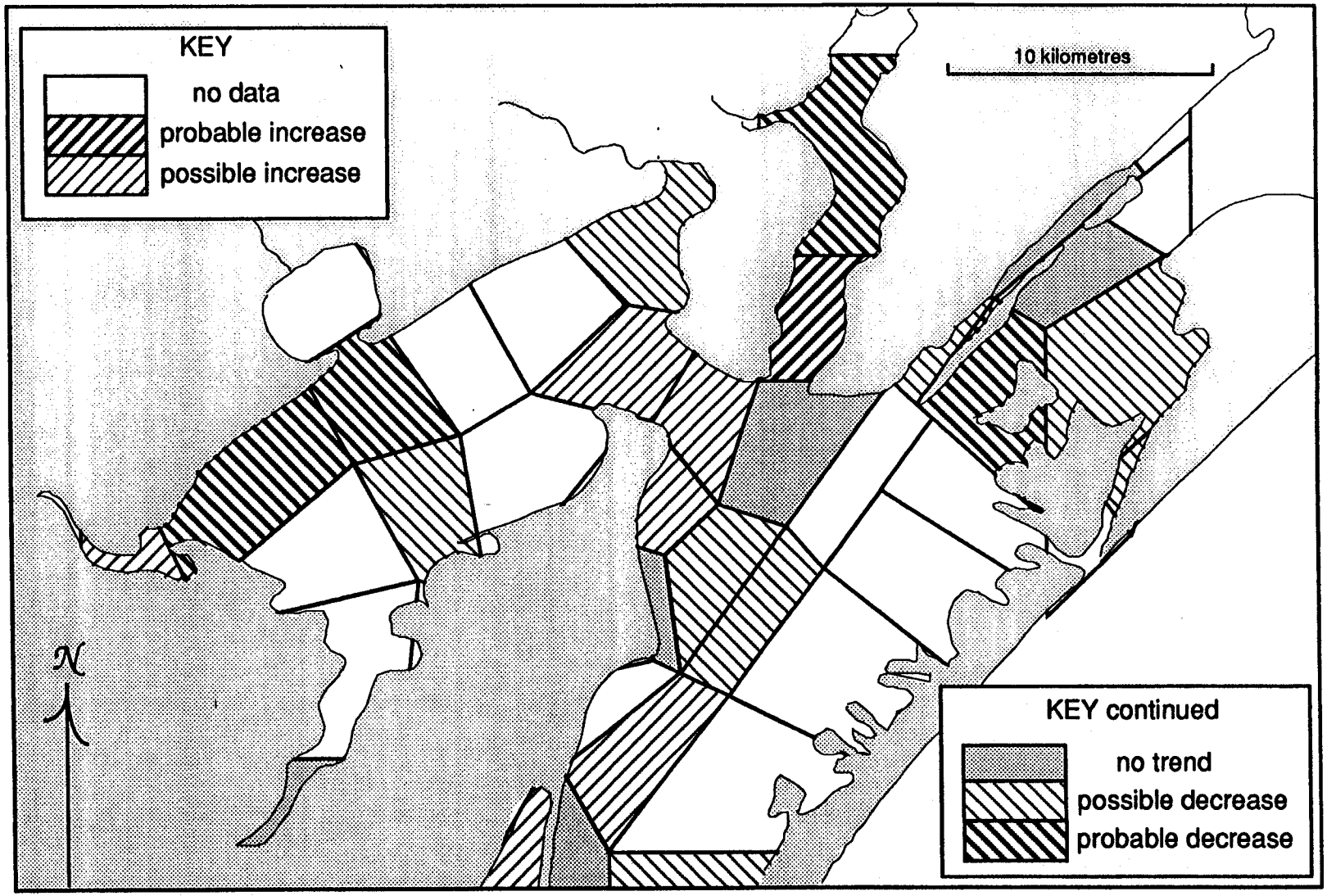


Figure 6-108. WQCHLA period-of-record time trends for Aransas-Copano system

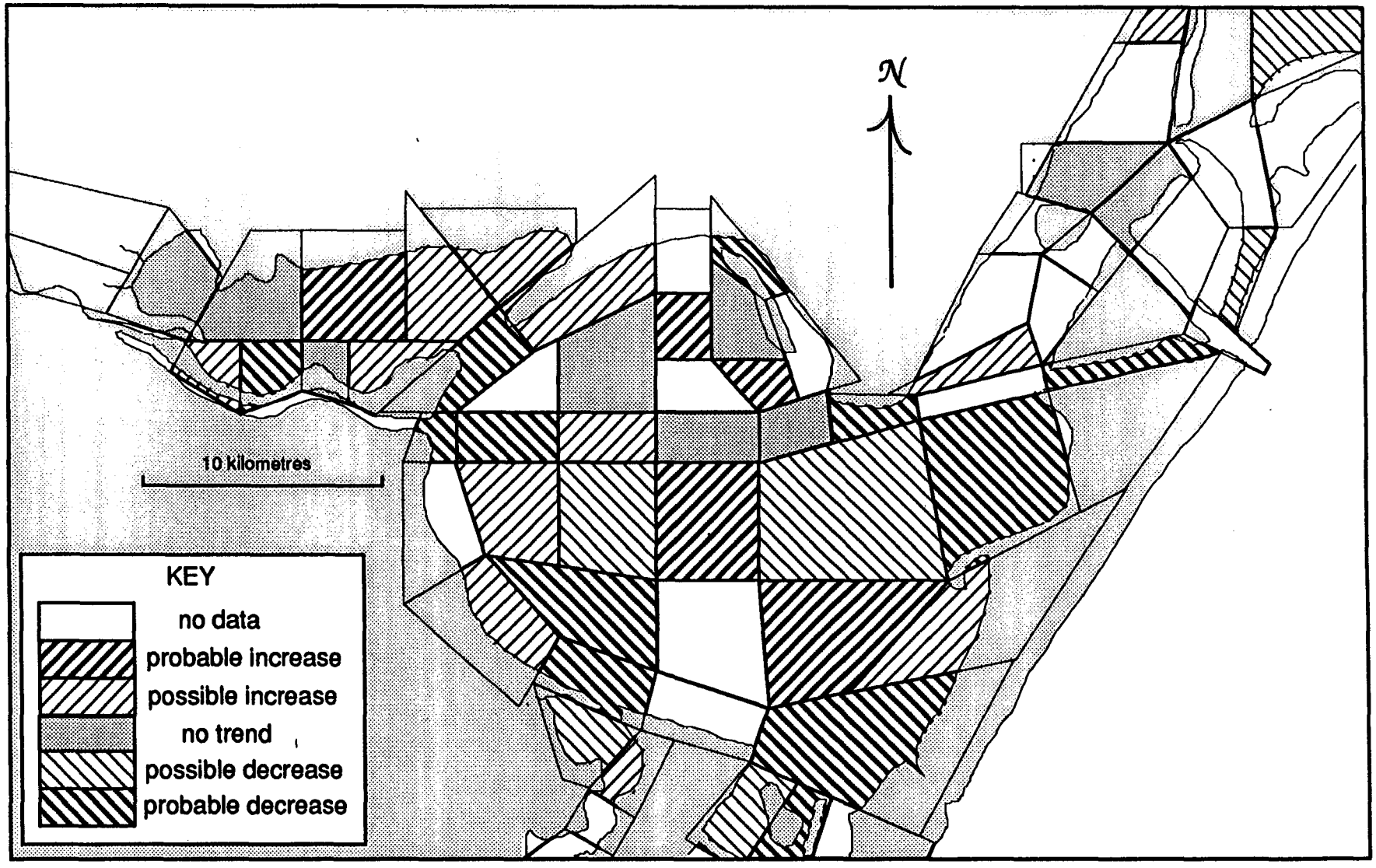


Figure 6-109. WQCHLA period-of-record trends for Corpus Christi system

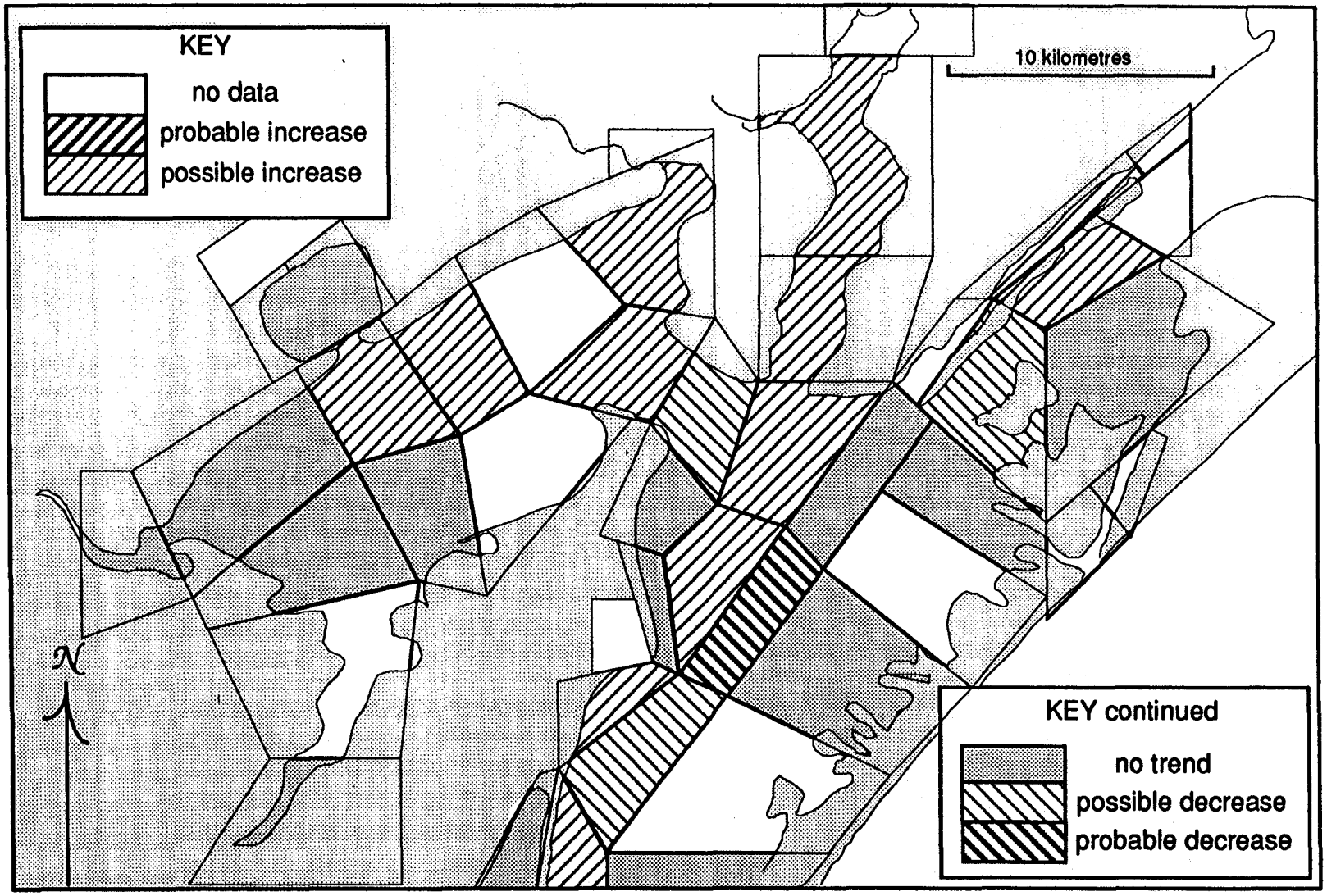


Figure 6-110. WQFCOLI period-of-record time trends for Aransas-Copano system

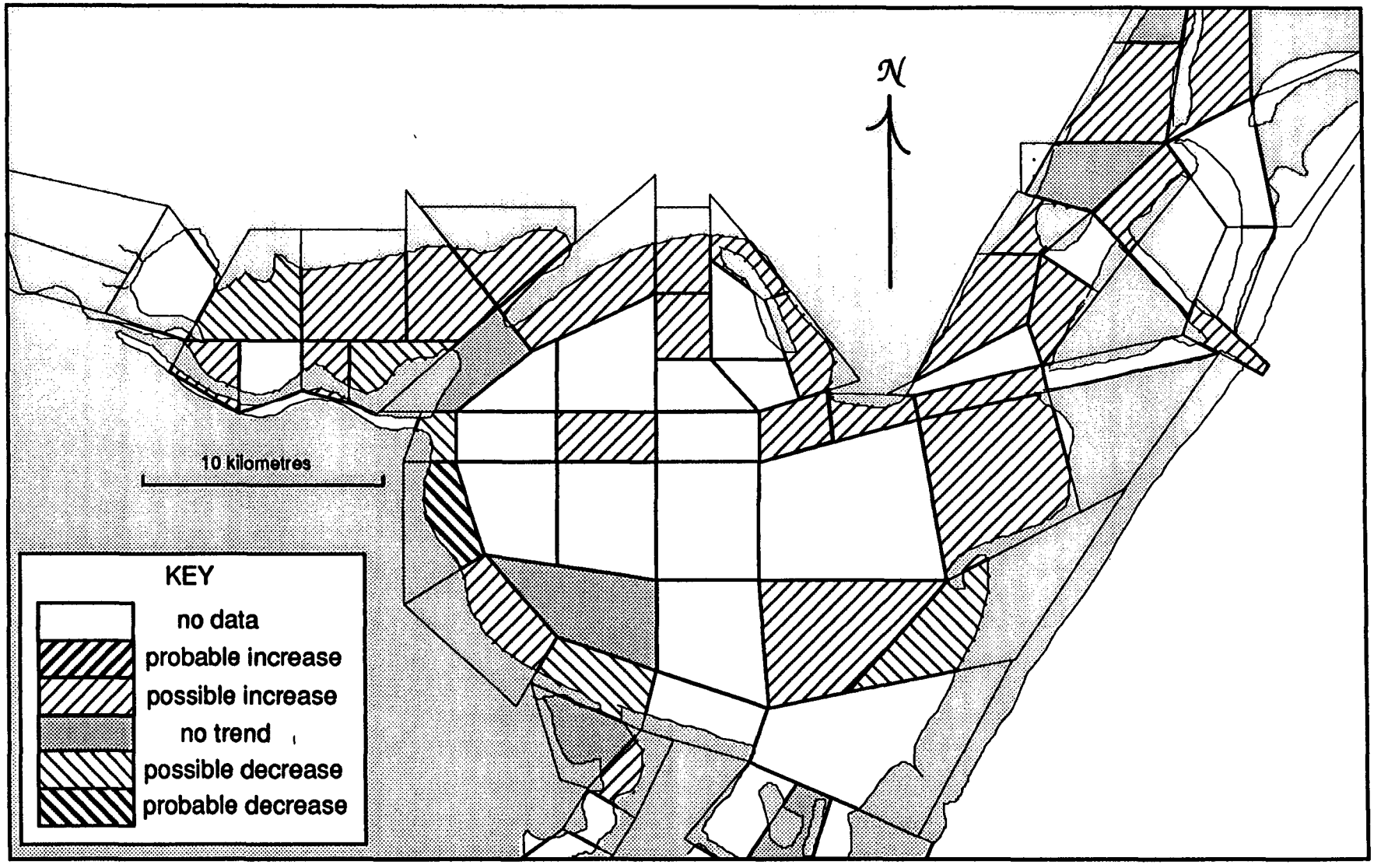


Figure 6-111. WQFCOLI period-of-record trends for Corpus Christi system

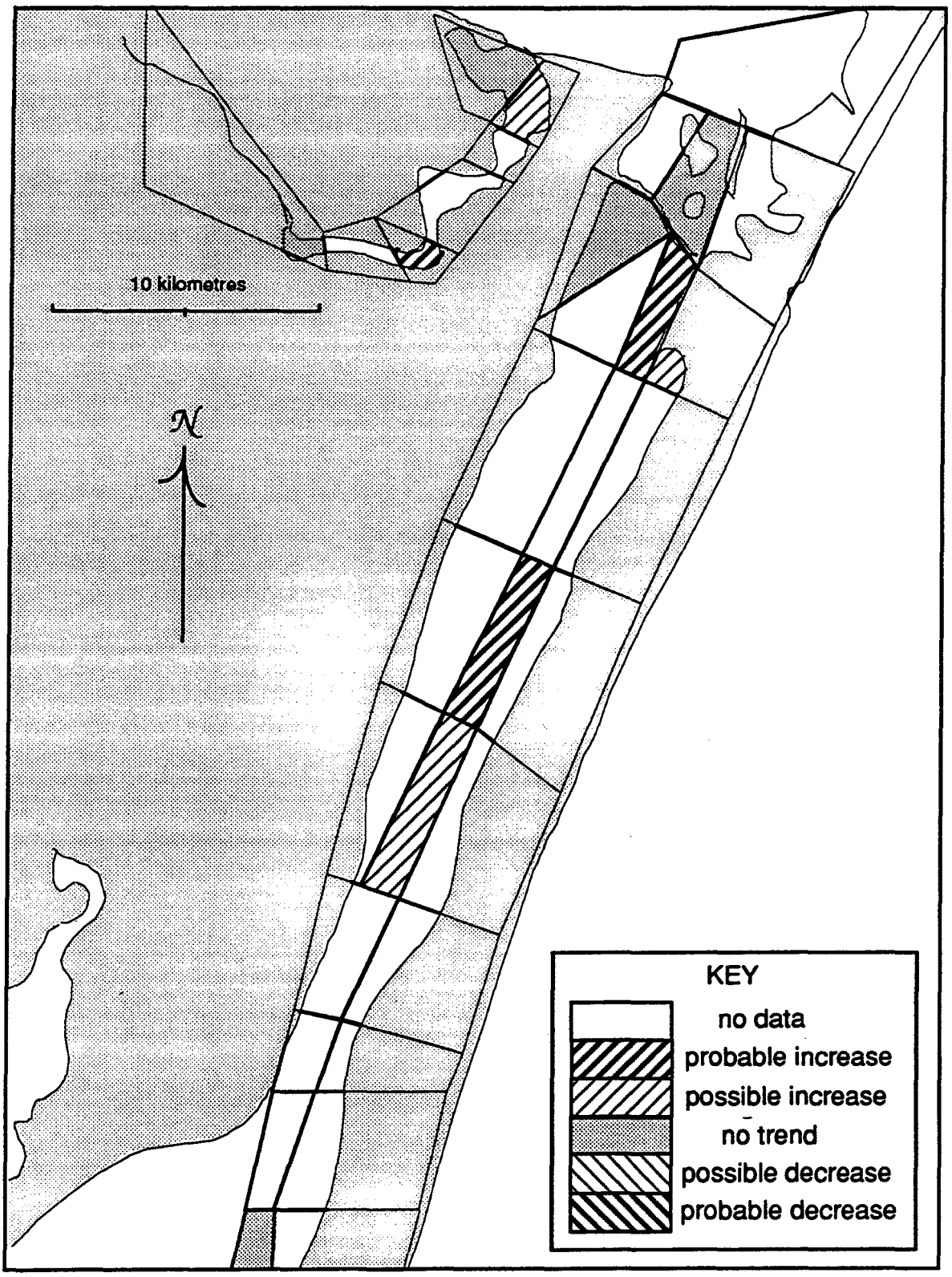


Figure 6-112. WQFCOLI period-of-record trends for Upper Laguna Madre and Oso Bay

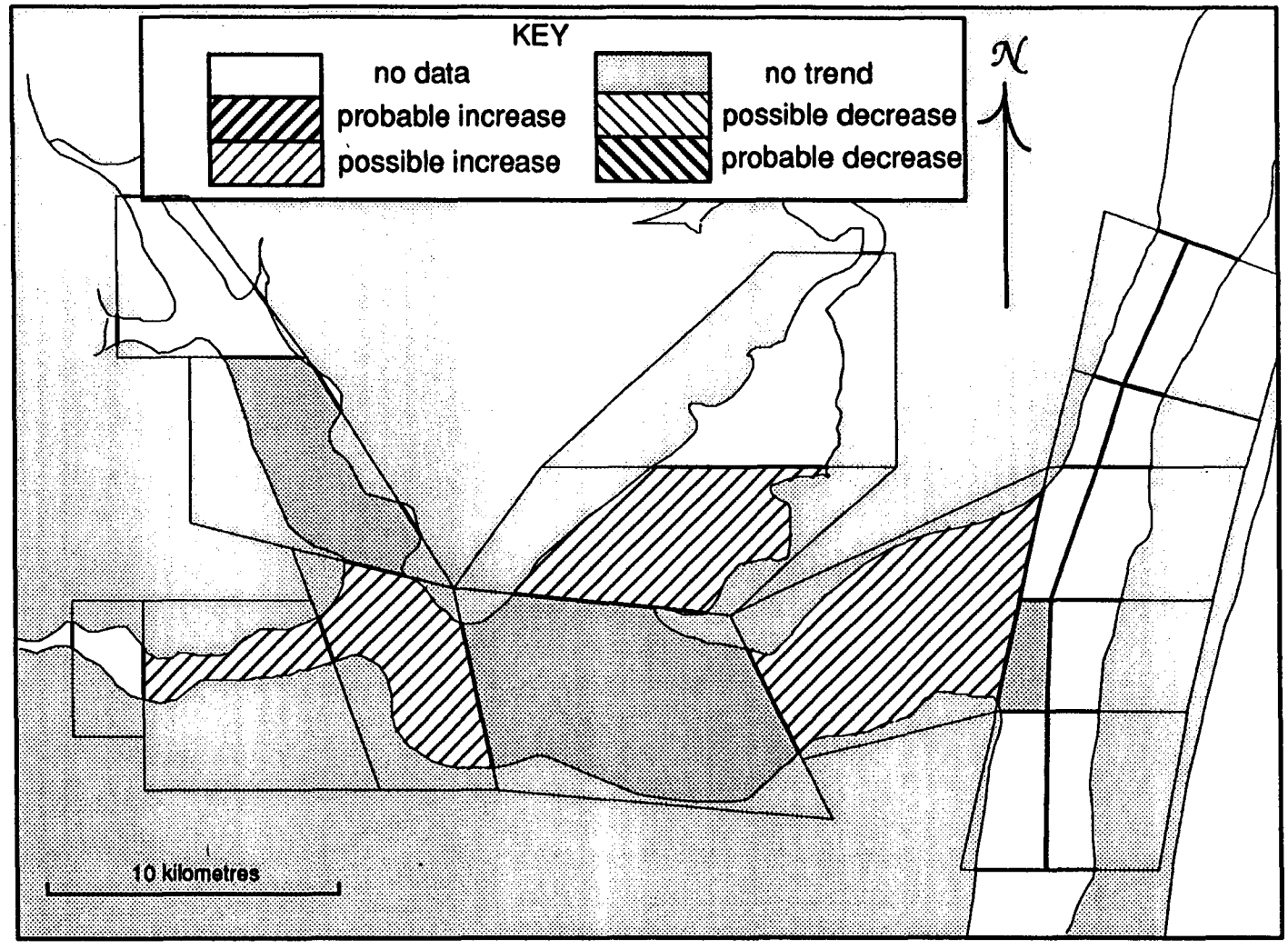


Figure 6-113. WQFCOLI period-of-record time trends for Baffin Bay region

6-43, declining in the open waters and increasing in the regions more affected by freshwater, on the order of 0.01 pH/yr. This trend, if real, would of course tend to render even more uniform the range of pH over the study area. It is interesting to note that, though the period of record is shorter, there seems to be a decline in alkalinity in the system, Table 6-42.

Dissolved oxygen variation is affected to a large extent by variation in solubility. The annual variation in temperature, Fig. 6-57, implies an annual variation in DO, as shown in Figs. 6-58 and 6-59. We therefore focus more on the dissolved oxygen deficit to identify spatial and temporal trends. Average dissolved oxygen concentrations in the open bay are uniformly high. Near-surface values, Figs. 6-13 to 6-17, exceed saturation almost everywhere, and never are less than 1 ppm below saturation. The lowest mean DO values (highest deficit values) in the system are found primarily in the Inner Harbor, north-central sections of Corpus Christi Bay, and in the shallow waters of the Upper Laguna Madre. In the adjacent Gulf of Mexico, near-surface concentrations are slightly lower on average than in the bays, but will within half a ppm of saturation. There is no clear seasonal pattern in deficit, but there seems to be a proclivity toward bimodality with minima in deficit (i.e., maxima in DO) in January and June in the upper bays and the Gulf of Mexico, Fig. 6-60, and April and September in the lower bays, Fig. 6-61.

Stratification in DO deficit dominates DO stratification, that is, the vertical variation in salinity and temperature have an at-most secondary effect on vertical DO variation. The stratification in DO deficit is uniformly negative, Table 6-29, and on the order of 0.1 - 0.2 ppm/m. There appears to be no correlation with depth or with dredged ship channels.

For dissolved oxygen, the time trends are not clear. There is more of a tendency for increasing trends in DO than decreasing, Table 6-40, but the statistical confidence is not particularly high, no doubt due to the high seasonal variability in DO resulting from solubility. Trends in deficit are somewhat better defined. In the Aransas-Copano system, deficit is declining, i.e. the DO climate is improving, Fig. 6-81, on the order of 0.03 ppm/yr, Table 6-41. In Corpus Christi Bay overall the trends are a wash, but there is a large area in the central region of the bay with coherent increasing values of deficit, on the order of 0.05 ppm/yr. The Inner Harbor, historically the site of greatest DO stress, does not exhibit any clear trend in DO or deficit, Fig. 6-83. In the Laguna the trends are variable, while in Baffin Bay, where a trend in deficit emerges, it is declining (i.e., DO is improving).

The spatial variation of BOD exhibits an expected pattern of uniformity in the open areas of each of the major bays of the system, and, also as expected, increases toward regions of waste discharge. What emerged from the data analysis that was unexpected is a general increase in BOD from the upper bays of Copano-Aransas, to the lower bays of the Laguna and Baffin. BOD's are about 1.5-2.0 in Copano and Aransas, with higher values in upper St. Charles Bay and the Aransas River mouth. In Corpus Christi, they are on the order of 2 ppm, with values of 3-5 in Oso Bay and the Inner Harbor (Fig. 6-19). In the Upper Laguna, BOD's generally exceed 3 ppm, Fig. 6-20, and in Baffin Bay range 3-6 ppm, Fig. 6-

21. Unfortunately, BOD is not widely sampled, and as a water-quality indicator its use (and hence sampling rate) has declined in recent years, so it is not clear how well this pattern represents the present conditions. It is noteworthy that BOD is declining in the Aransas-Copano system, Fig. 6-87, where deficit is improving. However, the reverse association occurs in Corpus Christi Bay, where BOD is declining in the open waters of the bay, Fig. 6-88, but deficit is increasing.

The concentrations of nitrogen species are fairly uniform throughout the study area. Ammonia ranges from 0.06 - 0.08 ppm on average, with seasonal variability from 0.05 to over 0.10 ppm, see Figs. 6-22 through 6-24, 6-61 and 6-62. Nitrate is noisier, with elevated values in regions influenced by runoff, especially Copano and Nueces Bays. The highest concentrations of ammonia and nitrate occur in the Inner Harbor, Fig. 6-24 and 6-27. Throughout the study area, ammonia tends to be slightly but systematically stratified with concentration decreasing upward in the water column, Table 6-31. The same is not true of nitrate, whose stratification is noisy and nonsystematic, Table 6-32. Where concentrations are high in ammonia and nitrates, the trends are generally declining. The prominent exception to this statement is the Inner Harbor, where ammonia is declining but nitrate does not show a clear trend. The decline in nitrogen species is particularly evident in the Baffin system, see Figs. 6-92 and 6-95.

The more common measures of phosphorous concentration are orthophosphates and total phosphorus. Generally, the latter is predominant in the Corpus Christi Bay data, hence was selected as the principal measure of phosphorous for analysis. One significant source of uncertainty in this measurement is the treatment of particulate (versus dissolved) phosphorus. Phosphorous is sorptive and has an affinity for fine-grained suspended sediments. In some of the data sets, it is not clear whether the total-phosphorous analyses are restricted to the dissolved fraction (i.e. whether the sample is filtered) or includes the particulate. Phosphorus is variable in concentration in the study area, and higher values occur in proximity to points of runoff, including Copano Bay, St. Charles Bay, Nueces Bay, Oso Bay, and the arms of Baffin Bay, Figs. 6-28 through 6-32. There is a widespread tendency for increasing phosphorus in the upper bays, see Table 6-46 and Fig. 6-96, but with low statistical confidence. Moreover, the (less extensive) data on total phosphates generally do not confirm this trend, Table 6-47. The exception is Baffin Bay, which exhibits some of the highest phosphorus in the study area, with probable increasing trends throughout the bay in both total phosphorus and total phosphates. The magnitude of these trends, however, though statistically "significant," are not regarded as physically significant, see Tables 6-46 and 6-47.

The concentrations of total suspended solids generally increase toward points of inflow and regions of runoff through out the system, and are generally higher in the bays than in the Gulf of Mexico, Figs. 6-33 through 6-38. Stratification in TSS is pronounced, and decreases upward, both in the direct TSS measurements, Table 6-34, and the proxy values of TSS based upon turbidity and transmissivity measurements, Table 6-35. The most remarkable feature of TSS in Corpus Christi Bay is the widespread declining trend throughout the study area. This declining trend increases in prominence from the upper bays to the lower. In

Copano, the trends are up and down, and could be judged a wash. In Corpus almost all *probable* trends are negative, the exceptions being near Aransas Pass, with probable trends very prominent in Nueces Bay and along the south shore near the City of Corpus Christi. In the Upper Laguna (Fig. 6-97) and Baffin Bay (Fig. 6-98) probable declining trends occur *uniformly* throughout these systems. The mean rate of decline, averaged over those segments with a probable negative trend, see Table 6-50, is on the order of 0.5 ppm/yr increasing to 1 ppm/yr in the lower bays. Trends in the Gulf of Mexico, Fig. 6-102, generally based upon fewer data per segment over a shorter period of record, are variable and incoherent. Measurements are spottier for the volatile component of the suspended solids, but generally VSS ranges 5-25 ppm through the system, is highest in Nueces Bay, Oso Bay and the mouth of the Aransas River, otherwise appears to be fairly uniformly distributed. Almost everywhere in the system (where data exist) there is a probable declining trend. Data on oil and grease are even more limited, with most areas of the bay unsampled. Of those regions sampled, the largest systematic concentrations are found in the Inner Harbor, and the GIWW at Carlos Bay.

Data on total organic carbon is limited in many areas of the bay system. Generally the values are about a factor of 2 higher in the upper bays, declining from 20-30 ppm in Copano to 5-15 ppm in Baffin and the Laguna, with a seasonal peak in early summer, see Fig. 6-66. Where concentrations are higher, the trend is declining. Therefore, declining trends are more prominent in Aransas-Copano, Nueces and the open waters of Corpus Christi Bay, but not in the lower bays, Table 6-51 and Figs. 6-103 through 6-107. The prominent exception to this is in the Inner Harbor, where average TOC is the highest in the study area, Fig. 6-39, and is increasing in time, Fig. 6-105.

Available data are even sparser for chlorophyll-a. Where data exists, the pattern seems to be one of higher concentrations in the shallower bays subject to runoff and inflow, Figs. 6-40 through 6-43. There appear to be higher variability and more of a seasonal variation in the outer bays than in the main body of Corpus Christi Bay, see Fig. 6-67. For the instances in which chlorophyll-a was sampled at two or more points in the vertical, the stratification is predominantly *negative*, i.e. decreasing in concentration up the water column, see Table 6-48. The paucity of data also obscures time trend analysis, but there is a tendency for declining chlorophyll-a concentrations in Copano Bay and some of the peripheral (nearshore) areas of the main body of Corpus Christi Bay.

Fecal coliforms, Figs. 6-44 through 6-46, are highest in the upper bays in proximity to sources of inflow and runoff, especially in urbanized areas. The highest average coliforms in the system occur in the nearshore segments from Corpus Christi Beach to Oso Bay, Fig. 6-45. Much higher values are represented in the fecal coliforms in this region than the older total coliform determinations from the same area. Coliform data tend to be particularly "spikey," with many small values with rare, large values interspersed. The period of record average, and other statistics, therefore are especially sensitive to the intensity of sampling. It is perhaps no surprise, then, that time trends do not carry a high degree of statistical confidence. We note the predominance of increasing trends in the

outer bays, *viz.* Copano and St. Charles Bay, Fig. 6-110, Baffin and the Upper Laguna, Figs. 6-112 and 6-113.

Most areas of the Corpus Christi Bay system have an inadequate data base for metals, and even less data for organic compounds. For the metals, some of whose mean concentrations are plotted in Figs. 6-47 *et seq.*, the "stencil mask" of missing data covers the majority of the bay, and seriously hampers our ability to judge the extent of metals occurrence in the system. Generally, the areas sampled are those in which metals are expected to be encountered, namely the principal ship channels, the Inner Harbor and La Quinta Channel, and regions subjected to runoff from urban or industrialized areas. Elevated concentrations have indeed been detected in these regions. But we are unable to judge to what extent such concentrations might be dispersed through the system. This paucity of information is compounded by the fact that the majority of the determinations of metals are reported as below detection limits. With these limitations noted, the statistical behavior of metals is as follows:

- Elevated concentrations of arsenic (7-10 ppb) occur in Redfish Bay and adjacent Corpus Christi Ship Channel, and in Baffin Bay. The highest concentration in the system is found in NB7 in Nueces Bay, the only segment sampled for this metal in Nueces Bay. There are no clear time trends in the system.

- Cadmium is generally less than 10 ppb through the system. The highest values in the study area by two orders of magnitude are in the La Quinta Channel and in NB7 in Nueces Bay, the segment mainly sampled for this metal in Nueces Bay, see Fig. 6-47. There are no clear time trends in the system.

- Chromium is noisy. Occasional freak values of 50-90 ppb have been measured throughout the system, but it is difficult to ascribe any significance to these. The highest systematic values occur in the Inner Harbor, La Quinta Channel, and in Nueces Bay. The trend is probable and increasing in La Quinta Channel, and probable and declining in the Inner Harbor.

- Copper, like chromium, is spikey. Systematic elevated concentrations occur in the Inner Harbor (10-20 ppb) region, La Quinta Channel region (10-40 ppb), Baffin Bay (10-60 ppb), and Nueces Bay (20 ppb), see Fig. 6-48 and 6-49. There are no clear time trends.

- Elevated mercury concentrations (> 0.2 ppb) occur in La Quinta Channel, the Inner Harbor, Nueces Bay (NB7, again) and Baffin Bay. An extreme value of 1.7 ppb occurs in the King Ranch reach of the Upper Laguna (I12), and an even more extreme value of 3.7 ppb at the mouth of Baffin Bay. There are no clear time trends.

- Nickel, like chromium, is spikey. The La Quinta Channel and Inner Harbor regions are systematically elevated in concentration (10-60 ppb), but the largest concentrations occurring in the system are in Redfish Bay adjacent to Harbor Island (RB8, 130 ppb), the entrance of Oso Bay (OS7, 200 ppb) and the Upper Laguna (I12, 100 ppb). There are no clear time trends.

• Lead is similar to mercury in its distribution, see Fig. 6-51 and 6-52, except that the highest values in the system are found in Nueces Bay and its mouth. The only probable trends in time are in the Inner Harbor, and are increasing, see Fig. 6-114.

• As with the other metals, for zinc the Inner Harbor, La Quinta Channel and Nueces Bay (NB7) show systematic elevated concentrations, Fig. 6-53 and 6-54. High concentrations of zinc have also been observed in the Aransas River Mouth, Baffin Bay, the Laguna Madre and Oso Bay, but the data base in these areas is generally not as extensive. Single measurements of concentrations over 100 ppb have been made occasionally scattered throughout the system, but it is difficult to judge how real these are. The only probable trends occur in the La Quinta Channel area and the Inner Harbor, the former increasing and the latter declining, see Fig. 6-115.

One impression that emerges from the survey of the individual metals is that, apart from the industrialized areas, there are isolated regions of the system that show unexpectedly high concentrations in most of the metals. One of these is the southeast corner of Nueces Bay (NB7). Unfortunately, this is the only segment in Nueces Bay that is regularly sampled. Occasional sampling in other areas of Nueces Bay confirm a proclivity for high metals which raises the question of whether this might be prevalent throughout the bay. Also, the mouth of the Aransas River (AR1), the mouth of Oso Bay, the Harbor Island area of Redfish Bay, and a point about midway in the King Ranch reach of the Laguna Madre show high concentrations of most of the metals. For most of these, the segments around the area are not sampled, so, as in Nueces Bay, it is not clear whether the elevated metals are isolated or representative of this entire region of the system. In the last case, however, the segment is I12 in and around the GIWW in the Upper Laguna. The segments both north and south of this region have also been sampled for metals, but do not exhibit the systematically high concentrations of I12. It should be noted that Table 6-26 attempts to display the average concentrations of metals away from regions that might be locally influenced so as to be unrepresentative of the component-bay. Therefore, Segment AR1 is excluded from Copano Bay, and Segment NB7 is excluded from Nueces Bay, yet these are the very segments exhibiting high concentrations. On the other hand, Table 6-26 clearly shows the higher metals prevalent in the Baffin system.

From a statistical point-of-view, very little can be said about organics in the study area. The best-monitored pesticide is DDT, and the greatest data base is that assembled by proxying the principal isomer. Even at this, most areas of the bay do not have data, and those segments which do are most often below detection limits (counted as a value of 0 in these averages). Only four non-zero average values occur in the entire study area, two in the GIWW at Ayres Bay, one in Nueces Bay, and one in Baffin Bay. For toxaphene, only one non-zero value occurs, that in Nueces Bay. The situation is similar for the other organics, with only one or a few non-zero values, and inadequate data to determine any trends or spatial variation.

7. SEDIMENT QUALITY OF CORPUS CHRISTI BAY

Sediment data for Corpus Christi Bay were analyzed in exactly the same way as water quality data, therefore the introductory comments of Chapter 6 apply here as well. Again, the data record for each parameter was sorted into two different segmentations of the bay: the Texas Natural Resource Conservation Commission (TNRCC) water quality segments, and the hydrographic-area segments developed for this project. Reference is made to Chapter 3 where both segmentation systems are described and to the defining quadrilaterals given in the Appendix, Tables A-4 and A-5. Similarly, the remarks in Chapter 6 about Corpus Christi Bay being undersampled apply even more strongly to sediment, because there is roughly an order of magnitude less sediment data from Corpus Christi Bay than water quality data. On the other hand, sediment transport processes and kinetics are thought to vary on time scales longer than that of the overlying water, so relative to the time and space scales of natural variability less data would be needed for sediment chemistry than water chemistry (though probably not an order of magnitude). The fundamental problem with sediment data is its spatial sparsity. When distributed into the hydrographic segments, those segments having data generally do not have the temporal density necessary for valid statistics or trend extraction. For most areas of the system, as will be seen, the available data is below the threshold from which meaningful analyses may be performed.

Again, as a preliminary, Table 7-1 (from Ward and Armstrong, 1992a) shows nominal uncertainty levels for each of the primary sediment quality parameters of this study. The discussion in Chapter 6 and the information in Section 4.2.3 apply here as well. Because sediment concentrations are generally much higher than those in the water column, there is less problem with measurements reported as below detection limits than was the case with the water analytes.

TABLE 7-1

NOMINAL UNCERTAINTY IN MEASUREMENT OF SEDIMENT PARAMETERS
(See Table 2-1 for definition of abbreviations)

abbreviation	*units*	*nominal standard deviation (as percentage of value)*
	Conventional Parameters	
SEDAMMN	mg/kg	20
SEDORGN	mg/kg	20
SEDKJLN	mg/kg	20
SEDTOTP	mg/kg	10
SEDVOLS	mg/kg	25
SEDO&G	mg/kg	25
SEDTOC	g/kg	10
	Metals	
SEDMETAS	mg/kg	20
SEDMETBA	mg/kg	5
SEDMETB	mg/kg	20
SEDMETCD	mg/kg	35
SEDMETCR	mg/kg	20
SEDMETCU	mg/kg	25
SEDMETFE	mg/kg	10
SEDMETPB	mg/kg	60
SEDMETMN	mg/kg	5
SEDMETHG	mg/kg	20
SEDMETNI	mg/kg	50
SEDMETSE	mg/kg	35
SEDMETAG	mg/kg	50
SEDMETZN	mg/kg	10
	Organics	
SED-ABHC	µg/kg	25
SED-LIND	µg/kg	25
SED-XDDT	µg/kg	25
SED-ALDR	µg/kg	20

(continued)

TABLE 7-1

(continued)

abbreviation	*units*	*nominal standard deviation (as percentage of value)*
SED-CHLR	µg/kg	25
SED-DIEL	µg/kg	25
SED-ENDO	µg/kg	10
SED-ENDR	µg/kg	20
SED-TOXA	µg/kg	25
SED-HEPT	µg/kg	25
SED-HEPX	µg/kg	20
SED-MTHX	µg/kg	10
SED-PCB	µg/kg	25
SED-MALA	µg/kg	35
SED-PARA	µg/kg	10
SED-DIAZ	µg/kg	20
SED-MTHP	µg/kg	10
SED-24D	µg/kg	15
SED-245T	µg/kg	15
SED-PAH	µg/kg	25
SED-ACEN	µg/kg	15
SED-NAPT	µg/kg	25
SED-FLRA	µg/kg	5
SED-BNZA	µg/kg	10

7.1 Space and Time Variation in Sediment Quality

Table 5-3 presents the baywide summary of sediment data. The historical statistics for each of the study parameters are given in detail in Appendix C, for each of the TNRCC segments and for each of the hydrographic segments (for which data exist); these tables together are regarded as the principal product of this study. As with water quality in Chapter 6, for each sediment parameter there is a pair of tables, the first presenting basic data on magnitude and variance of the measurements, and the second data on the time trend analysis. Tables 7-2 through 7-5 are examples. All hydrographic segments are shown in these tables. In Appendix C, to conserve paper, the only entries in the tables are for those hydrographic areas for which data exist. Reference is made to Sections 6.1 and 6.2 for a discussion of the meaning and computation of the entries in these tables.

In the Chapter 5 survey of the data base, Figures 5-61 through 5-78 depict sampling intensity throughout the bay for several of the key sediment parameters. The sampling activities of the Corps of Engineers in association with channel maintenance dominates the data base in many areas of the bay, and the highest intensity is seen to track the presence of channels (more to the point, the presence of channels with frequent maintenance). Thus, for most of the sediment parameters, large areas of the bay have never been sampled. Moreover, for the measurements which do exist, there is a bias for those regions of the bay most heavily impacted by the activities of man. A few of the parameters, such as TOC and several of the metals, are dominated by the BEG Submerged Lands Project data base (Project Code 12), and are therefore more uniformly distributed.

Average concentrations (with BDL values taken to be 0) of representative parameters are depicted in Figs. 7-1 through 7-48. For Figs. 7-1 through 7-39, the conventional parameters and metals, "no data" designated "ND" means there are fewer than two measurements extant for the given segment. Therefore, we avoid ascribing reality to a single measurement of sediment chemistry, but require the average of a minimum of two measurements in order to plot the result. (For water, it will be recalled, an average of a minimum of three measurements was required.) For volatile organics, Figs. 7-40 through 7-48, the data is so sparse that we plot as well those segments with a single measurement of the parameter, but flag these "means" of a single number by italics. Figures 7-49 *et seq.* display the spatial distribution of time trends, following the same convention as described in Chapter 6. The segments with a "probable" trends have both 95% confidence limits of the same sign, and those with a "possible" trend have both 80% confidence bounds of the same sign. At least three independent measurements (above detection limits) in the period of analysis are required before a trend is presented, so we avoid the artifact of a trend line connecting two measurements.

Following the practice of Chapter 6, principal "component bays" of the study area are identified, and defined by hydrographic segments chosen to be representative of the open regions of that component bay, excluding any segments influenced by local external factors. For the sediment data, Oso Bay, consisting of the broad,

seaward section of this bay, was included as a component bay. These principal component bays are defined as follows:

principal component bay	*hydrographic segments*
Aransas	A1-A4, A8-A12, I4-I7
Copano	CP02-CP10
St. Charles	SC2-SC3
Mesquite*	MB1, MB2, AYB, CB
Redfish Bay	RB2-RB9
Corpus Christi	C01-C08, C10, C11, C13, C14, C16-C23
CCSC (open bay)	CCC3-CCC7
Inner Harbor	IH1-IH7
Nueces Bay	NB2-NB5, NB8
Oso Bay	O5-O7
Causeway N	C24, C25, I9
Causeway S	UL01, UL02, UL04, I10
Laguna (King Ranch)	UL03, UL05-UL11, I11-I15
Laguna (Baffin)	UL12-UL14, I16-I18
Baffin	BF1-BF3, AL2, GR2
Aransas Pass area	INL, LAC, CCC1, HI1
GOM inlet	GMI5-GMI7, GMO5-GMO7

*including Carlos and Ayres Bays

Summaries of sediment chemistry for selected conventional parameters, metals, pesticides and PAH's are given in Tables 7-6 through 7-9, respectively. Again, any component bay average consisting of a single measurement was expunged from the table: only averages based upon two or more measurements are retained. The trend analyses by component bay are summarized in Tables 7-10 through 7-25. In these tables, in contrast to the corresponding tables for water analytes (e.g., Tables 6-42 *et seq.*), two separate columns are added tabulating the number of segments in the component bay and those actually having extant data for which a trend analysis can be carried out. For example, in Table 7-10, for Kjeldahl nitrogen (SEDKJLN), in Copano Bay consisting of 9 hydrographic segments (defined above) only *one* segment has adequate data for a trend analysis, and that trend is increasing and probable. (The specific segment and its actual number of data points used in the trend determination, along with time period of analysis and measures of scatter about the trend line, may be found by consulting the corresponding table in Appendix C.)

TABLE 7-2
Period of record statistics for CCBNEP Hydrographic Segments
SEDTOC

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
A1	8	7.38	5.5	8	100	2	760407	2	760407	18	760407	7.38	7.38
A2	6	4.83	1.8	6	100	3	760326	3	760326	8	760625	4.83	4.83
A3	5	7.16	5.2	5	100	2	760625	2	760625	16	760625	7.16	7.16
A4	7	15.00	2.4	7	100	11	760625	11	760625	18	760531	15.00	15.00
A5	2	1.50	0.5	2	100	1	760531	1	760531	2	760531	1.50	1.50
A6	5	5.60	2.7	5	100	2	760531	2	760531	9	760531	5.60	5.60
A8	2	2.50	0.5	2	100	2	760625	2	760625	3	760625	2.50	2.50
A9	3	3.67	0.94	3	100	3	760625	3	760625	5	760625	3.67	3.67
A10	8	7.88	7.6	8	100	1	760531	1	760531	18	760531	7.88	7.88
A11	11	12.00	6.4	11	100	2	760531	2	760531	21	760531	12.00	12.00
A12	7	6.71	6.7	7	100	1	760531	1	760531	19	760531	6.71	6.71
A13	7	4.58	3.2	7	100	1	760531	1	760531	11	760531	4.58	4.58
AL1	8	7.00	3.9	8	100	1	760922	1	760922	12	760922	7.00	7.00
AL2	17	8.06	5	17	100	2	760922	2	760922	17	760922	8.06	8.06
AR1	5	9.60	5.8	5	100	3	760919	3	760919	19	760919	9.60	9.60
AYB	3	6.33	2.6	3	100	4	760812	4	760812	10	760812	6.33	6.33
BF1	13	10.60	6.3	13	100	3	760921	3	760921	21	760921	10.60	10.60
BF2	28	13.40	8.1	28	100	2	760921	2	760921	27	760921	13.40	13.40
BF3	22	11.70	7.2	22	100	4	760921	4	760921	27	760921	11.70	11.70
C01	4	3.19	2.9	4	100	0.74	930723	0.74	930723	8	770625	3.19	3.19
C02	4	8.25	7.2	4	100	2	770625	2	770625	20	770625	8.25	8.25
C03	5	9.80	7.4	5	100	1	770625	1	770625	18	770625	9.80	9.80
C04	7	12.30	1.8	7	100	9	770625	9	770625	15	770625	12.30	12.30
C05	4	14.30	1.9	4	100	11	770625	11	770625	16	770625	14.30	14.30
C06	7	14.10	3.8	7	100	7	770625	7	770625	19	770625	14.10	14.10
C07	6	15.30	1.6	6	100	12	770625	12	770625	17	770625	15.30	15.30

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
C08	10	13.00	3.3	10	100	7	770625	7	770625	20	770625	13.00	13.00
C09	5	8.40	7	5	100	1	770625	1	770625	17	770625	8.40	8.40
C10	10	16.00	2.5	10	100	12	930720	12	930720	20	770625	16.00	16.00
C11	16	9.23	4.9	16	100	1	770625	1	770625	17	770625	9.23	9.23
C12	15	6.20	3.2	15	100	1	770625	1	770625	11	770625	6.20	6.20
C13	6	11.80	7.6	6	100	1	770625	1	770625	19	770625	11.80	11.80
C14	17	5.87	6.2	15	88	0.092	931221	0.092	931221	17	770625	5.18	5.19
C15	14	5.15	3.6	14	100	1	770625	1	770625	13	770625	5.15	5.15
C16	3	12.00	2.2	3	100	10	770625	10	770625	15	770625	12.00	12.00
C17	6	7.67	6.3	6	100	1	770625	1	770625	17	770625	7.67	7.67
C18	8	11.00	2.8	8	100	6.8	840930	6.8	840930	15	770625	11.00	11.00
C19	4	4.75	3.3	4	100	1	770625	1	770625	9	770625	4.75	4.75
C20	2	12.00	2	2	100	10	770625	10	770625	14	770625	12.00	12.00
C21	2	10.50	0.5	2	100	10	770625	10	770625	11	770625	10.50	10.50
C22	11	6.73	4.2	11	100	1.1	920729	1.1	920729	14	770625	6.73	6.73
C23	2	5.00	3	2	100	2	770625	2	770625	8	770625	5.00	5.00
C24	3	14.00	3.3	3	100	10	760924	10	760924	18	760924	14.00	14.00
C25	2	11.50	5.5	2	100	6	760924	6	760924	17	760924	11.50	11.50
CB	7	6.61	3.5	7	100	2	760814	2	760814	12	760814	6.61	6.61
CBH	1	0.00	0	0	0								
CBY1	2	14.00	2	2	100	12	760814	12	760814	16	760814	14.00	14.00
CBY2	1	3.00	0	1	100	3	760814	3	760814	3	760814	3.00	3.00
CCC1	4	4.75	1.8	4	100	2	880715	2	880715	7	880715	4.75	4.75
CCC2	5	3.00	1	2	40	2	760713	2	760713	4	760713	1.20	1.26
CCC3	2	2.50	0.5	2	100	2	770625	2	770625	3	770625	2.50	2.50
CCC4	5	4.89	6.4	3	60	0.22	950112	0.22	950112	14	770625	2.93	2.97
CCC5	8	4.00	4.9	8	100	0.12	950112	0.12	950112	11	770625	4.00	4.00

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
CCC6	7	3.56	5.3	7	100	0.12	950112	0.12	950112	12	770625	3.56	3.56
CCC7	5	4.71	4	5	100	0.24	950112	0.24	950112	10	770625	4.71	4.71
CCC8	4	0.80	0.85	3	75	0.19	950112	0.19	950112	2	770625	0.60	0.63
CP01	0												
CP02	13	5.00	3	13	100	1	760328	1	760328	11	760328	5.00	5.00
CP03	14	7.64	5.2	14	100	1	760331	1	760331	15	760331	7.64	7.64
CP04	10	9.66	5.5	10	100	2	760331	2	760331	19	910805	9.66	9.66
CP05	8	11.50	5.3	8	100	1	760331	1	760331	15	760331	11.50	11.50
CP06	14	11.40	3.7	14	100	3	760331	3	760331	16	760331	11.40	11.40
CP07	7	7.43	5.6	7	100	1	760331	1	760331	17	760331	7.43	7.43
CP08	12	8.92	7.9	12	100	1	760331	1	760331	21	760331	8.92	8.92
CP09	9	7.56	4.7	9	100	1	760328	1	760328	16	760328	7.56	7.56
CP10	14	10.20	6.3	14	100	1	760328	1	760328	19	920729	10.20	10.20
EF	1	3.00	0	1	100	3	770625	3	770625	3	770625	3.00	3.00
GR1	2	4.50	0.5	2	100	4	760921	4	760921	5	760921	4.50	4.50
GR2	14	8.64	5.1	14	100	2	760921	2	760921	17	760921	8.64	8.64
HI1	3	0.00	0	0	0							0.00	0.10
HI2	0												
I1	4	1.50	0.5	2	50	1	760802	1	760802	2	760813	0.75	0.80
I2	7	4.00	1.1	5	71	3	760813	3	760813	6	760813	2.86	2.89
I3	5	3.05	2.6	5	100	0.086	950111	0.086	950111	6	760813	3.05	3.05
I4	21	3.88	4.7	14	67	0.0031	950111	0.0031	950111	16	760625	2.59	2.62
I5	19	5.68	5.8	16	84	0.023	940105	0.023	940105	16	870715	4.78	4.80
I6	14	9.75	6.3	10	71	0.045	940105	0.045	940105	18	760531	6.96	6.99
I7	10	6.60	5.3	10	100	1	760531	1	760531	21	760531	6.60	6.60
I8	6	2.00	0.82	6	100	1	760531	1	760531	3	760531	2.00	2.00
I9	3	14.00	3	2	67	11	760924	11	760924	17	760924	9.33	9.37

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
I10	5	21.00	11	3	60	6	760924	6	760924	32	760924	12.60	12.60
I11	7	17.20	10	5	71	8	760924	8	760924	37	760924	12.30	12.30
I12	6	14.50	14	6	100	5	760924	5	760924	44	760618	14.50	14.50
I13	11	26.50	21	8	73	2	760924	2	760924	57	770210	19.30	19.30
I14	4	21.50	12	4	100	8	770210	8	770210	35	770109	21.50	21.50
I15	3	7.00	0	1	33	7	770210	7	770210	7	770210	2.33	2.40
I16	9	5.77	3.9	4	44	0.068	931221	0.068	931221	11	760921	2.56	2.62
I17	5	7.35	5.7	3	60	0.035	931221	0.035	931221	14	770210	4.41	4.45
I18	13	4.25	3.8	9	69	0.049	931221	0.049	931221	12	771216	2.94	2.97
IH1	1	0.25	0	1	100	0.25	940316	0.25	940316	0.25	940316	0.25	0.25
IH2	1	0.42	0	1	100	0.42	940316	0.42	940316	0.42	940316	0.42	0.42
IH3	2	0.23	0.047	2	100	0.19	940316	0.19	940316	0.28	940316	0.23	0.23
IH4	1	0.59	0	1	100	0.59	940316	0.59	940316	0.59	940316	0.59	0.59
IH5	1	0.68	0	1	100	0.68	940316	0.68	940316	0.68	940316	0.68	0.68
IH6	3	0.66	0.16	2	67	0.5	940316	0.5	940316	0.82	940316	0.44	0.47
IH7	4	0.22	0.024	2	50	0.2	940316	0.2	940316	0.24	940316	0.11	0.16
INL	3	4.50	1.5	2	67	3	760511	3	760511	6	760511	3.00	3.03
LAC	0												
LB	0												
LQ1	5	2.50	0.5	2	40	2	770625	2	770625	3	770625	1.00	1.06
LQ2	4	2.00	0	2	50	2	770625	2	770625	2	770625	1.00	1.05
LS1	1	9.00	0	1	100	9	760921	9	760921	9	760921	9.00	9.00
LS2	7	12.60	6	7	100	4	760921	4	760921	20	760921	12.60	12.60
M1	4	12.30	7	4	100	3	760917	3	760917	19	760917	12.30	12.30
M2	18	9.28	3.3	18	100	4	760917	4	760917	14	760917	9.28	9.28
MB1	4	4.25	2.2	4	100	3	760813	3	760813	8	760813	4.25	4.25
MB2	11	5.18	2.1	11	100	2	760813	2	760813	8	760813	5.18	5.18

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
NB1	5	7.80	3.3	5	100	3	760910	3	760910	12	760910	7.80	7.80
NB2	3	4.50	2.5	2	67	2	760910	2	760910	7	760910	3.00	3.03
NB3	3	7.56	3.7	3	100	2.8	910805	2.8	910805	12	930723	7.56	7.56
NB4	4	9.00	4.3	4	100	2	760910	2	760910	13	760910	9.00	9.00
NB5	7	5.14	3	7	100	1	760910	1	760910	10	760910	5.14	5.14
NB6	2	6.50	4.5	2	100	2	760910	2	760910	11	760910	6.50	6.50
NB7	3	3.67	1.7	3	100	2	760910	2	760910	6	760910	3.67	3.67
NB8	4	6.33	2.5	3	75	3	760910	3	760910	9	760910	4.75	4.78
NB9	5	6.40	2.4	5	100	3	760910	3	760910	9	760910	6.40	6.40
ND1	0												
ND2	1	4.00	0	1	100	4	760910	4	760910	4	760910	4.00	4.00
ND3	0												
ND4	0												
NR1	0												
NR2	0												
NR3	1	12.00	0	1	100	12	760910	12	760910	12	760910	12.00	12.00
NR4	2	10.00	7	2	100	3	760910	3	760910	17	760910	10.00	10.00
NR5	2	6.50	3.5	2	100	3	760910	3	760910	10	760910	6.50	6.50
OS1	0												
OS2	0												
OS3	0												
OS4	0												
OS5	2	13.50	0.5	2	100	13	760916	13	760916	14	760916	13.50	13.50
OS6	4	9.75	6.3	4	100	3	760916	3	760916	16	760916	9.75	9.75
OS7	4	5.50	2.9	4	100	3	760916	3	760916	10	760916	5.50	5.50
PB1	1	9.00	0	1	100	9	760916	9	760916	9	760916	9.00	9.00
PB2	14	5.36	3.2	14	100	1	760916	1	760916	12	760916	5.36	5.36

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
RB1	2	24.00	14	2	100	10	760713	10	760713	38	760713	24.00	24.00
RB2	6	15.70	6.7	6	100	4	760713	4	760713	23	760713	15.70	15.70
RB3	5	23.70	4.8	3	60	17	760713	17	760713	28	760713	14.20	14.20
RB4	0												
RB5	5	9.20	1.2	5	100	8	760713	8	760713	11	760713	9.20	9.20
RB6	5	9.22	7.1	5	100	4.1	920729	4.1	920729	23	760713	9.22	9.22
RB7	3	3.67	0.94	3	100	3	760713	3	760713	5	760713	3.67	3.67
RB8	3	5.50	1.5	2	67	4	760713	4	760713	7	760713	3.67	3.70
RB9	3	3.33	0.94	3	100	2	760713	2	760713	4	760713	3.33	3.33
SC1	4	7.00	3.9	4	100	2	760925	2	760925	13	760925	7.00	7.00
SC2	8	4.75	1.6	8	100	2	760925	2	760925	8	760925	4.75	4.75
SC3	4	7.50	3.2	4	100	3	760925	3	760925	11	760925	7.50	7.50
UL01	5	16.00	6.9	5	100	6	760924	6	760924	23	760924	16.00	16.00
UL02	3	27.70	9	3	100	19	760924	19	760924	40	760924	27.70	27.70
UL03	11	15.70	17	11	100	4	760924	4	760924	64	760924	15.70	15.70
UL04	0												
UL05	5	9.00	4.3	5	100	3	760924	3	760924	16	760924	9.00	9.00
UL06	10	4.00	1.9	10	100	1	760924	1	760924	8	760924	4.00	4.00
UL07	5	6.80	2.6	5	100	2	760924	2	760924	9	760924	6.80	6.80
UL08	4	3.75	1.9	4	100	2	770109	2	770109	7	770109	3.75	3.75
UL09	5	5.20	3.5	5	100	1	770109	1	770109	9	760924	5.20	5.20
UL10	7	5.43	2.8	7	100	1	770210	1	770210	9	770210	5.43	5.43
UL11	3	8.33	5.4	3	100	1	770210	1	770210	14	770210	8.33	8.33
UL12	2	7.00	0	2	100	7	770210	7	770210	7	770210	7.00	7.00
UL13	2	11.50	9.5	2	100	2	770210	2	770210	21	770210	11.50	11.50
UL14	3	7.00	2.8	3	100	3	771216	3	771216	9	770109	7.00	7.00

(continued)

TABLE 7-2
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
GMI1	7	1.86	0.4	7	100	1	760315	1	760315	2	760302	1.86	1.86
GMI2	9	1.22	0.4	9	100	1	760303	1	760303	2	760519	1.22	1.22
GMI3	12	2.08	0.6	12	100	1	760511	1	760511	3	760511	2.08	2.08
GMI4	6	2.17	0.4	6	100	2	760511	2	760511	3	760511	2.17	2.17
GMI5	14	2.21	0.8	14	100	1	760511	1	760511	3	760511	2.21	2.21
GMI6	10	3.11	2.2	9	90	1	760511	1	760511	8	760511	2.80	2.81
GMI7	18	1.72	0.6	18	100	1	760508	1	760508	3	760511	1.72	1.72
GMI8	8	1.63	0.7	8	100	1	760508	1	760508	3	760814	1.63	1.63
GMI9	5	2.60	2.7	5	100	1	760508	1	760508	8	760508	2.60	2.60
GMO1	32	4.19	2.0	32	100	1	760302	1	760302	11	760302	4.19	4.19
GMO2	47	3.74	2.2	47	100	1	760303	1	760303	8	760519	3.74	3.74
GMO3	61	4.67	2.0	61	100	1	760511	1	760511	9	760511	4.67	4.67
GMO4	26	4.04	1.8	26	100	1	760511	1	760511	8	760511	4.04	4.04
GMO5	49	5.69	2.3	49	100	2	760511	2	760511	10	760511	5.69	5.69
GMO6	24	4.61	2.3	23	96	2	760511	2	760511	9	760511	4.42	4.42
GMO7	68	4.18	2.4	68	100	1	760508	1	760508	14	760508	4.18	4.18
GMO8	33	4.03	2.2	33	100	1	760508	1	760508	8	760508	4.03	4.03
GMO9	33	4.52	2.3	33	100	1	760508	1	760508	9	760508	4.52	4.52

TABLE 7-3
Period of record statistics for CCBNEP Hydrographic Segments
SEDMETZN

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
A1	1	0.0	0.0	0	0							0.0	10.0
A2	2	18.0	0.0	1	50	18.0	760407	18.0	760407	18	760407	9.0	14.0
A3	2	96.3	0.0	1	50	96.0	930720	96.0	930720	96	930720	48.2	53.2
A4	2	42.0	2.0	2	100	40.0	760625	40.0	760625	44	760531	42.0	42.0
A5	1	24.0	0.0	1	100	24.0	760531	24.0	760531	24	760531	24.0	24.0
A6	1	10.0	0.0	1	100	10.0	760531	10.0	760531	10	760531	10.0	10.0
A8	1	0.0	0.0	0	0							0.0	10.0
A9	1	10.0	0.0	1	100	10.0	760625	10.0	760625	10	760625	10.0	10.0
A10	1	70.0	0.0	1	100	70.0	760531	70.0	760531	70	760531	70.0	70.0
A11	2	18.5	8.5	2	100	10.0	760531	10.0	760531	27	760531	18.5	18.5
A12	3	47.0	17.0	2	67	30.0	751103	30.0	751103	64	760531	31.3	34.7
A13	3	28.4	5.7	3	100	21.0	930720	21.0	930720	35	740723	28.4	28.4
AL1	7	35.2	25.0	6	86	14.0	880615	14.0	880615	86	880615	30.2	31.6
AL2	11	45.9	18.0	10	91	9.4	880615	9.4	880615	72	880615	41.7	42.6
AR1	11	31.0	23.0	11	100	3.4	800819	3.4	800819	85	760919	31.0	31.0
AYB	1	6.8	0.0	1	100	6.8	840823	6.8	840823	6.8	840823	6.8	6.8
BF1	22	47.2	22.0	21	95	4.6	880615	4.6	880615	97	860527	45.1	45.5
BF2	21	40.4	26.0	20	95	3.1	880615	3.1	880615	79	880615	38.5	39.0
BF3	23	43.6	36.0	22	96	3.4	880615	3.4	880615	160	860527	41.7	42.1
C01	5	85.9	70.0	5	100	15.0	930723	15.0	930723	210	880615	85.9	85.9
C02	4	54.9	21.0	4	100	31.0	770625	31.0	770625	84	880615	54.9	54.9
C03	5	45.0	31.0	5	100	7.1	880615	7.1	880615	90	880615	45.0	45.0
C04	6	81.9	29.0	6	100	24.0	880615	24.0	880615	120	880615	81.9	81.9
C05	7	93.5	18.0	7	100	60.0	741024	60.0	741024	120	770625	93.5	93.5
C06	7	100.0	17.0	7	100	60.0	880615	60.0	880615	110	880615	100.0	100.0
C07	9	97.1	31.0	9	100	38.0	870331	38.0	870331	130	770625	97.1	97.1

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
C08	8	93.7	21.0	8	100	48.0	870331	48.0	870331	120	920729	93.7	93.7
C09	5	55.2	27.0	5	100	19.0	770625	19.0	770625	94	880615	55.2	55.2
C10	13	96.0	28.0	13	100	18.0	880615	18.0	880615	160	930720	96.0	96.0
C11	18	75.6	33.0	16	89	21.0	880615	21.0	880615	160	940724	67.2	68.3
C12	14	44.2	29.0	13	93	5.5	880615	5.5	880615	100	751031	41.1	41.8
C13	7	74.3	29.0	6	86	40.0	880615	40.0	880615	120	880615	63.7	65.1
C14	16	45.6	31.0	13	81	2.6	880615	2.6	880615	90	880615	37.1	38.9
C15	17	75.7	42.0	17	100	9.7	880615	9.7	880615	170	860529	75.7	75.7
C16	4	104.0	18.0	4	100	81.0	880615	81.0	880615	130	770625	104.0	104.0
C17	5	63.4	14.0	5	100	46.0	880615	46.0	880615	84	880615	63.4	63.4
C18	10	96.2	26.0	10	100	43.0	870331	43.0	870331	140	890902	96.2	96.2
C19	3	65.2	2.8	2	67	62.0	880615	62.0	880615	68	770625	43.5	46.8
C20	2	59.2	31.0	2	100	28.0	880615	28.0	880615	90	880615	59.2	59.2
C21	2	52.0	27.0	2	100	25.0	751030	25.0	751030	79	880615	52.0	52.0
C22	11	67.5	53.0	10	91	8.8	920729	8.8	920729	160	890902	61.3	62.2
C23	2	22.3	19.0	2	100	3.6	880615	3.6	880615	41	770625	22.3	22.3
C24	3	25.6	14.0	3	100	5.7	880615	5.7	880615	39	760924	25.6	25.6
C25	3	9.7	2.0	3	100	7.2	880615	7.2	880615	12	760924	9.7	9.7
CB	2	20.0	0.0	1	50	20.0	751103	20.0	751103	20	751103	10.0	12.5
CBH	1	0.0	0.0	0	0							0.0	0.1
CBY1	1	20.6	0.0	1	100	21.0	760814	21.0	760814	21	760814	20.6	20.6
CBY2	1	153.0	0.0	1	100	150.0	760814	150.0	760814	150	760814	153.0	153.0
CCC1	3	47.0	6.0	3	100	41.0	880715	41.0	880715	55	880715	47.0	47.0
CCC2	10	17.7	9.3	10	100	6.2	910919	6.2	910919	38	810507	17.7	17.7
CCC3	10	56.3	23.0	10	100	12.0	930109	12.0	930109	89	720716	56.3	56.3
CCC4	13	42.7	26.0	13	100	19.0	891219	19.0	891219	100	740723	42.7	42.7
CCC5	17	61.5	49.0	17	100	23.0	891219	23.0	891219	190	720716	61.5	61.5

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
CCC6	38	64.4	37.0	38	100	4.3	690717	4.3	690717	170	740723	64.4	64.4
CCC7	15	71.7	39.0	15	100	9.7	891219	9.7	891219	140	751209	71.7	71.7
CCC8	26	125.0	68.0	26	100	16.0	910822	16.0	910822	280	790201	125.0	125.0
CP01	0												
CP02	6	19.8	5.3	5	83	11.0	760328	11.0	760328	27	760328	16.5	18.2
CP03	9	43.4	14.0	5	56	28.0	720918	28.0	720918	67	760331	24.1	28.6
CP04	2	81.5	23.0	2	100	59.0	760331	59.0	760331	100	910805	81.5	81.5
CP05	2	36.0	19.0	2	100	17.0	760331	17.0	760331	55	760331	36.0	36.0
CP06	7	69.9	15.0	7	100	42.0	760331	42.0	760331	90	860715	69.9	69.9
CP07	2	56.0	36.0	2	100	20.0	751103	20.0	751103	92	760331	56.0	56.0
CP08	2	0.0	0.0	0	0							0.0	10.0
CP09	3	23.5	9.5	2	67	14.0	760328	14.0	760328	33	760328	15.7	19.0
CP10	16	60.0	26.0	16	100	13.0	760831	13.0	760831	110	940724	60.0	60.0
EF	1	6.6	0.0	1	100	6.6	880615	6.6	880615	6.6	880615	6.6	6.6
GR1	1	44.0	0.0	1	100	44.0	760921	44.0	760921	44	760921	44.0	44.0
GR2	10	35.4	13.0	10	100	7.8	880615	7.8	880615	50	880615	35.4	35.4
HI1	4	4.6	0.8	4	100	3.5	940804	3.5	940804	5.6	880615	4.6	4.6
HI2	1	13.0	0.0	1	100	13.0	880615	13.0	880615	13	880615	13.0	13.0
I1	3	136.0	0.0	1	33	140.0	760813	140.0	760813	140	760813	45.3	45.4
I2	7	52.5	58.0	3	43	5.7	840823	5.7	840823	130	760813	22.5	24.0
I3	12	14.1	5.3	9	75	5.6	840823	5.6	840823	25	950111	10.6	12.2
I4	40	18.6	11.0	39	98	5.4	880127	5.4	880127	50	950111	18.2	18.3
I5	24	30.8	16.0	24	100	8.3	900110	8.3	900110	71	950111	30.8	30.8
I6	25	37.8	29.0	25	100	3.0	900110	3.0	900110	99	930720	37.8	37.8
I7	2	31.5	21.0	2	100	11.0	760531	11.0	760531	52	760531	31.5	31.5
I8	2	13.5	1.5	2	100	12.0	760531	12.0	760531	15	760531	13.5	13.5
I9	4	29.7	34.0	4	100	5.1	880615	5.1	880615	89	760618	29.7	29.7

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
I10	6	31.1	33.0	6	100	9.3	880615	9.3	880615	100	760618	31.1	31.1
I11	8	53.5	41.0	6	75	13.0	901116	13.0	901116	120	760618	40.1	42.6
I12	17	57.9	33.0	16	94	8.0	870507	8.0	870507	110	760618	54.5	55.1
I13	12	19.3	13.0	12	100	3.3	880909	3.3	880909	47	770109	19.3	19.3
I14	9	22.9	15.0	9	100	5.5	880909	5.5	880909	47	880615	22.9	22.9
I15	7	34.6	44.0	7	100	8.4	880615	8.4	880615	140	771217	34.6	34.6
I16	15	23.7	22.0	14	93	4.1	880615	4.1	880615	91	771217	22.1	22.8
I17	7	24.1	9.4	7	100	7.7	880615	7.7	880615	39	931221	24.1	24.1
I18	18	38.9	45.0	18	100	3.4	901116	3.4	901116	210	771217	38.9	38.9
IH1	21	478.0	600.0	21	100	9.1	790515	9.1	790515	2600	731024	478.0	478.0
IH2	6	1450.0	950.0	6	100	210.0	940316	210.0	940316	2900	751209	1450.0	1450.0
IH3	16	2480.0	2000.0	16	100	130.0	940316	130.0	940316	6000	751209	2480.0	2480.0
IH4	10	3020.0	3000.0	10	100	93.0	880615	93.0	880615	9700	720716	3020.0	3020.0
IH5	27	1940.0	1800.0	27	100	23.0	910710	23.0	910710	6200	720716	1940.0	1940.0
IH6	31	636.0	570.0	31	100	56.0	910822	56.0	910822	2400	720716	636.0	636.0
IH7	20	388.0	500.0	20	100	31.0	910822	31.0	910822	2000	751209	388.0	388.0
INL	4	7.1	3.7	3	75	2.4	900404	2.4	900404	11	940804	5.3	6.6
LAC	1	5.9	0.0	1	100	5.9	740723	5.9	740723	5.9	740723	5.9	5.9
LB	0												
LQ1	22	35.6	19.0	21	95	5.0	940617	5.0	940617	72	880615	34.0	34.2
LQ2	25	55.8	25.0	24	96	10.0	940617	10.0	940617	99	880524	53.6	53.8
LS1	1	40.0	0.0	1	100	40.0	760921	40.0	760921	40	760921	40.0	40.0
LS2	6	39.6	16.0	6	100	19.0	880615	19.0	880615	64	880615	39.6	39.6
M1	2	44.9	28.0	2	100	17.0	760917	17.0	760917	73	760917	44.9	44.9
M2	8	57.6	12.0	8	100	38.0	760917	38.0	760917	73	760917	57.6	57.6
MB1	18	35.2	22.0	16	89	0.6	760902	0.6	760902	87	860318	31.3	31.8
MB2	4	44.0	7.0	2	50	37.0	760813	37.0	760813	51	760813	22.0	27.0

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
NB1	5	106.0	70.0	5	100	44.0	880615	44.0	880615	240	880615	106.0	106.0
NB2	1	430.0	0.0	1	100	430.0	760910	430.0	760910	430	760910	430.0	430.0
NB3	3	145.0	75.0	3	100	41.0	910805	41.0	910805	210	880615	145.0	145.0
NB4	3	93.1	77.0	3	100	23.0	880615	23.0	880615	200	760910	93.1	93.1
NB5	9	89.0	58.0	8	89	18.0	880615	18.0	880615	170	720919	79.1	80.2
NB6	4	98.8	57.0	4	100	29.0	880615	29.0	880615	160	760910	98.8	98.8
NB7	15	138.0	71.0	15	100	33.0	770105	33.0	770105	250	840625	138.0	138.0
NB8	3	75.2	25.0	3	100	47.0	880615	47.0	880615	110	880615	75.2	75.2
NB9	2	31.8	10.0	2	100	22.0	880615	22.0	880615	42	760910	31.8	31.8
ND1	0												
ND2	1	39.3	0.0	1	100	39.0	880615	39.0	880615	39	880615	39.3	39.3
ND3	0												
ND4	1	25.9	0.0	1	100	26.0	880615	26.0	880615	26	880615	25.9	25.9
NR1	0												
NR2	0												
NR3	0												
NR4	9	106.0	82.0	9	100	10.0	810826	10.0	810826	220	850403	106.0	106.0
NR5	2	75.9	4.2	2	100	72.0	880615	72.0	880615	80	751030	75.9	75.9
OS1	3	144.0	100.0	3	100	58.0	841227	58.0	841227	290	801126	144.0	144.0
OS2	0												
OS3	2	50.5	1.5	2	100	49.0	731025	49.0	731025	52	750121	50.5	50.5
OS4	0												
OS5	2	90.1	2.7	2	100	87.0	760916	87.0	760916	93	760916	90.1	90.1
OS6	3	49.6	37.0	3	100	9.0	760916	9.0	760916	98	760916	49.6	49.6
OS7	3	28.9	9.5	3	100	16.0	880615	16.0	880615	39	760916	28.9	28.9
PB1	1	15.0	0.0	1	100	15.0	760916	15.0	760916	15	760916	15.0	15.0
PB2	3	16.0	0.0	1	33	16.0	760916	16.0	760916	16	760916	5.3	12.0

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
RB1	1	76.0	0.0	1	100	76.0	760713	76.0	760713	76	760713	76.0	76.0
RB2	2	39.8	34.0	2	100	5.7	760713	5.7	760713	74	760713	39.8	39.8
RB3	3	72.2	18.0	3	100	52.0	940804	52.0	940804	96	940804	72.2	72.2
RB4	1	14.0	0.0	1	100	14.0	880615	14.0	880615	14	880615	14.0	14.0
RB5	4	39.5	15.0	4	100	15.0	880615	15.0	880615	55	760713	39.5	39.5
RB6	4	30.5	29.0	4	100	7.6	880615	7.6	880615	79	760713	30.5	30.5
RB7	2	26.8	0.0	1	50	27.0	880615	27.0	880615	27	880615	13.4	18.4
RB8	18	36.4	16.0	18	100	6.9	790925	6.9	790925	75	731003	36.4	36.4
RB9	1	11.0	0.0	1	100	11.0	740723	11.0	740723	11	740723	11.0	11.0
SC1	1	17.0	0.0	1	100	17.0	760925	17.0	760925	17	760925	17.0	17.0
SC2	6	32.4	16.0	5	83	18.0	760925	18.0	760925	63	720918	27.0	28.7
SC3	9	18.6	16.0	9	100	3.3	810828	3.3	810828	41	860716	18.6	18.6
UL01	7	25.8	11.0	6	86	9.2	880615	9.2	880615	41	880615	22.1	23.5
UL02	3	29.3	23.0	3	100	11.0	880615	11.0	880615	62	880615	29.3	29.3
UL03	8	55.2	80.0	7	88	11.0	880615	11.0	880615	250	880615	48.3	49.6
UL04	1	101.0	0.0	1	100	100.0	880615	100.0	880615	100	880615	101.0	101.0
UL05	3	17.5	1.3	2	67	16.0	880615	16.0	880615	19	880615	11.7	15.0
UL06	8	23.7	17.0	6	75	6.7	880615	6.7	880615	55	880615	17.8	20.3
UL07	5	36.1	26.0	4	80	9.1	880615	9.1	880615	66	880615	28.9	30.9
UL08	4	9.1	3.8	3	75	3.8	880615	3.8	880615	12	760924	6.9	9.4
UL09	2	39.1	24.0	2	100	15.0	880615	15.0	880615	63	880615	39.1	39.1
UL10	5	14.2	12.0	4	80	3.8	880615	3.8	880615	34	770210	11.3	13.3
UL11	3	11.9	3.0	3	100	8.8	880615	8.8	880615	16	770210	11.9	11.9
UL12	3	32.7	8.2	3	100	23.0	770210	23.0	770210	43	770210	32.7	32.7
UL13	3	23.0	1.6	3	100	21.0	770210	21.0	770210	25	770210	23.0	23.0
UL14	5	18.8	4.8	4	80	12.0	880615	12.0	880615	25	771216	15.0	17.0

(continued)

TABLE 7-3
(continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
GMI1	4	18.00	0.0	1	25	18	760315	18	760315	18	760315	4.50	15.80
GMI2	4	21.00	0.0	1	25	21	760519	21	760519	21	760519	5.25	16.50
GMI3	5	18.00	1.0	2	40	17	760511	17	760511	19	760511	7.20	16.20
GMI4	3	41.00	0.0	1	33	41	760511	41	760511	41	760511	13.70	23.70
GMI5	5	39.50	14.0	2	40	26	760511	26	760511	53	760511	15.80	24.80
GMI6	20	28.40	27.0	15	75	2.3	900404	2.3	900404	93	860814	21.30	23.50
GMI7	6	22.00	7.0	2	33	15	760511	15	760511	29	760511	7.33	17.30
GMI8	4	153.00	0.0	1	25	150	760814	150	760814	150	760814	38.30	49.50
GMI9	3	0.00	0.0	0								0.00	15.00
GMO1	9	38.30	16.0	6	67	18	760303	18	760303	70	760303	25.60	30.60
GMO2	9	31.80	15.0	8	89	15	760303	15	760303	62	760519	28.20	29.90
GMO3	12	34.30	13.0	10	83	19	760511	19	760511	59	760511	28.60	31.10
GMO4	5	23.30	3.1	4	80	20	760511	20	760511	28	760511	18.60	21.60
GMO5	14	26.20	12.0	13	93	16	760511	16	760511	55	760511	24.30	25.40
GMO6	18	20.70	12.0	13	72	2.4	900404	2.4	900404	44	760511	15.00	16.90
GMO7	18	37.40	17.0	15	83	17	760511	17	760511	81	760508	31.20	33.70
GMO8	7	42.40	16.0	7	100	16	760508	16	760508	60	760508	42.40	42.40
GMO9	7	35.00	13.0	5	71	19	760508	19	760508	59	760508	25.00	29.30

Table 7-4
Time Trend Analysis for CCBNEP Hydrographic Segments: SEDTOC

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
A1	760407	760625	760407	760625	37	-2.99E+01	9.80	4.55	0.68	-7.30E+01	1.40E+01	poss
A2	760326	760625	760326	760625	24	8.30E+00	4.00	1.54	0.75	-1.20E+01	2.80E+01	poss
A3	760531	930720	760531	930720	0.29	1.96E-01	6.50	5.00	0.93	-1.10E+00	1.50E+00	poss
A4	760531	760625	760531	760625	100	-3.13E+01	16.00	2.26	0.85	-1.20E+02	5.40E+01	
A5	760531	760531	760531	760531	2							
A6	760531	760531	760531	760531	5							
A8	760625	760625	760625	760625	2							
A9	760625	760625	760625	760625	3							
A10	760531	760625	760531	760625	120	-5.59E+01	9.80	7.37	0.94	-2.80E+02	1.60E+02	
A11	760531	760531	760531	760531	11							
A12	760531	760531	760531	760531	7							
A13	760531	930720	760531	930720	0.41	-3.72E-02	4.70	3.15	1.00	-6.40E-01	5.70E-01	
AL1	760922	760922	760922	760922	8							
AL2	760921	760922	760921	760922	6200	1.96E+03	3.00	4.87	0.94	-2.20E+03	6.10E+03	poss
AR1	760331	760919	760331	760919	11	1.49E+01	4.00	5.06	0.77	-3.50E+01	6.50E+01	poss
AYB	760812	760812	760812	760812	3							
BF1	760921	760921	760921	760921	13							
BF2	760921	760922	760921	760922	10000	-3.18E+03	14.00	7.89	0.96	-9.40E+03	3.10E+03	
BF3	760921	760921	760921	760921	22							
C01	770625	930723	770625	930723	0.25	-2.03E-01	4.00	2.55	0.77	-1.30E+00	9.10E-01	
C02	770625	770625	770625	770625	4							
C03	770625	770625	770625	770625	5							
C04	770625	770625	770625	770625	7							
C05	770625	770625	770625	770625	4							
C06	770625	770625	770625	770625	7							
C07	770625	770625	770625	770625	6							

(continued)

Table 7-4
(continued)

Segment	Period of record		Analysis period		Avg	Regression on time				95% confidence limits on slope		
	dates		Start date	End date	obs /yr	slope (per yr)	intercept (@ start)	SEE	residual variance	lower	upper	
C08	770625	920729	770625	920729	0.66	-2.14E-01	13.00	3.16	0.91	-7.80E-01	3.60E-01	
C09	770625	770625	770625	770625	5							
C10	770625	930720	770625	930720	0.62	-3.15E-01	17.00	1.96	0.62	-6.50E-01	1.70E-02	poss
C11	770625	940724	770625	940724	0.94	9.17E-02	9.10	4.92	0.99	-5.90E-01	7.70E-01	poss
C12	770625	770625	770625	770625	15							
C13	760924	770625	760924	770625	8	1.57E+01	2.00	6.18	0.66	-1.50E+01	4.60E+01	poss
C14	760924	931221	760924	931221	0.87	-3.30E-01	6.40	6.07	0.95	-1.20E+00	5.40E-01	
C15	760910	880715	760910	880715	1.2	6.95E-02	4.70	3.61	0.99	-3.90E-01	5.30E-01	poss
C16	770625	770625	770625	770625	3							
C17	770625	770625	770625	770625	6							
C18	770625	890902	770625	890902	0.66	-4.35E-01	13.00	1.84	0.44	-8.20E-01	-4.80E-02	prob
C19	770625	770625	770625	770625	4							
C20	770625	770625	770625	770625	2							
C21	770625	770625	770625	770625	2							
C22	770625	920729	770625	920729	0.73	-3.25E-01	8.90	3.79	0.82	-8.50E-01	2.00E-01	poss
C23	770625	770625	770625	770625	2							
C24	760924	760924	760924	760924	3							
C25	760924	760924	760924	760924	2							
CB	760813	761001	760813	761001	52	-2.79E+01	7.70	3.03	0.77	-8.60E+01	3.00E+01	
CBH	940804	940804										
CBY1	760814	760814	760814	760814	2							
CBY2	760814	760814	760814	760814	1							
CCC1	760713	880715	760713	880715	0.33	-2.78E-02	5.00	1.78	0.99	-1.10E+00	1.00E+00	
CCC2	760713	910919	760713	760713	2							
CCC3	770625	770625	770625	770625	2							
CCC4	770625	950112	770625	950112	0.17	-7.79E-01	14.00	0.09	0.00	-9.20E-01	-6.40E-01	prob

(continued)

Table 7-4
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
CCC5	770625	950112	770625	950112	0.46	-5.78E-01	10.00	0.58	0.01	-6.50E-01	-5.10E-01	prob
CCC6	770625	950112	770625	950112	0.4	-6.73E-01	12.00	0.05	0.00	-6.80E-01	-6.70E-01	prob
CCC7	770625	950112	770625	950112	0.28	-4.21E-01	7.70	1.59	0.16	-7.60E-01	-8.10E-02	prob
CCC8	770625	950112	770625	950112	0.17	-1.05E-01	2.00	0.03	0.00	-1.50E-01	-6.30E-02	prob
CP01												
CP02	760328	760328	760328	760328	13							
CP03	760331	760331	760331	760331	14							
CP04	760331	910805	760331	910805	0.65	6.39E-01	8.60	4.68	0.72	-2.00E-01	1.50E+00	poss
CP05	760331	760331	760331	760331	8							
CP06	760328	870715	760328	870715	1.2	-3.27E-01	13.00	3.25	0.78	-7.10E-01	5.50E-02	poss
CP07	760331	760331	760331	760331	7							
CP08	760328	760331	760328	760331	1500	9.18E+02	2.00	7.58	0.93	-1.40E+03	3.30E+03	poss
CP09	760328	760328	760328	760328	9							
CP10	760328	940818	760328	940818	0.76	4.85E-01	6.50	4.68	0.56	1.40E-01	8.30E-01	prob
EF	770625	770625	770625	770625	1							
GR1	760921	760921	760921	760921	2							
GR2	760921	760921	760921	760921	14							
HI1	940804	940804										
HI2												
I1	760802	930216	760802	760813	66							
I2	760813	930216	760813	760813	5							
I3	760813	950111	760813	950111	0.27	-2.66E-01	5.00	1.09	0.17	-4.90E-01	-4.40E-02	prob
I4	760326	950111	760326	950111	0.75	-4.18E-01	7.80	2.76	0.34	-6.10E-01	-2.30E-01	prob
I5	760531	950111	760531	950111	0.86	-5.37E-01	11.00	4.48	0.60	-9.10E-01	-1.60E-01	prob
I6	760531	940105	760531	940105	0.57	-4.36E-01	12.00	5.24	0.69	-9.70E-01	9.90E-02	poss
I7	760531	760531	760531	760531	10							

(continued)

Table 7-4
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
I8	760531	760531	760531	760531	6							
I9	760924	931221	760924	760924	2							
I10	760924	901116	760924	760924	3							
I11	760924	901116	760924	760924	5							
I12	760618	760924	760618	760924	22	-5.90E+01	25.00	11.90	0.72	-1.90E+02	7.30E+01	
I13	760618	931221	760618	770210	12	3.37E+01	11.00	19.40	0.89	-6.20E+01	1.30E+02	poss
I14	770109	770210	770109	770210	46	-2.09E+02	26.00	9.25	0.59	-9.60E+02	5.40E+02	
I15	770210	931221	770210	770210	1							
I16	760921	931221	760921	931221	0.23	-4.45E-01	7.70	2.15	0.30	-1.30E+00	4.40E-01	poss
I17	770210	931221	770210	931221	0.18	-6.50E-01	11.00	2.45	0.18	-4.60E+00	3.30E+00	
I18	770210	931221	770210	931221	0.53	-3.82E-01	6.50	2.35	0.39	-6.60E-01	-1.10E-01	prob
IH1	940316	940316	940316	940316	1							
IH2	940316	940316	940316	940316	1							
IH3	940316	940316	940316	940316	2							
IH4	940316	940316	940316	940316	1							
IH5	940316	940316	940316	940316	1							
IH6	910822	940316	940316	940316	2							
IH7	910822	940316	940316	940316	2							
INL	760511	940804	760511	760511	2							
LAC												
LB												
LQ1	770625	901220	770625	770625	2							
LQ2	770625	901220	770625	770625	2							
LS1	760921	760921	760921	760921	1							
LS2	760921	760921	760921	760921	7							
M1	760917	760917	760917	760917	4							

(continued)

Table 7-4
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
M2	760917	760917	760917	760917	18							
MB1	760813	760813	760813	760813	4							
MB2	760813	760813	760813	760813	11							
NB1	760910	760910	760910	760910	5							
NB2	760910	760910	760910	760910	2							
NB3	760910	930723	760910	930723	0.18	1.16E-02	7.40	3.74	1.00	-6.30E+00	6.30E+00	poss
NB4	760910	760910	760910	760910	4							
NB5	760910	760910	760910	760910	7							
NB6	760910	760910	760910	760910	2							
NB7	760910	760910	760910	760910	3							
NB8	760910	760910	760910	760910	3							
NB9	760910	760910	760910	760910	5							
ND1												
ND2	760910	760910	760910	760910	1							
ND3												
ND4												
NR1												
NR2												
NR3	760910	760910	760910	760910	1							
NR4	760910	760910	760910	760910	2							
NR5	760910	760910	760910	760910	2							
OS1												
OS2												
OS3												
OS4												
OS5	760916	760916	760916	760916	2							

(continued)

Table 7-4
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
OS6	760916	760916	760916	760916	4							
OS7	760916	760916	760916	760916	4							
PB1	760916	760916	760916	760916	1							
PB2	760331	760916	760331	760916	30	-2.44E+00	6.00	3.17	0.97	-1.10E+01	6.30E+00	
RB1	760713	760713	760713	760713	2							
RB2	760713	760713	760713	760713	6							
RB3	760713	940804	760713	760713	3							
RB4												
RB5	760713	760713	760713	760713	5							
RB6	760713	920729	760713	920729	0.31	-3.99E-01	10.00	6.62	0.87	-2.30E+00	1.50E+00	
RB7	760713	760713	760713	760713	3							
RB8	760713	940804	760713	760713	2							
RB9	760713	760713	760713	760713	3							
SC1	760925	760925	760925	760925	4							
SC2	760925	760925	760925	760925	8							
SC3	760925	760925	760925	760925	4							
UL01	760924	760924	760924	760924	5							
UL02	760924	760924	760924	760924	3							
UL03	760924	760924	760924	760924	11							
UL04												
UL05	760924	760924	760924	760924	5							
UL06	760924	760924	760924	760924	10							
UL07	760924	760924	760924	760924	5							
UL08	760924	770109	760924	770109	14	3.44E+00	3.00	1.87	0.95	-4.20E+01	4.90E+01	poss
UL09	760924	770109	760924	770109	17	-1.64E+01	9.00	2.92	0.70	-6.30E+01	3.00E+01	
UL10	770210	770210	770210	770210	7							
UL11	770210	770210	770210	770210	3							

(continued)

Table 7-4
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
UL12	770210	770210	770210	770210	2							
UL13	770210	770210	770210	770210	2							
UL14	770109	771216	770109	771216	3.2	-3.20E+00	9.00	2.45	0.75	-7.40E+01	6.70E+01	
GMI1	760302	760315	760302	760315	200	-7.19E+00	2.00	0.33	0.88	-2.90E+01	1.50E+01	
GMI2	760303	760519	760303	760519	43	4.74E+00	1.00	0.00	0.00	4.70E+00	4.70E+00	prob
GMI3	760511	760519	760511	760519	550	-4.56E+00	2.10	0.64	1.00	-6.00E+01	5.10E+01	
GMI4	760511	760511	760511	760511	6							
GMI5	760511	760511	760511	760511	14							
GMI6	760511	760511	760511	760511	9							
GMI7	760508	760511	760508	760511	2200	8.11E+00	1.70	0.56	1.00	-8.80E+01	1.00E+02	poss
GMI8	760508	760814	760508	760814	30	5.88E+00	1.40	0.46	0.44	6.40E-01	1.10E+01	prob
GMI9	760508	760508	760508	760508	5							
GMO1	760302	760315	760302	760315	900	-1.58E+01	4.50	1.97	0.98	-5.80E+01	2.70E+01	
GMO2	760303	760519	760303	760519	220	4.81E+00	3.50	2.12	0.96	-2.00E+00	1.20E+01	poss
GMO3	760511	760519	760511	760519	2800	-5.04E+00	4.70	2.01	1.00	-6.50E+01	5.50E+01	
GMO4	760511	760511	760511	760511	26							
GMO5	760511	760511	760511	760511	49							
GMO6	760511	760511	760511	760511	23							
GMO7	760508	760511	760508	760511	8300	-2.17E+01	4.30	2.45	1.00	-1.70E+02	1.30E+02	
GMO8	760508	760508	760508	760508	33							
GMO9	760508	760508	760508	760508	33							

Table 7-5
Time Trend Analysis for CCBNEP Hydrographic Segments: SEDMETZN

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
A1	760407	760407										
A2	760326	760407	760407	760407	1							
A3	760531	930720	930720	930720	1							
A4	760531	760625	760531	760625	30							
A5	760531	760531	760531	760531	1							
A6	760531	760531	760531	760531	1							
A8	760625	760625										
A9	760625	760625	760625	760625	1							
A10	760531	760531	760531	760531	1							
A11	760531	760531	760531	760531	2							
A12	751103	760531	751103	760531	3.5							
A13	740723	930720	740723	930720	0.16	-6.24E-01	33.0	2.0	0.12	-3.60E+00	2.30E+00	
AL1	760922	880615	760922	880615	0.51	2.17E+00	14.0	23.6	0.86	-5.30E+00	9.70E+00	poss
AL2	760922	880615	760922	880615	0.85	1.37E+00	33.0	17.3	0.88	-1.60E+00	4.40E+00	poss
AR1	731029	890516	731029	890516	0.71	-2.30E+00	49.0	19.8	0.75	-5.30E+00	6.90E-01	poss
AYB	840823	840823	840823	840823	1							
BF1	731023	880615	731023	880615	1.4	1.67E-02	47.0	21.6	1.00	-2.00E+00	2.10E+00	poss
BF2	760921	880615	760921	880615	1.7	1.41E+00	28.0	25.3	0.93	-1.10E+00	3.90E+00	poss
BF3	760921	880615	760921	880615	1.9	-7.42E-01	50.0	35.8	0.99	-4.20E+00	2.70E+00	
C01	770625	930723	770625	930723	0.31	-5.27E+00	140.0	63.7	0.84	-2.70E+01	1.70E+01	
C02	770625	880615	770625	880615	0.36	2.90E+00	31.0	15.7	0.56	-7.10E+00	1.30E+01	poss
C03	770625	880615	770625	880615	0.46	-3.08E+00	72.0	28.4	0.82	-1.50E+01	8.80E+00	
C04	770625	880615	770625	880615	0.55	-7.72E-01	88.0	29.0	0.98	-8.60E+00	7.00E+00	
C05	741024	880615	741024	880615	0.51	7.57E-01	86.0	17.5	0.94	-2.80E+00	4.30E+00	poss
C06	770625	880615	770625	880615	0.64	3.65E-02	100.0	16.8	1.00	-5.00E+00	5.10E+00	poss
C07	740723	880615	740723	880615	0.65	-1.98E-01	99.0	30.7	1.00	-4.80E+00	4.40E+00	

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
C08	770625	920729	770625	920729	0.53	1.21E+00	82.0	20.9	0.95	-4.00E+00	6.40E+00	poss
C09	770625	880615	770625	880615	0.46	9.39E-01	49.0	26.8	0.97	-8.20E+00	1.00E+01	poss
C10	741024	930720	741024	930720	0.69	8.57E-01	86.0	27.8	0.97	-2.60E+00	4.30E+00	poss
C11	770625	940724	770625	940724	0.94	1.19E-01	75.0	32.8	1.00	-3.90E+00	4.10E+00	poss
C12	751031	880615	751031	880615	1	-2.01E+00	61.0	26.7	0.85	-5.20E+00	1.20E+00	poss
C13	770625	880615	770625	880615	0.55	1.45E+00	61.0	28.8	0.96	-8.30E+00	1.10E+01	poss
C14	760924	931221	880615	931221	2.4	-6.76E+00	53.0	28.1	0.81	-1.60E+01	2.50E+00	poss
C15	760412	880715	760412	880715	1.4	-6.47E-01	81.0	41.8	1.00	-5.60E+00	4.30E+00	
C16	770625	880615	770625	880615	0.36	-3.19E+00	130.0	9.8	0.30	-9.50E+00	3.10E+00	poss
C17	741024	880615	741024	880615	0.37	2.51E-01	61.0	13.5	0.99	-3.80E+00	4.30E+00	poss
C18	770625	890902	770625	890902	0.82	-2.27E+00	120.0	24.8	0.91	-8.30E+00	3.70E+00	
C19	770625	880615	770625	880615	0.18							
C20	880615	880615	880615	880615	2							
C21	751030	880615	751030	880615	0.16							
C22	770625	920729	840930	920729	1.3	1.76E+00	62.0	52.4	0.99	-1.70E+01	2.00E+01	poss
C23	770625	880615	770625	880615	0.18							
C24	760924	880615	760924	880615	0.26	-1.72E+00	39.0	10.7	0.56	-2.60E+01	2.30E+01	
C25	760924	880615	760924	880615	0.26	-2.89E-01	12.0	1.1	0.33	-2.90E+00	2.30E+00	
CB	751103	840823	751103	751103	1							
CBH	940804	940804										
CBY1	760814	760814	760814	760814	1							
CBY2	760814	760814	760814	760814	1							
CCC1	880715	880715	880715	880715	3							
CCC2	720716	910919	720716	910919	0.52	-5.54E-01	24.0	8.5	0.83	-1.50E+00	4.40E-01	
CCC3	720716	940617	720716	940617	0.46	-1.62E+00	73.0	17.5	0.56	-3.10E+00	-1.10E-01	prob
CCC4	740723	950112	740723	950112	0.64	-1.93E+00	66.0	23.1	0.78	-4.40E+00	5.10E-01	poss

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
CCC5	720716	950112	720716	950112	0.76	-4.04E+00	130.0	42.8	0.76	-8.00E+00	-7.50E-02	prob
CCC6	690717	950112	690717	950112	1.5	-9.72E-01	81.0	36.0	0.97	-2.80E+00	8.80E-01	
CCC7	751209	950112	751209	950112	0.79	-2.55E+00	100.0	37.0	0.90	-7.00E+00	1.90E+00	
CCC8	740723	950112	740723	950112	1.3	-5.86E+00	180.0	57.6	0.72	-9.80E+00	-1.90E+00	prob
CP01												
CP02	720918	760328	720918	760328	1.4	-6.64E-01	21.0	5.3	0.97	-7.30E+00	6.00E+00	
CP03	720918	760331	720918	760331	1.4	6.03E+00	30.0	11.3	0.63	-8.30E+00	2.00E+01	poss
CP04	760331	910805	760331	910805	0.13							
CP05	760331	760331	760331	760331	2							
CP06	760331	870715	760331	870715	0.62	2.76E+00	44.0	10.2	0.48	-3.10E-01	5.80E+00	poss
CP07	751103	760331	751103	760331	4.9							
CP08	760331	760331										
CP09	760328	760328	760328	760328	2							
CP10	731228	940818	731228	940818	0.78	2.61E+00	30.0	18.1	0.48	1.20E+00	4.00E+00	prob
EF	880615	880615	880615	880615	1							
GR1	760921	760921	760921	760921	1							
GR2	760921	880615	760921	880615	0.85	4.18E-01	32.0	12.8	0.97	-1.50E+00	2.40E+00	poss
HI1	880615	940804	880615	940804	0.65	-2.22E-01	5.6	0.5	0.42	-8.00E-01	3.50E-01	
HI2	880615	880615	880615	880615	1							
I1	760813	930216	760813	760813	1							
I2	760813	930216	760813	840823	0.37	-8.75E+00	76.0	47.4	0.67	-1.70E+02	1.50E+02	
I3	761001	950111	840508	950111	0.84	9.69E-01	10.0	3.8	0.51	8.70E-02	1.90E+00	prob
I4	760625	950111	760625	950111	2.1	2.16E-01	16.0	11.4	0.99	-6.60E-01	1.10E+00	poss
I5	840823	950111	840823	950111	2.3	1.51E+00	22.0	15.8	0.92	-7.40E-01	3.80E+00	poss
I6	690716	940105	690716	940105	1	3.53E-02	37.0	28.8	1.00	-1.60E+00	1.70E+00	poss
I7	760531	760531	760531	760531	2							

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
I8	760531	760531	760531	760531	2							
I9	760618	931221	760618	931221	0.23	-3.04E+00	52.0	25.6	0.55	-1.30E+01	7.20E+00	
I10	760618	901116	760618	901116	0.42	-4.06E+00	67.0	21.0	0.41	-8.70E+00	6.20E-01	poss
I11	760618	901116	760618	901116	0.42	-6.88E+00	130.0	22.6	0.31	-1.30E+01	-5.30E-01	prob
I12	731023	890808	731023	890808	1	-6.78E-01	64.0	32.7	0.99	-4.40E+00	3.00E+00	
I13	770109	931221	770109	931221	0.71	-2.71E-01	22.0	12.8	0.99	-1.90E+00	1.40E+00	
I14	770109	880909	770109	880909	0.77	-1.56E+00	37.0	12.8	0.75	-3.90E+00	8.20E-01	poss
I15	770210	931221	770210	931221	0.42	-4.19E+00	76.0	34.7	0.63	-1.00E+01	2.10E+00	poss
I16	760921	931221	771217	931221	0.87	-3.97E+00	69.0	16.5	0.54	-6.70E+00	-1.30E+00	prob
I17	770210	931221	770210	931221	0.42	5.31E-01	18.0	8.9	0.90	-1.30E+00	2.40E+00	poss
I18	770210	931221	770210	931221	1.1	-1.93E+00	56.0	43.4	0.92	-5.40E+00	1.50E+00	
IH1	731024	940316	731024	940316	1	-6.22E+01	970.0	497.0	0.69	-1.10E+02	-1.80E+01	prob
IH2	720716	940316	720716	940316	0.28	-8.14E+01	2000.0	753.0	0.63	-2.30E+02	6.60E+01	poss
IH3	720716	940316	720716	940316	0.74	-2.48E+02	4400.0	1250.0	0.41	-3.70E+02	-1.30E+02	prob
IH4	720716	940316	720716	940316	0.46	-3.54E+02	6300.0	1850.0	0.39	-5.90E+02	-1.20E+02	prob
IH5	720716	940316	720716	940316	1.2	-2.07E+02	4100.0	1230.0	0.48	-2.90E+02	-1.30E+02	prob
IH6	720716	940316	720716	940316	1.4	-5.87E+01	1200.0	442.0	0.61	-8.60E+01	-3.10E+01	prob
IH7	720716	940316	720716	940316	0.92	-3.52E+01	750.0	438.0	0.76	-6.60E+01	-4.20E+00	prob
INL	740723	940804	740723	940804	0.15	6.10E-02	6.3	3.6	0.98	-5.30E+00	5.40E+00	poss
LAC	740723	740723	740723	740723	1							
LB												
LQ1	720716	940617	720716	940617	0.96	-6.53E-01	43.0	18.5	0.92	-1.70E+00	4.20E-01	
LQ2	720716	940617	720716	940617	1.1	-1.23E+00	68.0	23.6	0.87	-2.60E+00	1.50E-01	poss
LS1	760921	760921	760921	760921	1							
LS2	760921	880615	760921	880615	0.51	1.30E+00	30.0	14.5	0.80	-2.40E+00	4.90E+00	poss
M1	760917	760917	760917	760917	2							

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
M2	760917	760917	760917	760917	8							
MB1	731221	880719	731221	880719	1.1	2.40E+00	13.0	19.6	0.76	-6.90E-02	4.90E+00	poss
MB2	760813	760813	760813	760813	2							
NB1	760910	880615	760910	880615	0.43	1.48E+00	96.0	69.8	0.99	-2.10E+01	2.40E+01	poss
NB2	760910	760910	760910	760910	1							
NB3	880615	930723	880615	930723	0.59	-1.04E+01	170.0	71.3	0.91	-4.40E+02	4.20E+02	
NB4	760910	880615	760910	880615	0.26	-1.36E+01	200.0	13.5	0.03	-4.50E+01	1.70E+01	poss
NB5	720919	880615	720919	880615	0.51	-1.61E+00	100.0	57.0	0.96	-9.80E+00	6.60E+00	
NB6	720919	880615	720919	880615	0.25	-7.75E+00	170.0	17.7	0.10	-1.50E+01	-6.30E-02	prob
NB7	731015	880527	731015	880527	1	2.93E+00	120.0	69.9	0.96	-5.70E+00	1.20E+01	poss
NB8	760910	880615	760910	880615	0.26	5.36E-01	71.0	25.1	0.99	-5.70E+01	5.80E+01	poss
NB9	760910	880615	760910	880615	0.17							
ND1												
ND2	880615	880615	880615	880615	1							
ND3												
ND4	880615	880615	880615	880615	1							
NR1												
NR2												
NR3												
NR4	800910	880615	800910	880615	1.2	2.44E+01	-1.0	51.8	0.40	6.80E+00	4.20E+01	prob
NR5	751030	880615	751030	880615	0.16							
OS1	801126	841227	801126	841227	0.73	-5.65E+01	260.0	43.3	0.17	-3.90E+02	2.70E+02	
OS2												
OS3	731025	750121	731025	750121	1.6							
OS4												
OS5	760916	760916	760916	760916	2							

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	End date	Avg obs /yr	Regression on time slope (per yr)	intercept (@ start)	SEE	residual variance	95% confidence limits on slope lower	upper	
OS6	760916	880615	760916	880615	0.26	-9.30E-01	53.0	36.1	0.98	-8.40E+01	8.20E+01	
OS7	760916	880615	760916	880615	0.26	-1.65E+00	35.0	2.7	0.08	-7.90E+00	4.60E+00	poss
PB1	760916	760916	760916	760916	1							
PB2	760331	760916	760916	760916	1							
RB1	760713	760713	760713	760713	1							
RB2	760713	760713	760713	760713	2							
RB3	760713	940804	760713	940804	0.17	2.66E-01	69.0	18.2	0.99	-2.70E+01	2.70E+01	poss
RB4	880615	880615	880615	880615	1							
RB5	760713	880615	760713	880615	0.34	-2.10E+00	52.0	8.8	0.33	-6.60E+00	2.40E+00	poss
RB6	760713	920729	760713	920729	0.25	-4.17E+00	72.0	14.4	0.25	-1.10E+01	3.10E+00	poss
RB7	760713	880615	880615	880615	1							
RB8	731003	940804	731003	940804	0.86	-1.15E+00	46.0	15.1	0.86	-2.70E+00	3.40E-01	poss
RB9	740723	740723	740723	740723	1							
SC1	760925	760925	760925	760925	1							
SC2	720918	760925	720918	760925	1.2	-8.34E+00	53.0	8.8	0.29	-1.80E+01	1.60E+00	poss
SC3	760925	880727	760925	880727	0.76	2.74E-02	18.0	15.7	1.00	-4.20E+00	4.20E+00	poss
UL01	760924	880615	760924	880615	0.51	3.89E-01	22.0	10.4	0.97	-2.90E+00	3.70E+00	poss
UL02	880615	880615	880615	880615	3							
UL03	760924	880615	760924	880615	0.6	2.71E+00	28.0	79.3	0.98	-1.90E+01	2.50E+01	poss
UL04	880615	880615	880615	880615	1							
UL05	760924	880615	880615	880615	2							
UL06	760924	880615	880615	880615	6							
UL07	760924	880615	760924	880615	0.34	2.74E+00	12.0	21.7	0.71	-1.00E+01	1.60E+01	poss
UL08	760924	880615	760924	880615	0.26	-3.67E-01	12.0	3.2	0.71	-7.70E+00	7.00E+00	
UL09	880615	880615	880615	880615	2							
UL10	770210	880615	770210	880615	0.35	-2.33E+00	34.0	2.3	0.04	-3.80E+00	-8.80E-01	prob

(continued)

Table 7-5
(continued)

Segment	Period of record dates		Analysis period Start date	Analysis period End date	Avg obs /yr	Regression on time slope (per yr)	Regression on time intercept (@ start)	Regression on time SEE	Regression on time residual variance	95% confidence limits on slope lower	95% confidence limits on slope upper	
UL11	770210	880615	770210	880615	0.26	-5.38E-01	16.0	0.9	0.09	-2.70E+00	1.60E+00	poss
UL12	770210	770210	770210	770210	3							
UL13	770210	770210	770210	770210	3							
UL14	770109	880615	770109	880615	0.35	-7.52E-01	23.0	2.5	0.26	-2.10E+00	6.10E-01	poss
GMI1	760302	760315	760315	760315	1							
GMI2	760303	760519	760519	760519	1							
GMI3	760511	760519	760511	760511	2							
GMI4	760511	760511	760511	760511	1							
GMI5	760511	760511	760511	760511	2							
GMI6	720716	900404	720716	900404	0.85	-7.27E-01	35.0	26.9	0.98	-3.60E+00	2.10E+00	
GMI7	760508	760511	760511	760511	2							
GMI8	760508	760814	760814	760814	1							
GMI9	760508	760508										
GMO1	760302	760315	760302	760315	170	-1.77E+02	41.0	15.6	0.97	-1.50E+03	1.20E+03	
GMO2	760303	760519	760303	760519	38	9.32E+01	27.0	12.3	0.68	-4.20E+01	2.30E+02	poss
GMO3	760511	760519	760511	760519	460	-2.45E+02	35.0	12.8	0.97	-1.40E+03	9.50E+02	
GMO4	760511	760511	760511	760511	4							
GMO5	760511	760511	760511	760511	13							
GMO6	760511	900404	760511	900404	0.94	-1.64E+00	31.0	7.6	0.40	-2.50E+00	-7.50E-01	prob
GMO7	760508	760511	760508	760511	1800	-4.74E+02	40.0	17.4	0.99	-3.20E+03	2.20E+03	
GMO8	760508	760508	760508	760508	7							
GMO9	760508	760508	760508	760508	5							

Table 7-6
Period of record average (with BDL=0) for principal component bays
Conventional sediment quality parameters

Parameter:	SEDAMMN		SEDKJLN		SEDTOTP	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	0		0		0	
Copano Bay	0		5	1610	9	388
St Charles	0		8	444	8	211
Mesquite	4	0	9	460	9	413
Redfish	0		15	750	17	363
Corpus Christi	0		1		1	
CCSC (bay)	4	117	22	1365	20	634
Inner Harbor	10	165	59	1302	62	488
Nueces Bay	0		1		1	
Aransas Pass	1		3	50	2	190
Oso Bay	0		0		0	
Causeway N	0		0		0	
Causeway S	0		0		0	
Laguna (King Ranch)	0		10	4190	15	636
Laguna (Baffin)	0		0		0	
Baffin Bay	0		12	1725	19	508
GOM inlet	11	42	18	277	12	639

Parameter:	SEDTOC		SEDO&G		SEDVOLS	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	78	8.4	1		0	
Copano Bay	101	8.8	9	1230	8	77200
St Charles	12	6.1	8	1570	8	24500
Mesquite	25	5.6	13	2560	8	160000
Redfish	30	10.0	17	452	14	17900
Corpus Christi	134	10.1	6	368	1	
CCSC (bay)	27	3.9	43	387	25	92821
Inner Harbor	13	0.4	97	1151	81	68800
Nueces Bay	21	6.5	10	547	1	
Aransas Pass	10	3.1	3	140	2	1
Oso Bay	10	9.6	0		0	
Causeway N	8	13.2	1		0	
Causeway S	13	21.6	1		0	
Laguna (King Ranch)	81	11.1	18	1008	12	75300
Laguna (Baffin)	34	7.1	0		0	
Baffin Bay	94	10.5	23	913	16	105700
GOM inlet	183	3.6	24	454	12	27100

Table 7-7
Period of record average (with BDL=0) for principal component bays
Sediment metals

Parameter:	SEDMETAS		SEDMETCD		SEDMETCR	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	33	3.98	33	1.89	52	11.4
Copano Bay	30	4.98	30	3.79	42	22.2
St Charles	11	2.53	11	5.00	12	12.5
Mesquite	20	3.70	22	2.92	21	6.8
Redfish	26	3.53	28	0.68	36	9.2
Corpus Christi	115	4.50	112	0.89	142	18.6
CCSC (bay)	90	3.50	86	0.95	90	14.2
Inner Harbor	114	6.33	125	16.41	117	36.1
Nueces Bay	14	3.62	15	1.68	16	12.8
Aransas Pass	12	1.96	12	0.52	12	14.7
Oso Bay	2	2.45	2	0.35	8	14.5
Causeway N	6	1.56	6	0.00	10	9.4
Causeway S	13	4.05	13	0.33	17	13.4
Laguna (King Ranch)	69	3.38	69	0.40	93	9.6
Laguna (Baffin)	32	3.20	32	0.31	51	7.5
Baffin Bay	67	4.09	68	1.22	88	19.6
GOM inlet	31	2.04	29	1.17	82	27.4

Parameter:	SEDMETCU		SEDMETHG		SEDMETNI	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	53	6.53	32	0.038	52	6.67
Copano Bay	50	8.51	22	0.036	42	10.25
St Charles	15	4.55	8	0.030	12	5.51
Mesquite	25	5.28	19	0.158	24	3.75
Redfish	35	6.47	28	0.029	35	6.09
Corpus Christi	143	9.81	113	0.083	139	10.58
CCSC (bay)	88	7.64	92	0.145	88	8.59
Inner Harbor	110	37.39	120	1.097	108	9.72
Nueces Bay	19	9.87	12	0.120	15	6.30
Aransas Pass	12	3.30	12	0.014	12	4.28
Oso Bay	8	10.13	2	0.060	8	3.67
Causeway N	10	7.43	6	0.027	10	3.98
Causeway S	17	14.81	13	0.054	17	7.79
Laguna (King Ranch)	93	8.23	70	0.100	93	6.21
Laguna (Baffin)	51	4.59	32	0.036	51	3.75
Baffin Bay	89	12.82	69	0.088	89	9.68
GOM inlet	81	7.64	31	0.083	81	8.03

(continued)

Table 7-7
Sediment metals (continued)

Parameter:	SEDMETPB		SEDMETSE		SEDMETZN	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	39	9.14	32	0.31	53	31.3
Copano Bay	50	13.14	15	0.60	49	43.3
St Charles	11	6.17	4	0.70	15	25.5
Mesquite	20	6.87	8	0.60	25	26.5
Redfish	27	7.31	16	0.13	35	33.8
Corpus Christi	112	17.98	109	0.21	144	73.7
CCSC (bay)	91	16.02	68	0.53	93	59.3
Inner Harbor	130	91.66	41	0.78	131	1484.6
Nueces Bay	15	13.15	11	0.12	19	166.5
Aransas Pass	12	6.31	9	0.12	12	16.1
Oso Bay	2	14.00	2	0.00	8	56.2
Causeway N	6	7.33	6	0.05	10	21.7
Causeway S	13	18.33	13	0.56	17	46.8
Laguna (King Ranch)	70	10.86	62	0.40	91	30.4
Laguna (Baffin)	32	11.98	32	0.23	51	26.9
Baffin Bay	69	30.84	59	0.35	87	42.5
GOM inlet	82	14.15	10	0.40	81	29.0

Table 7-8
Period of record average (with BDL=0) for principal component bays
Sediment pesticides and PCB's

Parameter:	SED-ALDR		SED-CHLR		SED-DIAZ	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	5	0.13	26	0.72	1	
Copano Bay	24	0.25	17	1.53	7	1.25
St Charles	12	0.10	12	0.50	8	0.00
Mesquite	16	0.08	11	0.33	4	0.00
Redfish	12	0.01	15	0.01	10	0.00
Corpus Christi	25	0.00	23	0.11	1	
CCSC (bay)	16	0.00	63	0.00	9	0.00
Inner Harbor	38	0.00	54	0.71	32	0.00
Nueces Bay	17	0.08	15	0.27	1	
Aransas Pass	5	0.08	7	0.00	0	
Oso Bay	1		1		1	
Causeway N	1		2	0.00	0	
Causeway S	1		3	0.00	0	
Laguna (King Ranch)	17	0.00	33	0.00	15	0.00
Laguna (Baffin)	0		23	0.00	0	
Baffin Bay	7	0.25	7	5.00	7	1.67
GOM inlet	12	0.00	19	0.00	1	

Parameter:	SED-DIEL		SED-LIND		SED-TOXA	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	5	0.13	2	0.02	25	0.00
Copano Bay	24	0.19	16	0.14	10	12.50
St Charles	12	0.10	8	0.00	10	0.00
Mesquite	16	0.12	12	0.00	9	0.00
Redfish	12	0.00	12	0.02	15	0.00
Corpus Christi	31	0.10	29	0.08	21	0.00
CCSC (bay)	16	0.00	14	0.00	63	0.00
Inner Harbor	38	0.72	37	0.00	54	0.00
Nueces Bay	17	0.08	12	0.03	14	2.50
Aransas Pass	5	0.02	5	0.00	7	0.00
Oso Bay	1		1		1	
Causeway N	1		1		2	0.00
Causeway S	1		1		3	0.00
Laguna (King Ranch)	17	0.00	17	0.00	33	0.00
Laguna (Baffin)	0		0		23	0.00
Baffin Bay	7	0.75	7	0.25	7	12.50
GOM inlet	12	0.00	12	0.00	19	0.00

(continued)

Table 7-8
Sediment pesticides and PCB's (continued)

Parameter:	SED-XDDT		SED-DDT		SED-PCB	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	28	0.09	5	0.15	28	0.77
Copano Bay	30	0.24	17	0.41	13	1.83
St Charles	20	0.10	12	0.10	11	1.00
Mesquite	18	0.36	7	0.10	11	0.67
Redfish	24	0.00	11	0.01	18	82.07
Corpus Christi	43	0.74	8	0.15	23	0.48
CCSC (bay)	67	0.97	10	0.00	60	17.00
Inner Harbor	62	0.00	34	0.00	54	48.96
Nueces Bay	18	0.06	7	0.09	18	3.77
Aransas Pass	10	0.00	0		7	0.00
Oso Bay	1		1		1	
Causeway N	2	0.00	0		2	0.00
Causeway S	3	0.00	0		3	0.00
Laguna (King Ranch)	39	0.00	17	0.00	35	13.47
Laguna (Baffin)	23	0.00	0		23	0.00
Baffin Bay	20	1.18	16	1.18	15	15.00
GOM inlet	19	0.00	1		19	6.00

Table 7-9
Period of record average (with BDL=0) for principal component bays
Sediment PAH's and TBT

Parameter:	SED-ACEN		SED-BNZA		SED-FLRA	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	22	0.06	23	1.00	23	2.1
Copano Bay	11	0.25	11	2.98	11	9.2
St Charles	0		0		0	
Mesquite	9	2.00	9	3.00	5	10.4
Redfish	4	0.20	5	5.37	5	6.1
Corpus Christi	26	0.37	34	7.29	34	12.7
CCSC (bay)	47	0.00	52	0.86	52	2.2
Inner Harbor	16	0.00	20	220.43	20	110.3
Nueces Bay	2	6.35	11	13.08	11	32.5
Aransas Pass	8	0.61	9	2.50	9	5.5
Oso Bay	0		0		0	
Causeway N	1		2	0.00	2	0.0
Causeway S	2	0.00	3	10.00	3	15.0
Laguna (King Ranch)	16	0.00	19	0.00	19	0.0
Laguna (Baffin)	23	0.00	23	0.00	23	0.0
Baffin Bay	0		4	0.00	4	0.0
GOM inlet	7	0.00	7	0.00	7	0.0

Parameter:	SED-NAPT		SED-PAH		SED-TBT	
Component bay	*No.of obs*	*Avg*	*No.of obs*	*Avg*	*No.of obs*	*Avg*
Aransas Bay	23	0.36	22	13.8	1	
Copano Bay	9	1.83	5	87.3	7	3.37
St Charles	0		0		0	
Mesquite	8	0.00	0		0	
Redfish	5	0.29	4	38.3	1	
Corpus Christi	34	5.54	11	69.2	5	2.46
CCSC (bay)	52	0.00	47	0.3	0	
Inner Harbor	20	1.43	16	505.7	0	
Nueces Bay	11	3.29	2	512.0	2	11.20
Aransas Pass	9	0.90	5	0.0	0	
Oso Bay	0		0		0	
Causeway N	2	0.00	1		0	
Causeway S	3	0.00	2	0.0	0	
Laguna (King Ranch)	19	0.00	16	0.0	0	
Laguna (Baffin)	23	0.00	23	0.0	0	
Baffin Bay	4	0.00	0		0	
GOM inlet	7	0.00	7	0.0	0	

Table 7-10
Summary of trend analysis by component bay for SEDKJLN
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	number segments	w/data	prob <0	poss <0	none	poss >0	prob >0	mean prob<0	mean prob>0
Aransas Bay	13	0							
Copano Bay	9	1	0.0	0.0	0.0	0.0	100.0		7.52E+00
St Charles	2	1	0.0	0.0	100.0	0.0	0.0		
Mesquite	4	1	0.0	0.0	100.0	0.0	0.0		
Redfish	8	1	0.0	0.0	100.0	0.0	0.0		
Corpus Christi	20	0							
CCSC (bay)	5	3	33.3	0.0	33.3	33.3	0.0	-3.52E+01	
Inner Harbor	7	7	14.3	14.3	71.4	0.0	0.0	-5.61E+00	
Nueces Bay	5	0							
Oso Bay	3	0							
Aransas Pass	4	0							
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	1	0.0	0.0	0.0	100.0	0.0		
Laguna (Baffin)	6	0							
Baffin Bay	5	2	0.0	0.0	50.0	50.0	0.0		
GOM inlet	6	6	0.0	0.0	100.0	0.0	0.0		

Table 7-11
Summary of trend analysis by component bay for SEDTOTP
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	number segments	w/data	prob <0	poss <0	none	poss >0	prob >0	mean prob<0	mean prob>0
Aransas Bay	13	0							
Copano Bay	9	1	0	100	0	0	0		
St Charles	2	1	0	0	100	0	0		
Mesquite	4	1	0	100	0	0	0		
Redfish	8	1	100	0	0	0	0	-7.71E+00	
Corpus Christi	20	0							
CCSC (bay)	5	1	0	100	0	0	0		
Inner Harbor	7	3	0	0	100	0	0		
Nueces Bay	5	0							
Oso Bay	3	0							
Aransas Pass	4	0							
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	1	0	0	100	0	0		
Laguna (Baffin)	6	0							
Baffin Bay	5	2	0	0	50	50	0		
GOM inlet	6	1	0	0	100	0	0		

Table 7-12
Summary of trend analysis by component bay for SEDTOC
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	number segments	w/data	prob <0	poss <0	none	poss >0	prob >0	mean prob<0	mean prob>0
Aransas Bay	13	8	0	25	50	25	0		
Copano Bay	9	4	0	25	0	50	25		5.39E-02
St Charles	2	0							
Mesquite	4	1	0	0	100	0	0		
Redfish	8	1	0	0	100	0	0		
Corpus Christi	20	8	12.5	25	37.5	25	0	-2.18E-02	
CCSC (bay)	5	4	100	0	0	0	0	-4.90E-01	
Inner Harbor	7	0							
Nueces Bay	5	1	0	0	0	100	0		
Oso Bay	3	0							
Aransas Pass	4	1	0	0	100	0	0		
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	5	0	0	60	40	0		
Laguna (Baffin)	6	4	25	25	50	0	0	-6.37E-02	
Baffin Bay	5	2	0	0	50	50	0		
GOM inlet	6	2	0	0	50	50	0		

Table 7-13
Summary of trend analysis by component bay for SEDO&G
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	number segments	w/data	prob <0	poss <0	none	poss >0	prob >0	mean prob<0	mean prob>0
Aransas Bay	13	0							
Copano Bay	9	1	0	0	0	100	0		
St Charles	2	1	0	0	0	100	0		
Mesquite	4	1	0	0	0	100	0		
Redfish	8	1	0	0	100	0	0		
Corpus Christi	20	0							
CCSC (bay)	5	5	40	0	60	0	0	-3.09E+01	
Inner Harbor	7	7	0	0	57.1	42.9	0		
Nueces Bay	5	1	0	0	0	100	0		
Oso Bay	3	0							
Aransas Pass	4	0							
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	1	0	0	0	100	0		
Laguna (Baffin)	6	0							
Baffin Bay	5	2	0	0	50	50	0		
GOM inlet	6	1	0	0	100	0	0		

Table 7-14
Summary of trend analysis by component bay for SEDVOLS
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	*number segments*	*w/data*	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	13	0							
Copano Bay	9	1	0	0	0	100	0		
St Charles	2	1	0	0	0	100	0		
Mesquite	4	1	0	0	100	0	0		
Redfish	8	1	0	0	100	0	0		
Corpus Christi	20	0							
CCSC (bay)	5	1	0	0	0	100	0		
Inner Harbor	7	7	0	0	85.7	14.3	0		
Nueces Bay	5	0							
Oso Bay	3	0							
Aransas Pass	4	0							
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	1	0	0	0	100	0		
Laguna (Baffin)	6	0							
Baffin Bay	5	2	0	0	0	100	0		
GOM inlet	6	1	0	0	0	100	0		

Table 7-15
Summary of trend analysis by component bay for SEDMETCD
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	*number segments*	*w/data*	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	13	1	0	0	100	0	0		
Copano Bay	9	2	100	0	0	0	0	-4.01E-02	
St Charles	2	0							
Mesquite	4	1	0	100	0	0	0		
Redfish	8	1	0	0	100	0	0		
Corpus Christi	20	5	0	20	20	40	20		7.85E-04
CCSC (bay)	5	4	0	25	25	25	25		6.28E-03
Inner Harbor	7	7	42.9	57.1	0	0	0	-8.53E-01	
Nueces Bay	5	2	0	0	100	0	0		
Oso Bay	3	0							
Aransas Pass	4	0							
Causeway N	3	0							
Causeway S	4	0							
Laguna (King)	13	2	0	0	50	50	0		
Laguna (Baffin)	6	0							
Baffin Bay	5	1	0	0	100	0	0		
GOM inlet	6	1	0	0	0	100	0		

Table 7-16
Summary of trend analysis by component bay for SEDMETCR
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	*number segments*	*w/data*	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	13	4	75	0	0	0	25	-4.44E-01	2.18E-01
Copano Bay	9	2	0	0	0	0	100		5.60E-01
St Charles	2	1	0	0	100	0	0		
Mesquite	4	1	0	0	0	100	0		
Redfish	8	4	25	0	50	25	0	-1.04E-01	
Corpus Christi	20	17	17.6	17.6	41.2	23.5	0	-3.14E-01	
CCSC (bay)	5	5	40	0	40	20	0	-5.76E-01	
Inner Harbor	7	7	71.4	0	28.6	0	0	-2.68E+00	
Nueces Bay	5	4	0	25	25	50	0		
Oso Bay	3	1	0	0	100	0	0		
Aransas Pass	4	1	0	100	0	0	0		
Causeway N	3	3	0	100	0	0	0		
Causeway S	4	2	50	50	0	0	0	-3.48E-01	
Laguna (King)	13	9	33.3	11.1	33.3	22.2	0	-3.96E-01	
Laguna (Baffin)	6	3	33.3	0	0	33.3	33.3	-2.58E-01	4.73E-01
Baffin Bay	5	5	0	20	0	80	0		
GOM inlet	6	4	0	25	50	25	0		

Table 7-17
Summary of trend analysis by component bay for SEDMETCU
Fraction (percent) of segments with data, exhibiting indicated trend for BDL>0
and average of probable trends (ppm/yr)

component bay	*number segments*	*w/data*	*prob <0*	*poss <0*	*none*	*poss >0*	*prob >0*	*mean prob<0*	*mean prob>0*
Aransas Bay	13	4	25	50	0	25	0	-1.06E-01	
Copano Bay	9	4	0	25	0	50	25		5.26E-02
St Charles	2	2	0	0	50	50	0		
Mesquite	4	1	0	0	0	100	0		
Redfish	8	4	0	50	25	25	0		
Corpus Christi	20	17	11.8	11.8	52.9	23.5	0	-1.03E-01	
CCSC (bay)	5	5	20	40	20	20	0	-2.32E-01	
Inner Harbor	7	7	14.3	42.9	28.6	14.3	0	-5.31E-01	
Nueces Bay	5	4	0	25	25	50	0		
Oso Bay	3	1	0	100	0	0	0		
Aransas Pass	4	1	0	0	0	100	0		
Causeway N	3	3	0	0	66.7	33.3	0		
Causeway S	4	2	0	50	50	0	0		
Laguna (King)	13	10	10	10	10	70	0	-1.06E-01	
Laguna (Baffin)	6	3	0	33.3	33.3	33.3	0		
Baffin Bay	5	5	0	0	20	80	0		
GOM inlet	6	4	0	25	50	25	0		

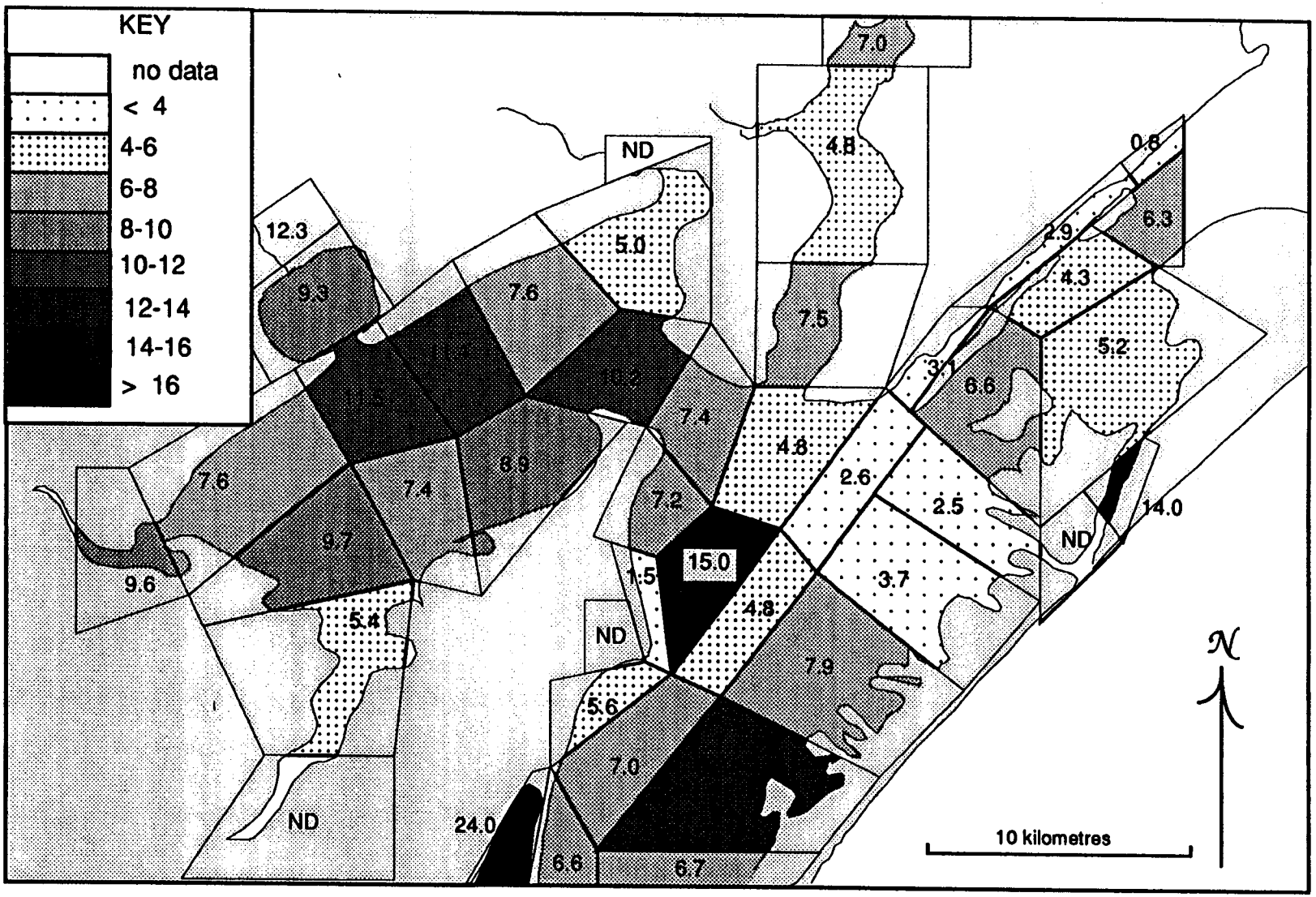


Figure 7-5. Period-of-record means of SEDTOC for Aransas-Copano system

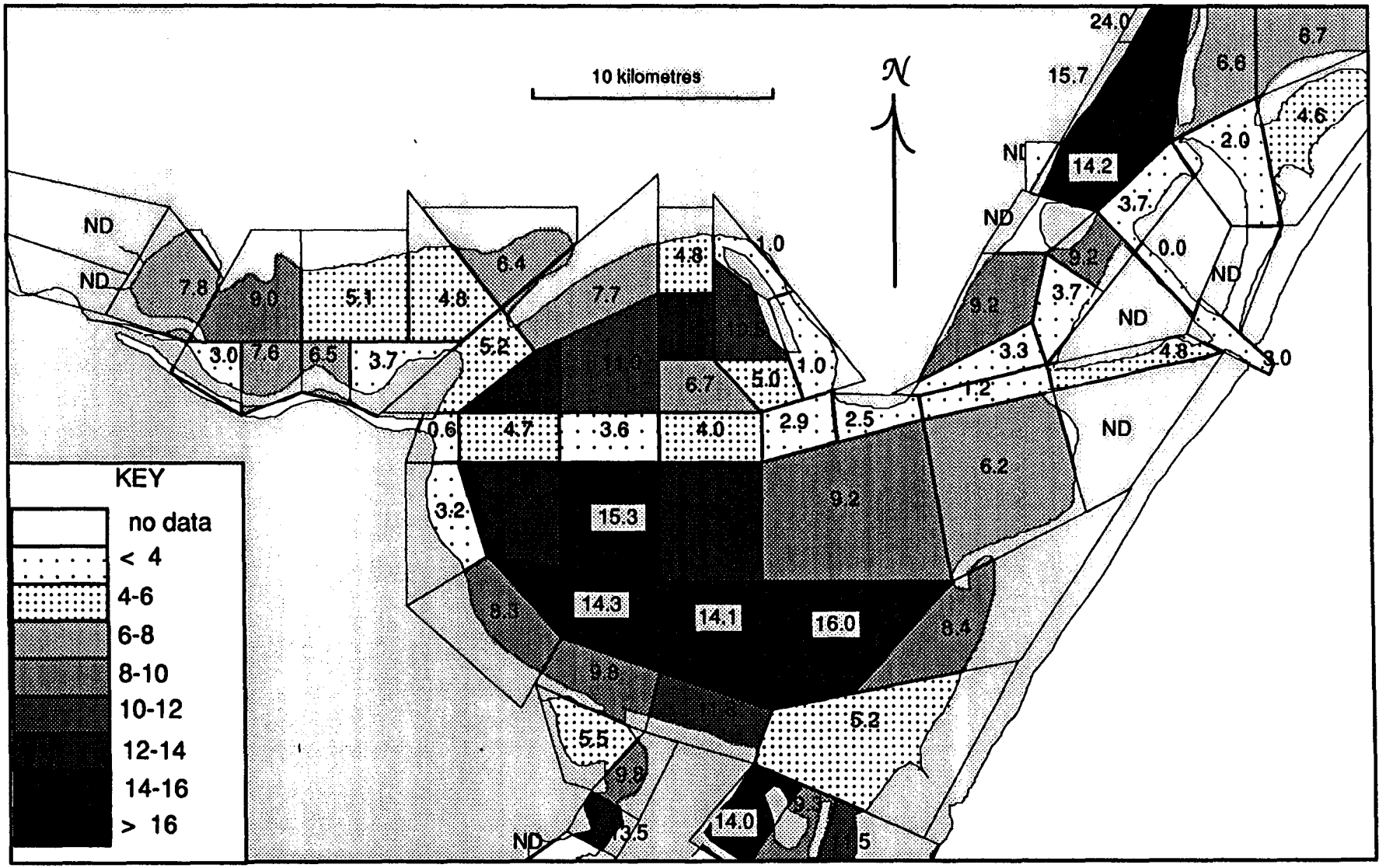


Figure7-6. Period-of-record means of SEDTOC for Corpus Christi system

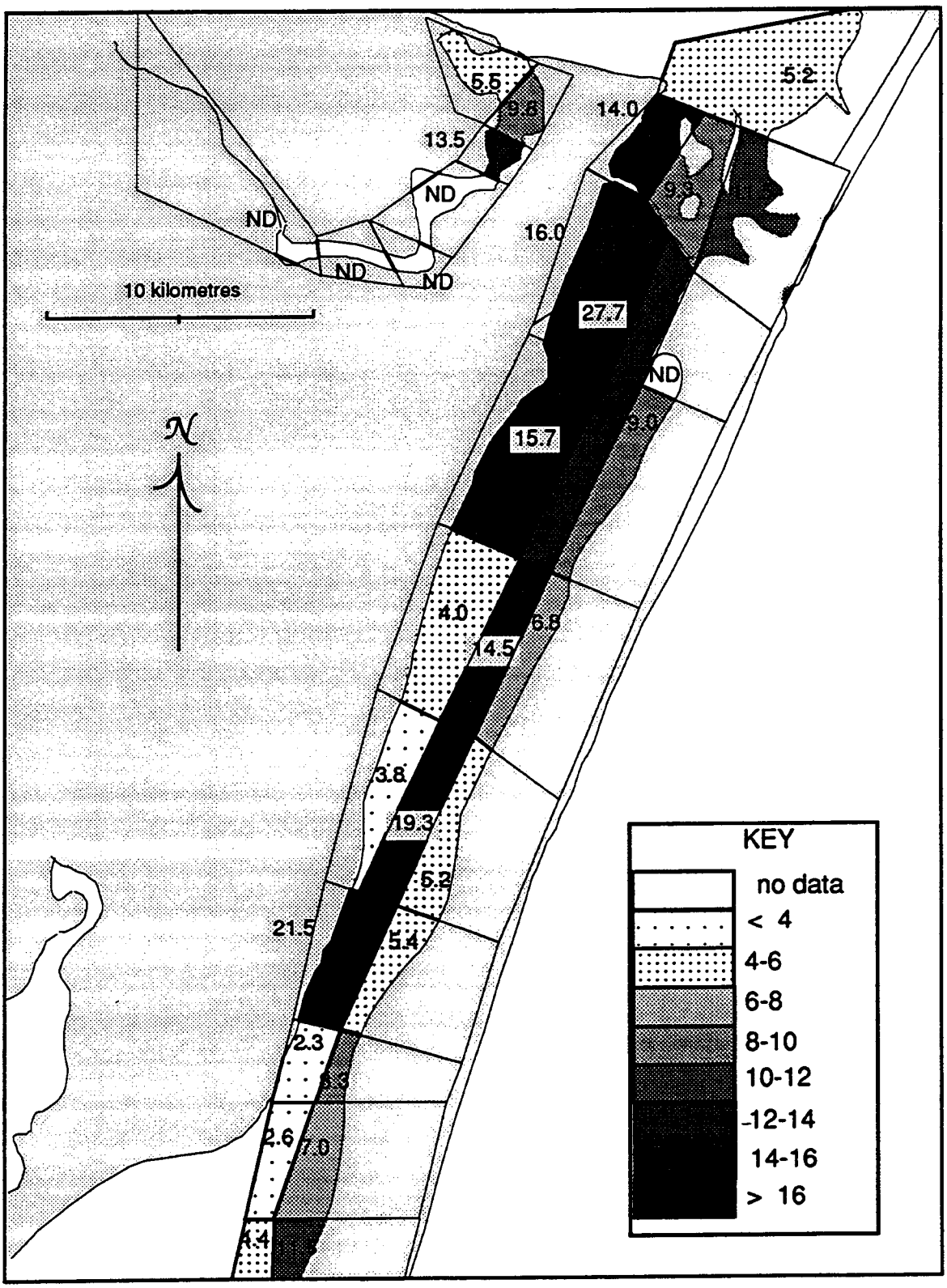


Figure 7-7. Period-of-record means of SEDTOC for Upper Laguna Madre and Oso Bay

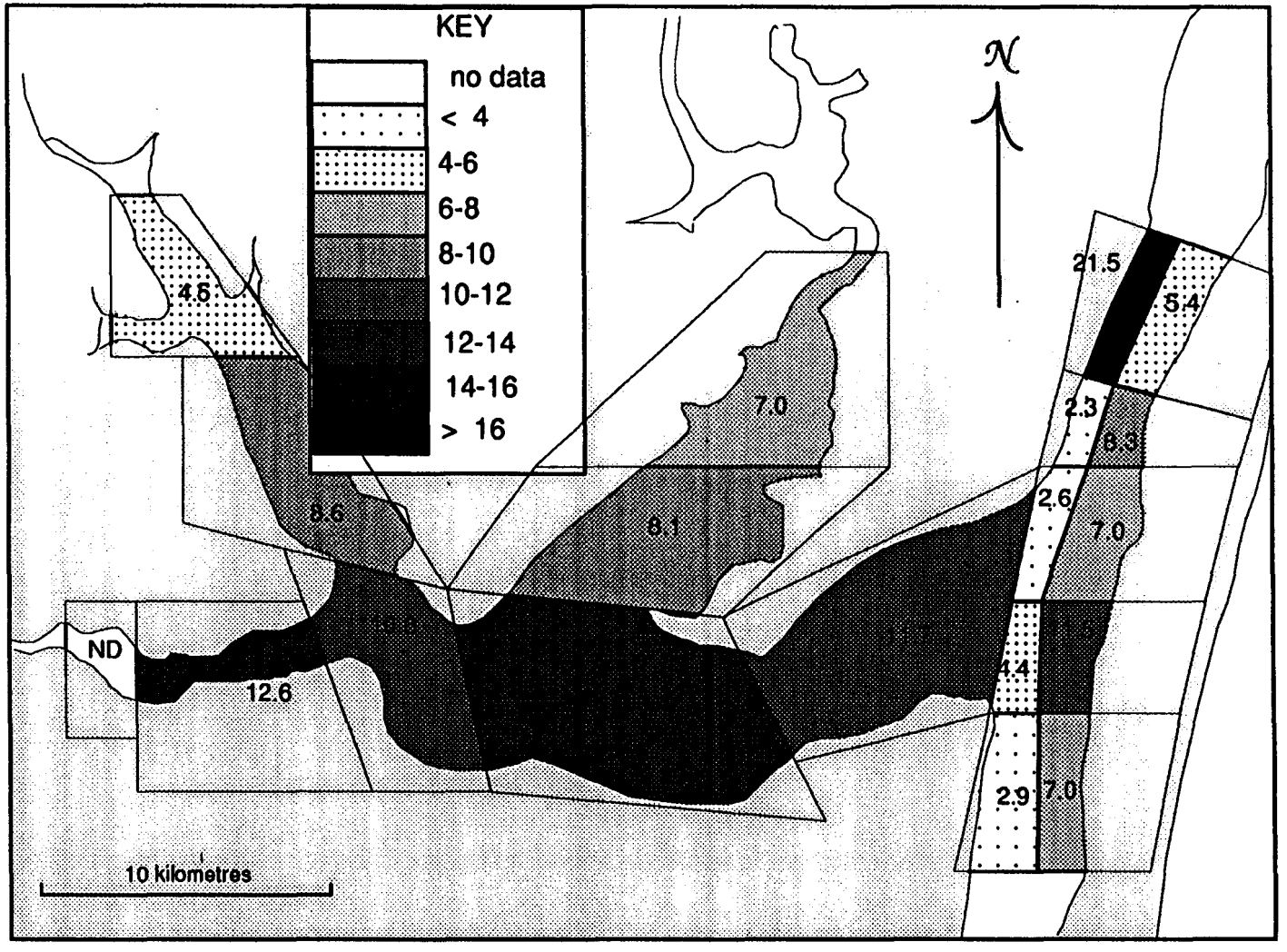


Figure 7-8. Period-of-record means of SEDTOC for Baffin Bay region

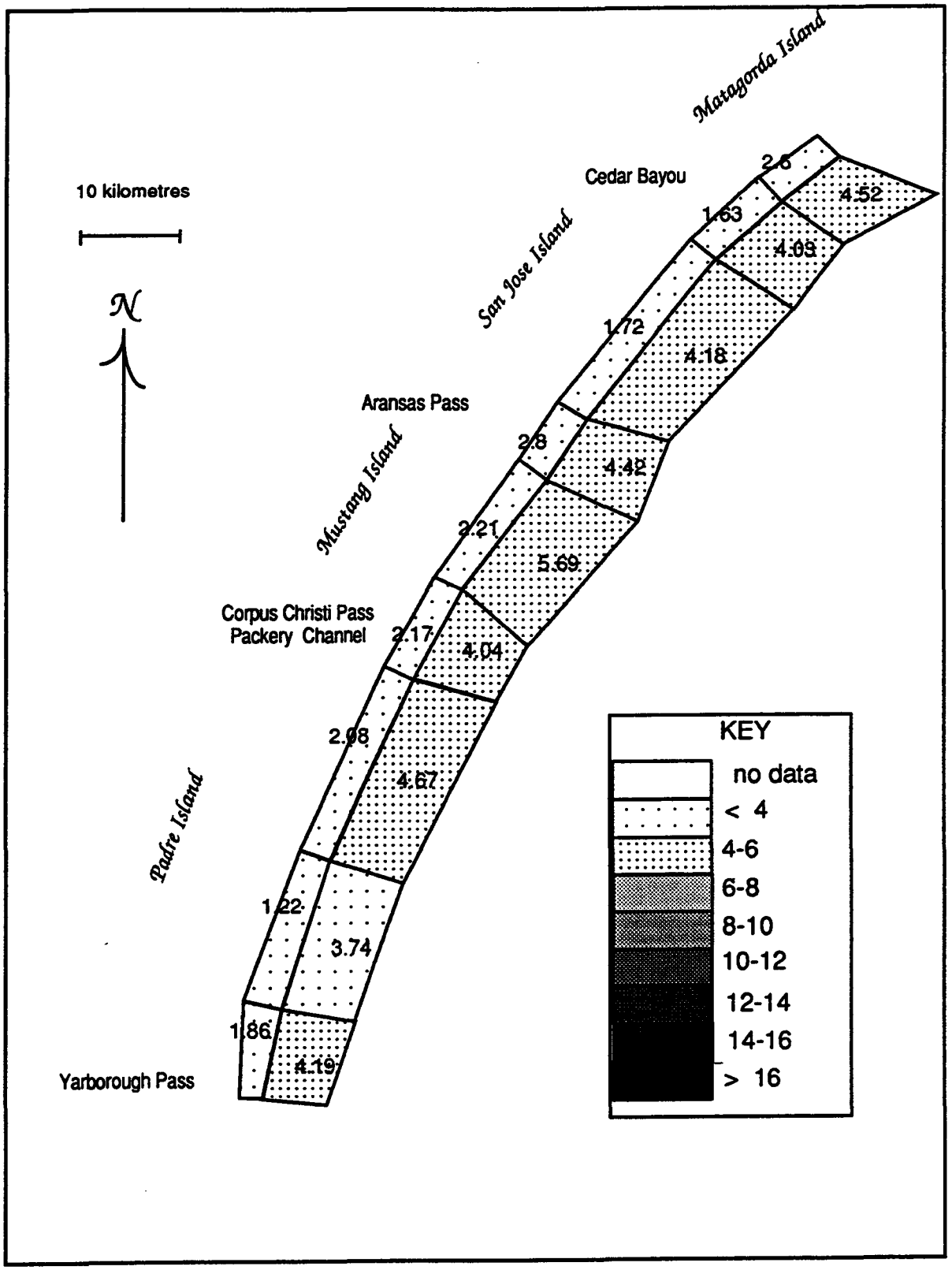


Figure 7-9. Period-of-record means of SEDTOC for Gulf of Mexico

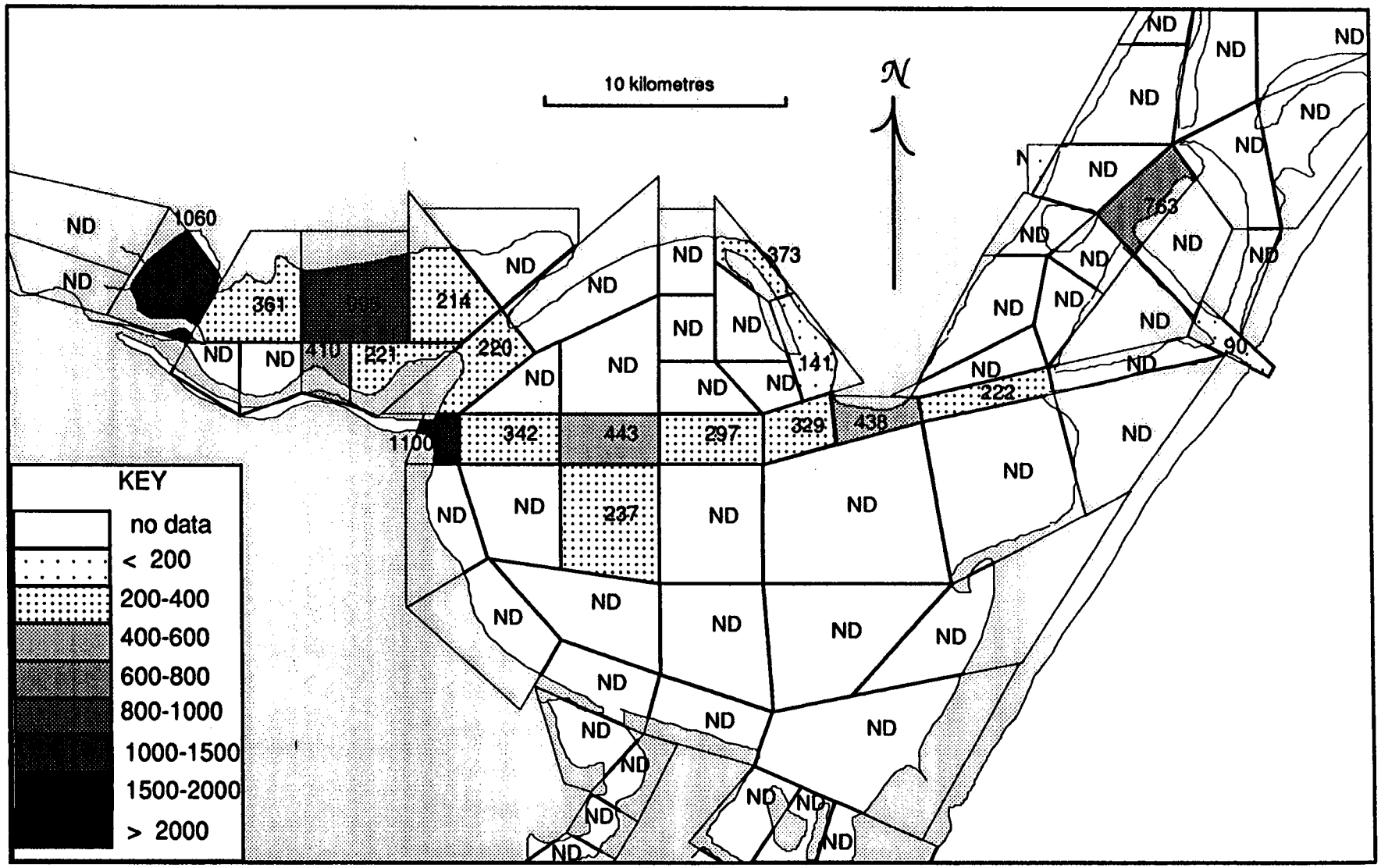


Figure 7-10. Period-of-record means of SEDO&G for Corpus Christi system

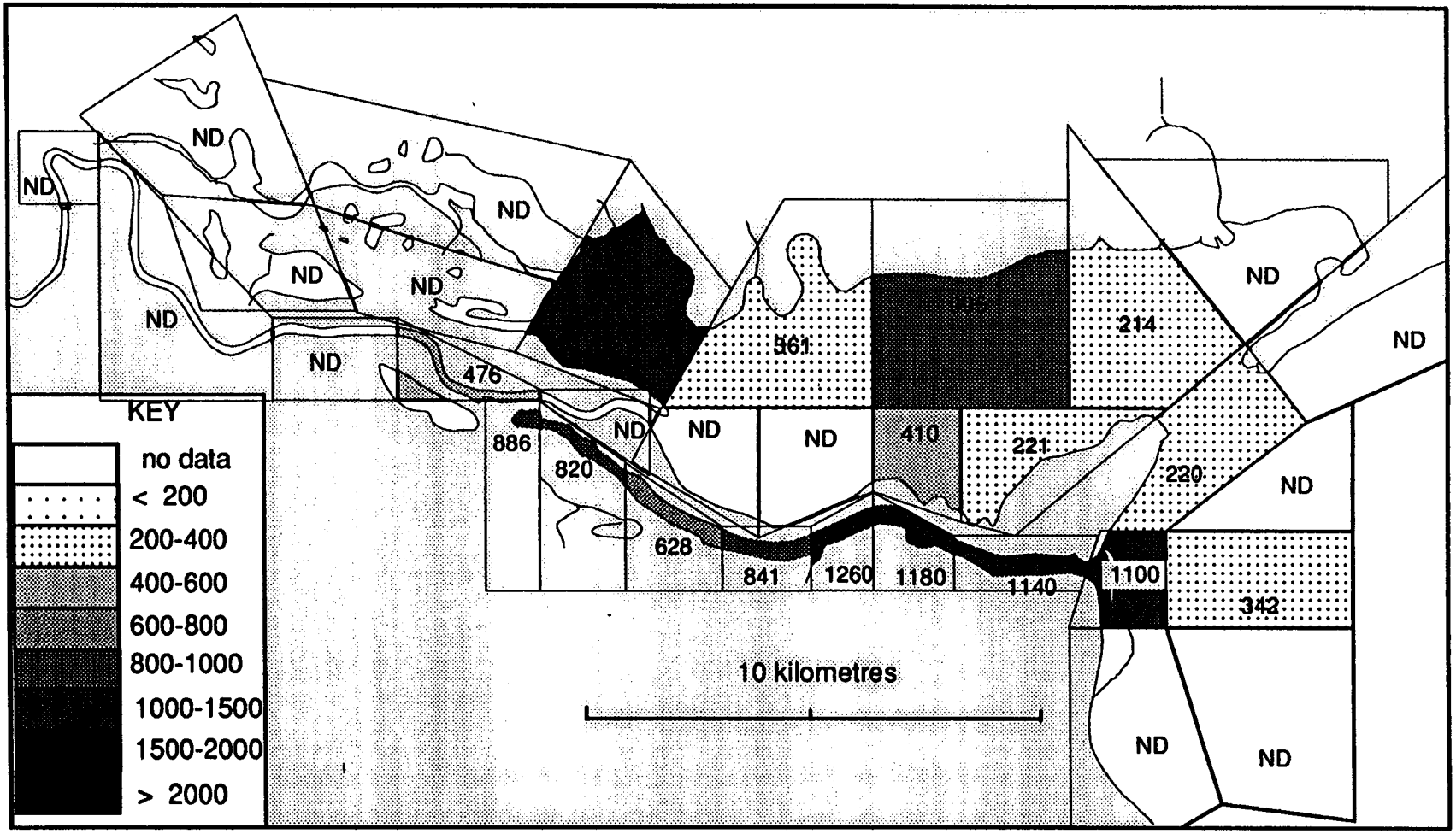


Figure 7-11. Period-of-record means of SEDO&G for Nueces Bay region, including Inner Harbor

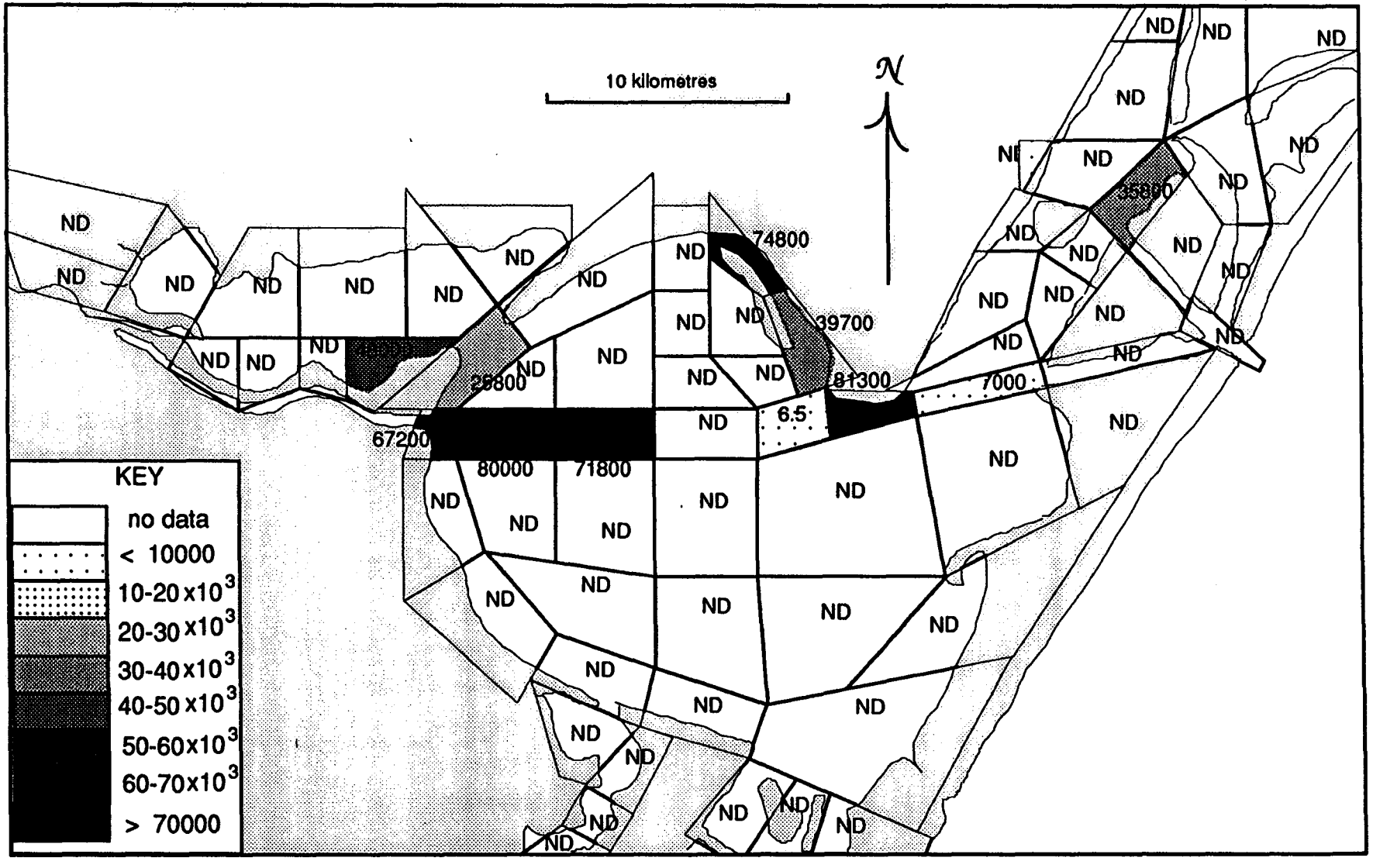


Figure 7-12. Period-of-record means of SEDVOLS for Corpus Christi system

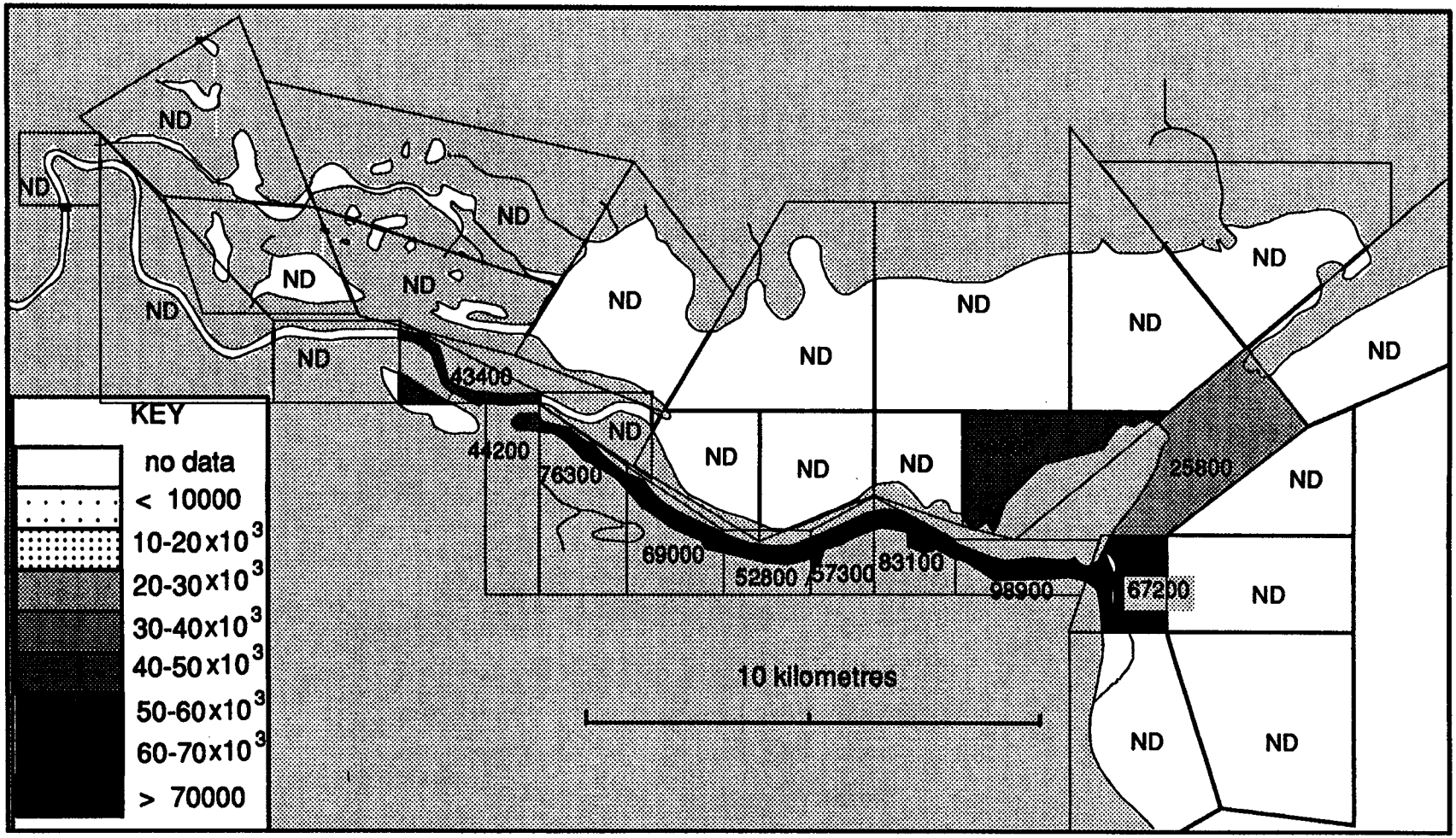


Figure 7-13. Period-of-record means of SEDVOLS for Nueces Bay region, including Inner Harbor

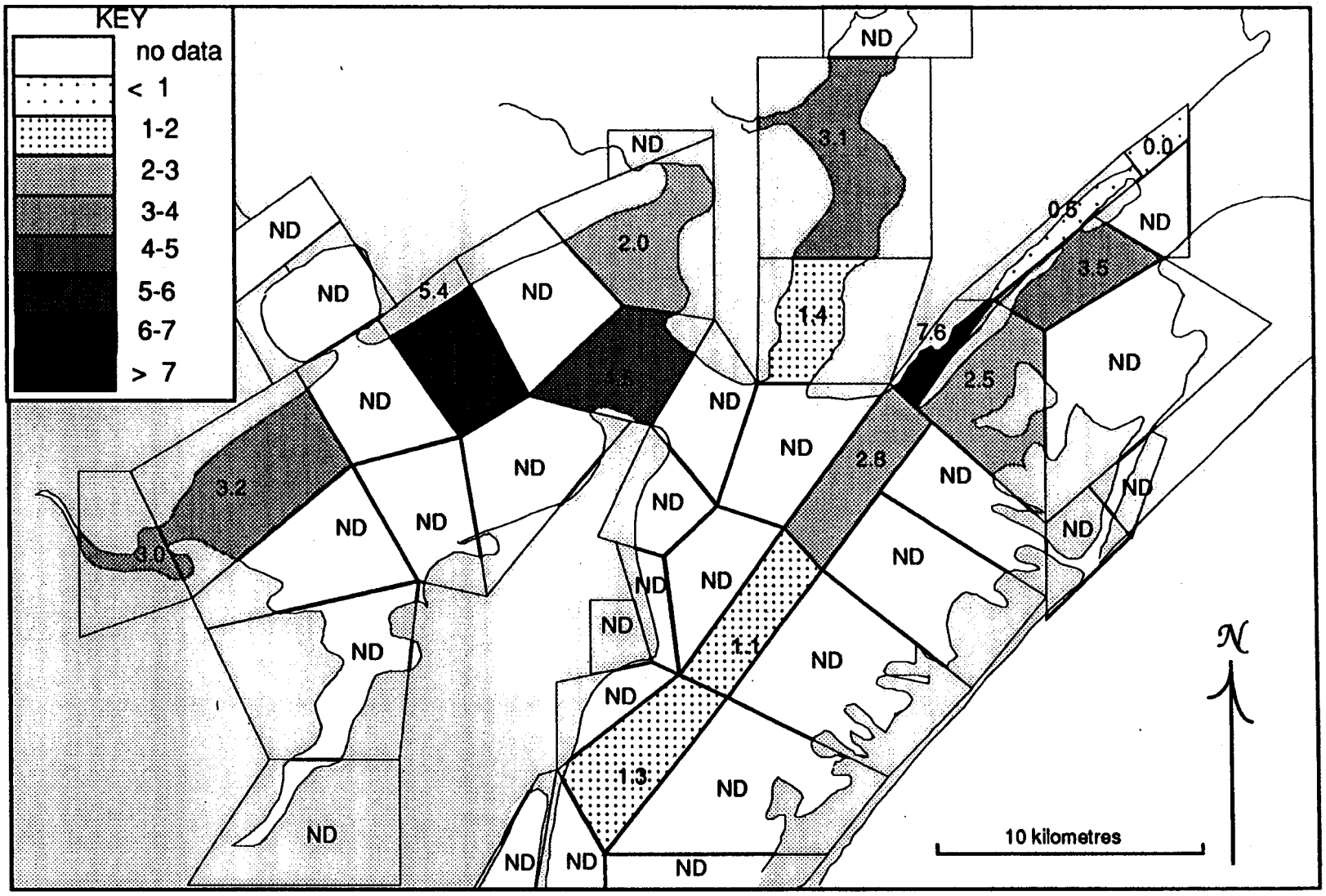


Figure 7-14. Period-of-record means of SEDMETAS for Aransas-Copano system

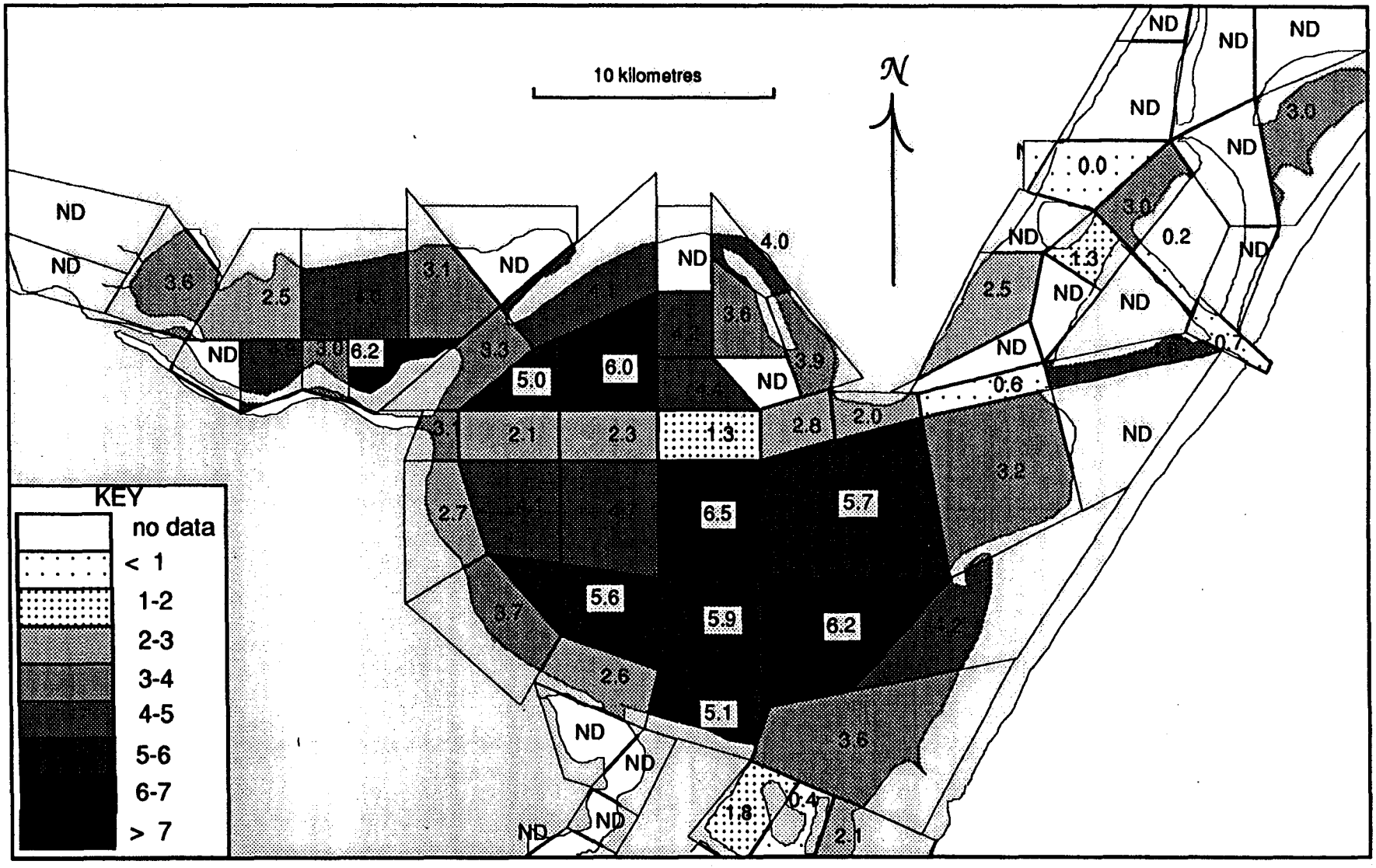


Figure 7-15. Period-of-record means of SEDMETAS for Corpus Christi system

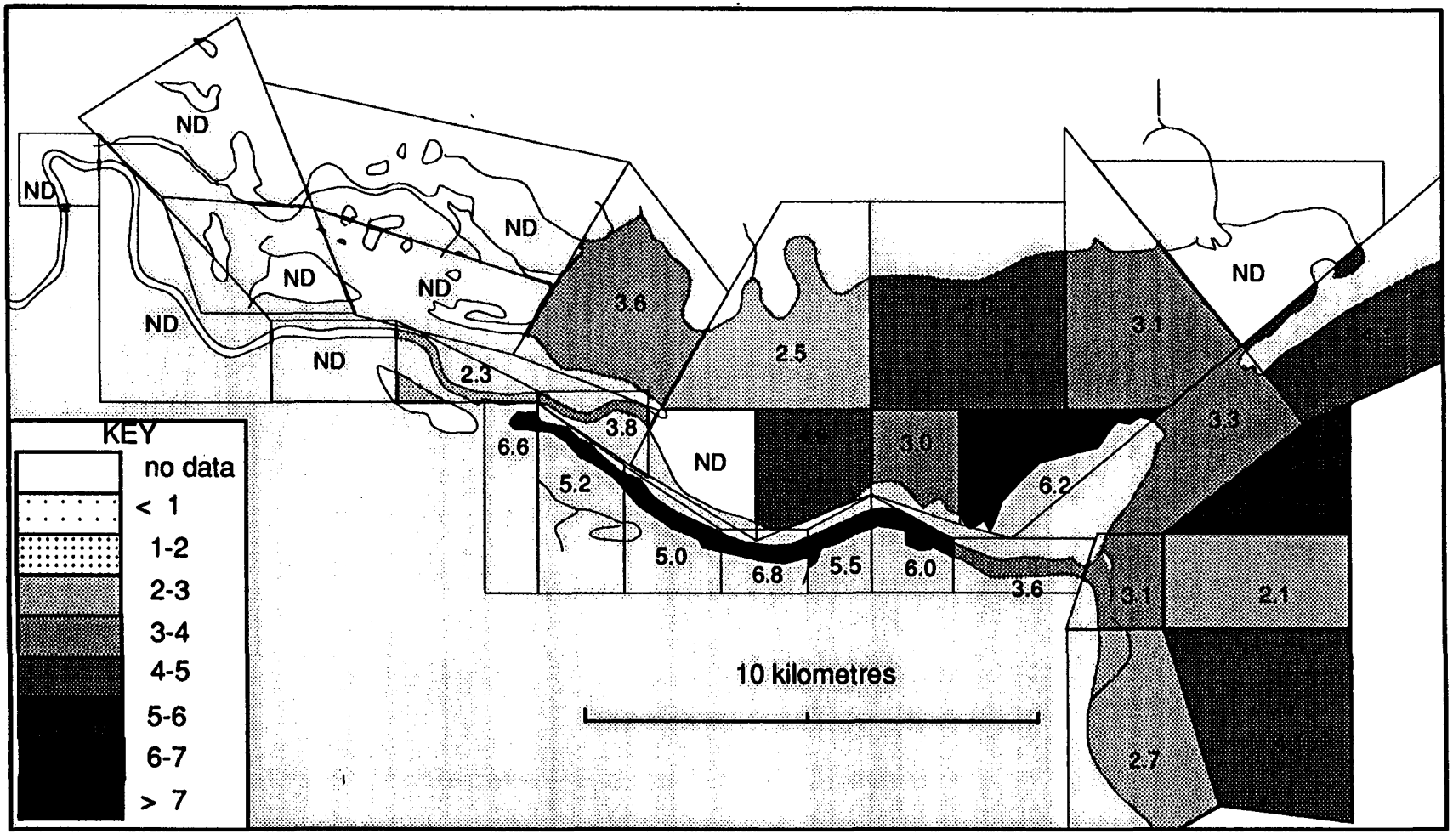


Figure 7-16. Period-of-record means of SEDMETAS for Nueces Bay region, including Inner Harbor

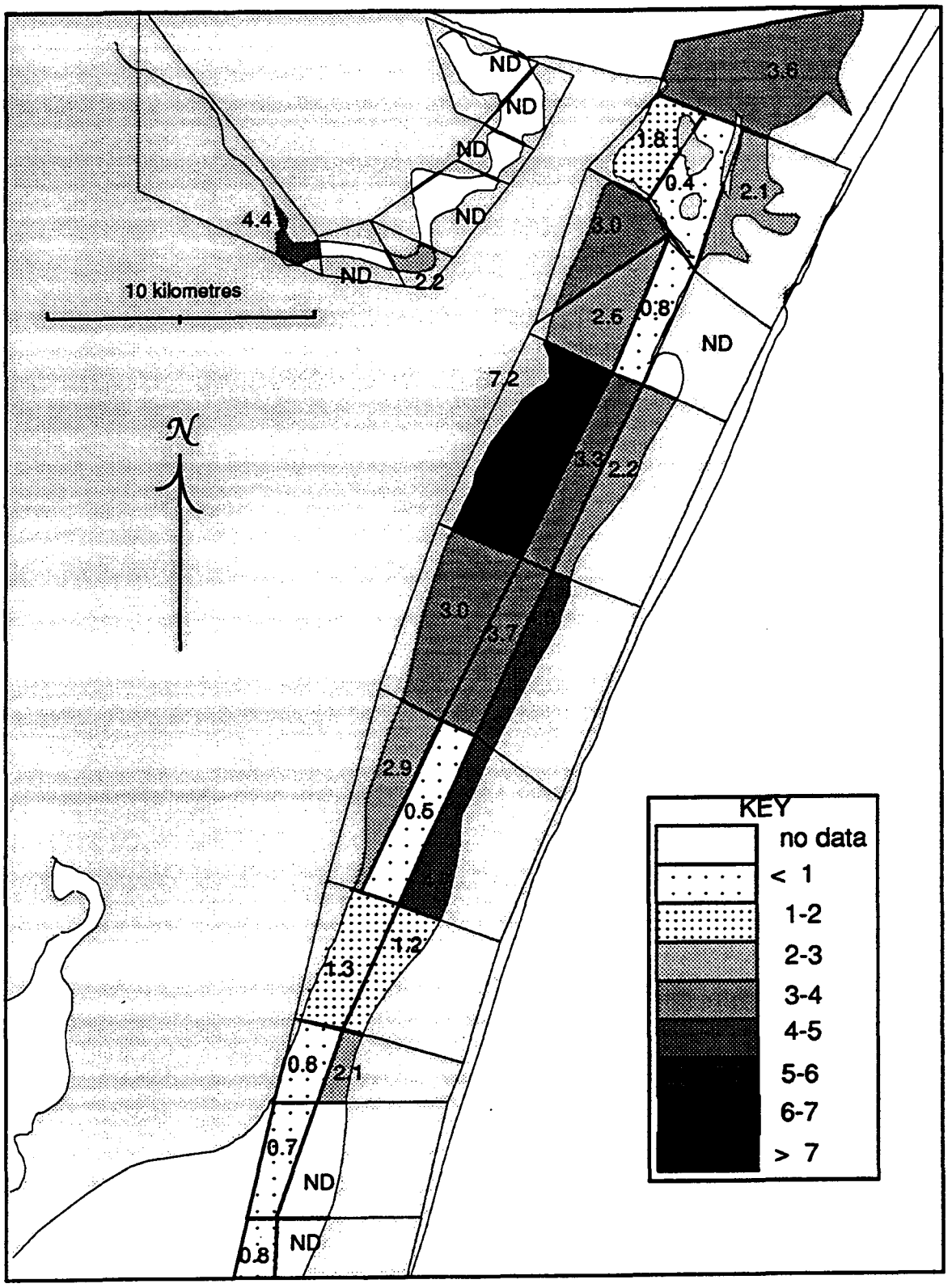


Figure 7-17. Period-of-record means of SEDMETAS for Upper Laguna Madre and Oso Bay

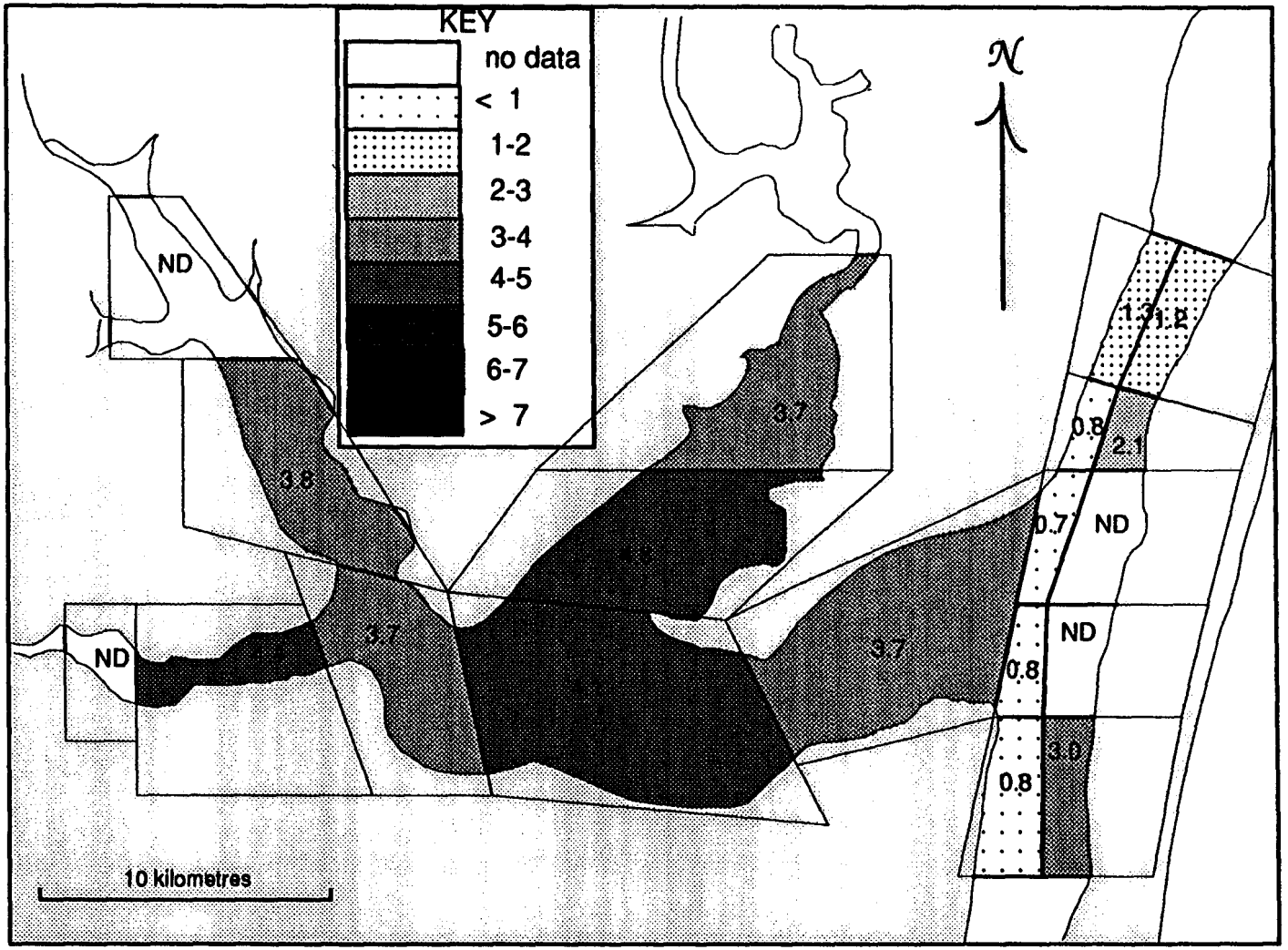


Figure 7-18. Period-of-record means of SEDMETAS for Baffin Bay region

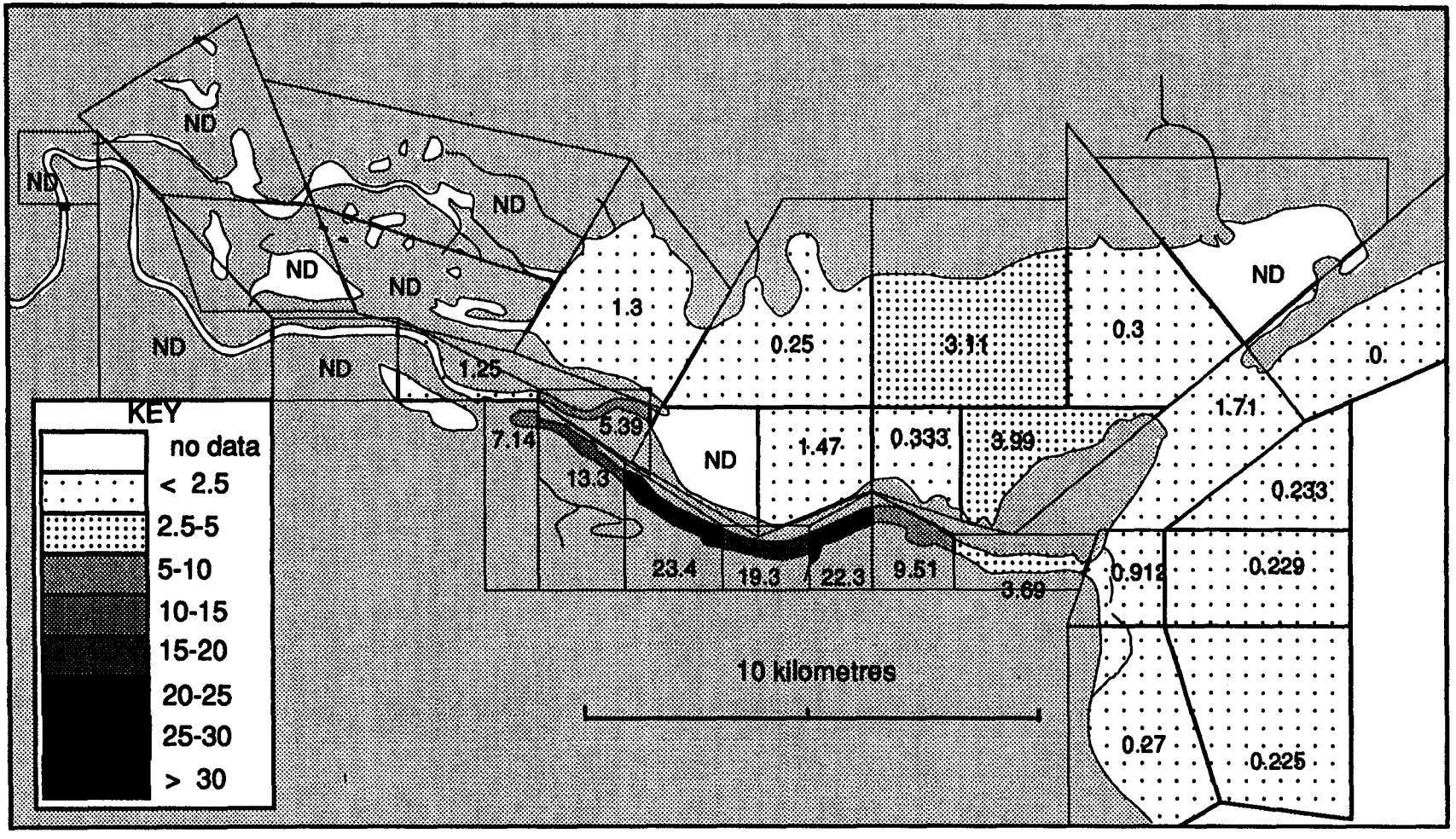


Figure 7-19. Period-of-record means of SEDMETCD for Nueces Bay region, including Inner Harbor

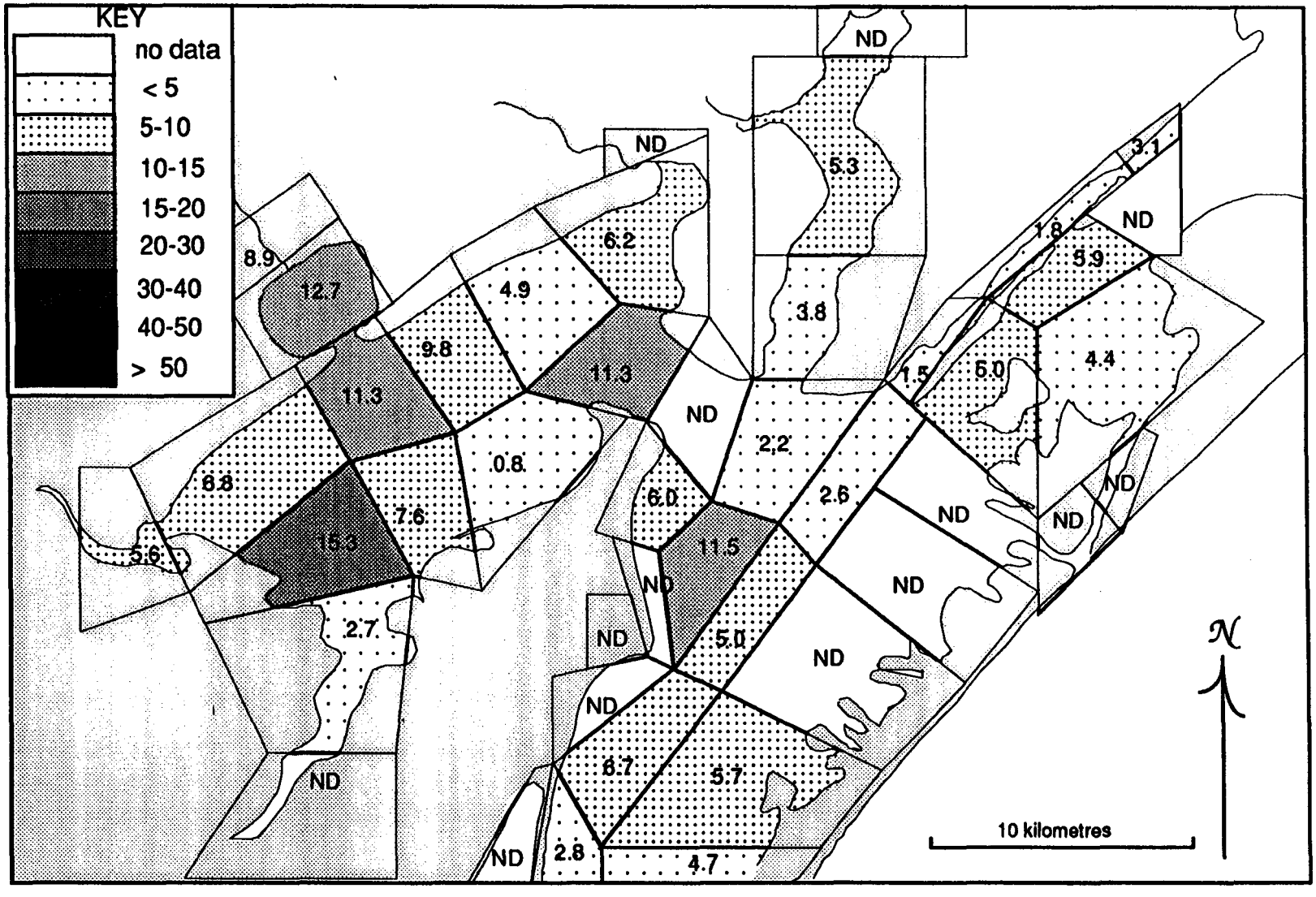


Figure 7-20. Period-of-record means of SEDMETCU for Aransas-Copano system

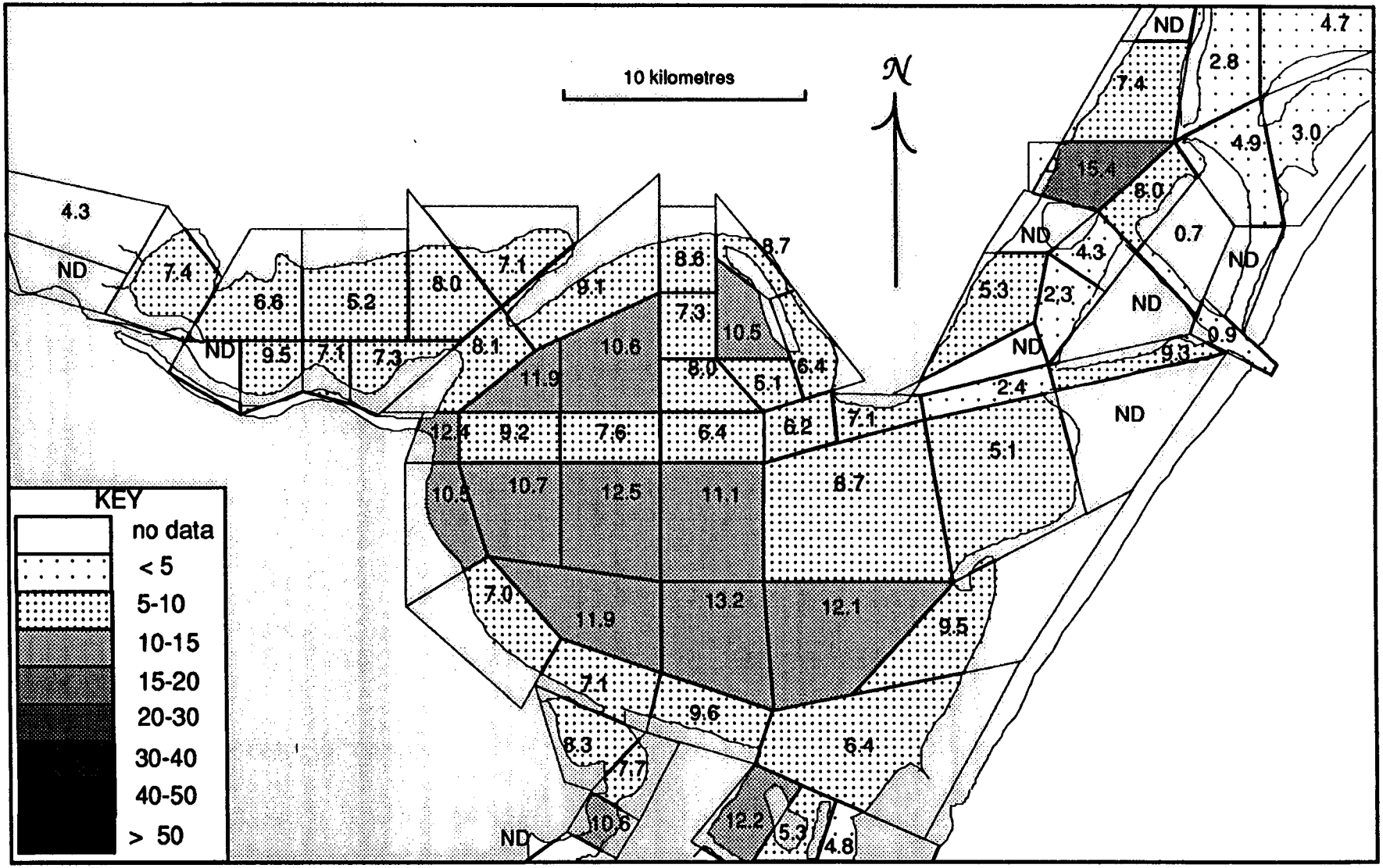


Figure 7-21. Period-of-record means of SEDMETCU for Corpus Christi system

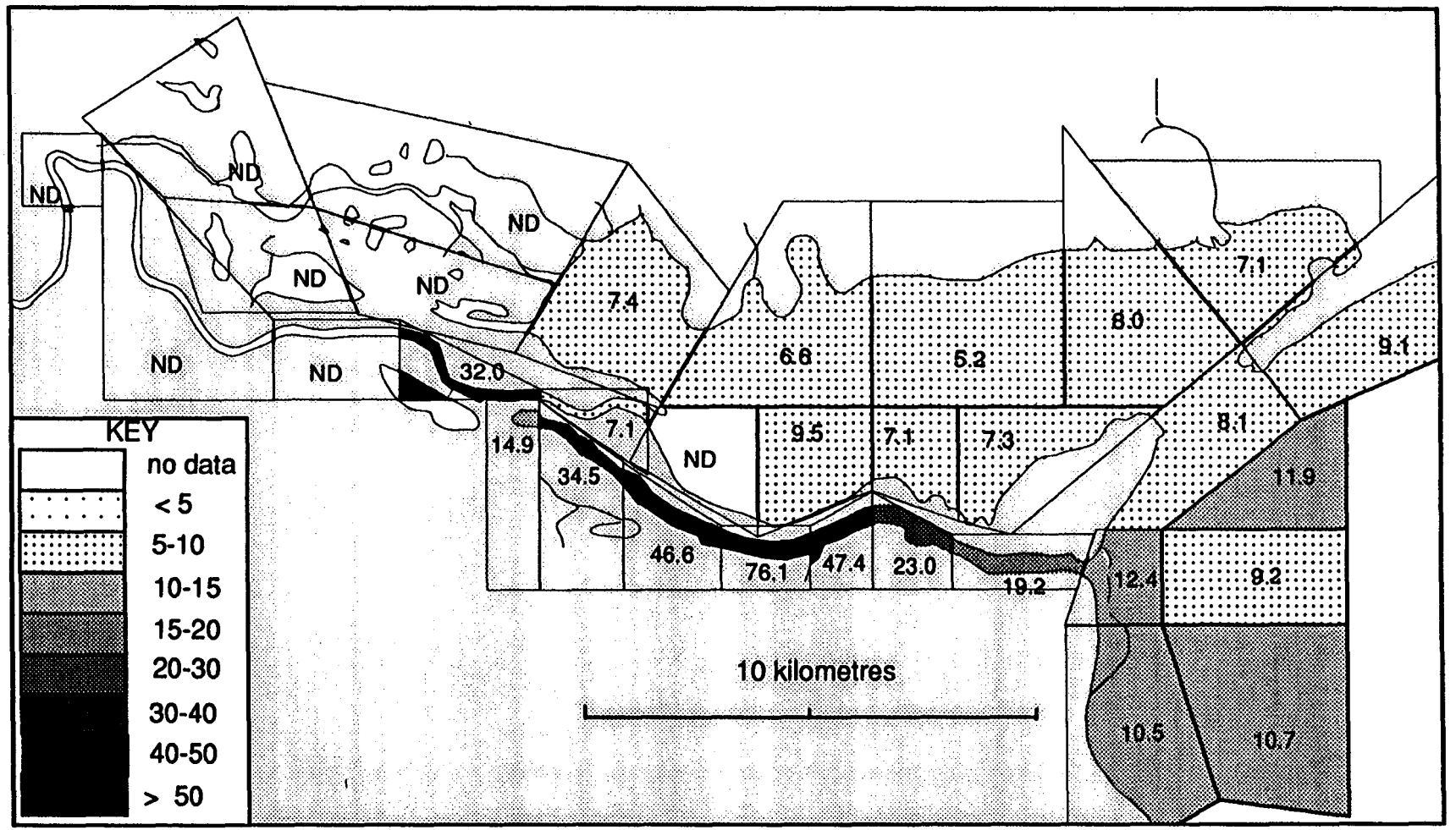


Figure 7-22. Period-of-record means of SEDMETCU for Nueces Bay region, including Inner Harbor

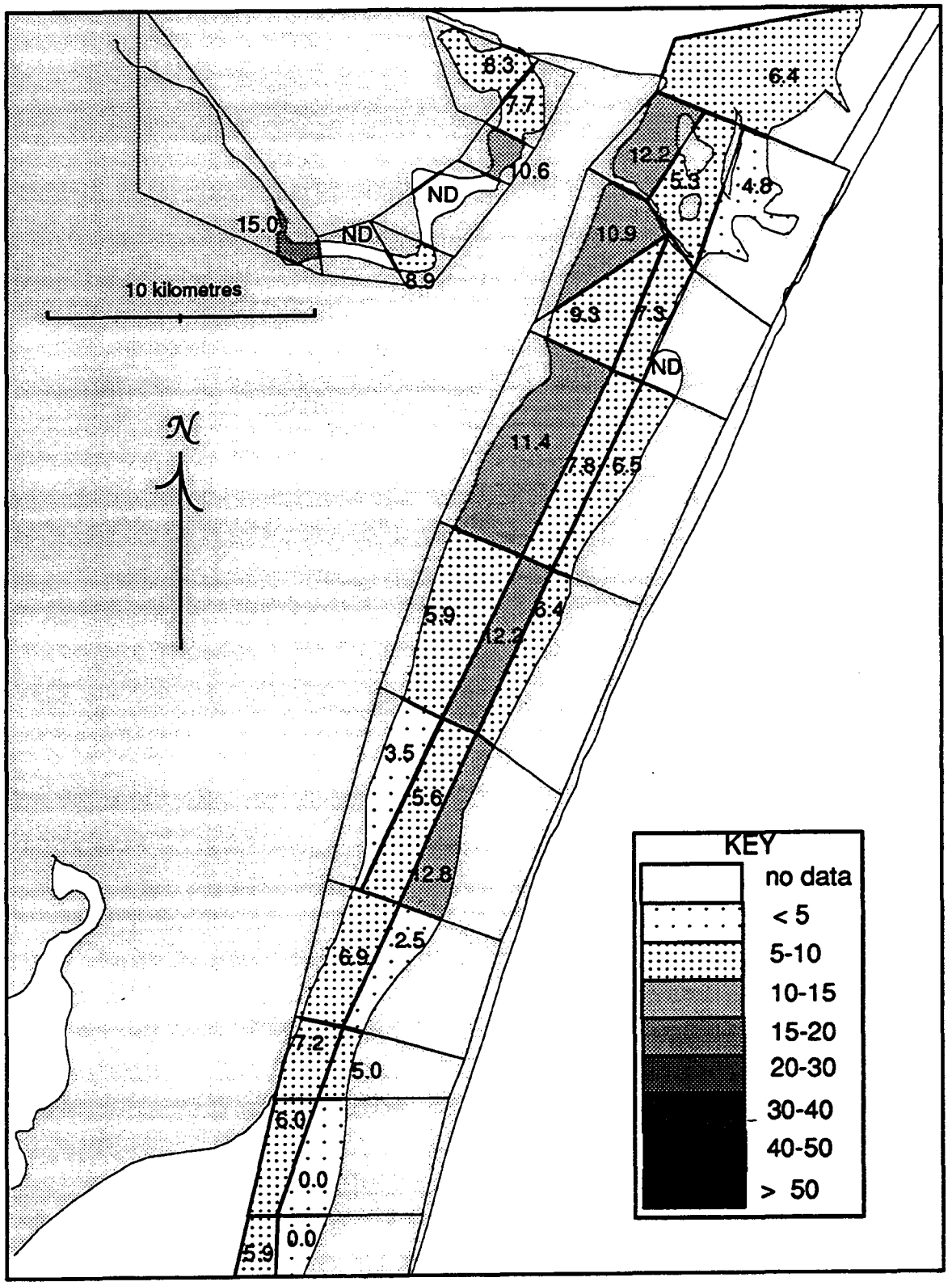


Figure 7-23. Period-of-record means of SEDMETCU for Upper Laguna Madre and Oso Bay

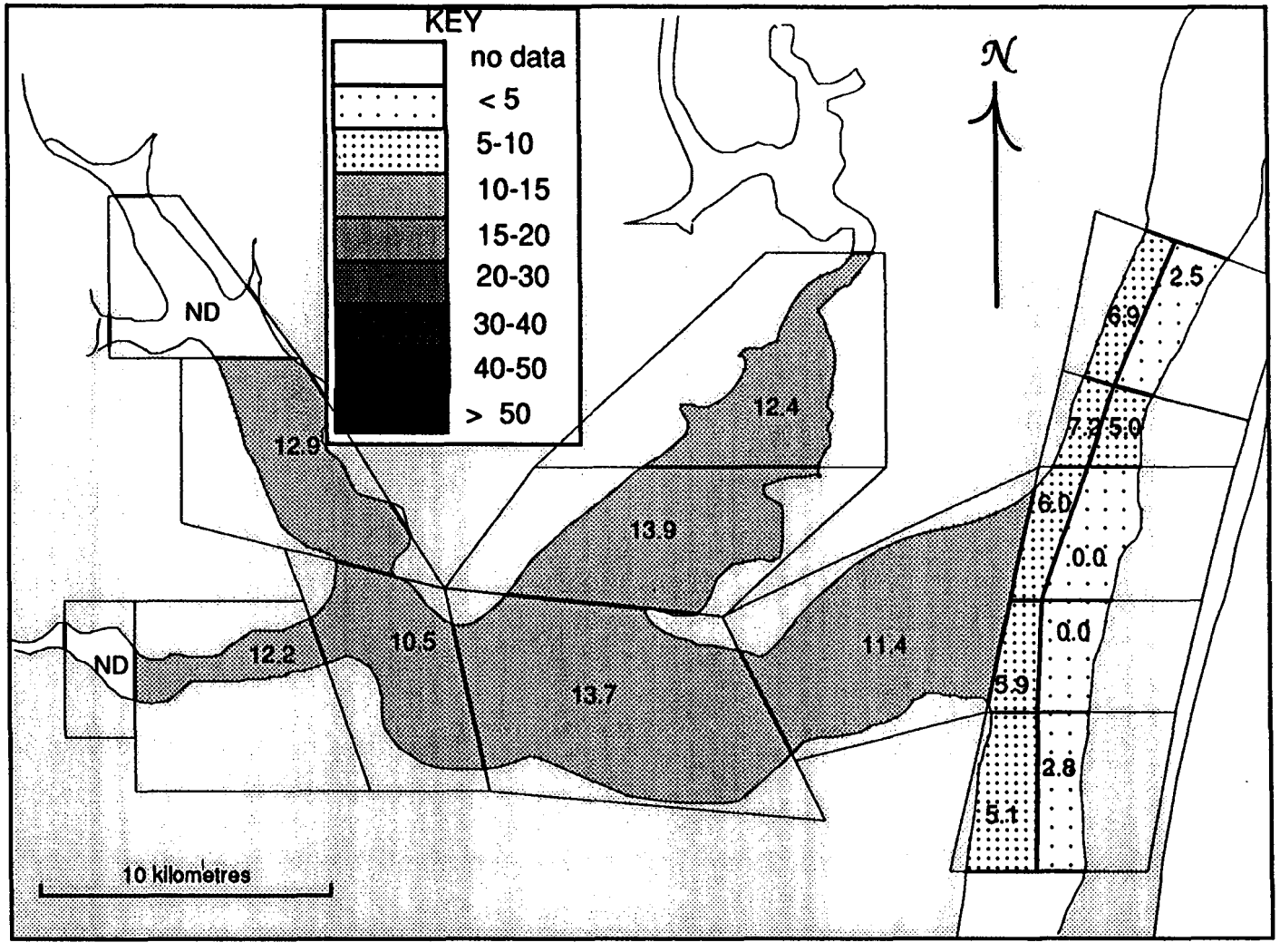


Figure 7-24. Period-of-record means of SEDMETCU for Baffin Bay region

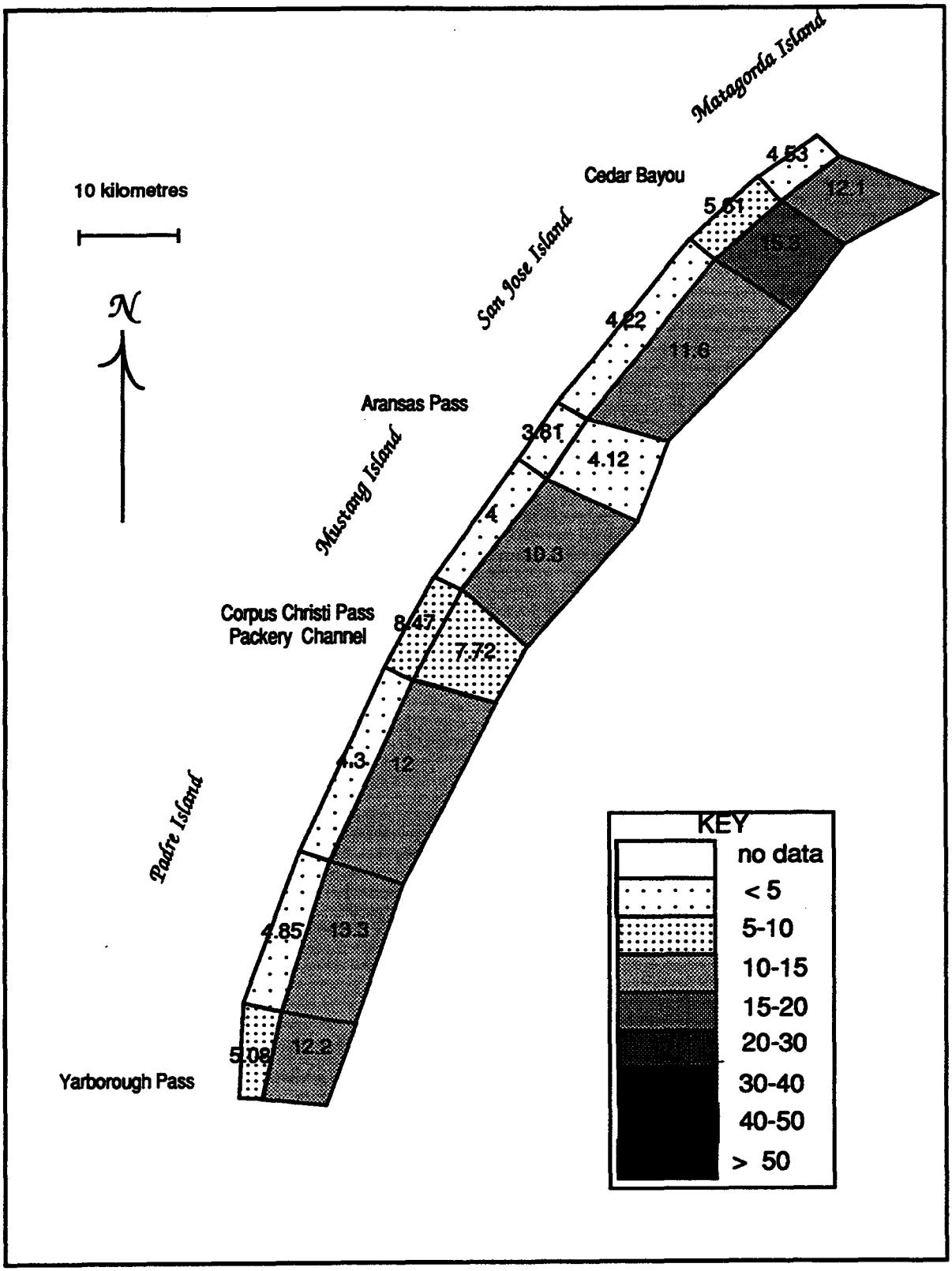


Figure 7-25. Period-of-record means of SEDMETCU for Gulf of Mexico

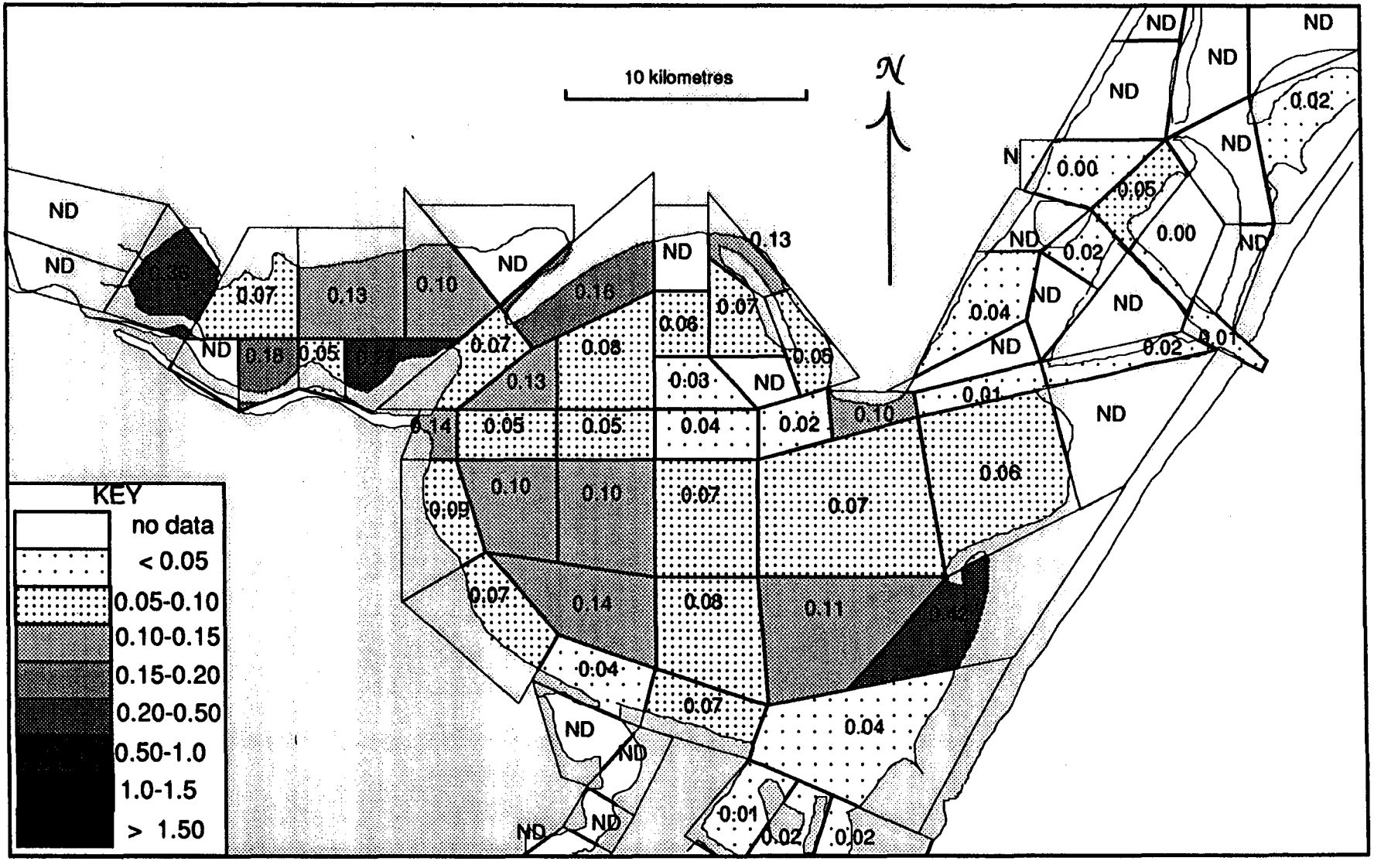


Figure 7-26. Period-of-record means of SEDMETHG for Corpus Christi system

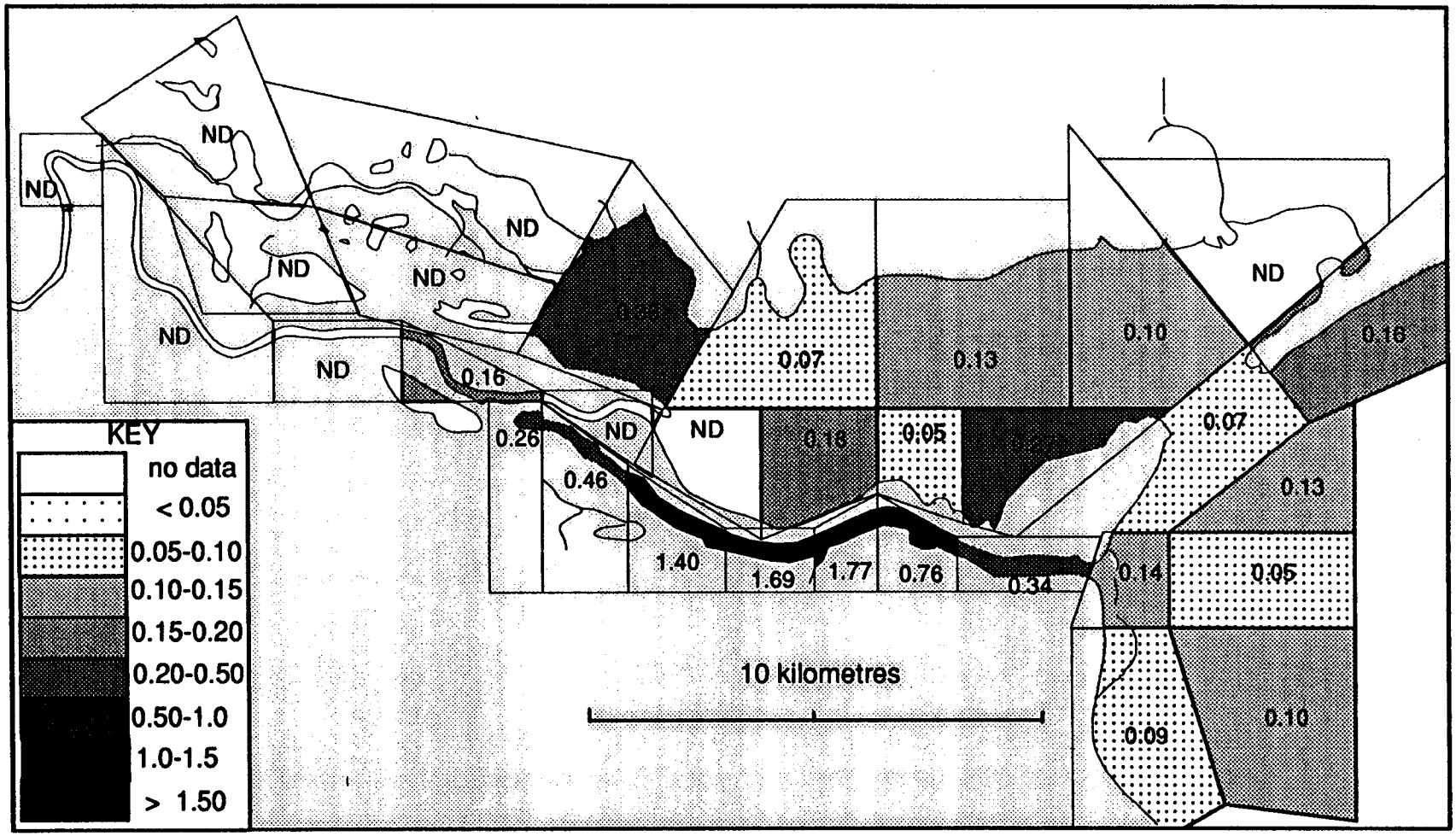


Figure 7-27. Period-of-record means of SEDMETHG for Nueces Bay region, including Inner Harbor

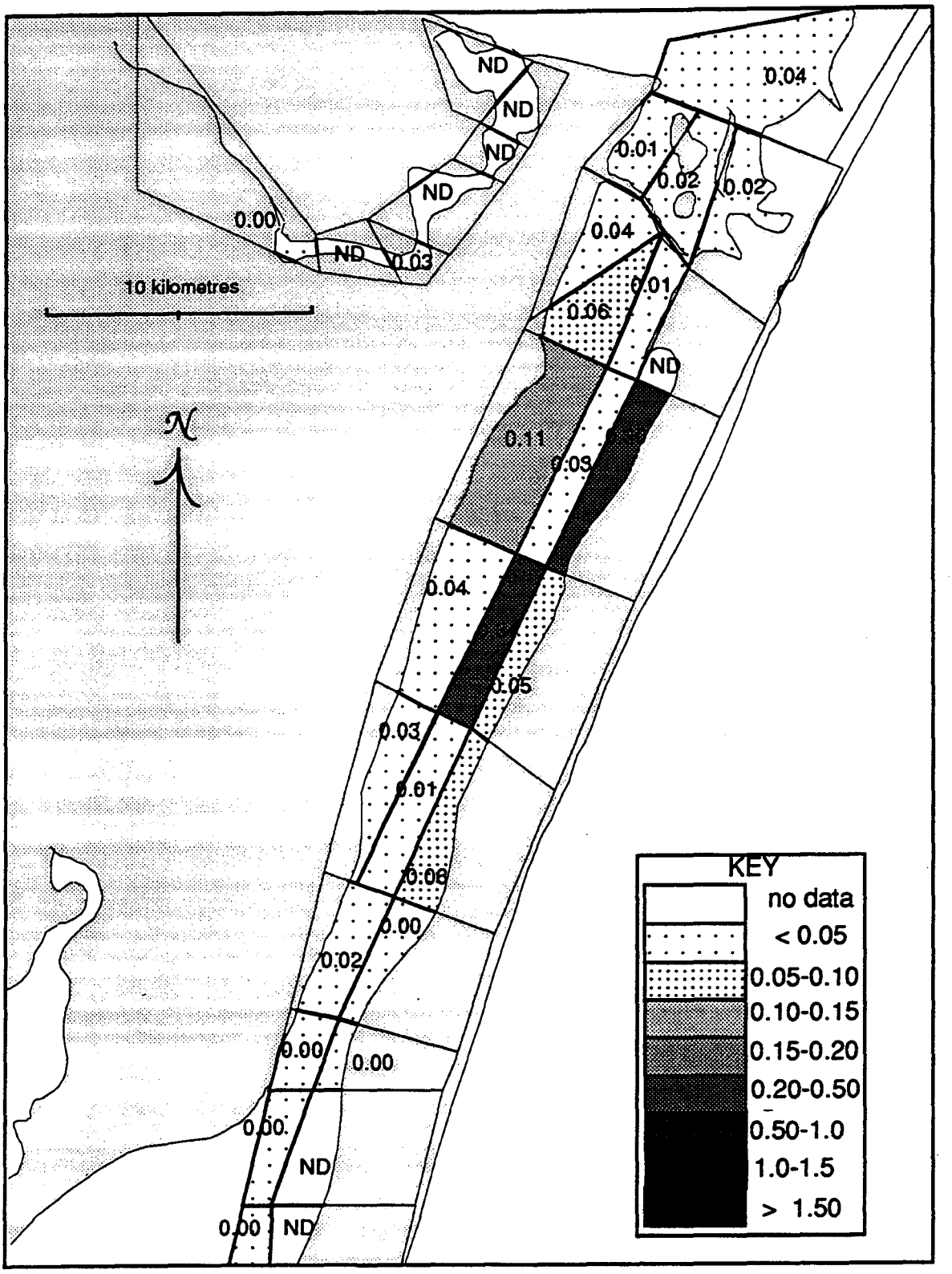


Figure 7-28. Period-of-record means of SEDMETHG for Upper Laguna Madre and Oso Bay

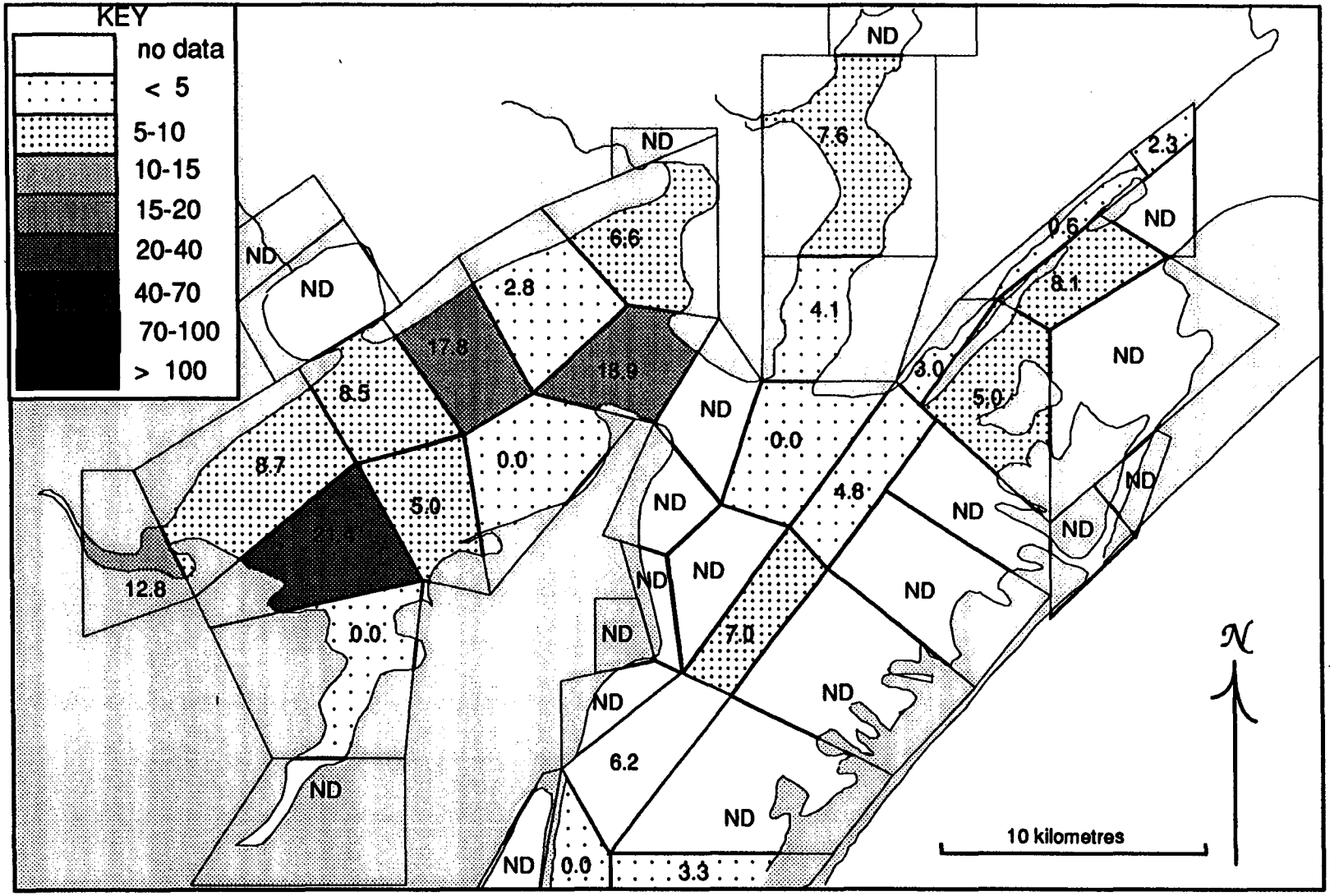


Figure 7-29. Period-of-record means of SEDMETPB for Aransas-Copano system

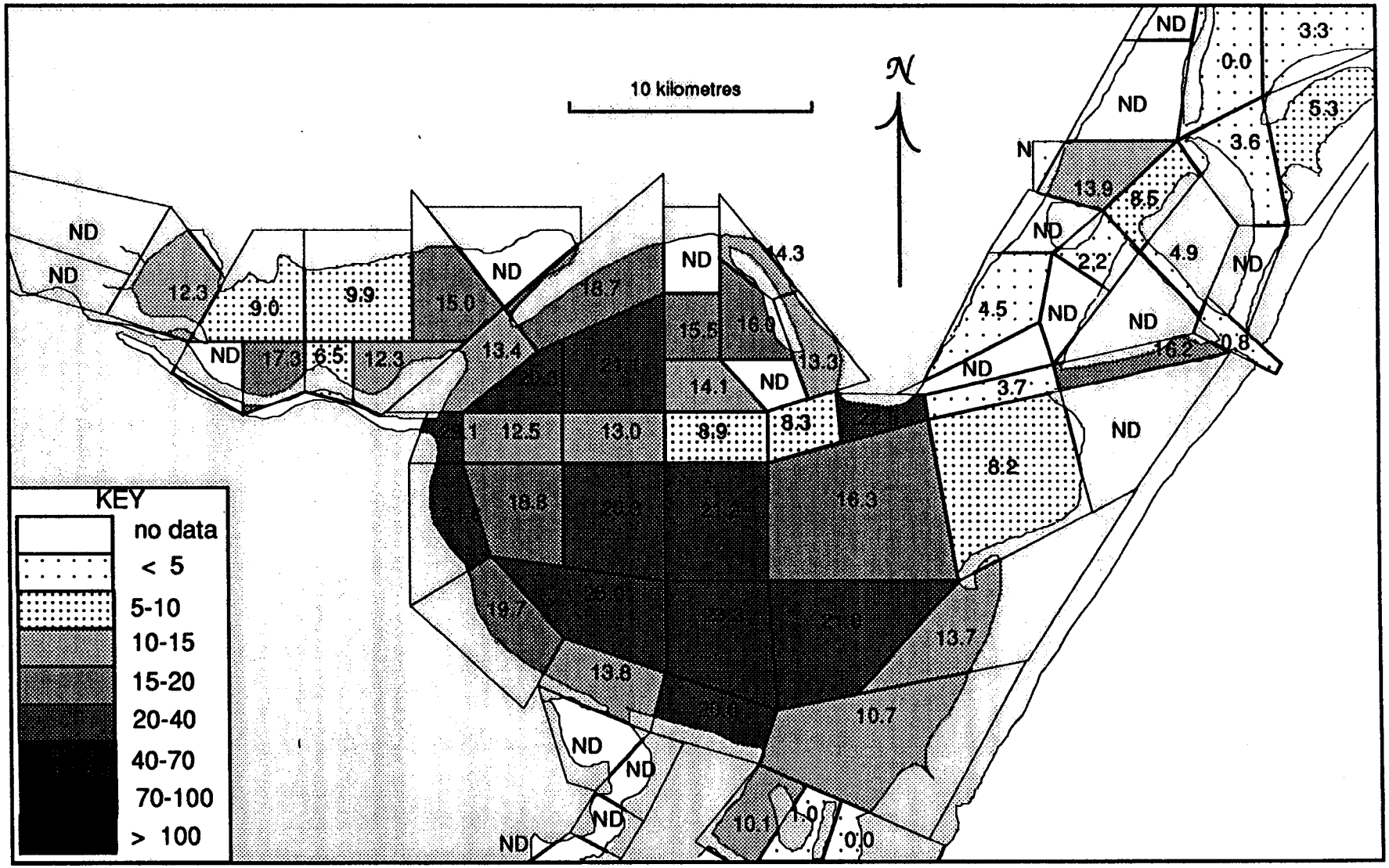


Figure 7-30. Period-of-record means of SEDMETPB for Corpus Christi system

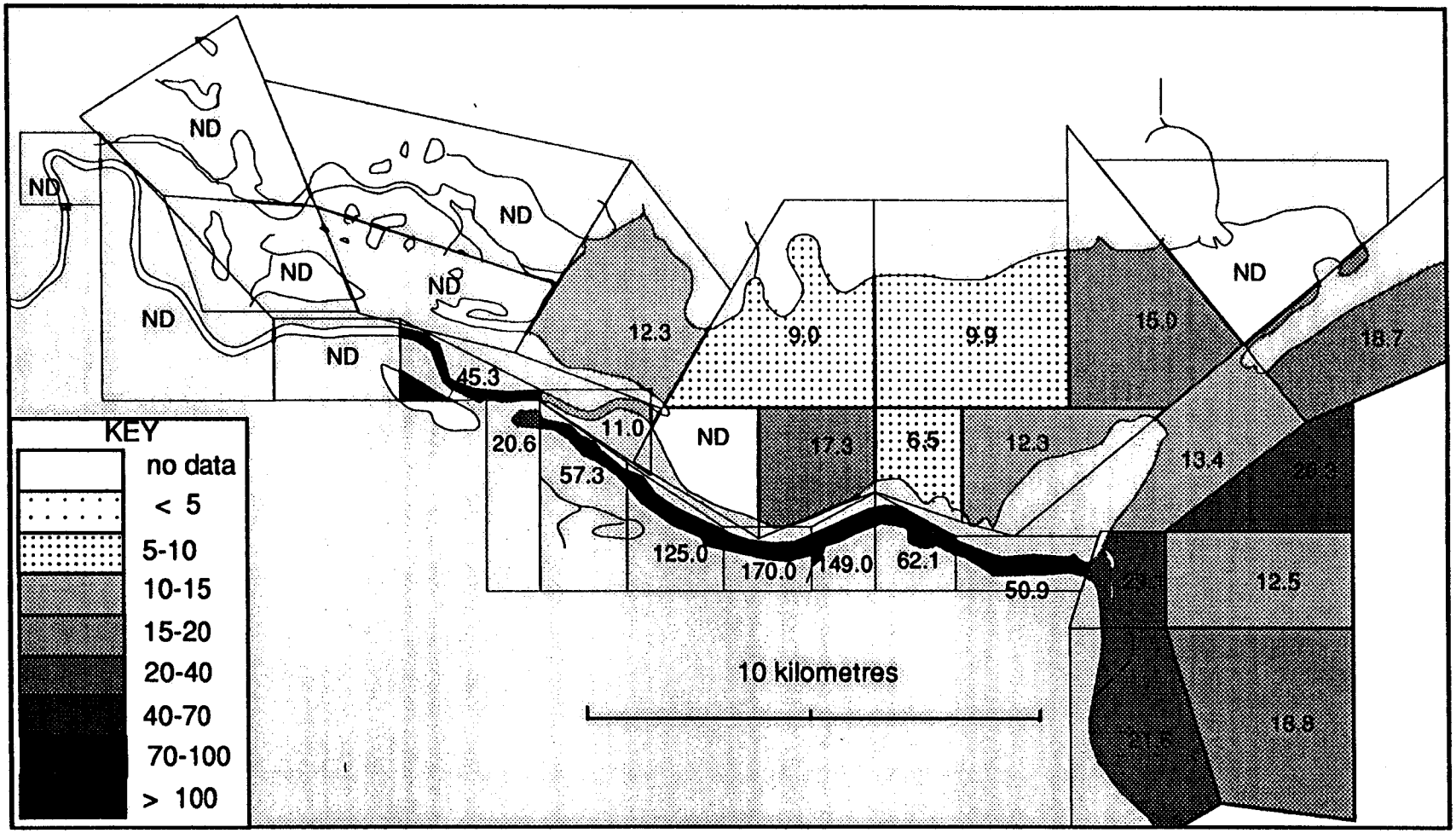


Figure 7-31. Period-of-record means of SEDMETPB for Nueces Bay region, including Inner Harbor

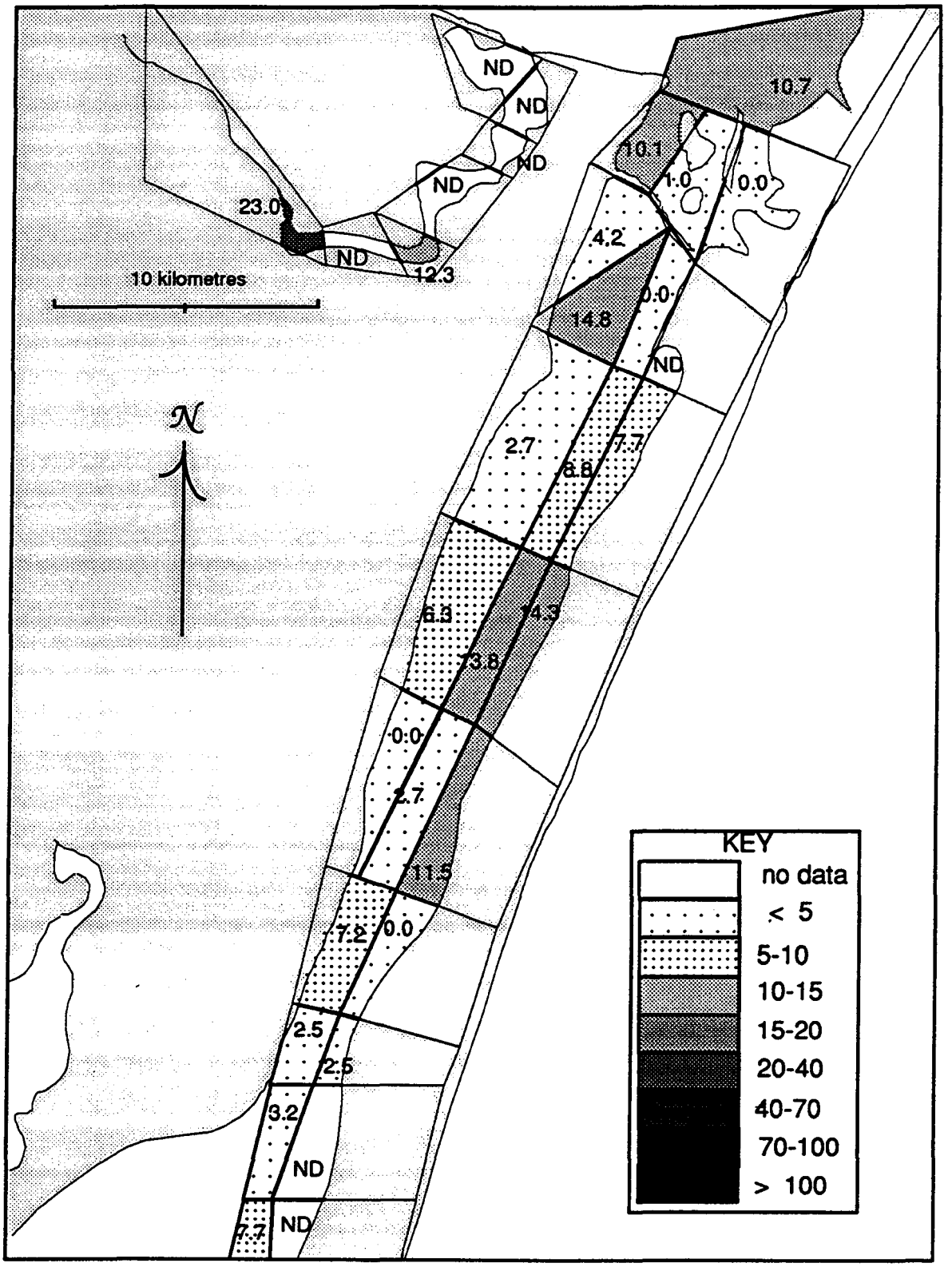


Figure 7-32. Period-of-record means of SEDMETPB for Upper Laguna Madre and Oso Bay

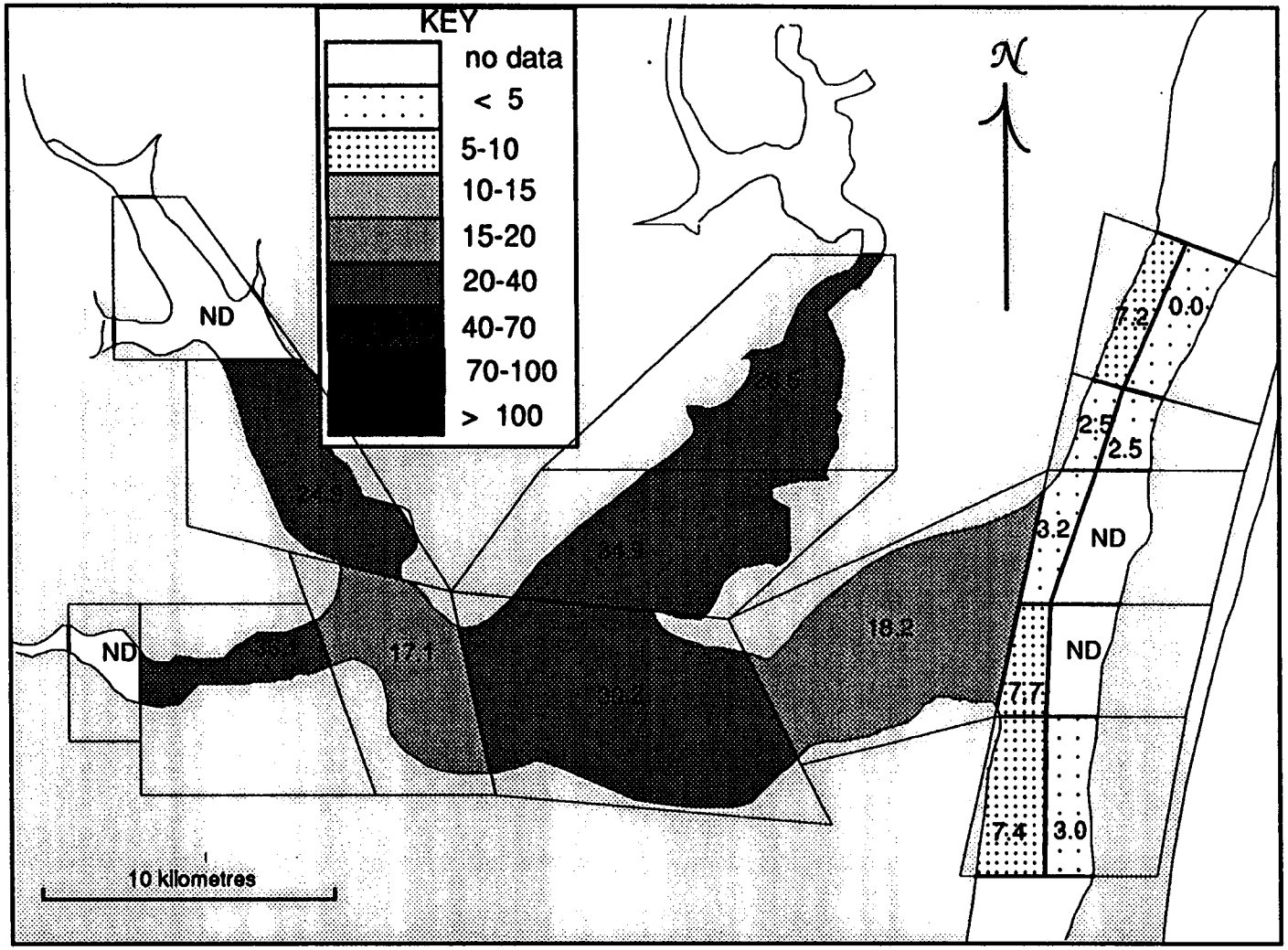


Figure 7-33. Period-of-record means of SEDMETPB for Baffin Bay region

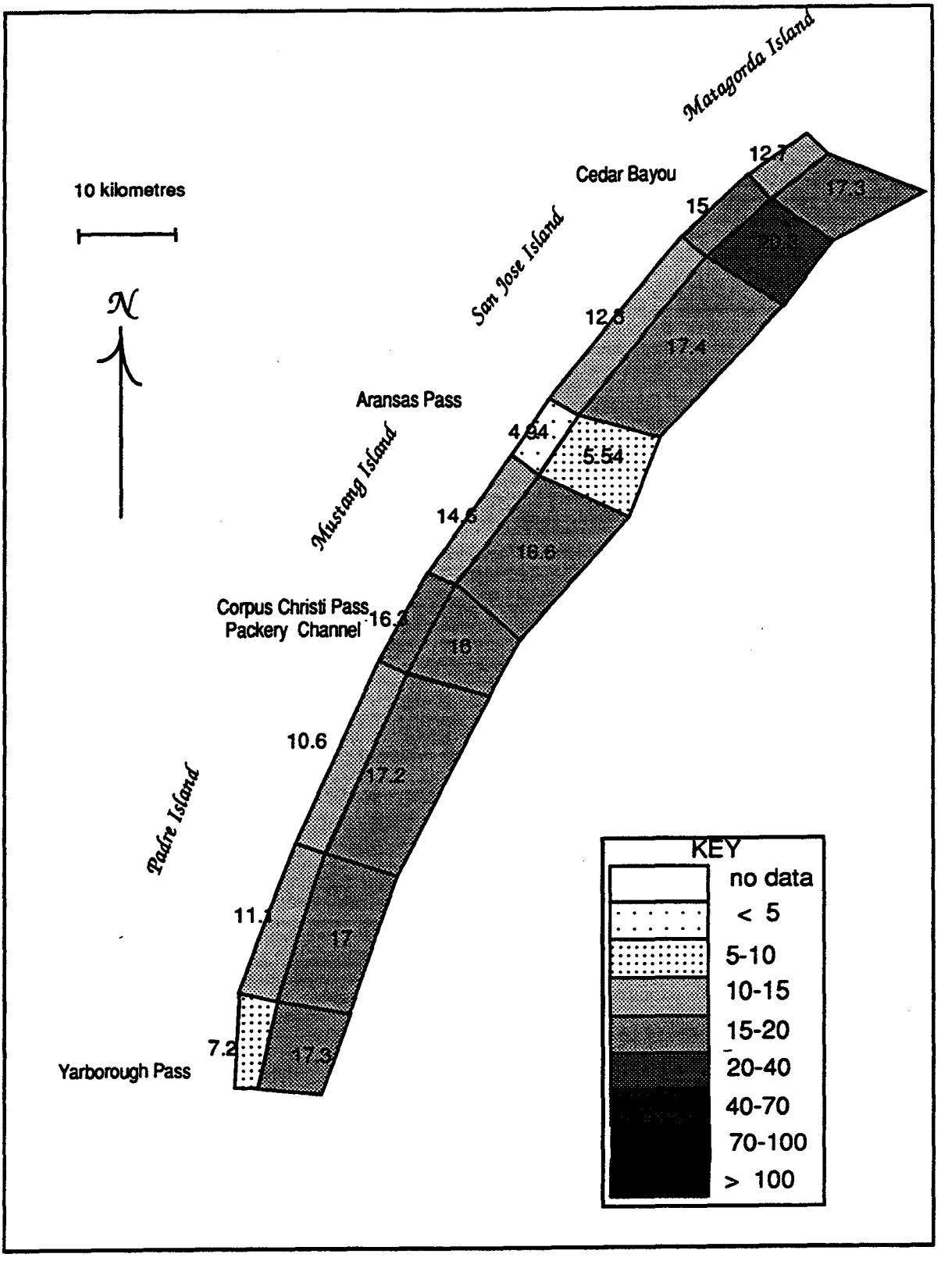


Figure 7-34. Period-of-record means of SEDMETPB for Gulf of Mexico

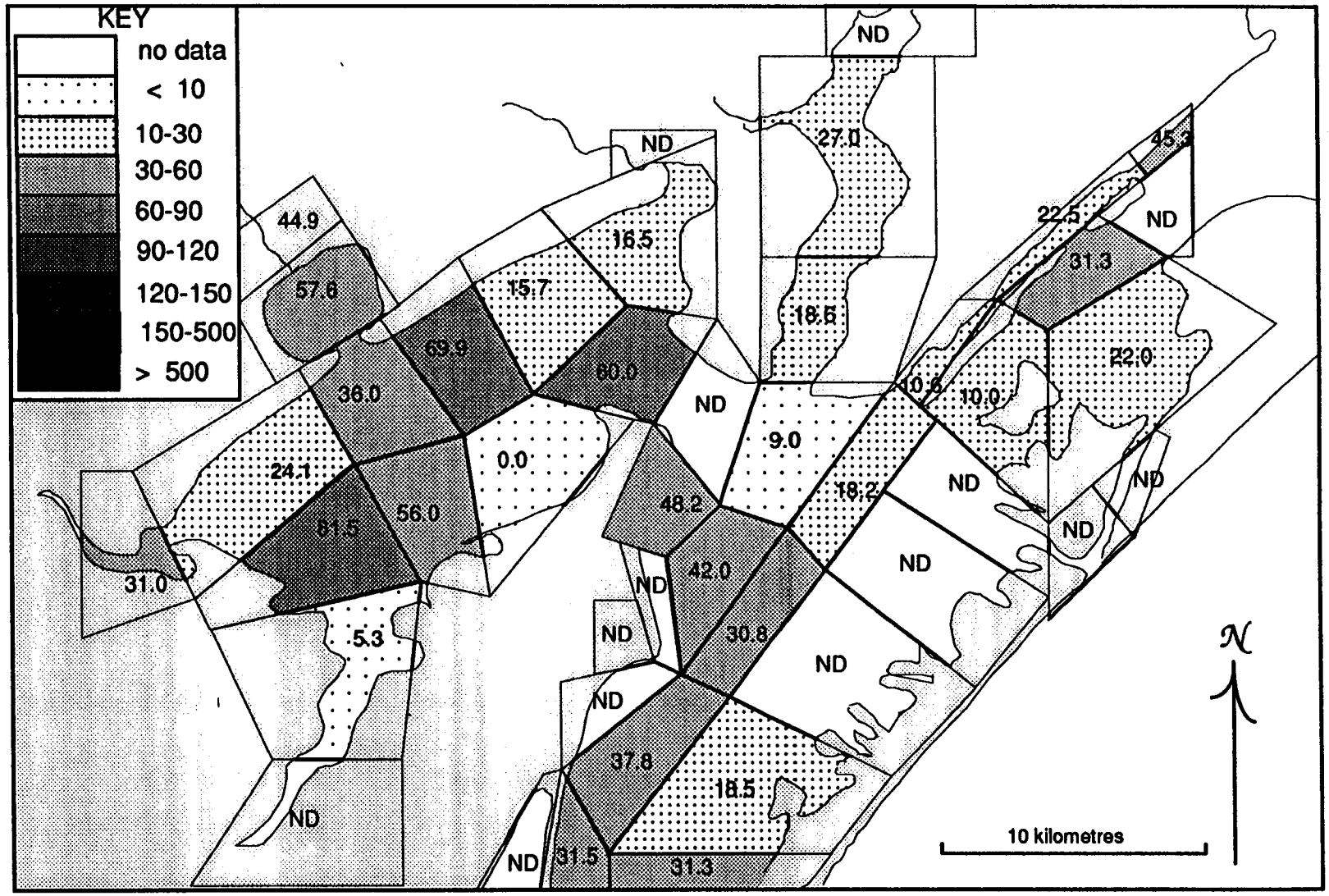


Figure 7-35. Period-of-record means of SEDMETZN for Aransas-Copano system

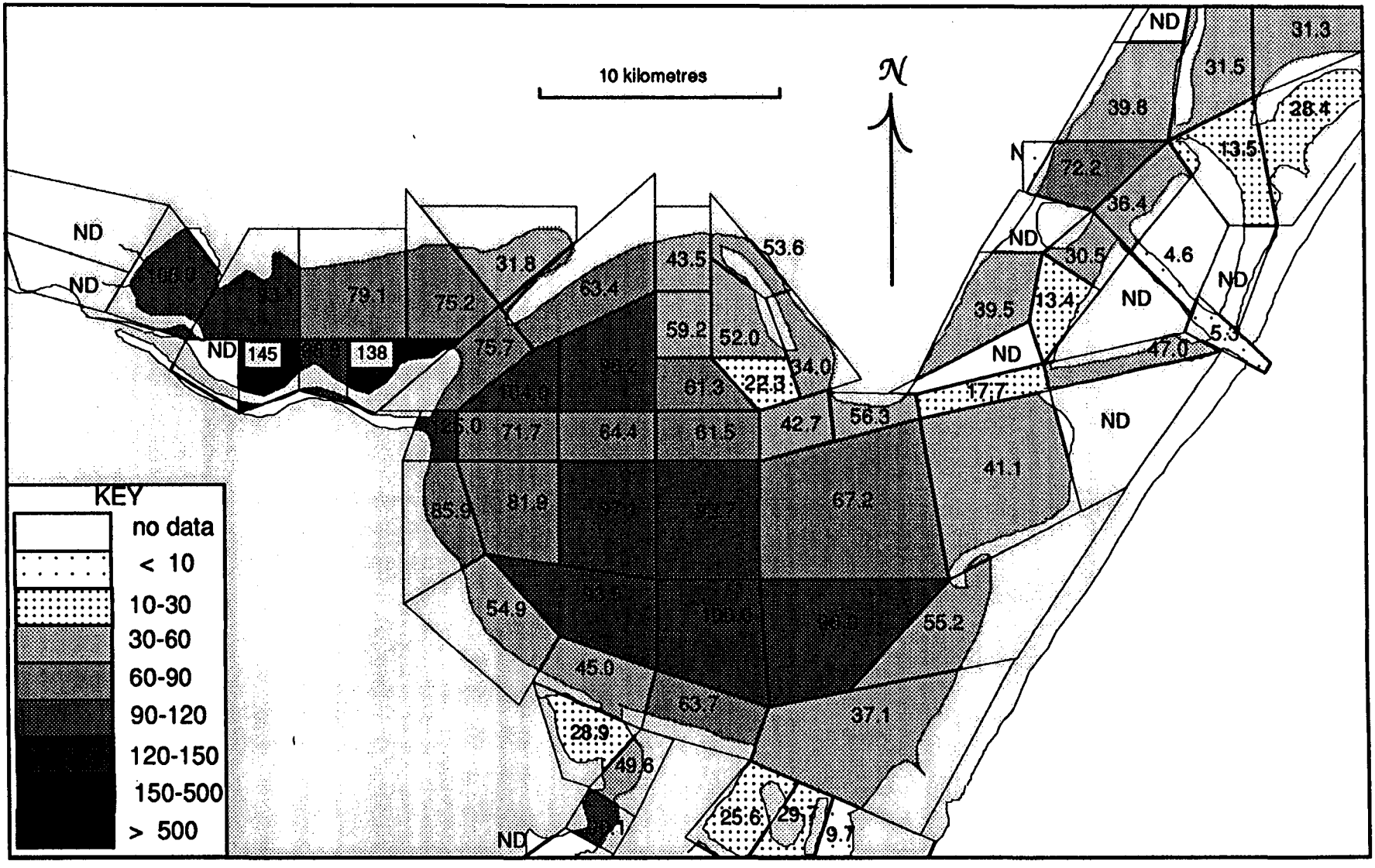


Figure 7-36. Period-of-record means of SEDMETZN for Corpus Christi system

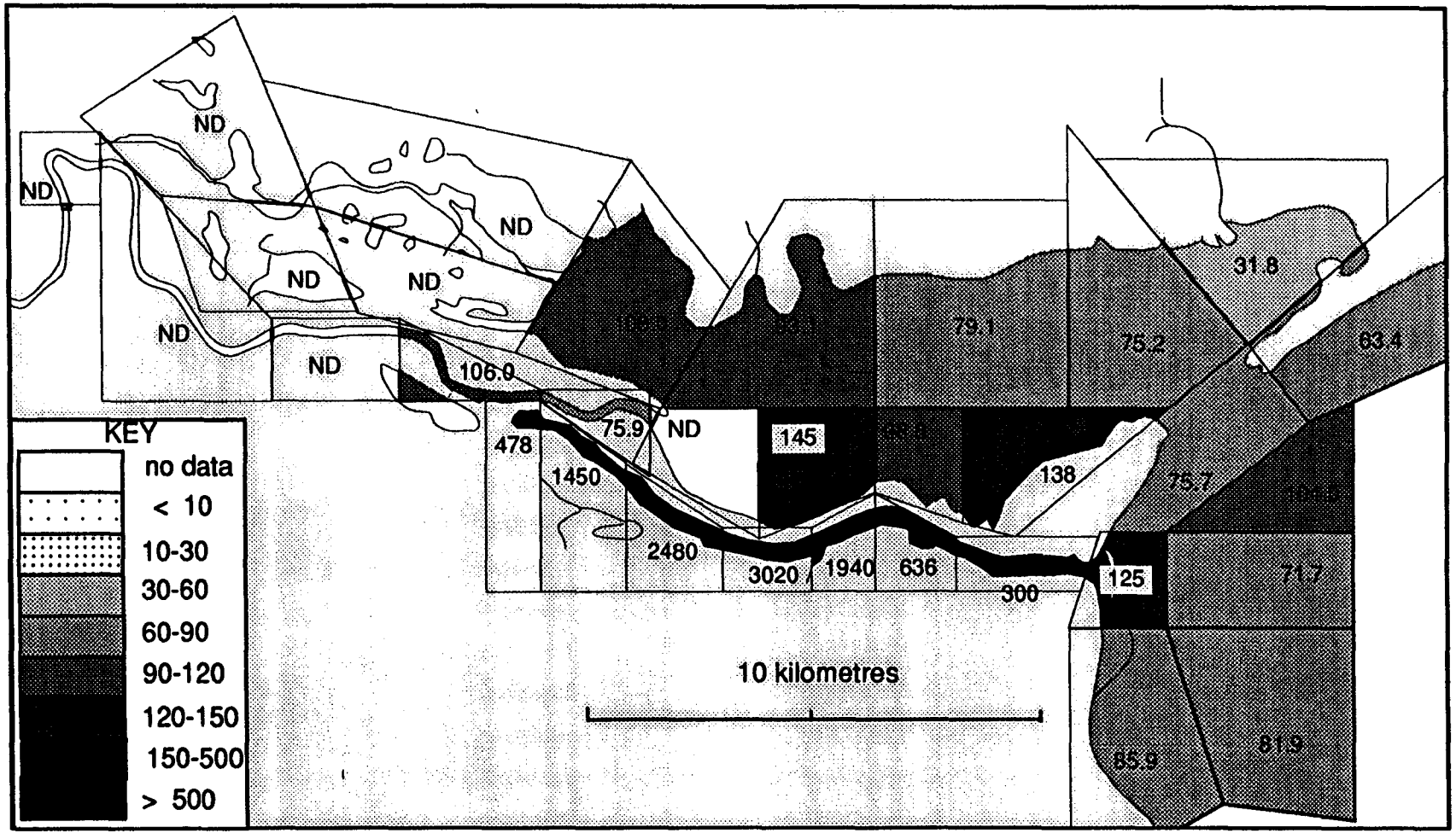


Figure 7-37. Period-of-record means of SEDMETZN for Nueces Bay region, including Inner Harbor

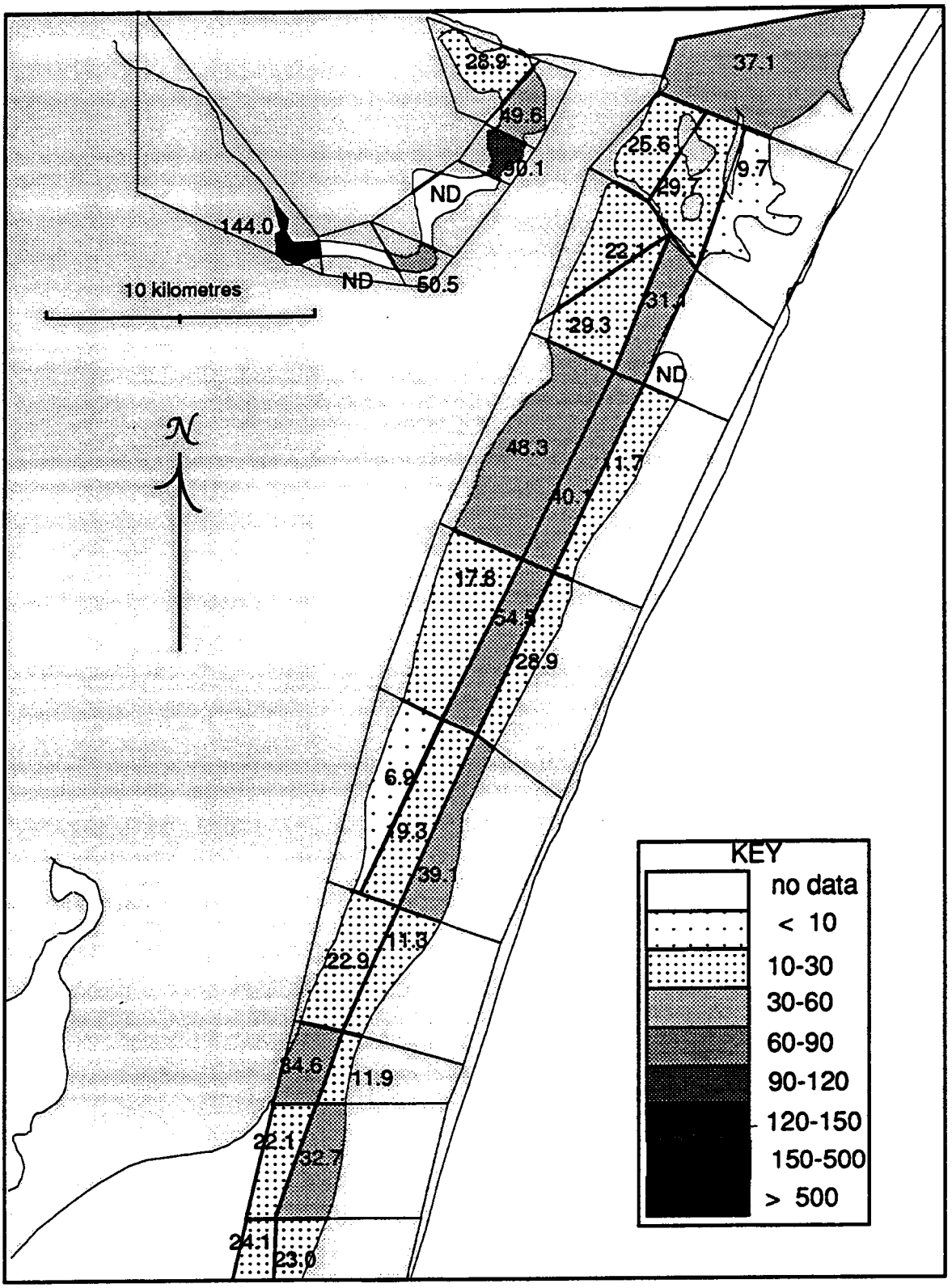


Figure 7-38. Period-of-record means of SEDMETZN for Upper Laguna Madre and Oso Bay

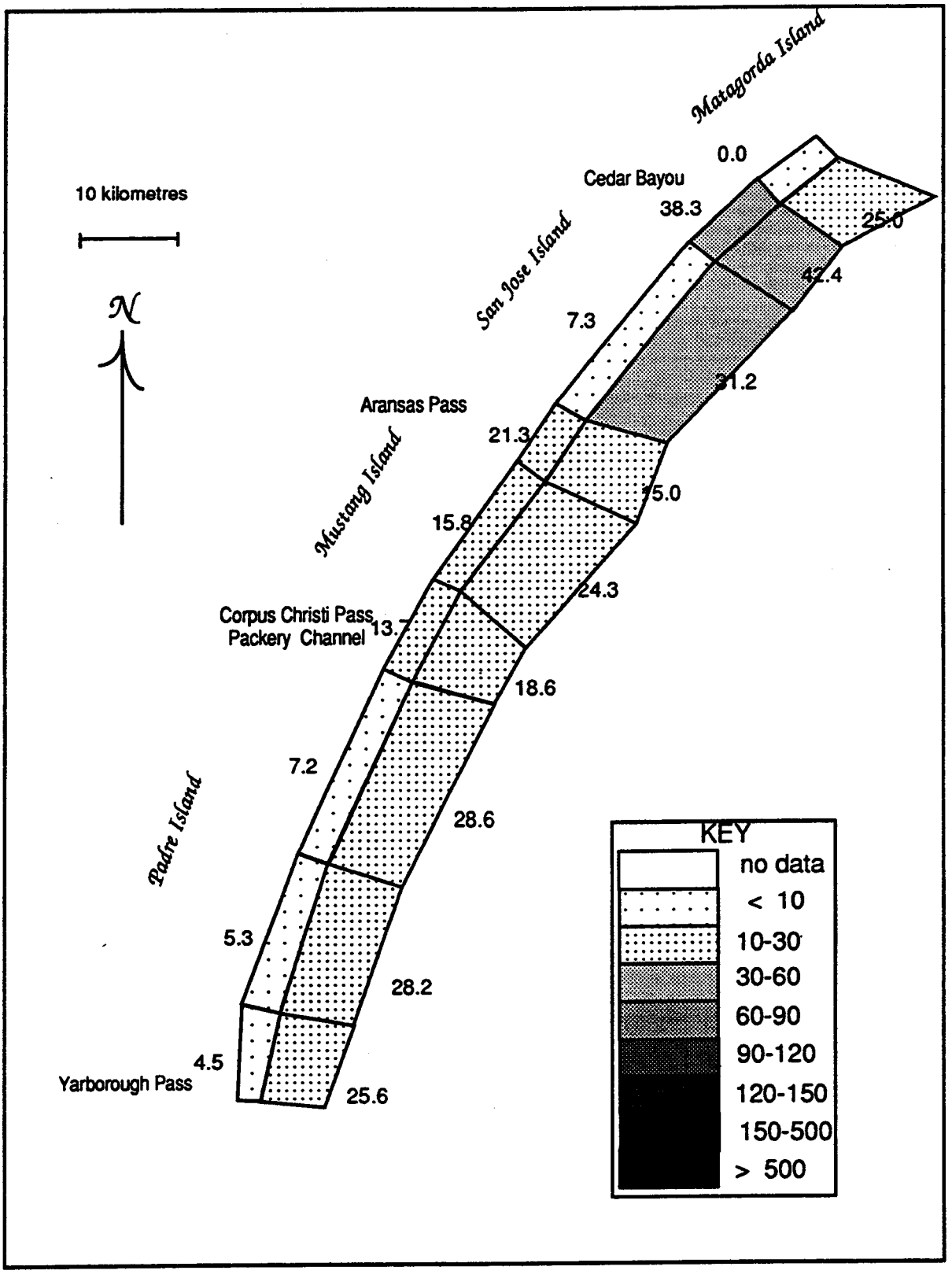


Figure 7-39. Period-of-record means of SEDMETZN for Gulf of Mexico

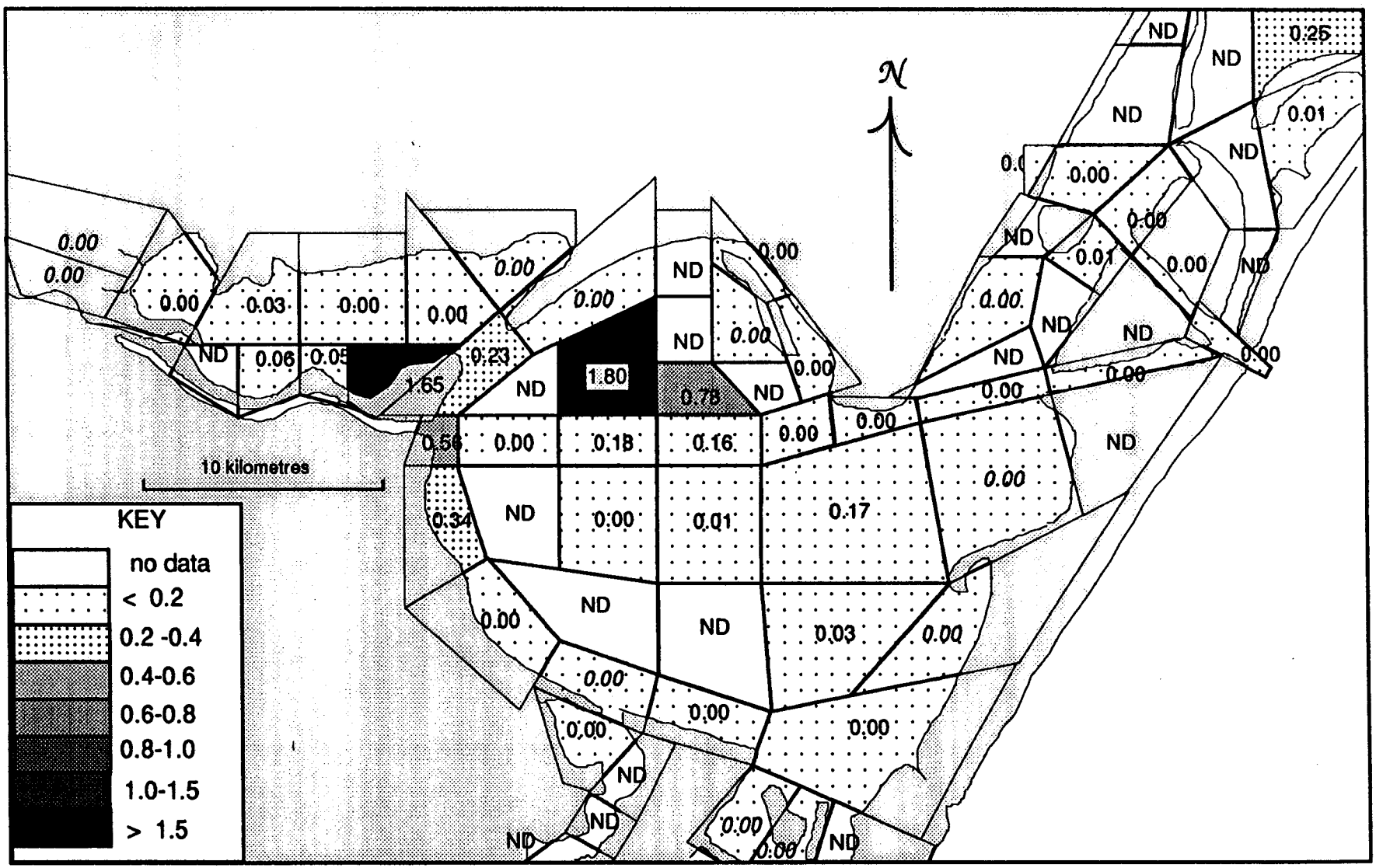


Figure 7-40. Period-of-record means of SED-XDDT for Corpus Christi system

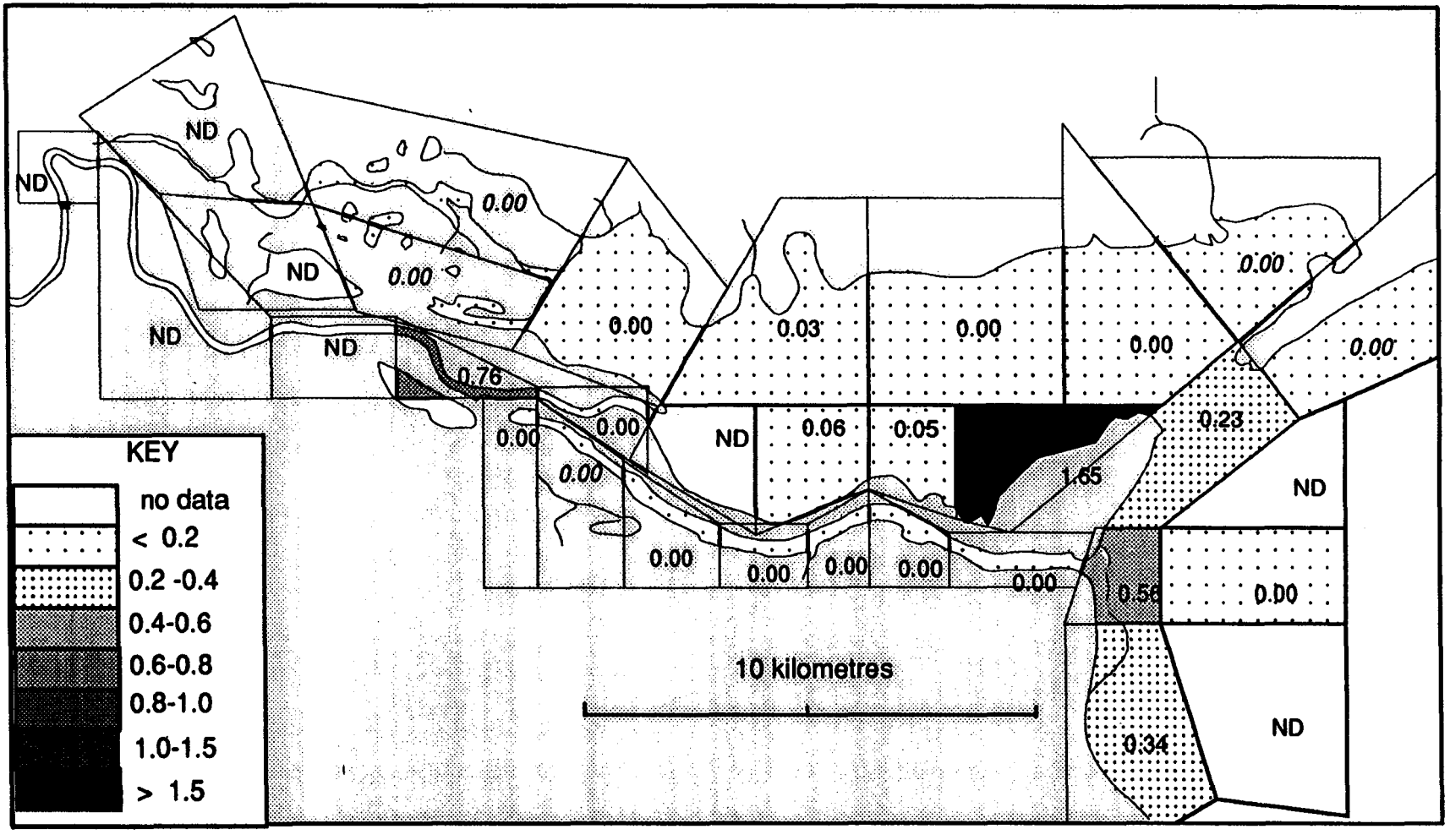


Figure 7-41. Period-of-record means of SED-XDDT for Nueces Bay region, including Inner Harbor

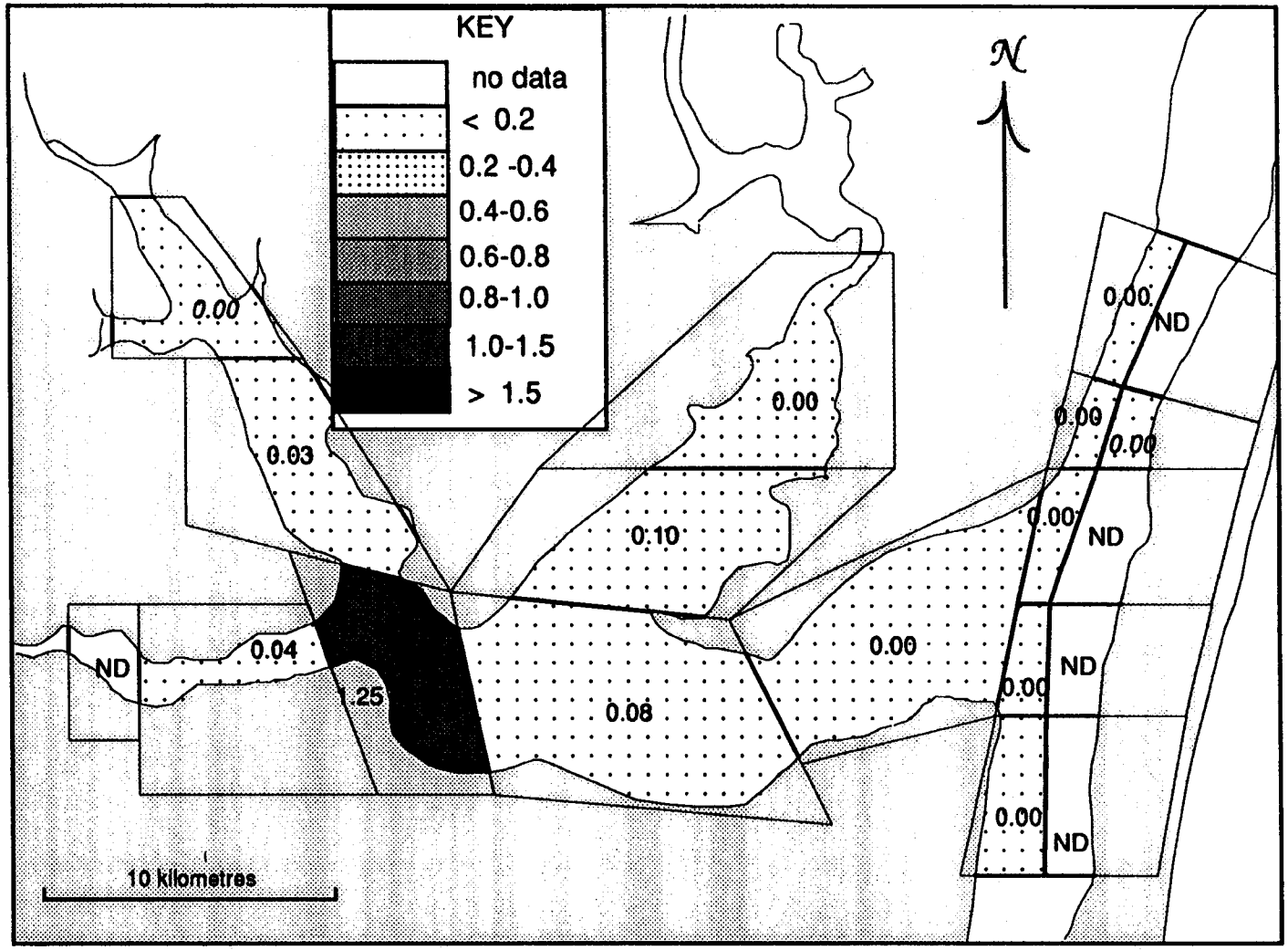


Figure 7-42. Period-of-record means of SED-XDDT for Baffin Bay region

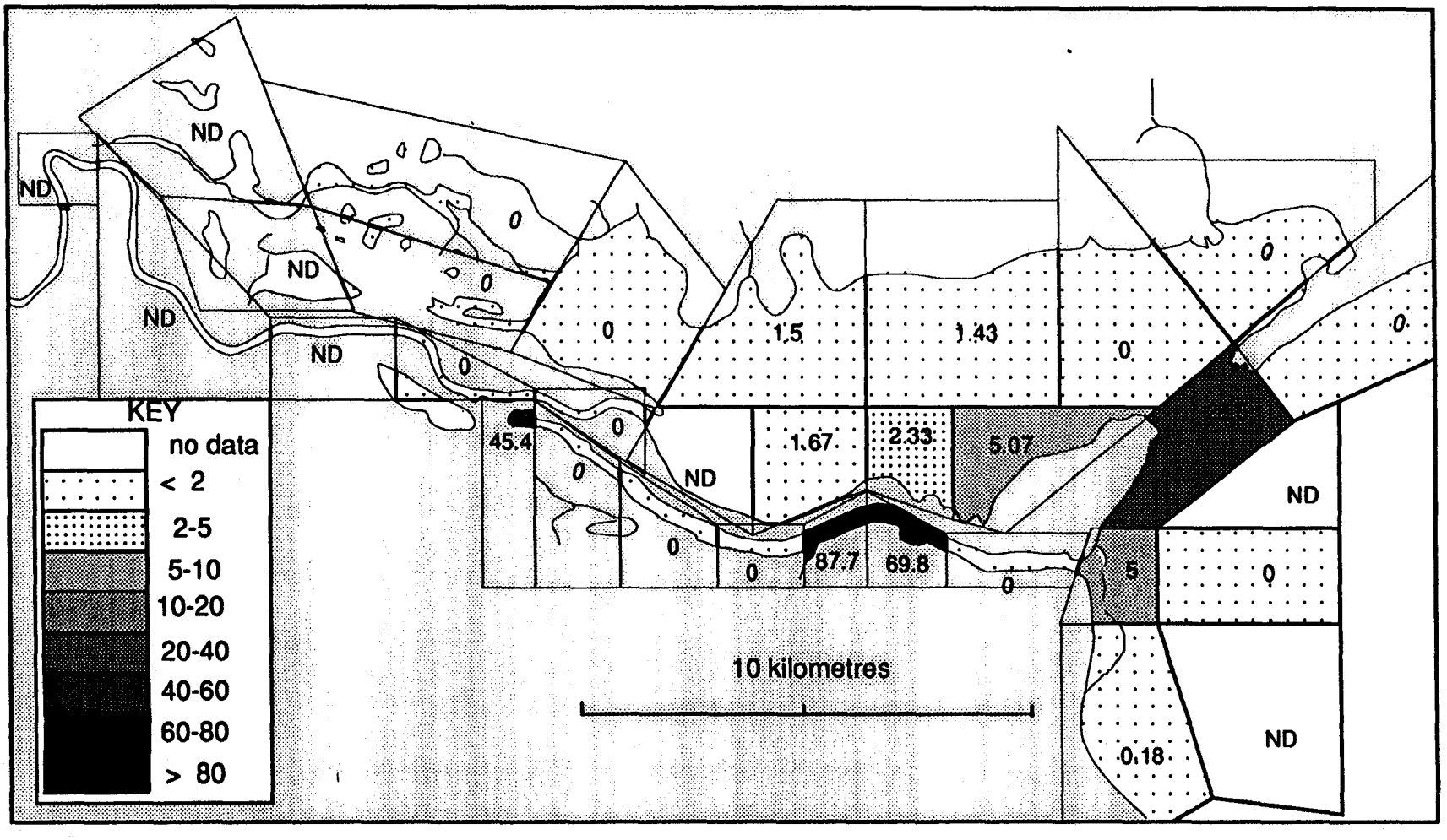


Figure 7-43. Period-of-record means of SED-PCB for Nueces Bay region, including Inner Harbor

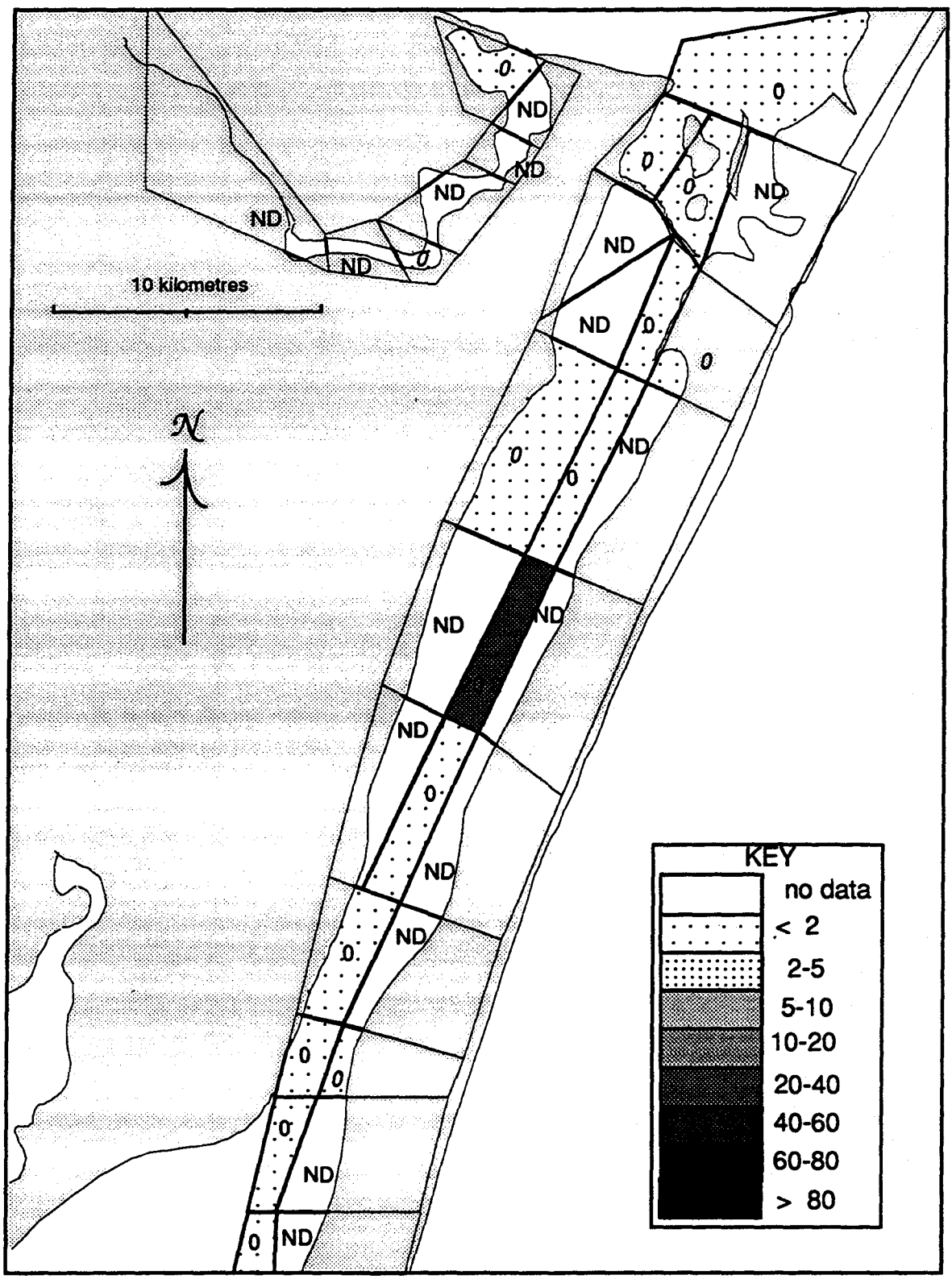


Figure 7-44. Period-of-record means of SED-PCB for Upper Laguna Madre and Oso Bay

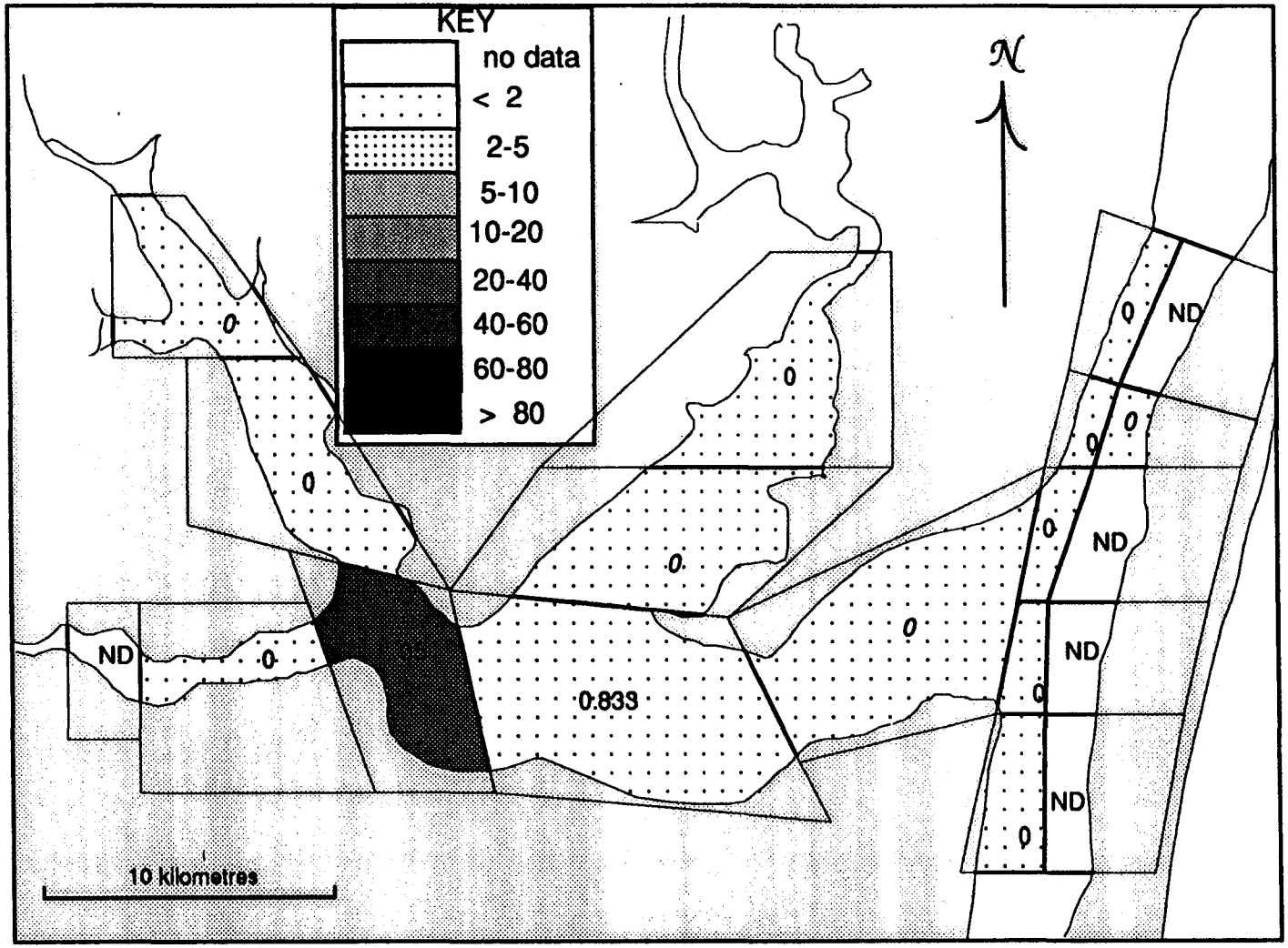


Figure 7-45. Period-of-record means of SED-PCB for Baffin Bay region

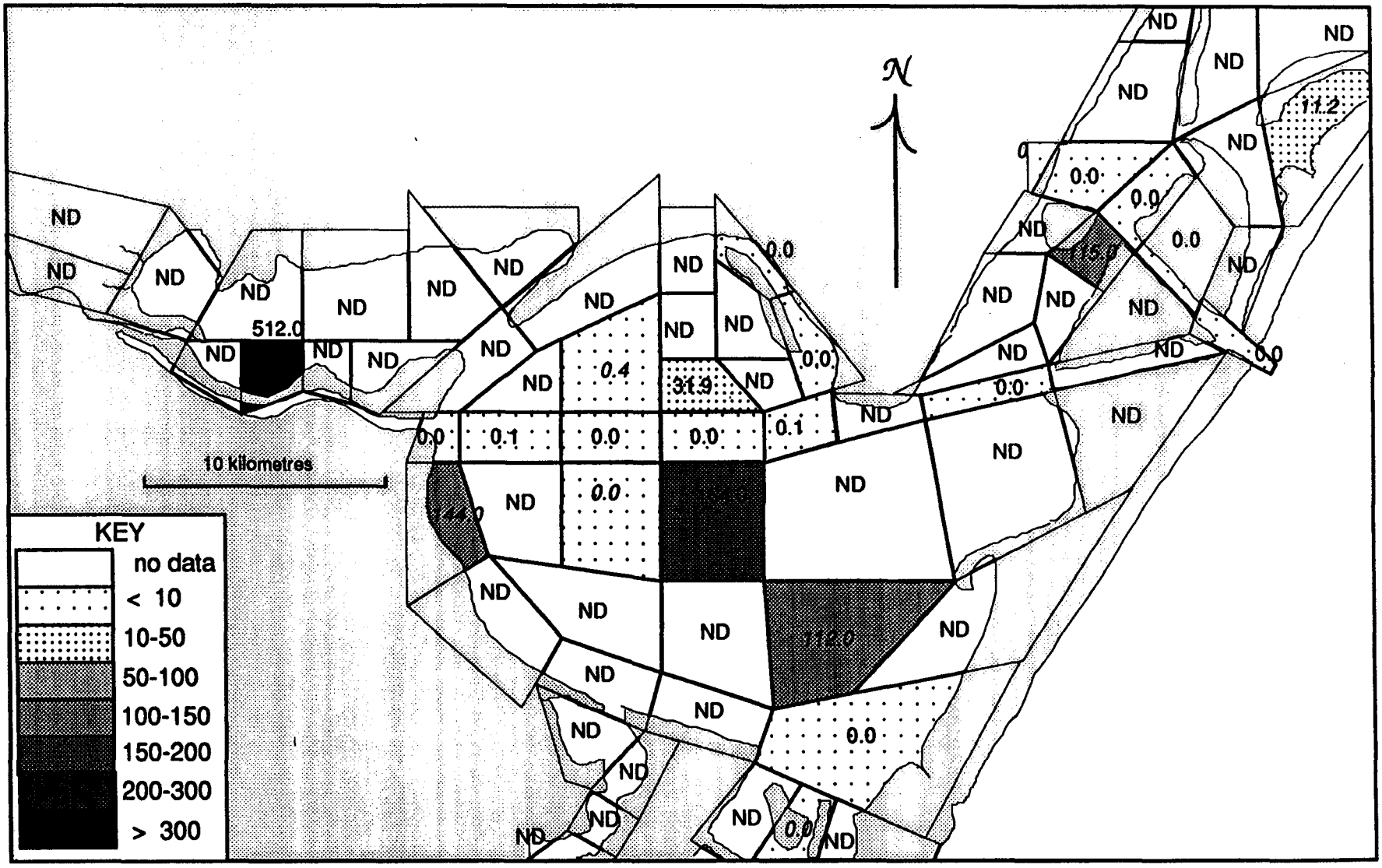


Figure 7-46. Period-of-record means of SED-PAH for Corpus Christi system

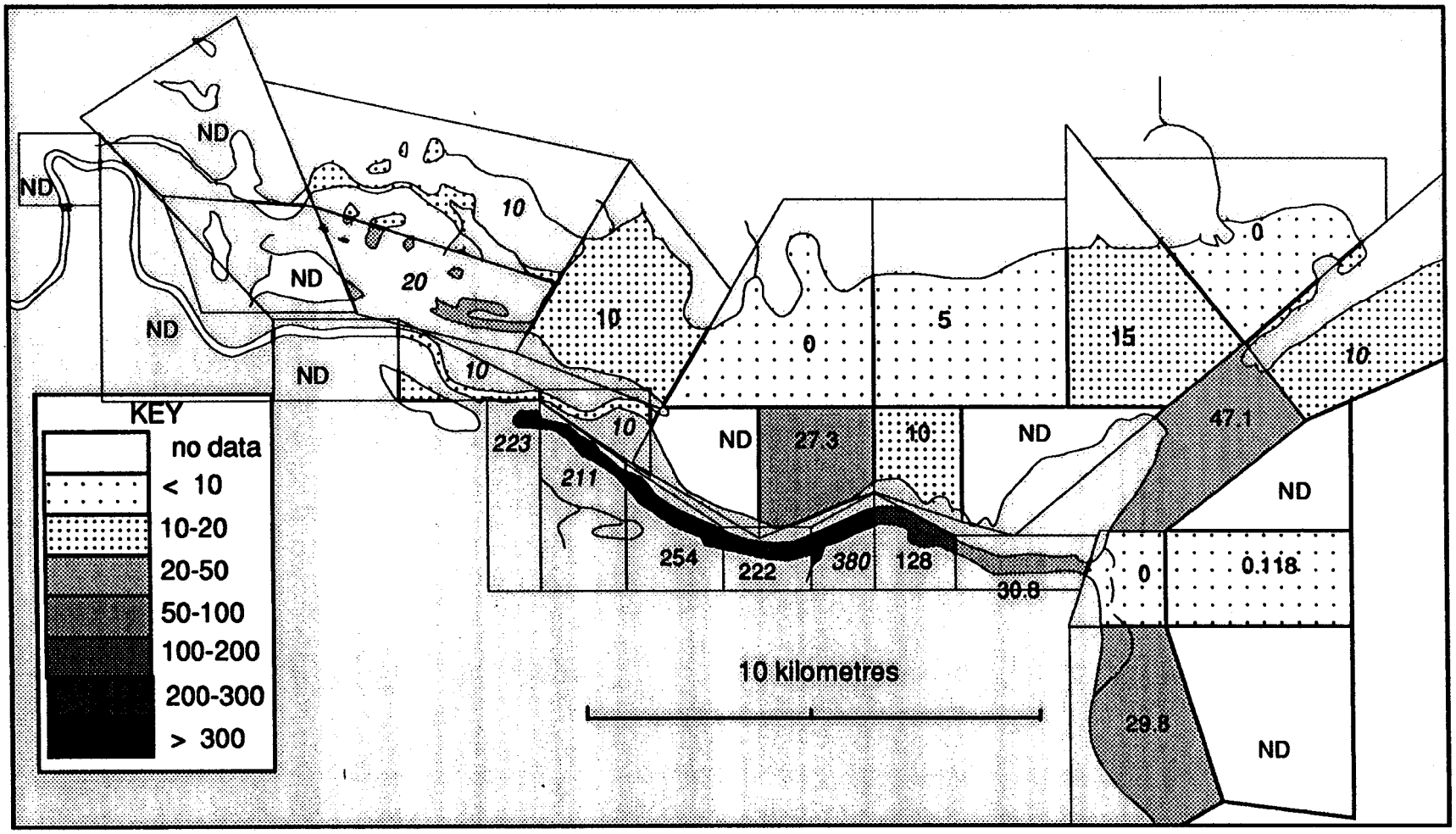


Figure 7-47. Period-of-record means of SED-BNZA for Nueces Bay region, including Inner Harbor

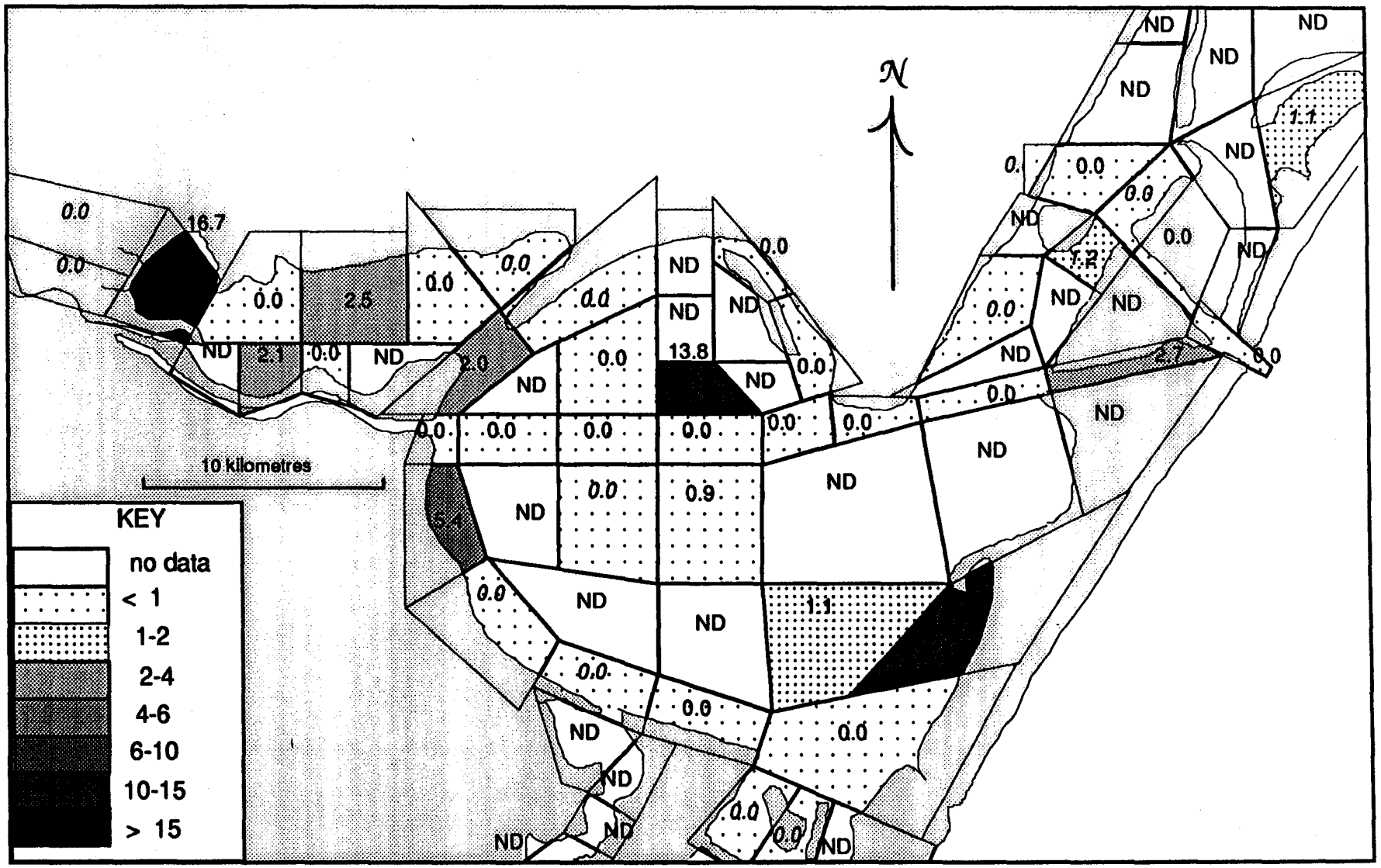


Figure 7-48. Period-of-record means of SED-NAPT for Corpus Christi system

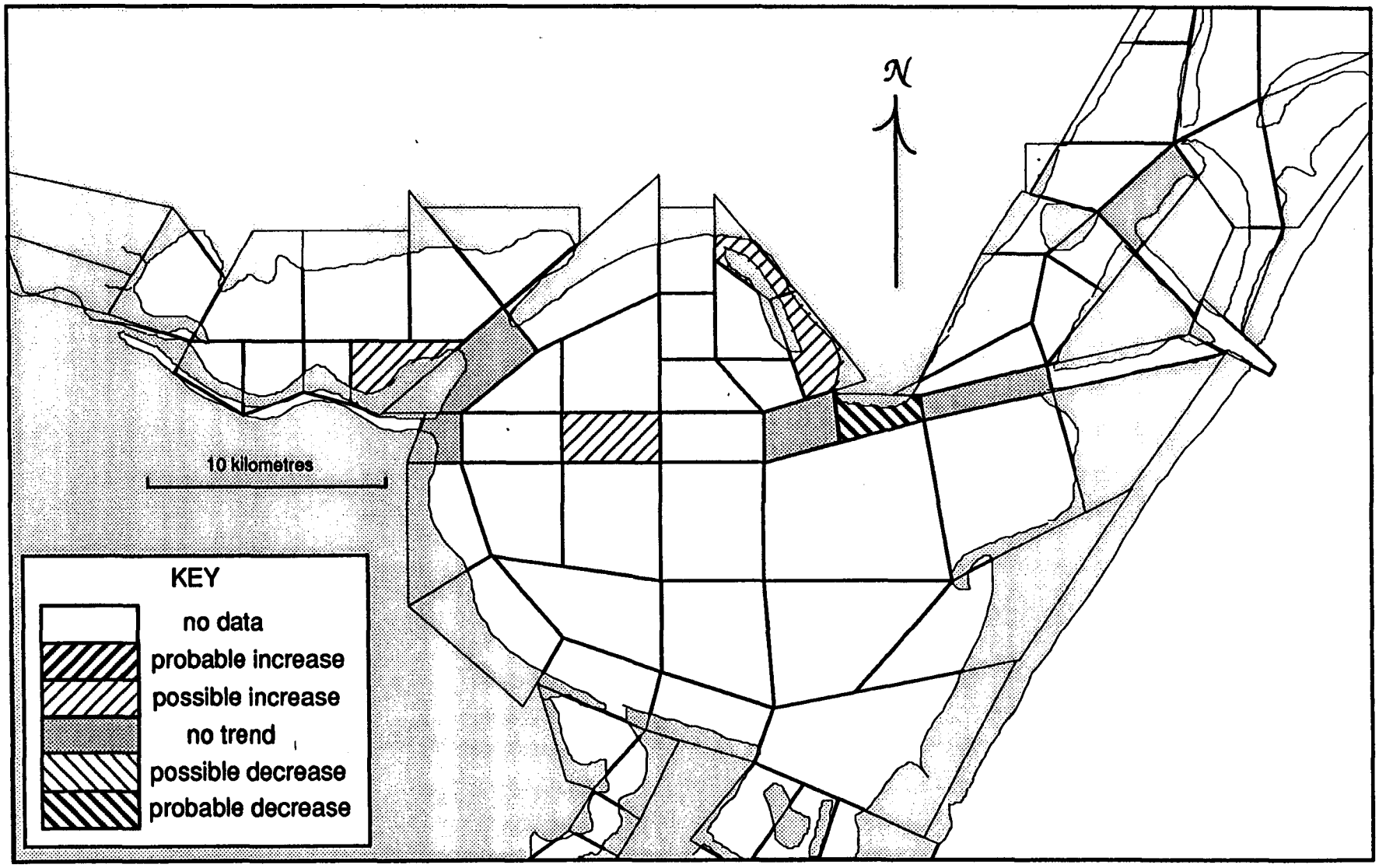


Figure 7-49. SEDKJLN period-of-record trends for Corpus Christi system

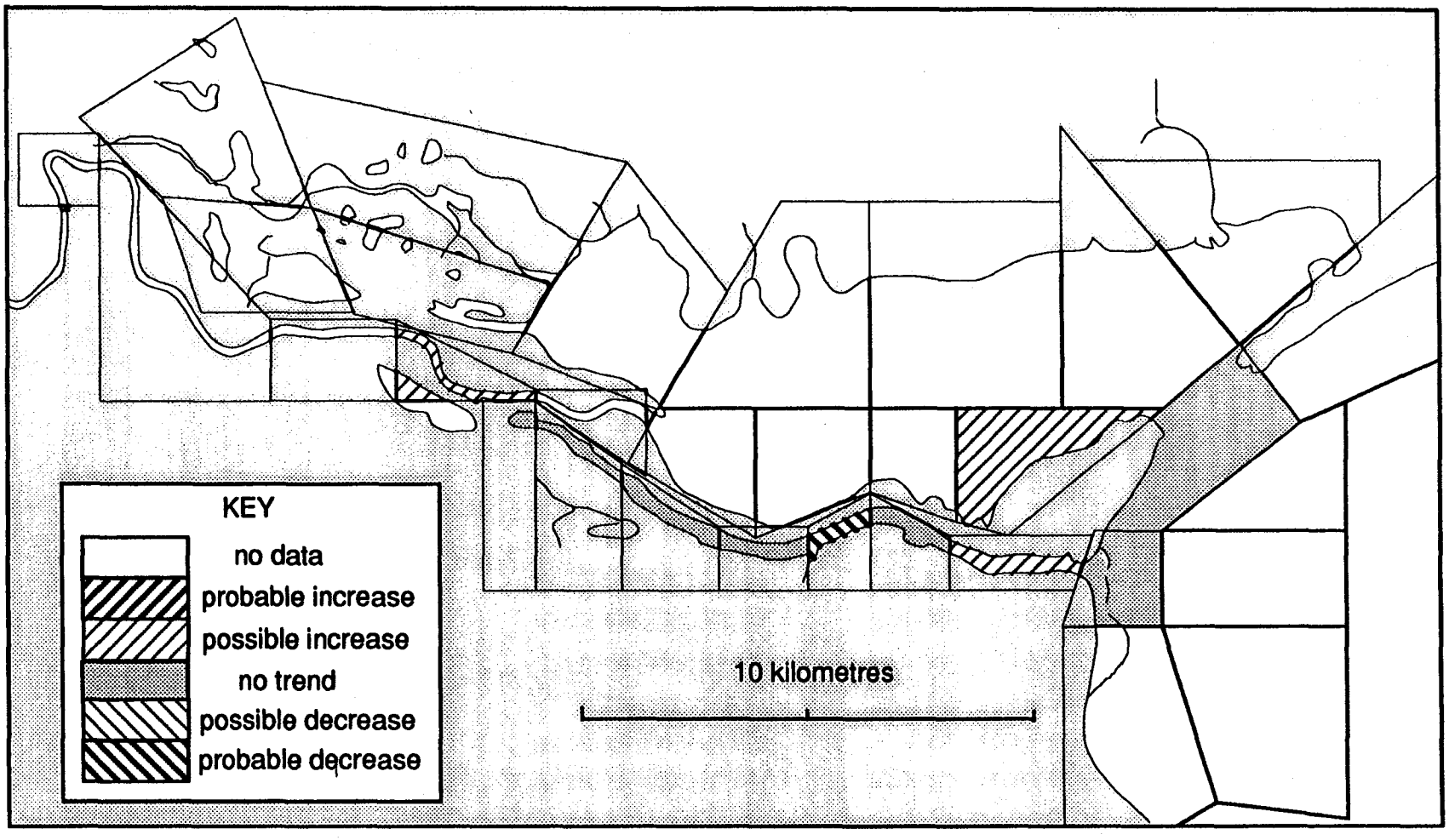


Figure 7-50. SEDKJLN period-of-record time trends for Nueces Bay region, including Inner Harbor

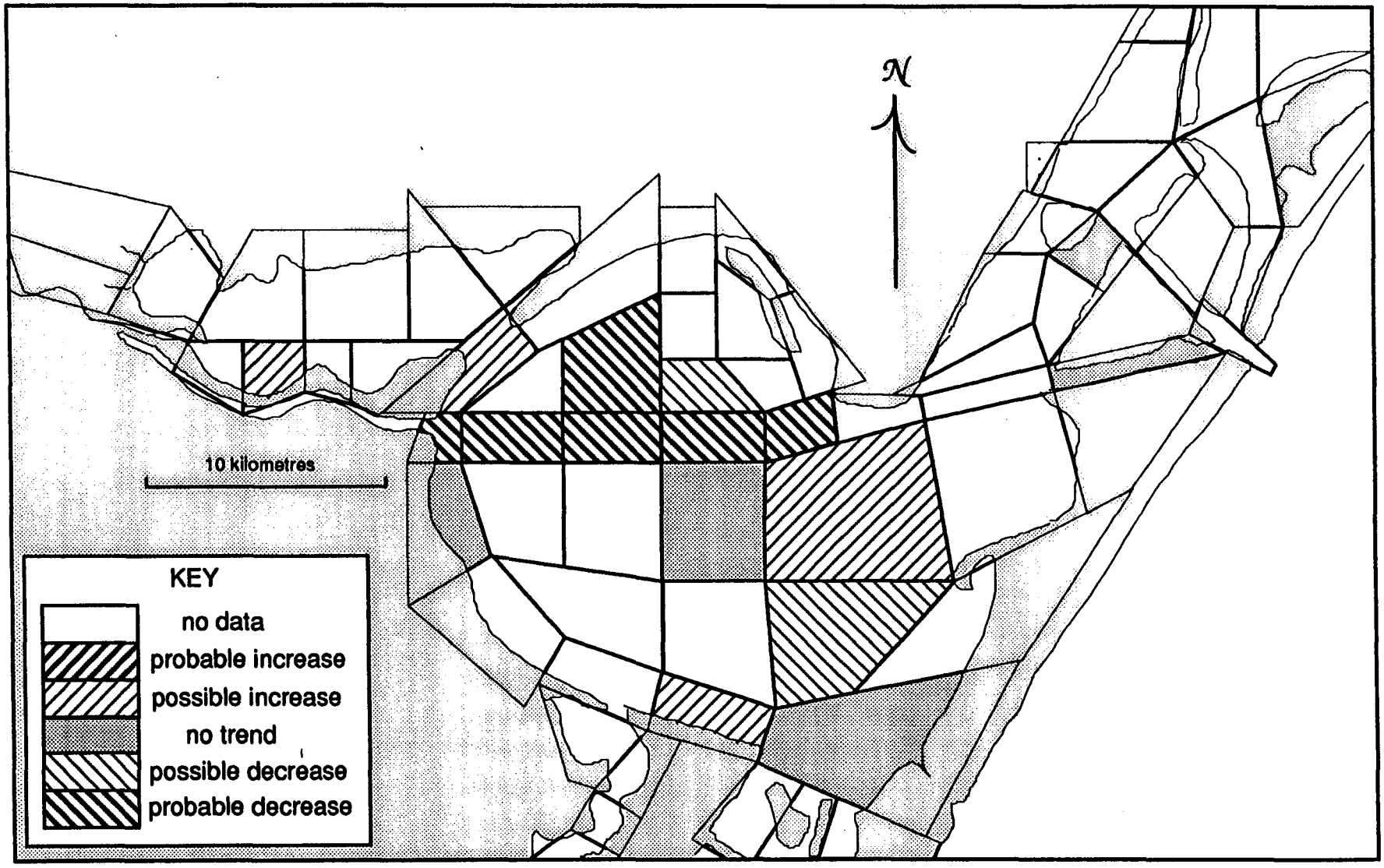


Figure 7-51. SEDTOC period-of-record trends for Corpus Christi system

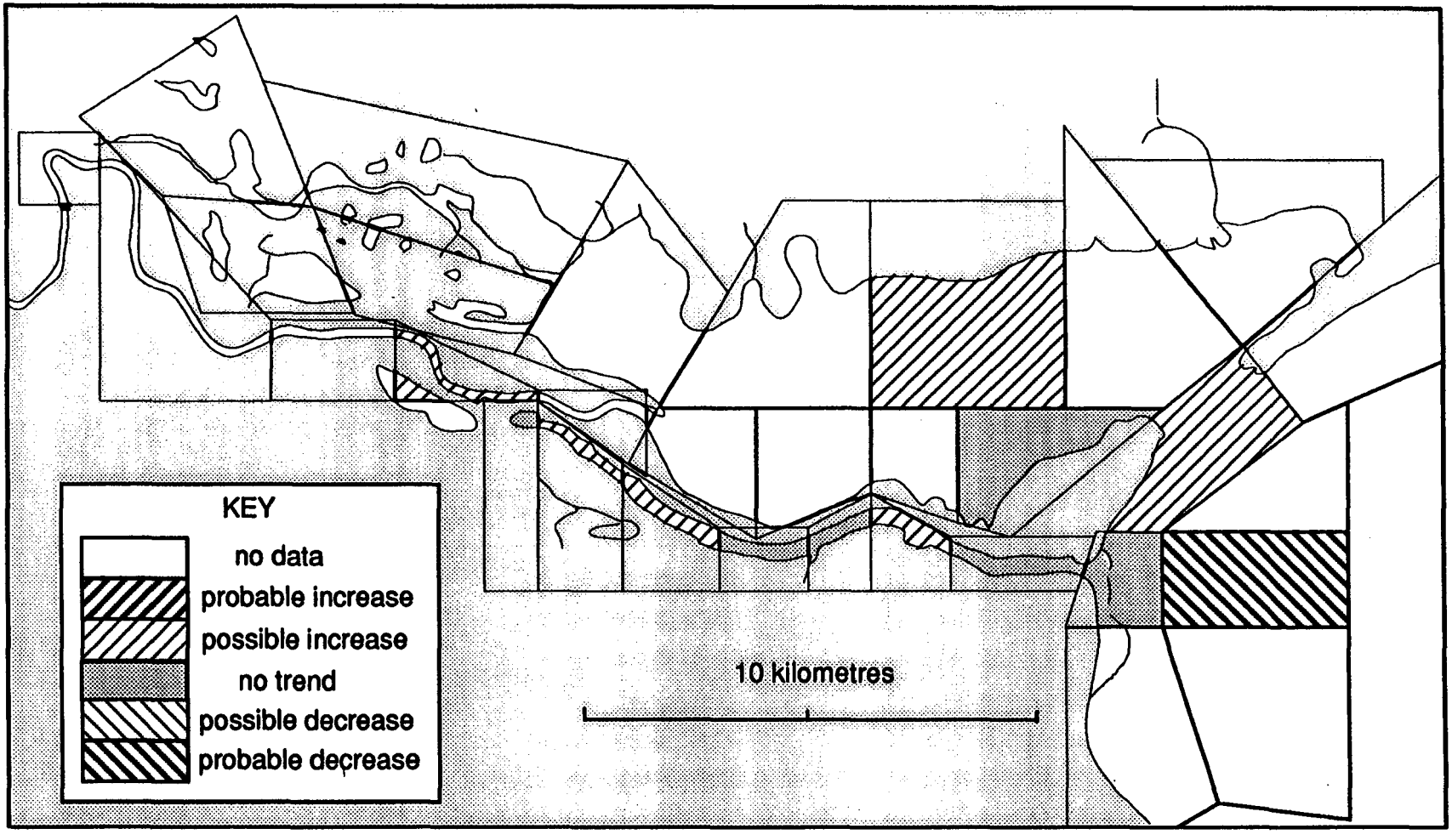


Figure 7-52. SEDO&G period-of-record time trends for Nueces Bay region, including Inner Harbor

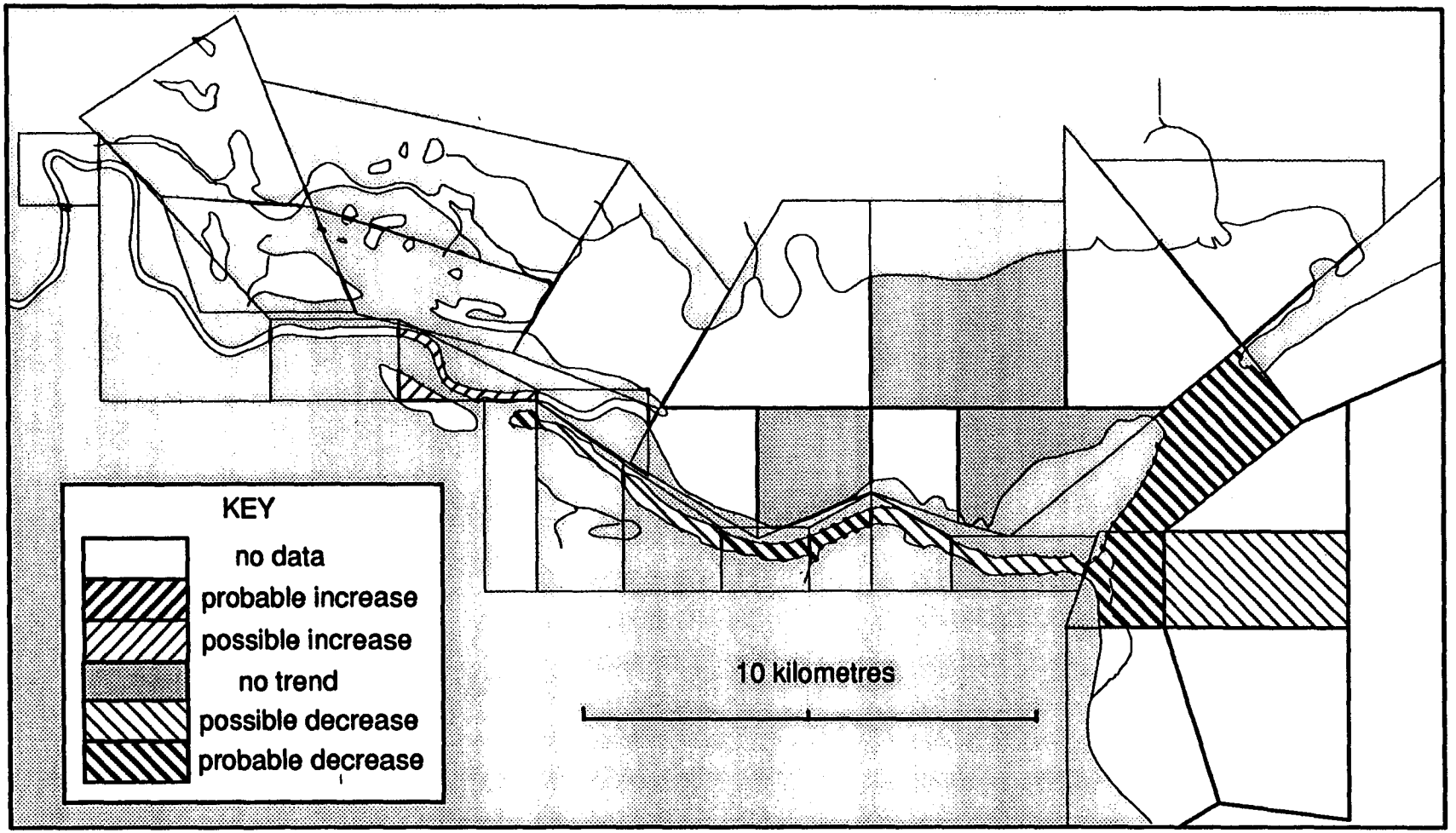


Figure 7-53. SEDMETCD period-of-record time trends for Nueces Bay region, including Inner Harbor

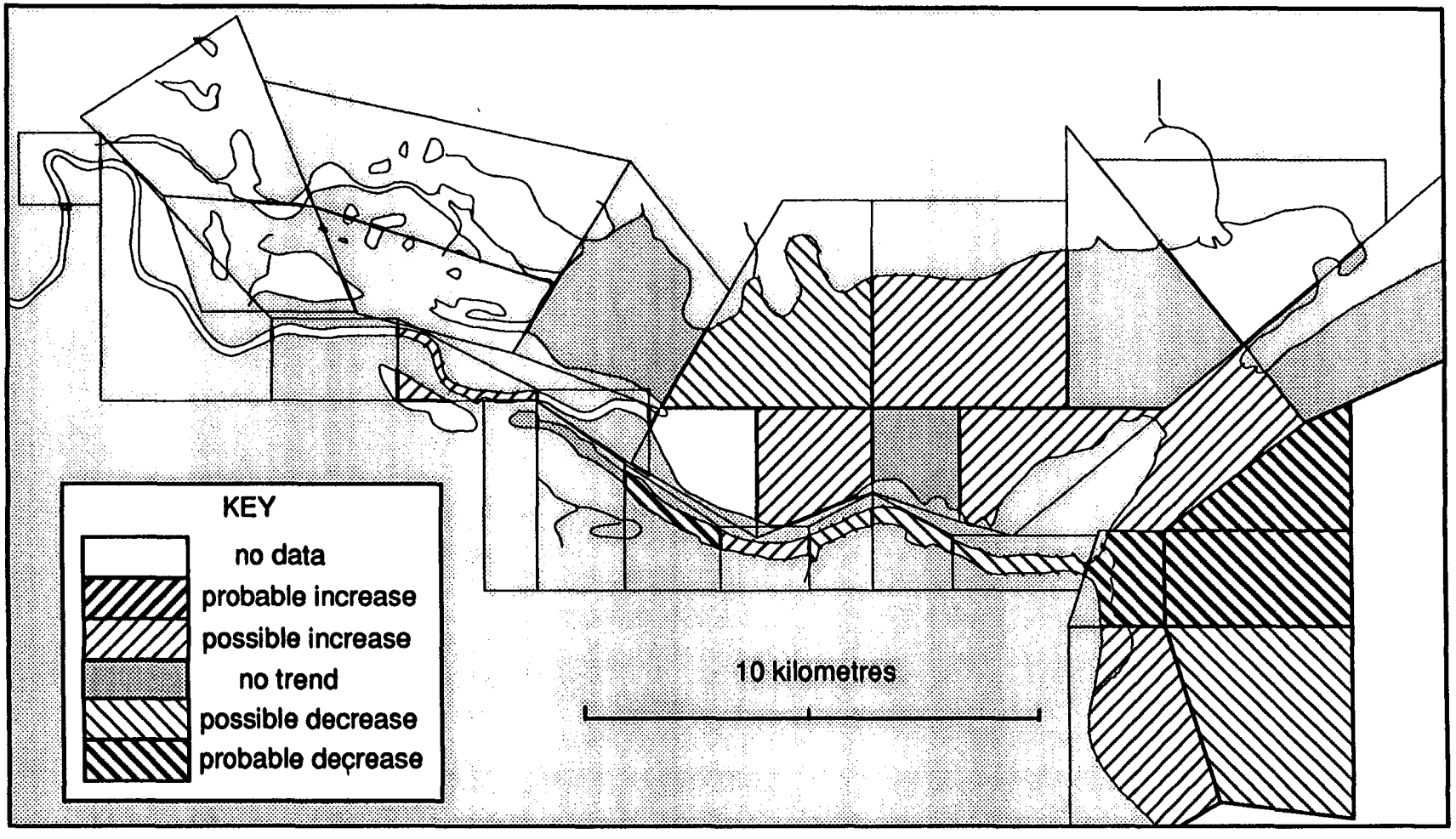


Figure 7-54. SEDMETCU period-of-record time trends for Nueces Bay region, including Inner Harbor

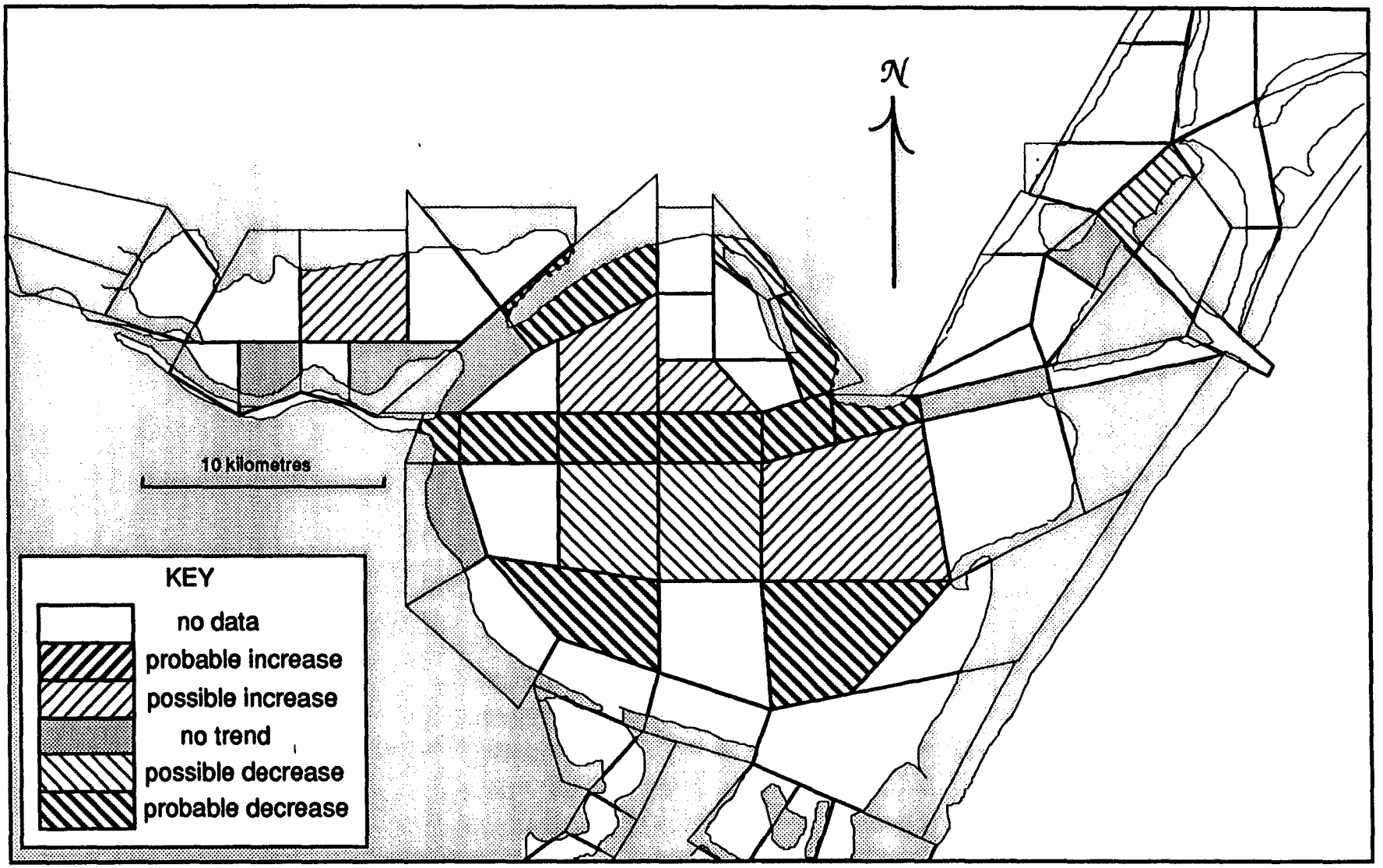


Figure 7-55. SEDMETHG period-of-record trends for Corpus Christi system

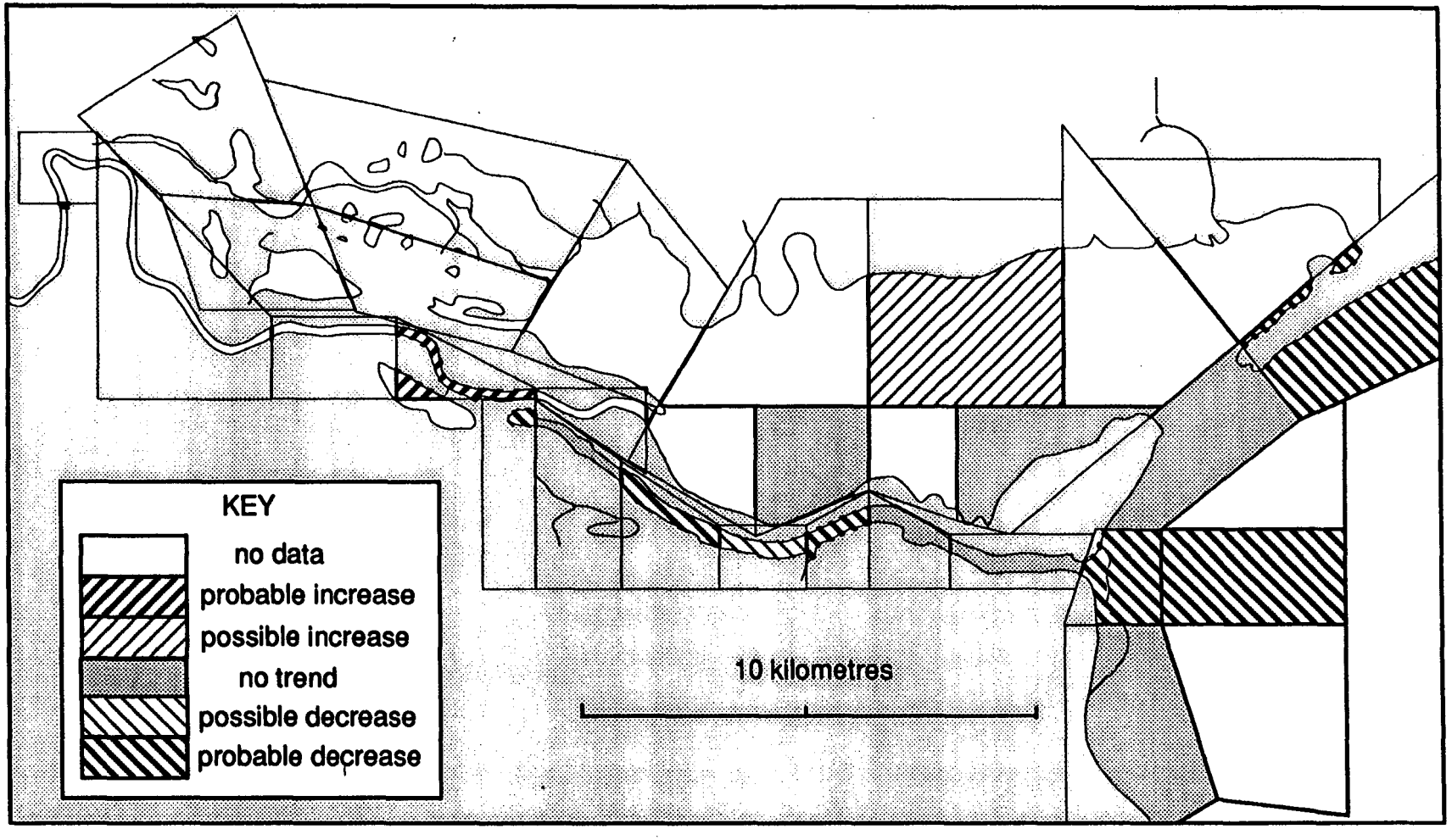


Figure 7-56. SEDMETHG period-of-record time trends for Nueces Bay region, including Inner Harbor

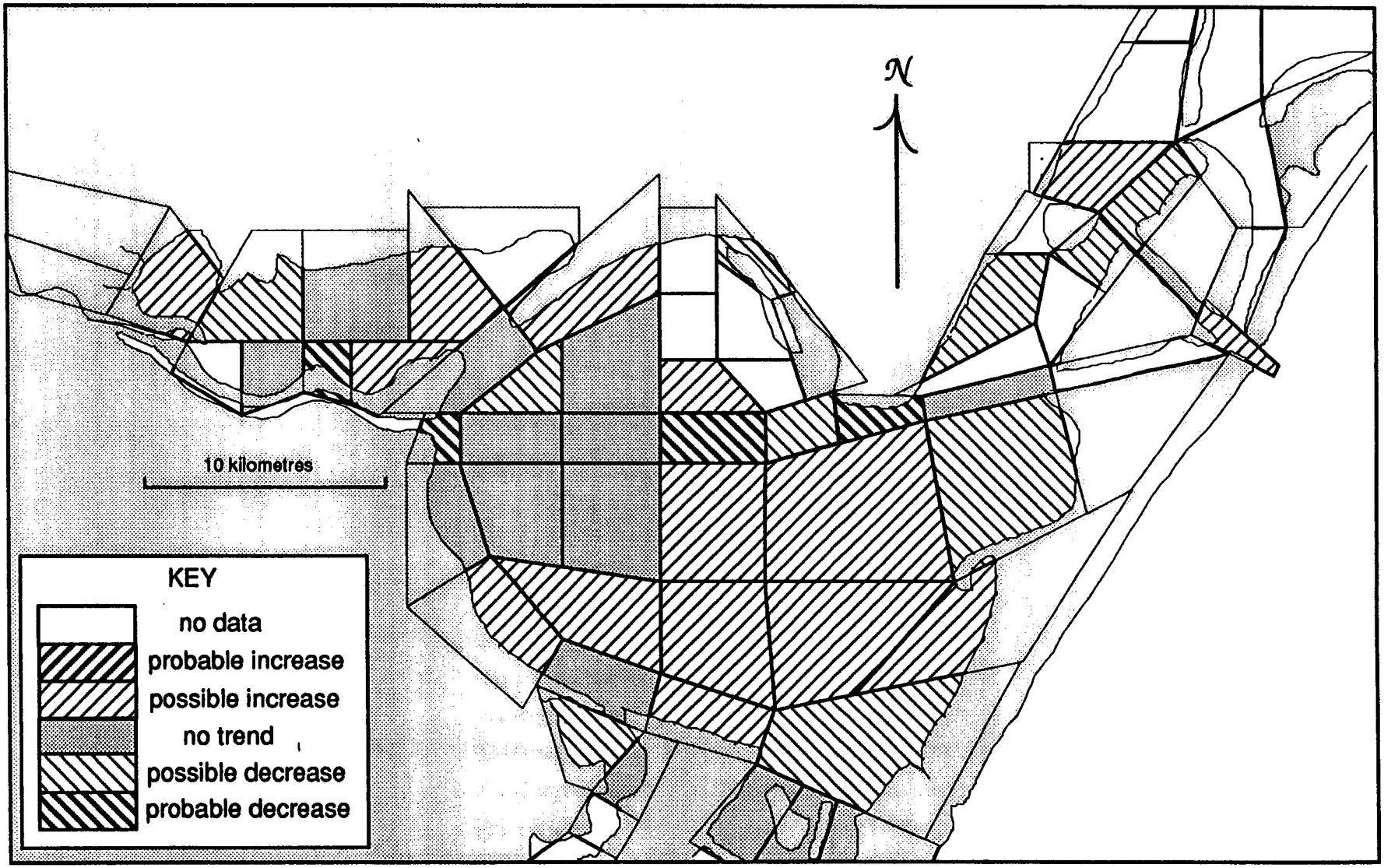


Figure 7-57. SEDMETZN period-of-record trends for Corpus Christi system

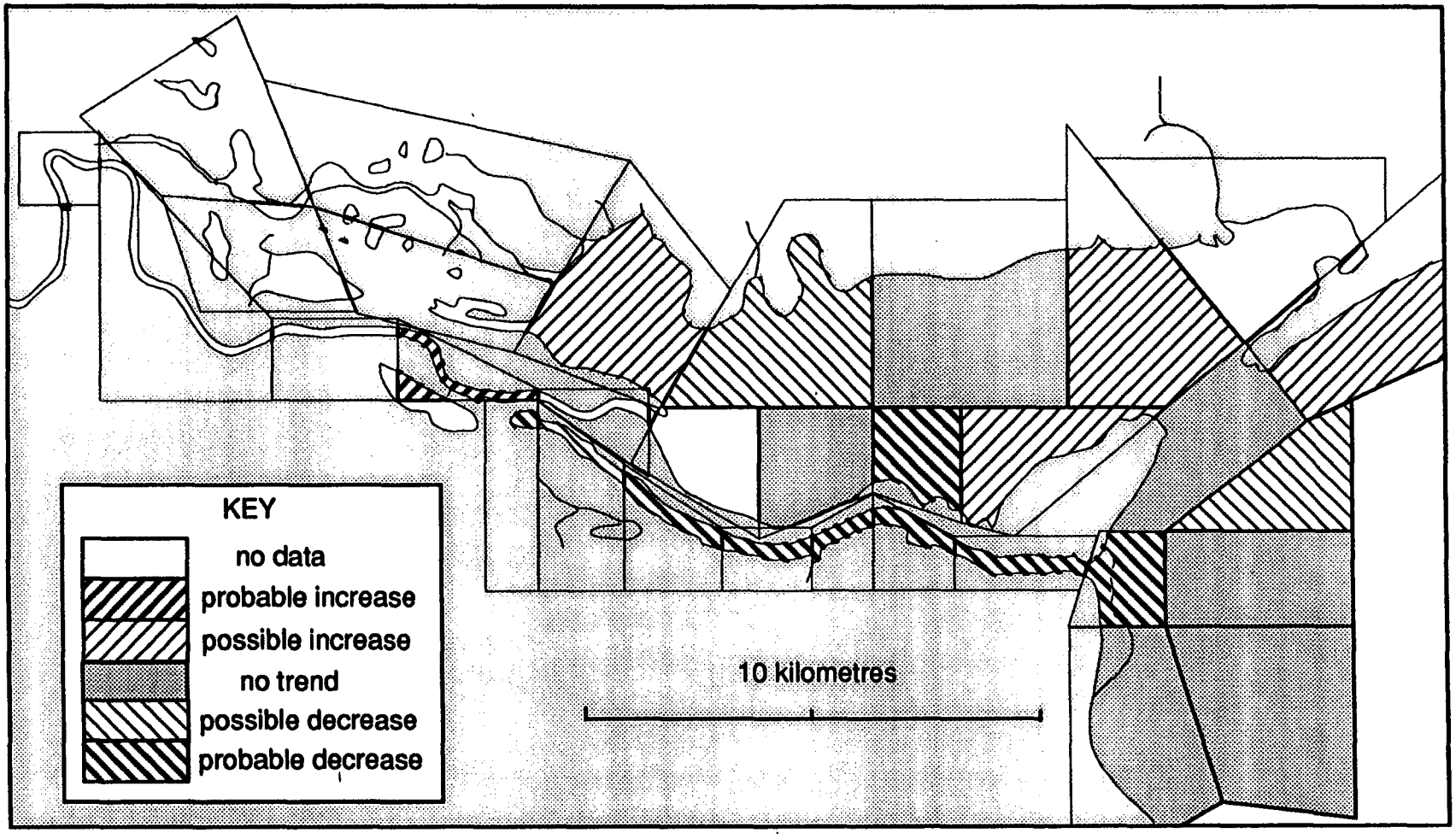


Figure 7-58 SEDMETZN period-of-record time trends for Nueces Bay region, including Inner Harbor

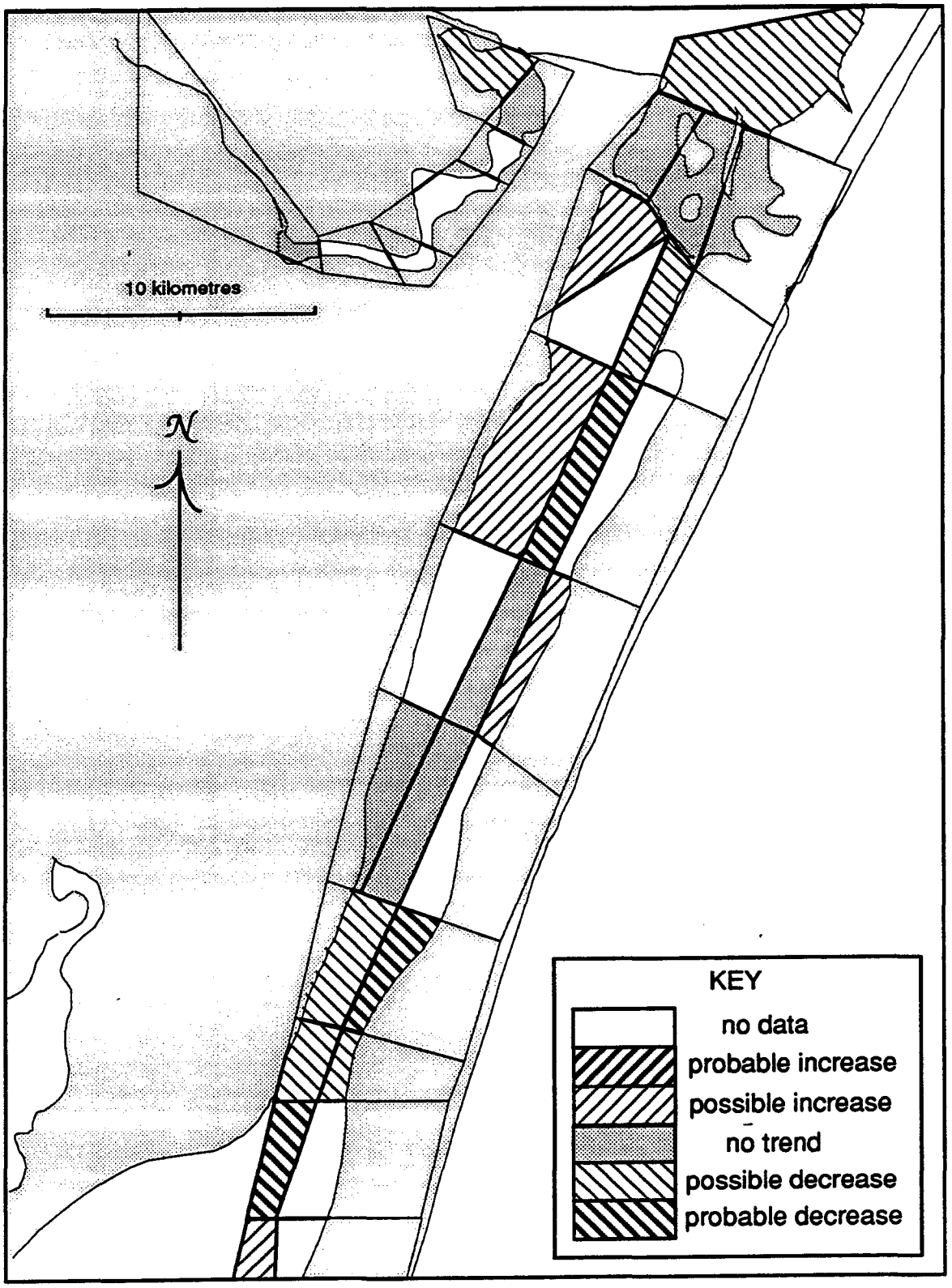


Figure 7-59. SEDMETZN period-of-record trends for Upper Laguna Madre and Oso Bay

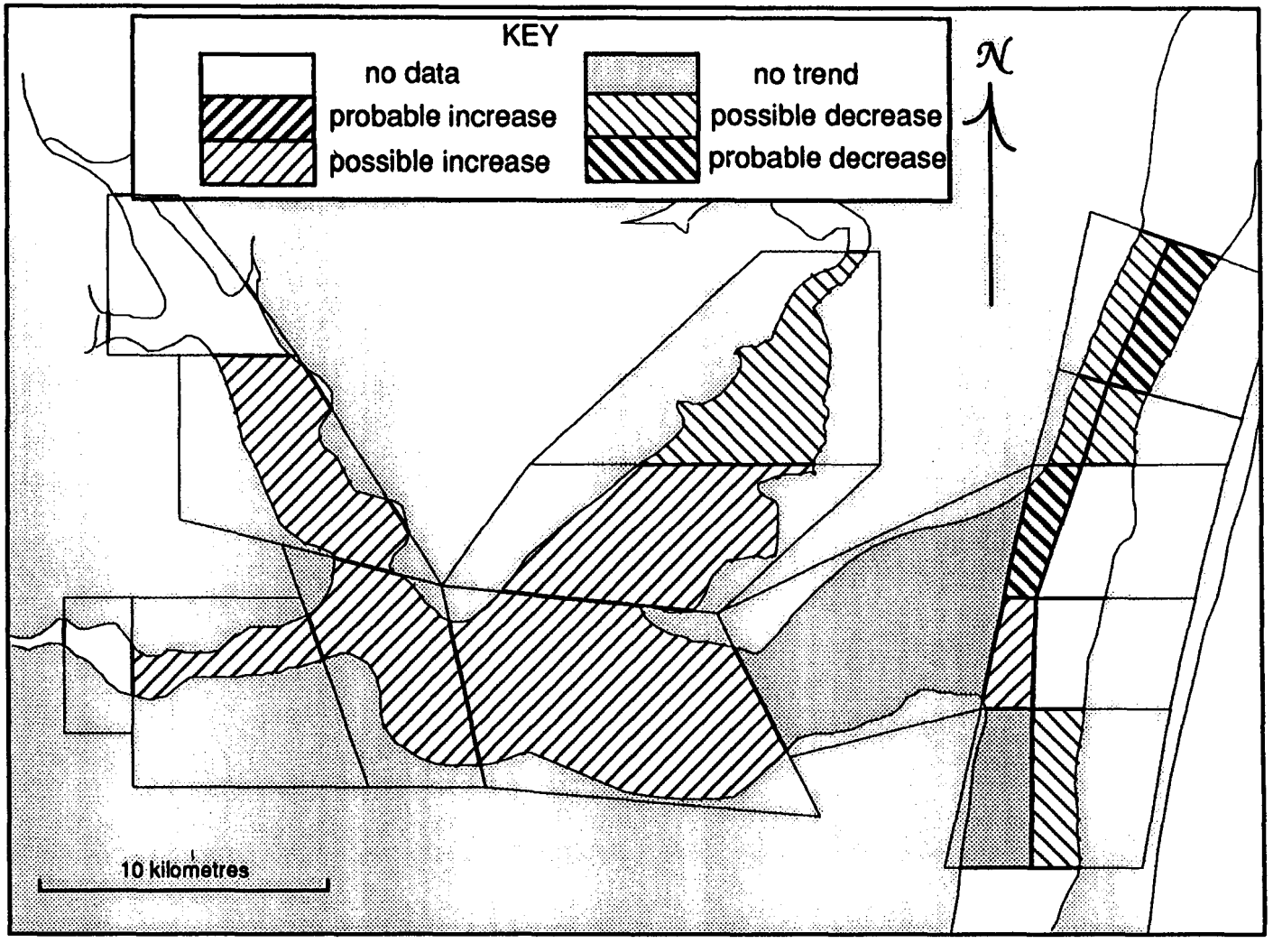


Figure7-60. SEDMETZN period-of-record time trends for Baffin Bay region

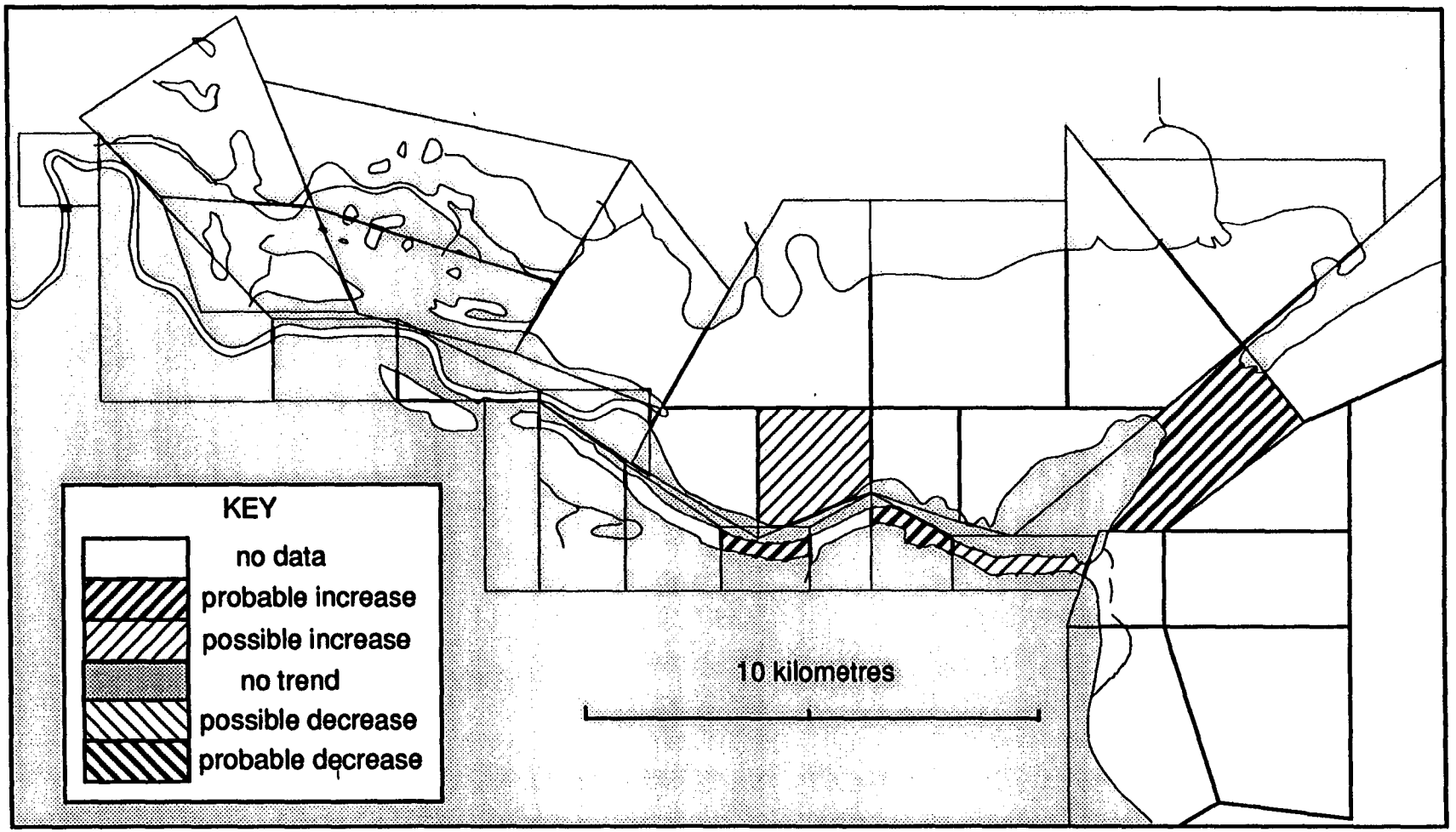


Figure 7-61. SED-BNZA period-of-record time trends for Nueces Bay region, including Inner Harbor

7.2 Observations

In one respect, the example statistical summaries of Tables 7-2 through 7-5 are misleading. This is that they give the impression that sediment data is widely available throughout the study area. In fact, among the conventional parameters, TOC (SEDTOC, Table 7-2) comprises the largest data base, and among the metals, zinc (SEDMETZN, Table 7-3) comprises the largest data base. For almost all of the other parameters, the spatial distribution of data is much sparser. For time-trend analysis, we require at least three measurements in order to perform a statistical analysis. Therefore, for those segments with only one or two measurements in the historical period of record, no time-trend results are presented. Consequently, the time-trend data are even sparser than the data for mean concentrations. The number of blank entries in Tables 7-4 and 7-5 are testimony to this. Of course, basing a time-trend inference on merely three data points in the period of record is aleatory in itself, statistical measures of confidence notwithstanding. Only if there is some degree of spatial coherence in the time-trend results do we feel justified in accepting its reality.

One would expect most of the conventional organic constituents in the sediment, e.g. total phosphorus, oil & grease, Kjeldahl nitrogen, and volatile solids, to correlate with the corresponding water analytes and to exhibit the same general pattern, particularly as elevated values in those regions loaded in waste discharges and runoff. This is not generally the case, however. Sediment ammonia (SEDAMMN) and Kjeldahl nitrogen (SEDKJLN) are systematically elevated in the Inner Harbor, Fig. 7-2, as is the corresponding water analytes. However, the highest concentrations in the system of SEDKJLN are found in Baffin Bay, Copano Bay and (especially) the King Ranch reach of the Laguna, Table 7-6, notably in Segment I12 (the same region that shows elevated water analyte values WQAMMN, see Table 6-2). For phosphorus, it will be recalled (e.g., Fig. 6-64) that there is a fairly systematic variation in the study area, with the lowest values of the water analyte in the main body of Corpus Christi and Aransas Bays, higher values in Baffin, Nueces and Copano, and the highest values in the system in the Inner Harbor. In the sediments, in contrast, there appears to be a fair degree of homogeneity throughout the study area, with somewhat *lower* values in the Inner Harbor. For TOC the contrast is even more striking. In the water column, TOC concentrations generally decrease southward across the study area in the main bays, from Copano to Baffin, see Fig. 6-66, the exceptions being depressed values in Nueces Bay, and much larger values (about an order of magnitude) in the Inner Harbor, Fig. 6-39. This is not the pattern for sediment concentrations, however. Instead, the *lowest* values of sediment TOC occur in the Inner Harbor, and the concentrations seem to *increase* southward across the study area, see Table 7-6 and Figs. 7-5 through 7-8. Nueces Bay in sediment as well as water evidences depressed values of TOC relative to the rest of the study area. Also, water- and sediment-phase TOC agree in showing higher values of the estuaries compared to the adjacent Gulf of Mexico, cf. Figs. 6-66 and 7-9. Curiously, the highest sediment concentrations of both oil & grease (SEDO&G) and volatile solids (SEDVOLS) occur in the Mesquite Bay area, Table 7-6. Recall that the GIWW segments are not included in the

Mesquite Bay definition, because they may be subject to nonrepresentative effects due to their proximity to land as well as channelization activity, so these elevated values of SEDO&G and SEDVOLS reflect only the open-water areas of this region.

For the metals, Table 7-7 and Figs. 7-14 through 7-39, the general statement can be made that the highest values, often by an order of magnitude, are found in the Inner Harbor sediments. The sole exception among the metals of Table 7-7 is nickel, for which the Inner Harbor concentrations are indeed elevated, but so also are those in the open bay areas of Corpus Christi, Baffin and Copano. This observation is in decided contrast to the case of water analytes, for which the Inner Harbor metals data is not particularly prominent, see Table 6-26. If one looks beyond the fact that the Inner Harbor dominates sediment metals, and examines the distribution in the remainder of the study area, Baffin and Copano are seen to be consistently high in metals concentrations. This is especially obvious for arsenic, cadmium, chromium, copper and nickel; it is interesting to note that this is also indicated in the water analytes of Table 6-26 (except for lead, whose concentrations in Copano are low). For specific metals, there are other regions of high concentration. Chromium is high in Corpus Christi Bay, copper in the offshore Gulf of Mexico (Fig. 7-25), mercury in Mesquite Bay, lead in Corpus Christi Bay and the Gulf of Mexico. There are also two regions of the study area that seem to have consistently elevated concentrations for most of the metals, namely Nueces Bay and the Upper Laguna, both adjacent to the Causeway and in the King Ranch reach. With respect to Nueces Bay, it should be noted that the definition of the Nueces Bay component as shown in Table 7-7 (and 6-26) excludes segment NB7 because it would not be representative of the open areas of Nueces Bay, yet this segment registers some of the highest average concentrations of metals in the system, apart from the Inner Harbor.

As was the case with water quality, the data base for complex organics is even more limited, due primarily to the small number of measurements but also because many are below detection limits (though not as great a proportion as with the water analytes). Table 7-8 summarizes the principal pesticides, as well as total PCB's. For all of the pesticides shown in this table, the highest concentrations, sometimes by an order of magnitude, are found in Baffin Bay. Almost equally high are those in Copano Bay, except for chlordane, dieldrin and DDT which are elevated nonetheless. In contrast, the concentrations of sediment pesticides in Nueces Bay are not especially high, except for toxaphene. PCB's follow a very different distribution, with very high concentrations (as expected) in the Inner Harbor, see Fig. 7-43, and with (unexpectedly) high concentrations in Redfish Bay. The high correlation of the sediment DDT in Baffin Bay (Fig. 7-42) with sediment PCB's (Fig. 7-45) raises the question of whether the latter may be an artifact due to misattribution of GC-MS peaks due to pesticides.

PAH's follow a very different distribution. First, and expectedly, the Inner Harbor dominates the concentrations of most of the PAH's, see Table 7-9. Second, there are also consistent elevated concentrations of some of the PAH compounds in Nueces Bay, Copano Bay, and Mesquite Bay. There is very little data on TBT's, and, as shown in Table 7-9, little can be said about their spatial distribution.

The paucity of good sediment records in the Corpus Christi Bay study area is especially demonstrated by the widespread lack of sufficient data to support a determination of trends. For conventional parameters, only a handful of trend results are available, as shown by Tables 7-10 through 7-14. A tendency for declining nitrogen in Corpus Christi Bay and the Inner Harbor (Table 7-10) is consistent with the declining trends determined for water-phase nitrogen (Tables 6-44 and 6-45). Similarly, the identifiable trends in sediment TOC, Table 7-12, are declining, consistent with the results for the water column, Table 6-51, cf. Fig. 7-51 and 6-104.

For metals, the data base allowing trend determinations is somewhat better than that for conventional parameters, Table 7-15 through 7-21. For the Inner Harbor, which was found to be the site of greatest metals concentrations, a probable declining trend is consistently indicated. Other trends throughout the system vary depending upon the specific metal, see Figs. 7-53 *et seq*. It is noteworthy that for Copano Bay, which shows among the highest concentrations in the study area (apart from the Inner Harbor) for chromium and nickel, also exhibits increasing probable trends for these metals, as well as for copper and zinc. Otherwise, in the principal components of the system, where a trend can be reliably established in a sediment metal it is generally declining. One exception is with sediment zinc, for which widespread *possible* increasing trends are indicated in large areas of the open waters of Corpus Christi Bay (Fig. 7-57) and Baffin Bay (Fig. 7-60). The widespread coherence in this pattern over many segments argues for attaching more importance to it than would be normally ascribed to a single segment.

On a baywide basis, little can be said about trends in organics, because the data base is so limited. Only one pesticide trend is evident, declining SED-XDDT in Copano. PCB's are highest in the Inner Harbor and do not evidence a trend, Table 7-23. BaP (SED-BNZA) is highest in the Inner Harbor and in Nueces Bay, and is trending upward in both areas, the former being a probable trend, see also Fig. 7-61.

8. TISSUE QUALITY

To include the acquisition and analysis of tissue data as a part of the present investigation has a certain logical appeal, in that most of the agencies engaged in the collection of tissue chemistry data are also those from which water/sediment chemistry data were sought, and in that some association might be expected of elevated body burdens in an organism with ambient sediment and water concentrations in the habitat of that organism. One might expect therefore that incorporating compilation and analysis of tissue data into the present project could potentially yield additional insight into the ambient environment of Corpus Christi Bay without substantially increasing or diverting the project effort. Unfortunately, both of these expectations proved false.

First, for all of the agencies that routinely acquire tissue data, that data is managed differently from the water and sediment chemistry data. Therefore, these data sets required special handling different from that of the water or sediment data. Second, for a specific chemical parameter, there is a greater range in what is measured and how it is reported in the tissue phase compared to water or sediment, and there is a corresponding lack of consistency among agencies (and sometimes within the same agency). This aggravated the compilation problems, and led to lack of intercomparability from data source to data source, and therefore a reduction in statistical inference power. This chapter summarizes this part of the effort and its results. Because this data proved to be sparse, noncomparable, and generally inconclusive—in short, more trouble than it was worth—this chapter is brief. Reference is made, however, to a companion CCBNEP report by Jensen et al. (1996) that uses these data to evaluate public health risks.

8.1 Tissue Data and its Compilation

Tissue body burden of a specific chemical or element is determined by first acquiring an organism from the estuary, excising a portion of that organism, mechanically homogenizing the excised portion, and performing a chemical analysis using generally the same protocols and analytical methodologies (see Section 2.6) as employed in a sediment or solids sample. The ultimate purpose of such analyses may be either (1) to determine flux of specific compounds or elements through the food chain; (2) to establish whether there is a public health risk entailed by consumption of that organism. Which objective is intending informs the entire procedure, from the initial organism to be sampled to the compounds chosen for analysis and how the results are presented. All of this entails a great range of variation in the nature of the data. Options are:

- element or chemical compound for analysis

- selection of organism:
  - one individual
  - multiple individuals
    - same species
    - various species

- organism portion to be analyzed:
  - whole organism
  - specific organ
  - edible portions ("filet")

- reporting convention:
  - wet-weight concentration
  - dry-weight concentration

There were no instances encountered in this compilation of analyses performed on specific organs, such as livers. Our data fell into the categories of either whole-organism or edible-portions ("filet"). For oysters, the two are equivalent: there was no instance encountered in which analyses was reported on an entire oyster, shell and all. There were a few instances (in the TNRCC SMN data base) in which tissue data were reported based upon a composite (probably a purée) of individuals of more than one species (the names of which were not noted). These data were not used in the present compilation. However, a scattering of analyses of more than one individual of the same species were reported, and were included in the compilation.

A wide range of chemical parameters were encountered. At the outset, we retained data for all of the chemical parameters in the data compilation, though it was clear that for most of them, the data resource was going to be too small to permit any reliable statistical analysis, particularly when further stratified in space and time. At a later stage, data sets that were simply too small to treat (i.e. one isolated measurement) were deleted. The exception was PCB's, in that we did not retain the individual PCB analyses, because there were too many that were non-interconvertible (reported by congenor number in some cases, Aroclor identifiers in others, and level of chlorination in yet other cases), instead retaining only the total-PCB determination. Table A-3 in the Appendix presents the complete list of chemical parameters retained in the tissue compilation.

For each chemical analyte, it is necessary to differentiate the organism sampled, whether the analysis was carried for the whole organism or filets, and whether the data is reported on a dry- or wet-weight basis. It should be noted that data from different organisms is fundamentally noncomparable. Accumulation of a compound in organism tissue is dependent upon the metabolism of the species, internal chemical transformation of the compound, activity of the species in a region of contamination, its activity in regions of noncontamination, its food sources and their respective exposures. Similarly, the concentration in the whole organism is fundamentally noncomparable to that in only the edible portion. The only two categories offering, in principle, a possibility of comparability are the wet-weight versus dry-weight reporting. These can be interconverted only if

separate reporting is made of the moisture content of the tissue sample. Incredibly, most of the agencies providing tissue data do not report (and apparently do not analyze) tissue moisture content.

The same basic data structure was employed in the master data base compilation of tissue data as used for water and sediment quality, as described in Section 4.1 above, and the processing steps were basically the same as presented in Section 4.2. As with water and sediment parameters, the parameter is given a unique abbreviation used in tabular output and in the naming of data files. These are given in Table A-3 in the Appendix. We differentiated between dry-weight and wet-weight data, and between whole-organism and filet analyses by the leading characters in the parameter name. The general format for tissue parameter abbreviations is:

TXparam

All tissue data parameters begin with the letter "T." The second character X is one of:

S	-	whole-organism, wet weight
F	-	filet (edible portions only), wet weight
D	-	filet, dry weight

The remainder of the name "param" is either made up of the prefix "MET" followed by the (1-2 character) chemical abbreviation for the element, in the case of elemental analyses, or a hyphen followed by the compound abbreviation, in the case of volatile organic compounds. For example, TF-DDT represents the wet-weight concentration of total DDT in the edible tissue of an organism. No data were encountered of whole organism concentrations in dry weight so no separate identifier was necessary. (Actually, the USF&WS did report such data, but also provided proportion of moisture, so the results could be converted to wet-weight.)

The same basic data-record format was the same as for water and sediment data, see Section 4.3. That is, each data entry represents a point in time (to resolution of a day) and space (horizontal position), together with the measurement of parameter concentration, in a 50-byte record. The format of each record in the Derivative Data Files is:

DATE LATITUDE LONGITUDE ORG MEASRMT UNCRNTY PRJ

where DATE, LATITUDE AND LONGITUDE are 6-digit fields (YRMODA and the latitude/longitude coordinates are degrees/minutes/seconds), the sample depth is in meters, and MEASRMT is the measured value of the parameter (retaining three significant figures). The place for measurement uncertainty UNCRNTY is held in the record, to be consistent with the water/sediment data format, but separate establishment of appropriate uncertainties for the parameters in the tissue data set was beyond the scope of this effort. The most important difference between the tissue data records and those of the water/sediment data is that the depth field is replaced by an "organism field." Clearly, the depth from which an organism is captured is totally meaningless as

any sort of explanatory or analytical variable (even if it were reported, which it is not). Therefore, this field is used to contain a code uniquely identifying the organism.

Organisms were identified by a two-digit code, presented in Table 8-1. It should be noted that some sampling agencies reported only a "common" name, without speciation. When we were confident of the species (e.g., blue crab or pink shrimp), the specific name was supplied, even if the sampling agency did not. In some cases, such as code 02 or 21, we have no idea.

A number of anomalies were encountered in the management of tissue data. These are detailed in the individual data-source reports in the accompanying report on the CCBNEP data base (Ward and Armstrong, 1997a), but it is useful to mention these here to give some indication of the effort necessary to put this data in a usable form. Probably, the two most important sources for tissue data were the TNRCC Statewide Monitoring Network and the Texas Department of Health, since both of these agencies have collected this sort of data for a number of years in the system. Other data sources included the OXYCHEM project in and around the La Quinta Channel, the Corps of Engineers, the NOS Status & Trends and Mussel Watch projects, and the EPA EMAP/REMAP project. Both of the last two federal projects maintain their tissue data in files in a completely different format than the water/sediment data, requiring separate retrievals and *ad hoc* de-coding and processing routines. Both the Corps and the OXYCHEM project had information in hardcopy only, that required manual keyboarding.

The entirety of the available tissue data from the TDH has been compiled into a hardcopy report. Despite the fact that this entailed a substantial keyboarding effort, there is no magnetic version of this data base. Therefore, this project had to manually keyboard the information from the hardcopy report (Ward and Armstrong, 1997a). Location of the organism collection site is given by state tract number. Each of these had to be individually identified and located on a map. A probable collection site, for which latitude/longitude were determined, was then assigned as the centroid of open water for fish and shrimp organisms, or the centroid of major reefs in the tract for oysters. Another problem encountered was the fact that only organic compounds above detection limits were reported in the TDH data. From the public-health viewpoint, this is appropriate. For the purposes of a status & trends analysis, however, the nondetects are of equal importance and need to be included in the data base. Unfortunately, several different suites of compounds are analyzed by TDH, and no records could be provided as to which were applied to a given sample. We finally elected to assume the minimum suite of analytes for all such analyses (see Ward and Armstrong, 1997a).

For the TNRCC tissue data, the greatest impediment to compiling the data is that no organism information is included in the TNRCC computer data base. That is, the date, station, analytes and measured concentrations for a tissue analysis are input into the system and could be retrieved for the present data compilation. But the species was not identified. Ultimately, this information had to be individually

Table 8-1
CODES FOR TISSUE ORGANISMS

Code	Common name	Specific name
00	unknown	no information provided
01	southern flounder	*Paralichthys lethostigma*
02	fin perch	unknown
03	speckled trout	
04	American oyster	*Crassostrea virginica*
05	hardhead catfish	*Arius felis*
06	gafftopsail catfish	*Bagre marinus*
07	Atlantic croaker	*Micropogonias undulatus*
08	brown shrimp	*Penaeus aztecus*
09	penaeid shrimp (undiff.)	*Penaeus spp.*
10	blue crab	*Callinectes sapidus*
11	toadfish	*Opsanus beta*
12	calico crab	*Eriphia gonagra*
13	shoalgrass	*Halodule wrightii*
14	sheepshead	*Archosargus probatocephalus*
15	black drum	*Pogonias cromis*
16	red drum (redfish)	*Sciaenops ocellatus*
17	clam	*Mercenaria*
18	menhaden	*Brevoortia patronus*
19	whiting	
20	white shrimp	*Penaeus setiferus*
21	sea catfish	
22	ladyfish	
23	alligator gar	
24	carp	*Cyprinus carpio*
25	pinfish	*Lagodon rhombiodes*
26	tarpon	*Megalops atlantica*
27	spot croaker (spot)	*Leistomus xanthurus*
28	mullet	*Mugil spp.*
29	stone crab	
30	Spanish mackerel	
31	pigfish	
32	longnose killifish	*Fundulus similis*
33	perch	unknown
34	spotted seatrout	*Cynoscion nebulosus*

determined by looking up the tag data for each tissue sample and manually entering the organism data into our data base. Even with this effort, for a significant proportion of the SMN tissue data the organism could not be identified. This information was retained in the present data base, though little use could be made of it in this analysis. This is the reason for the code 00 in Table 8-1. Additional information on problems and processing of all of the tissue data is given for the separate projects in Ward and Armstrong (1997a).

8.2 Data Base for Tissue in Corpus Christi Bay

All told, there are 8201 individual records of tissue/analyte/date/location from the Corpus Christi Bay study area, encompassing the period from 1977 to 1994. At first glance this might appear to be a workable amount of data, until one considers that it is divided among approximately 100 individual analytes, 34 individual species (including the no-information species), and one of the three noncomparable categories whole-organism wet-weight, filet wet-weight or filet dry-weight. A census of the data holdings by chemical parameter abbreviation (which separates whole organism, filet wet-weight and filet dry-weight) subdivided by the eleven primary organisms is given in Table 8-2. For the purpose of this census the primary organisms and their respective codes are taken to be:

southern flounder	01	black drum	15
speckled trout	03	red drum (redfish)	16
American oyster	04	white shrimp	20
brown shrimp	08	spot croaker (spot)	27
blue crab	10	spotted seatrout	34
sheepshead	14		

which arguably neglects the extensive toadfish and gar fisheries of the bay. Table 8-3 presents exactly the same information except with the census limited to the measurements above detection limits (and the parameters deleted for which no detectable concentrations occur in the data base). An inspection of Tables 8-2 and 8-3 discloses the following:

- By far, the greatest quantity of data has been taken for the metals analytes.
- The most-sampled organism is the American oyster, followed by the blue crab, followed by speckled trout, red drum and black drum.
- Brown shrimp and white shrimp, relatively speaking, are rarely sampled. One sample of each appears in the data base.
- Among the organics, the greatest data base is that of the pesticides, especially the common commercial mixtures such as chlordane and toxaphene, and that of PCB's.
- Most of the organics in the suite of analytes have never been detected in the tissues of organisms.
- The data base of detected PAH's and related hydrocarbons is negligible. For only a few, such as pyrene, have there been detects logged in the data.

The last observation may be as much due to bias in the sampling as to low concentrations, in that PAH's are analyzed about 1/15 times as often as pesticides.

The one organism for which whole-body and edible portions are equivalent is the oyster, since all of the sampling agencies involved here shuck the organism and analyze a blend of the meat and liquor. Moreover, there seems to be relative consistency in the moisture content of oysters, around 85% (R. Presley, TAMU, pers. comm. 1996; P. Jensen, EH&A, pers. comm. 1996). The one source of data including moisture determinations available to this project was that of the U.S. Fish & Wildlife Service (Corpus Christi Bay contaminants study), whose data for oysters show a mean moisture content of 84.5% with a standard deviation of 1.2% (see Project 27 in Ward and Armstrong, 1997a). With this relation, the data for oysters could be combined into one proxy data set of equivalent wet-weight concentrations, identified by the abbreviation prefix TO.

The above census is, of course, without regard to geographical distribution in the system. Figures 8-1 and 8-2 display the sites from which oysters for tissue analysis have been taken. Clearly, the majority of the data are from Nueces Bay and Aransas Bay. Even at that, the spatial dense is sparse. (There are no oyster sites in the Laguna or Baffin systems.) The next-best-sampled organism, blue crab, is depicted in Figs. 8-3 through 8-6. The blue crab is more ubiquitous than the oyster, and the samples are better distributed through the study area, but even at this the sampling density is low. For the other organisms, the sampling distributions through the study area are even sparser. Because of this low sampling density there was little merit in the sorting by hydrographic areas, since the vast majority of the segments will contain either 0 or 1 sample. Accordingly, the statistical analyses were limited to distribution by TNRCC segment.

The same protocols for data handling were observed for the tissue data as outlined in Chapter 4, except, as noted above, that sorting into hydrographic areas was deemed unnecessary, and that no screening for aberrant values was performed, both because the data are so sparse. Tables 8-4 and 8-5 present summary statistics for the entire aggregated study area, composited across all organisms, for the principal metals and organic analytes. The validity of a composite data base irrespective of the species is highly questionable, because the tissue concentrations will depend upon geographical exposure and the metabolism of each species. Some, like many finfish and shrimp, move large distances through the system, as well as through the nearshore Gulf, while others are territorial, like the black drum, and still others are sessile, like oysters. Some, like filter feeders and some top carnivores, will exhibit a greater degree of concentration, than others. On the other hand, some readers may wish a general indication of relative elevations of individual analytes in the study area, which would be provided by these tables.

Many of the same remarks concerning the water/sediment data, made in Chapter 5, apply as well to the tissue data, including the concerns with data management. Most of these do not warrant repeating here. However, it is worth pointing out

that the first causative factor compromising the integrity of modern data bases discussed in Section 5.3.2, of poor data recovery procedures, is particularly painful with respect to tissue data. One of the more valuable data sets on tissue in the study area is the USF&WS contaminants project in the late 1980's (Barrera, et al., 1995), in which 37 sites from Baffin Bay and the Upper Laguna to Redfish Bay were sampled for biota, and tissue analyses performed for an extensive suite of metals and organics. Due apparently to a data-transfer bug, *all* of the organic analyses for the tissue samples were inadvertently deleted from the archival digital files attached to the report in diskettes. USF&WS advises that the only way to recover the lost data would be to go back to the raw lab sheets and completely re-keyboard them. Therefore, this valuable, comprehensive set of recent tissue data is not included in the present compilation.

Table 8-2
Census of tissue data holdings for principal organism codes
Organism codes defined in Table 8-1
Parameter codes defined in Table A-3 of Appendix

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TDMETAG	0	0	81	0	0	0	0	0	0	0	0	81
TDMETAS	0	0	101	0	0	0	0	0	0	0	0	101
TDMETCD	0	0	101	0	0	0	0	0	0	0	0	101
TDMETCR	0	0	81	0	0	0	0	0	0	0	0	81
TDMETCU	0	0	101	0	0	0	0	0	0	0	0	101
TDMETHG	0	0	101	0	0	0	0	0	0	0	0	101
TDMETNI	0	0	101	0	0	0	0	0	0	0	0	101
TDMETPB	0	0	101	0	0	0	0	0	0	0	0	101
TDMETSE	0	0	101	0	0	0	0	0	0	0	0	101
TDMETZN	0	0	101	0	0	0	0	0	0	0	0	101
TD-ACEN	0	0	101	0	0	0	0	0	0	0	0	101
TD-ACENY	0	0	101	0	0	0	0	0	0	0	0	101
TD-ALDR	0	0	101	0	0	0	0	0	0	0	0	101
TD-BNZA	0	0	101	0	0	0	0	0	0	0	0	101
TD-CHRY	0	0	101	0	0	0	0	0	0	0	0	101
TD-DIEL	0	0	101	0	0	0	0	0	0	0	0	101
TD-ENDR	0	0	101	0	0	0	0	0	0	0	0	101
TD-FLRA	0	0	101	0	0	0	0	0	0	0	0	101
TD-FLRN	0	0	101	0	0	0	0	0	0	0	0	101
TD-HEPT	0	0	101	0	0	0	0	0	0	0	0	101
TD-HEPX	0	0	101	0	0	0	0	0	0	0	0	101
TD-LIND	0	0	101	0	0	0	0	0	0	0	0	101
TD-NAPT	0	0	101	0	0	0	0	0	0	0	0	101
TD-PDDD	0	0	101	0	0	0	0	0	0	0	0	101
TD-PDDE	0	0	101	0	0	0	0	0	0	0	0	101
TD-PDDT	0	0	101	0	0	0	0	0	0	0	0	101
TFMETAG	0	0	0	1	0	0	0	0	0	0	0	20
TFMETAS	1	7	12	1	14	3	19	12	0	0	0	89
TFMETCD	4	34	39	1	35	5	25	21	0	0	0	190
TFMETCR	0	0	0	1	0	0	0	0	0	0	0	20
TFMETCU	4	34	39	1	35	5	25	21	0	0	0	190
TFMETHG	4	35	39	1	35	5	24	21	0	0	0	190
TFMETNI	0	0	0	1	0	0	0	0	0	0	0	20
TFMETPB	4	34	39	1	35	5	25	21	0	0	0	190
TFMETZN	4	33	39	1	35	5	25	21	0	0	0	189
TF-ABHC	3	14	24	0	22	2	15	13	0	0	0	96

(continued)

Table 8-2
Census of tissue data holdings for principal organism codes
(continued)

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TF-ACEN	0	0	6	0	0	0	0	0	0	0	0	6
TF-ACENA	0	0	6	0	0	0	0	0	0	0	0	6
TF-ALDR	3	14	24	1	22	2	15	13	0	0	0	113
TF-ANTHR	0	0	6	0	0	0	0	0	0	0	0	6
TF-BNZA	0	0	6	0	0	0	0	0	0	0	0	6
TF-BNZB	0	0	6	0	0	0	0	0	0	0	0	6
TF-BNZE	0	0	6	0	0	0	0	0	0	0	0	6
TF-BNZGP	0	0	6	0	0	0	0	0	0	0	0	6
TF-BNZK	0	0	6	0	0	0	0	0	0	0	0	6
TF-CHLR	3	14	24	0	22	2	15	13	0	0	0	96
TF-CHRYS	0	0	6	0	0	0	0	0	0	0	0	6
TF-DBANE	0	0	6	0	0	0	0	0	0	0	0	6
TF-DDD	3	14	24	0	22	2	15	13	0	0	0	96
TF-DDE	3	14	24	0	22	2	15	13	0	0	0	96
TF-DDT	3	14	24	0	22	2	15	13	0	0	0	109
TF-DIEL	3	14	24	1	22	2	15	13	0	0	0	113
TF-ENDO	3	14	24	0	22	2	15	13	0	0	0	96
TF-ENDR	3	14	24	1	22	2	15	13	0	0	0	113
TF-FLRA	0	0	6	0	0	0	0	0	0	0	0	6
TF-FLRN	0	0	6	0	0	0	0	0	0	0	0	6
TF-HEPT	3	14	24	1	22	2	15	13	0	0	0	113
TF-HEPX	3	14	24	1	22	2	15	13	0	0	0	113
TF-HEXA	0	0	6	0	0	0	0	0	0	0	0	6
TF-I123P	0	0	6	0	0	0	0	0	0	0	0	6
TF-LIND	3	14	24	1	22	2	15	13	0	0	0	113
TF-MTHX	3	14	24	0	22	2	15	13	0	0	0	96
TF-NAPT	0	0	6	0	0	0	0	0	0	0	0	6
TF-PCB	3	14	24	1	22	2	15	13	0	0	0	109
TF-PDDD	0	0	0	1	0	0	0	0	0	0	0	17
TF-PDDE	0	0	0	1	0	0	0	0	0	0	0	17
TF-PDDT	0	0	0	1	0	0	0	0	0	0	0	17
TF-PHNAN	0	0	6	0	0	0	0	0	0	0	0	6
TF-PYRN	0	0	6	0	0	0	0	0	0	0	0	6
TF-TOXA	3	14	24	1	22	2	15	13	0	0	0	113
TSMETAG	1	1	4	0	33	0	0	0	0	0	0	83
TSMETAS	1	1	5	0	53	0	1	0	1	2	0	140
TSMETCD	1	1	5	0	53	0	1	0	1	2	0	140

(continued)

Table 8-2
Census of tissue data holdings for principal organism codes
(continued)

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TSMETCR	1	1	5	0	53	0	1	0	1	2	0	140
TSMETCU	1	1	5	0	53	0	1	0	1	2	0	140
TSMETHG	1	1	5	0	53	0	1	0	1	2	0	140
TSMETNI	1	1	4	0	51	0	0	0	0	0	0	101
TSMETPB	1	1	5	0	53	0	1	0	1	2	0	140
TSMETSE	0	0	4	0	33	0	0	0	0	0	0	95
TSMETZN	1	1	4	0	51	0	0	0	0	0	0	101
TS-124TC	0	0	0	0	0	0	0	0	0	0	0	7
TS-12DCB	0	0	0	0	0	0	0	0	0	0	0	7
TS-12DPH	0	0	0	0	0	0	0	0	0	0	0	7
TS-13DCB	0	0	0	0	0	0	0	0	0	0	0	7
TS-14DCB	0	0	0	0	0	0	0	0	0	0	0	7
TS-246TC	0	0	0	0	0	0	0	0	0	0	0	7
TS-24DCP	0	0	0	0	0	0	0	0	0	0	0	7
TS-24DMP	0	0	0	0	0	0	0	0	0	0	0	7
TS-24DNH	0	0	0	0	0	0	0	0	0	0	0	7
TS-24DNT	0	0	0	0	0	0	0	0	0	0	0	7
TS-26DNC	0	0	0	0	0	0	0	0	0	0	0	7
TS-26DNT	0	0	0	0	0	0	0	0	0	0	0	7
TS-2CLNP	0	0	0	0	0	0	0	0	0	0	0	7
TS-2NIPH	0	0	0	0	0	0	0	0	0	0	0	7
TS-33DCB	0	0	0	0	0	0	0	0	0	0	0	7
TS-3PCM	0	0	0	0	0	0	0	0	0	0	0	1
TS-4BRPE	0	0	0	0	0	0	0	0	0	0	0	7
TS-4C34	0	0	0	0	0	0	0	0	0	0	0	7
TS-4CLPE	0	0	0	0	0	0	0	0	0	0	0	7
TS-ABHC	1	1	0	0	2	0	0	0	0	2	1	32
TS-ACEN	1	1	0	0	18	0	0	0	0	0	0	28
TS-ACENA	1	1	0	0	0	0	0	0	0	0	0	10
TS-ALDR	1	1	0	0	20	0	0	0	0	2	1	60
TS-ANTHR	1	1	0	0	18	0	0	0	0	0	0	28
TS-B2CE	0	0	0	0	0	0	0	0	0	0	0	7
TS-B2CEN	0	0	0	0	0	0	0	0	0	0	0	7
TS-B2CM	0	0	0	0	0	0	0	0	0	0	0	7
TS-B2EPH	0	0	0	0	0	0	0	0	0	0	0	7
TS-BBHC	0	0	0	0	0	0	0	0	0	0	0	7
TS-BNZA	1	1	0	0	18	0	0	0	0	0	0	28
TS-BNZAA	0	0	0	0	0	0	0	0	0	0	0	7

(continued)

Table 8-2
Census of tissue data holdings for principal organism codes
(continued)

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TS-BNZDE	0	0	0	0	0	0	0	0	0	0	0	7
TS-BNZGP	0	0	0	0	0	0	0	0	0	0	0	7
TS-BNZJ	0	0	0	0	0	0	0	0	0	0	0	7
TS-BNZK	0	0	0	0	0	0	0	0	0	0	0	7
TS-BUBZP	0	0	0	0	0	0	0	0	0	0	0	7
TS-CHLR	1	1	0	0	20	0	0	0	0	2	1	60
TS-CHLRC	0	0	0	0	2	0	0	0	0	2	1	28
TS-CHLRN	0	0	0	0	2	0	0	0	0	2	1	28
TS-CHLRT	0	0	0	0	2	0	0	0	0	2	1	28
TS-CHRY	0	0	0	0	18	0	0	0	0	0	0	18
TS-CHRYS	0	0	0	0	0	0	0	0	0	0	0	7
TS-CLPN	0	0	0	0	0	0	0	0	0	0	0	7
TS-DBANE	0	0	0	0	0	0	0	0	0	0	0	7
TS-DBHC	0	0	0	0	0	0	0	0	0	0	0	7
TS-DDD	0	0	0	0	0	0	0	0	0	0	0	28
TS-DDE	0	0	0	0	0	0	0	0	0	0	0	32
TS-DDT	0	0	0	0	2	0	0	0	0	2	0	36
TS-DIBUP	0	0	0	0	0	0	0	0	0	0	0	7
TS-DIEL	1	1	0	0	20	0	0	0	0	2	1	62
TS-DIETP	0	0	0	0	0	0	0	0	0	0	0	7
TS-DIMET	0	0	0	0	0	0	0	0	0	0	0	7
TS-DIN8	0	0	0	0	0	0	0	0	0	0	0	7
TS-DIPH	0	0	0	0	0	0	0	0	0	0	0	7
TS-ENDO	1	1	0	0	0	0	0	0	0	0	0	10
TS-ENDOS	0	0	0	0	0	0	0	0	0	0	0	7
TS-ENDR	1	1	0	0	2	0	0	0	0	2	1	42
TS-ENDRA	0	0	0	0	0	0	0	0	0	0	0	7
TS-FLRA	1	1	0	0	0	0	0	0	0	0	0	10
TS-FLRN	1	1	0	0	18	0	0	0	0	0	0	28
TS-HEPT	1	1	0	0	18	0	0	0	0	0	0	46
TS-HEPX	0	0	0	0	0	0	0	0	0	0	0	25
TS-HXCBU	0	0	0	0	0	0	0	0	0	0	0	7
TS-HXCCP	0	0	0	0	0	0	0	0	0	0	0	7
TS-HXCLB	0	0	0	0	2	0	0	0	0	2	1	39
TS-HXCLE	0	0	0	0	0	0	0	0	0	0	0	7
TS-I123P	0	0	0	0	0	0	0	0	0	0	0	7
TS-ISPHR	0	0	0	0	0	0	0	0	0	0	0	7
TS-LIND	1	1	0	0	20	0	0	0	0	2	1	60

(continued)

Table 8-2
Census of tissue data holdings for principal organism codes
(continued)

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TS-MTHX	1	1	0	0	2	0	0	0	0	2	1	41
TS-NAPT	1	1	0	0	18	0	0	0	0	0	0	28
TS-NITRB	0	0	0	0	0	0	0	0	0	0	0	7
TS-NNNPR	0	0	0	0	0	0	0	0	0	0	0	7
TS-NNSM	0	0	0	0	0	0	0	0	0	0	0	7
TS-NNSP	0	0	0	0	0	0	0	0	0	0	0	7
TS-ODDD	0	0	0	0	2	0	0	0	0	2	1	29
TS-ODDE	0	0	0	0	2	0	0	0	0	2	1	29
TS-ODDT	0	0	0	0	2	0	0	0	0	2	1	29
TS-PCB	0	0	0	0	20	0	0	0	0	2	1	60
TS-PCP	1	1	0	0	0	0	0	0	0	0	0	10
TS-PDDD	1	1	0	0	20	0	0	0	0	2	1	50
TS-PDDE	1	1	0	0	20	0	0	0	0	2	1	50
TS-PDDT	1	1	0	0	20	0	0	0	0	2	1	50
TS-PHEN	1	1	0	0	0	0	0	0	0	0	0	3
TS-PHNAN	0	0	0	0	0	0	0	0	0	0	0	7
TS-PYRN	0	0	0	0	0	0	0	0	0	0	0	7
TS-T0XA	0	0	0	0	0	0	0	0	0	0	0	25
TS-TOXA	1	1	0	0	18	0	0	0	0	0	0	21
TS-TPHEN	1	1	0	0	0	0	0	0	0	0	0	10

Table 8-3
Census of tissue data holdings exceeding detection limits
for principal organism codes

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TDMETAG	0	0	81	0	0	0	0	0	0	0	0	81
TDMETAS	0	0	101	0	0	0	0	0	0	0	0	101
TDMETCD	0	0	101	0	0	0	0	0	0	0	0	101
TDMETCR	0	0	81	0	0	0	0	0	0	0	0	81
TDMETCU	0	0	101	0	0	0	0	0	0	0	0	101
TDMETHG	0	0	99	0	0	0	0	0	0	0	0	99
TDMETNI	0	0	101	0	0	0	0	0	0	0	0	101
TDMETPB	0	0	101	0	0	0	0	0	0	0	0	101
TDMETSE	0	0	101	0	0	0	0	0	0	0	0	101
TDMETZN	0	0	101	0	0	0	0	0	0	0	0	101
TD-ACEN	0	0	63	0	0	0	0	0	0	0	0	63
TD-ACENY	0	0	63	0	0	0	0	0	0	0	0	63
TD-ALDR	0	0	44	0	0	0	0	0	0	0	0	44
TD-BNZA	0	0	63	0	0	0	0	0	0	0	0	63
TD-CHRY	0	0	63	0	0	0	0	0	0	0	0	63
TD-DIEL	0	0	94	0	0	0	0	0	0	0	0	94
TD-ENDR	0	0	101	0	0	0	0	0	0	0	0	101
TD-FLRA	0	0	63	0	0	0	0	0	0	0	0	63
TD-FLRN	0	0	63	0	0	0	0	0	0	0	0	63
TD-HEPT	0	0	48	0	0	0	0	0	0	0	0	48
TD-HEPX	0	0	80	0	0	0	0	0	0	0	0	80
TD-LIND	0	0	87	0	0	0	0	0	0	0	0	87
TD-NAPT	0	0	63	0	0	0	0	0	0	0	0	63
TD-PDDD	0	0	92	0	0	0	0	0	0	0	0	92
TD-PDDE	0	0	100	0	0	0	0	0	0	0	0	100
TD-PDDT	0	0	72	0	0	0	0	0	0	0	0	72
TFMETAG	0	0	0	1	0	0	0	0	0	0	0	16
TFMETAS	1	0	4	1	3	2	10	0	0	0	0	38
TFMETCD	0	1	37	1	24	0	0	1	0	0	0	72
TFMETCR	0	0	0	1	0	0	0	0	0	0	0	19
TFMETCU	2	18	39	1	35	3	14	8	0	0	0	144
TFMETHG	4	35	11	1	35	5	24	21	0	0	0	159
TFMETNI	0	0	0	1	0	0	0	0	0	0	0	19
TFMETPB	0	1	1	0	2	0	0	0	0	0	0	18
TFMETZN	4	33	39	1	35	5	25	21	0	0	0	189
TF-ALDR	0	0	0	0	0	0	0	0	0	0	0	3
TF-CHLR	0	0	0	0	2	0	0	0	0	0	0	2

(continued)

Table 8-3
Census of tissue data holdings exceeding detection limits
(continued)

	organism codes:											
parameter:	*1*	*3*	*4*	*8*	*10*	*14*	*15*	*16*	*20*	*27*	*34*	*all organisms*
TF-DDE	0	5	4	0	4	0	1	0	0	0	0	14
TF-DDT	0	0	0	0	0	0	0	0	0	0	0	13
TF-HEPT	0	0	0	0	0	0	0	0	0	0	0	2
TF-HEPX	0	0	0	0	0	0	0	0	0	0	0	1
TF-PCB	3	14	24	1	22	2	15	13	0	0	0	109
TF-PDDD	0	0	0	0	0	0	0	0	0	0	0	1
TF-PDDE	0	0	0	0	0	0	0	0	0	0	0	7
TF-PDDT	0	0	0	0	0	0	0	0	0	0	0	9
TF-PYRN	0	0	6	0	0	0	0	0	0	0	0	6
TSMETAG	0	1	0	0	0	0	0	0	0	0	0	2
TSMETAS	1	0	4	0	34	0	1	0	0	0	0	86
TSMETCD	0	0	5	0	37	0	0	0	0	0	0	70
TSMETCR	0	1	5	0	34	0	1	0	1	2	0	96
TSMETCU	1	0	5	0	50	0	1	0	1	2	0	133
TSMETHG	0	0	4	0	28	0	1	0	1	2	0	93
TSMETNI	0	1	4	0	17	0	0	0	0	0	0	41
TSMETPB	1	0	2	0	6	0	0	0	1	2	0	34
TSMETSE	0	0	4	0	33	0	0	0	0	0	0	77
TSMETZN	1	1	4	0	51	0	0	0	0	0	0	101
TS-CHLR	0	0	0	0	0	0	0	0	0	0	0	1
TS-CHLRN	0	0	0	0	0	0	0	0	0	0	0	1
TS-DDD	0	0	0	0	0	0	0	0	0	0	0	3
TS-DDE	0	0	0	0	0	0	0	0	0	0	0	19
TS-DDT	0	0	0	0	0	0	0	0	0	0	0	1
TS-DIBUP	0	0	0	0	0	0	0	0	0	0	0	1
TS-DIEL	0	0	0	0	0	0	0	0	0	0	0	3
TS-ENDR	0	0	0	0	0	0	0	0	0	0	0	1
TS-FLRA	0	0	0	0	0	0	0	0	0	0	0	1
TS-HXCLB	0	0	0	0	0	0	0	0	0	1	0	3
TS-PCB	0	0	0	0	1	0	0	0	0	2	-0	16
TS-PDDD	0	0	0	0	0	0	0	0	0	0	0	1
TS-PDDE	0	0	0	0	1	0	0	0	0	0	1	17
TS-PYRN	0	0	0	0	0	0	0	0	0	0	0	1
TS-TPHEN	1	1	0	0	0	0	0	0	0	0	0	3

Table 8-4
Systemwide summary statistics of tissue concentrations in all organisms
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. > DLs*	*% > DLs*	*Max*	*date*	*average with BDL=0*	*BDL=DL*
TFMETAS	89	1.09E+00	3.10E+00	38	43	19	930723	4.66E-01	7.46E-01
TFMETCD	190	9.81E-01	1.00E+00	72	38	5.1	800505	3.72E-01	5.57E-01
TFMETCU	190	1.10E+01	1.30E+01	144	76	72	940818	8.35E+00	8.52E+00
TFMETHG	190	1.06E-01	8.30E-02	159	83	0.57	800708	8.85E-02	9.35E-02
TFMETPB	190	2.47E-01	3.00E-01	18	9	1	810816	2.34E-02	7.33E-01
TFMETZN	189	1.42E+02	4.00E+02	189	100	2500	940818	1.42E+02	1.42E+02
TF-ACEN	6								1.00E+00
TF-ALDR	117	1.18E-03	6.60E-04	3	3	0.0019	930720	3.03E-05	1.75E-03
TF-BNZA	6								1.00E+00
TF-CHLR	100	2.28E-01	3.00E-01	4	4	0.75	781130	9.13E-03	1.89E-02
TF-DDT	113	2.87E-03	1.80E-03	13	11	0.0082	920729	3.30E-04	9.53E-03
TF-DIEL	117								5.05E-03
TF-ENDO	96								1.00E-02
TF-ENDR	117								5.08E-03
TF-FLRN	6								1.00E+00
TF-NAPT	6								1.90E+01
TF-PCB	113	3.05E-02	1.40E-01	113	100	1.2	781130	3.05E-02	3.05E-02
TF-TOXA	113								1.00E-01
TSMETAS	140	3.24E+00	3.30E+00	86	61	23	890901	1.99E+00	2.44E+00
TSMETCD	140	4.57E-01	5.10E-01	70	50	3	890901	2.28E-01	3.58E-01
TSMETCU	140	8.90E+00	1.80E+01	133	95	190	890901	8.45E+00	8.58E+00
TSMETHG	140	1.02E-01	9.50E-02	93	66	0.43	890901	6.79E-02	1.94E-01
TSMETPB	140	1.22E+00	1.40E+00	34	24	7.7	771020	2.96E-01	1.34E+00
TSMETZN	101	1.09E+02	2.40E+02	101	100	1700	890901	1.09E+02	1.09E+02
TS-ACEN	28								5.58E+01
TS-ALDR	60								2.01E+01
TS-BNZA	28								5.58E+01
TS-CHLR	60	3.90E-02	0.00E+00	1	2	0.039	781130	6.50E-04	1.00E+02
TS-DDT	36	3.00E-02	0.00E+00	1	3	0.03	890815	8.33E-04	2.94E-02
TS-DIEL	62	7.20E-02	8.30E-03	3	5	0.081	770128	3.48E-03	1.95E+01
TS-ENDO	10								1.20E+02
TS-ENDR	42	3.50E-02	0.00E+00	1	2	0.035	790214	8.33E-04	2.86E+01
TS-FLRN	28								5.58E+01
TS-NAPT	28								5.58E+01
TS-PCB	60	1.71E-01	2.30E-01	16	27	1	781130	4.57E-02	3.09E+00
TS-TOXA	46								3.01E+01

Table 8-5
Systemwide summary time trends of tissue concentrations in all organisms
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TFMETAS	840514	940818	840709	940818	3.8	2.73E-02	8.70E-01	3.14E+00	1.00	-3.20E-01	3.80E-01	poss
TFMETCD	800505	940818	800505	940818	5	-9.12E-02	1.30E+00	9.52E-01	0.90	-1.60E-01	-2.70E-02	prob
TFMETCU	800505	940818	800505	940818	10	-6.46E-01	1.40E+01	1.30E+01	0.95	-1.10E+00	-1.90E-01	prob
TFMETHG	800505	940818	800505	940817	11	1.66E-03	9.70E-02	8.27E-02	0.99	-1.20E-03	4.50E-03	poss
TFMETPB	800505	940818	810316	930723	1.5	-5.99E-02	7.90E-01	1.15E-01	0.15	-7.30E-02	-4.70E-02	prob
TFMETZN	800505	940818	800505	940818	13	-4.24E+00	1.60E+02	3.99E+02	1.00	-1.80E+01	9.10E+00	
TF-ACEN	801211	801211										
TF-ALDR	781130	930927	920729	930722	3.1	1.38E-03	2.80E-04	1.79E-04	0.07	-3.50E-03	6.30E-03	poss
TF-BNZA	801211	801211										
TF-CHLR	781130	930927	781130	840814	0.7	-7.07E-02	4.30E-01	2.26E-01	0.56	-3.10E-01	1.70E-01	
TF-DDT	781130	930927	910805	930723	6.6	7.41E-04	1.90E-03	1.79E-03	0.94	-1.20E-03	2.70E-03	poss
TF-DIEL	781130	930927										
TF-ENDO	800505	930927										
TF-ENDR	781130	930927										
TF-FLRN	801211	801211										
TF-NAPT	801211	801211										
TF-PCB	781130	930927	781130	930927	7.6	-5.90E-03	6.40E-02	1.36E-01	0.98	-1.30E-02	1.20E-03	poss
TF-TOXA	800505	930927										
TSMETAS	771020	930302	771020	930302	5.6	1.30E-01	1.80E+00	3.30E+00	0.99	-1.10E-01	3.70E-01	poss
TSMETCD	771020	930302	771020	890901	5.9	-3.34E-02	8.20E-01	5.05E-01	0.97	-7.90E-02	1.20E-02	poss
TSMETCU	771020	930302	771020	930302	8.7	3.94E-01	5.10E+00	1.84E+01	0.99	-4.00E-01	1.20E+00	poss
TSMETHG	771020	930302	771020	910723	6.8	3.76E-03	6.80E-02	9.39E-02	0.97	-6.70E-04	8.20E-03	poss
TSMETPB	771020	930302	771020	930302	2.2	-5.51E-02	1.70E+00	1.35E+00	0.95	-1.40E-01	3.20E-02	
TSMETZN	840823	930302	840823	930302	12	1.41E+01	4.90E+01	2.35E+02	0.99	-9.00E+00	3.70E+01	poss
TS-ACEN	830616	930302										
TS-ALDR	771020	930302										
TS-BNZA	830616	930302										
TS-CHLR	771020	930302	781130	781130	1							

(continued)

Table 8-5
(continued)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TS-DDT	771020	910806	890815	890815	1							
TS-DIEL	770128	930302	770128	790214	1.5	1.47E-03	7.10E-02	8.16E-03	0.97	-1.10E-01	1.10E-01	
TS-ENDO	830616	930302										
TS-ENDR	771020	930302	790214	790214	1							
TS-FLRN	830616	930302										
TS-NAPT	830616	930302										
TS-PCB	750618	910806	750618	910806	0.99	-5.46E-03	2.10E-01	2.28E-01	0.98	-2.80E-02	1.70E-02	
TS-TOXA	830616	930302										

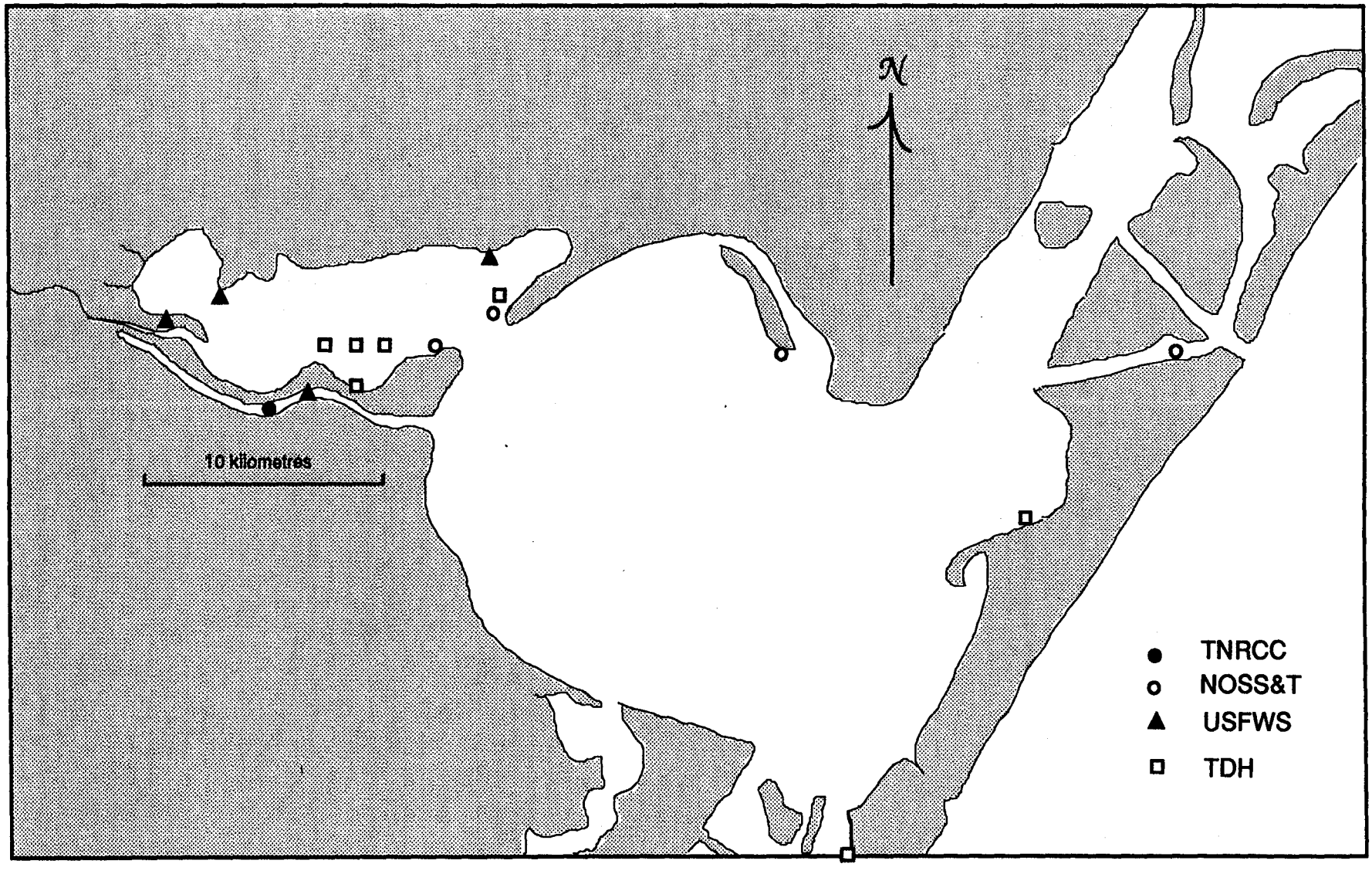


Figure 8-1. Sites of oyster samples in tissue data base, Corpus Christi Bay

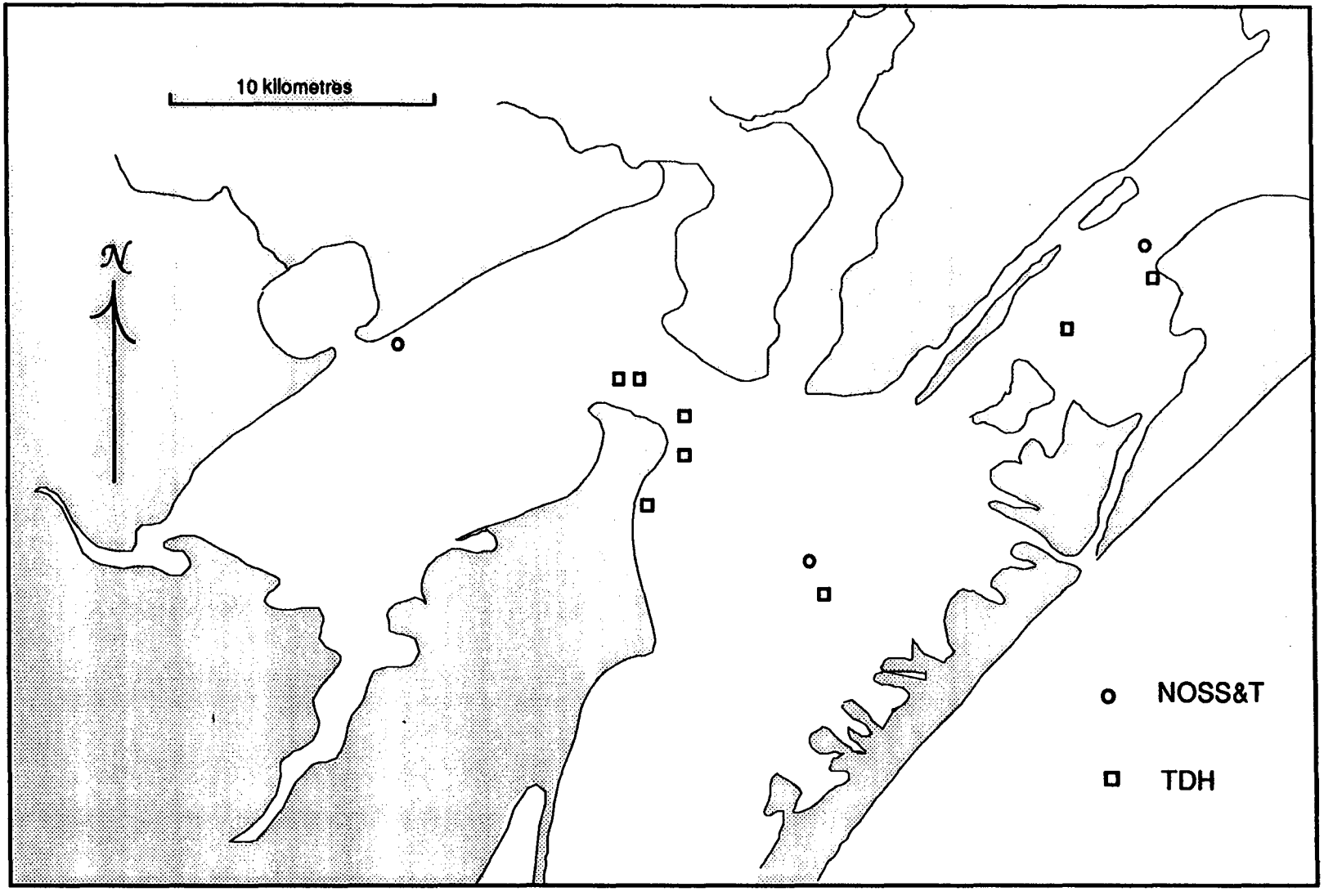


Figure 8-2. Sites of oyster samples in tissue data base, Copano-Aransas Bay

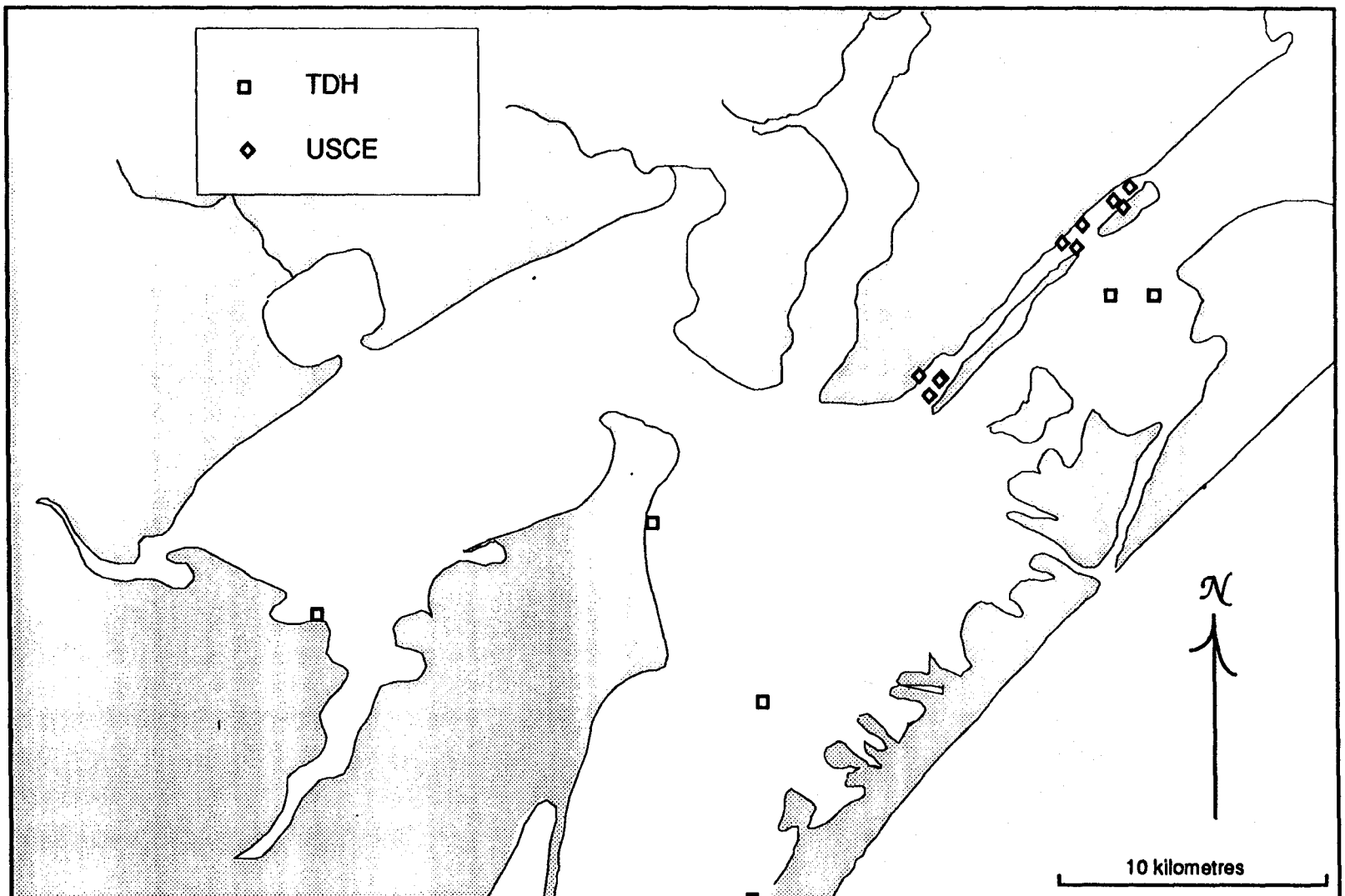


Figure 8-3. Sites of blue crab samples in tissue data base, Aransas-Copano Bay

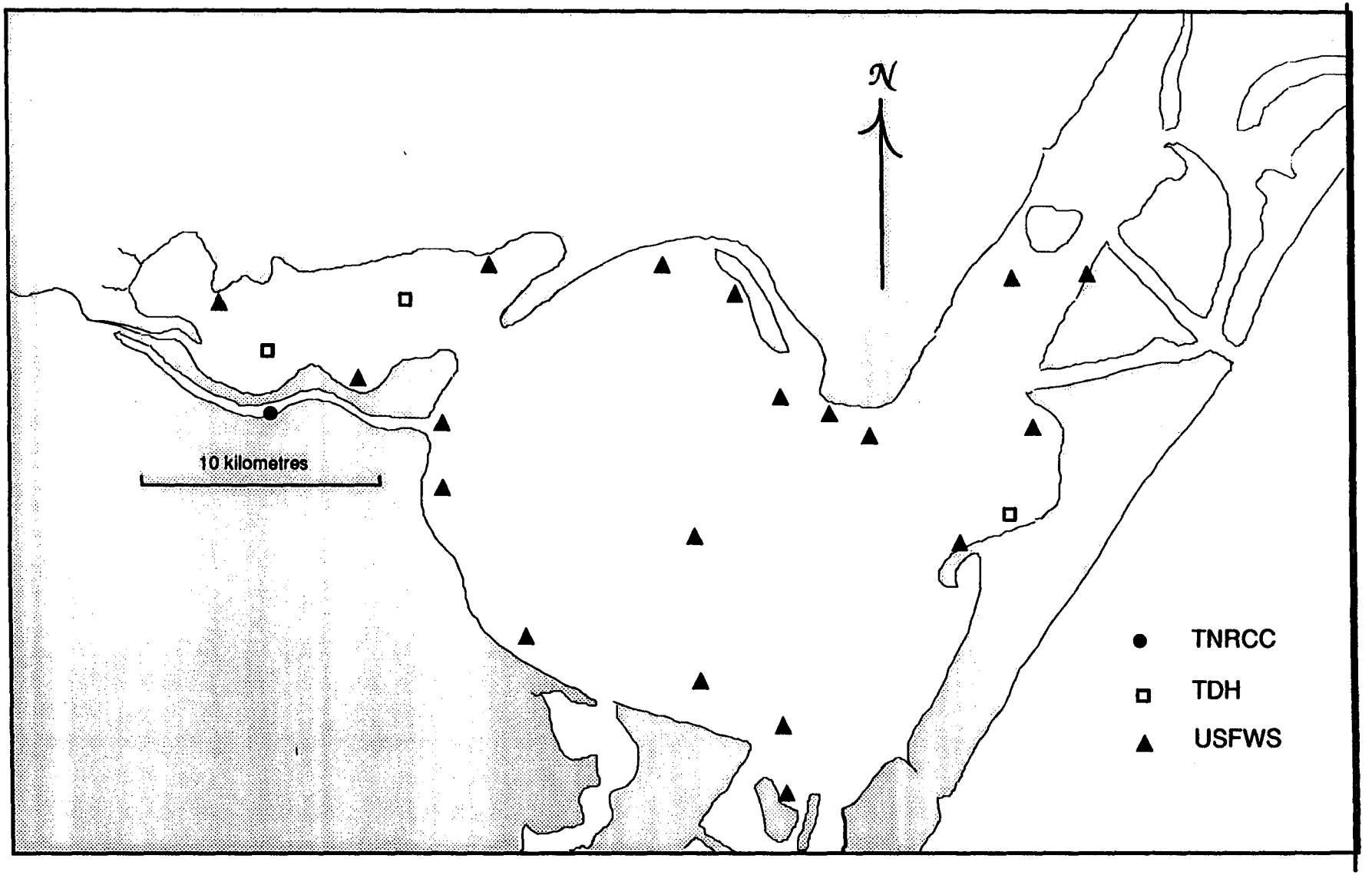


Figure 8-4. Sites of blue crab samples in tissue data base, Corpus Christi Bay

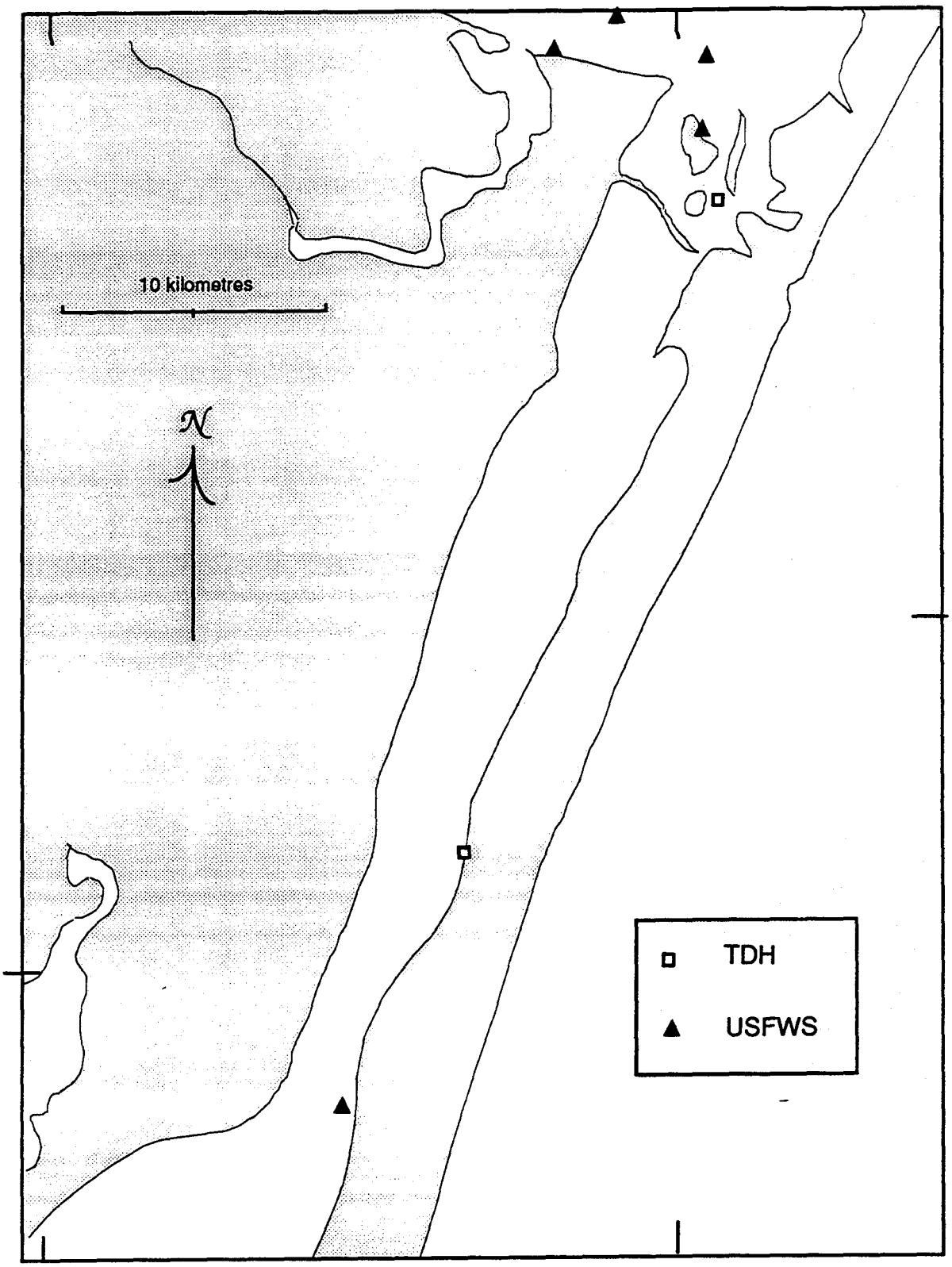


Figure 8-5. Sites of blue crab samples in tissue data base, Upper Laguna and Oso Bay

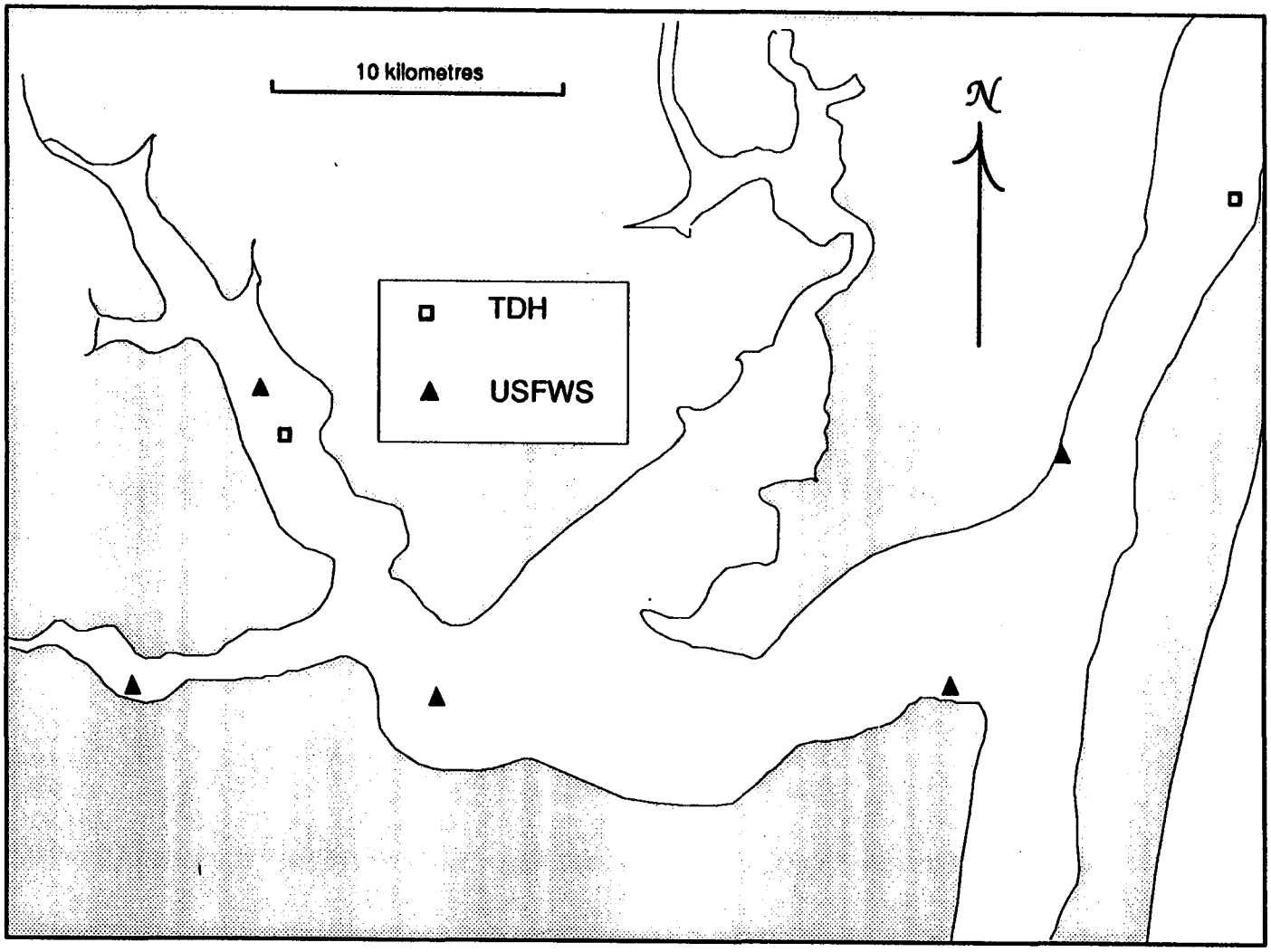


Figure 8-6. Sites of blue crab samples in tissue data base, Baffin Bay

8.3 Data analyses and observations

Statistical analyses for the more important organisms of Table 8-1 aggregated by TNRCC segment are presented in Appendix D. To save paper, only those segments/analytes are given for which data exist. Some readers may wonder about the general behavior of a specific analyte in a given species, independent of location in the bay. Particularly in view of the sparsity of data in space, a statistical composite of all oyster data, say, may be considered to provide some indication of the extent of tissue contamination within the study area. Such analyses are provided in Tables 8-6 *et seq.*, for oyster, blue crab, speckled trout, red drum and black drum.

For oyster, Table 8-6 indicates elevated concentrations of some of the metals, notably arsenic, cadmium, copper and zinc. Some of the analytes exhibit declining trends with time. We note that attaching significance to any of these statistics without cognizance of their underlying geographical distribution is aleatory. For example, an oyster analysis from the open waters of Corpus Christi Bay in the 1970's pooled with an analysis from the Inner Harbor in the 1990's would display an apparent increasing time trend, but this would have no real validity. For this reason, Tables 8-6 *et seq.* should be interpreted with caution. Of course, for organisms that are ubiquitous and have a high degree of mobility in the system, the geographical pooling of Tables 8-6 *et seq.* has some value. Thus for crab (Tables 8-8 and 8-9) and speckled trout (Tables 8-10 and 8-11), the elevation of some metals and PCB's, and the possible increasing trends, may be indicative of real variability in these analytes.

To display statistical behavior with separation of geographical dependency, Tables 8-16 et seq. show statistics and time trends for the major metals analytes and PCB's, for three species with the greatest data base, oyster, blue crab and black drum, aggregated by the principal regional TNRCC segments, *viz.* Mesquite, Copano and Aransas Bays (the upper bays), Redfish, Corpus Christi and Nueces Bays (the central region) and the Upper Laguna and Baffin Bay (the lower bays).

For the oyster, the upper bays and the main body of Corpus Christi Bay show somewhat elevated concentrations of arsenic with no clear time trends. Nueces Bay exhibits systematically elevated metals. For cadmium (Table 8-17), copper (Table 8-18), lead (Table 8-20) and zinc (Table 8-21), the highest mean tissue concentrations are found in Nueces Bay. (This statement means apart from the Inner Harbor, but since the Inner Harbor tissue mean is based on only two samples it is not as statistically secure as those for Copano and Nueces Bay.) The second runner is Copano Bay for cadmium and copper, and it exceeds Nueces Bay slightly for mercury (Table 8-19). This conclusion generally agrees with the relative concentrations in the sediments, cf. Table 7-7, if the Inner Harbor and tertiary bays are discounted. (And, of course, there are no oyster samples from the lower bays.) Time trends are mixed both with respect to the analyte and with respect to geography. Some are statistically probable, but the small data bases still render them suspect.

Blue crab data, Tables 8-23 through 8-29, are generally much sparser than oyster data, and the conclusions are even more tenuous. Noise in the data no doubt obscures the relative magnitudes of the mean concentrations. Redfish Bay and Baffin show elevated levels of most metals. The high arsenic concentrations in the Upper Laguna and Baffin Bay should be especially noted. The data base would not support any trend determinations anywhere.

The black drum data is sparser yet, the data base for Nueces Bay being the only one even remotely adequate for statistical analysis. This does indicate some elevated metals concentrations, especially for mercury and zinc, and where a time trend can be resolved that is either possible or probable, it is increasing.

When one considers that the data base greatest for the species and analytes of Tables 8-16 *et seq.*, and is sparser yet for the remainder of the species and analytes, it becomes apparent why so little can be concluded concerning tissue concentrations in this system.

Table 8-6
Systemwide summary statistics for oyster (code 04)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*average with BDL=DL*
TOMETAS	118	1.24E+00	4.50E-01	109	92	1.40E-01	920715	1.40E-01	920715	2.40E+00	880715	1.15E+00	1.19E+00
TOMETCD	145	1.06E+00	6.90E-01	143	99	1.90E-02	920715	1.90E-02	920715	4.10E+00	800505	1.05E+00	1.05E+00
TOMETCU	145	2.43E+01	1.90E+01	145	100	3.00E+00	910715	3.00E+00	910715	1.90E+02	890901	2.43E+01	2.43E+01
TOMETHG	145	1.89E-02	1.40E-02	114	79	1.50E-03	870715	1.50E-03	870715	1.20E-01	890901	1.49E-02	2.01E-02
TOMETPB	145	1.17E-01	1.50E-01	104	72	2.80E-02	870715	2.80E-02	870715	1.40E+00	771020	8.36E-02	2.56E-01
TOMETZN	144	4.47E+02	4.50E+02	144	100	2.70E+01	910715	2.70E+01	910715	2.50E+03	940818	4.47E+02	4.47E+02
TO-ACEN	107	3.33E-03	2.90E-03	63	59	5.10E-04	910715	5.10E-04	910715	1.70E-02	880715	1.96E-03	5.91E-02
TO-ALDR	125	3.04E-04	3.60E-04	44	35	6.00E-06	890715	6.00E-06	890715	1.50E-03	900715	1.07E-04	5.29E-04
TO-BNZA	107	3.33E-03	2.90E-03	63	59	5.10E-04	910715	5.10E-04	910715	1.70E-02	880715	1.96E-03	5.91E-02
TO-CHLR	24			0	0								1.00E-02
TO-DIEL	125	5.12E-04	5.90E-04	94	75	1.90E-05	910715	1.90E-05	910715	3.40E-03	860715	3.85E-04	1.55E-03
TO-ENDO	24			0	0								1.00E-02
TO-ENDR	125	2.30E-06	1.50E-05	101	81	0.00E+00	860715	3.00E-06	910715	1.50E-04	920715	1.86E-06	1.15E-03
TO-FLRN	107	3.33E-03	2.90E-03	63	59	5.10E-04	910715	5.10E-04	910715	1.70E-02	880715	1.96E-03	5.91E-02
TO-NAPT	107	3.33E-03	2.90E-03	63	59	5.10E-04	910715	5.10E-04	910715	1.70E-02	880715	1.96E-03	1.07E+00
TO-TOXA	24			0	0								1.00E-01
TO-DDT	125	5.13E-04	7.00E-04	72	58	1.60E-05	930715	1.60E-05	930715	4.40E-03	890715	2.95E-04	2.23E-03
TO-PCB	24	4.38E-02	1.50E-01	24	100	0.00E+00	820125	4.40E-02	830310	7.70E-01	840712	4.38E-02	4.38E-02

Table 8-7
Systemwide summary time trends for oyster (code 04)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TOMETAS	771020	940818	840709	940818	11	-2.66E-02	1.40E+00	4.42E-01	0.99	-6.80E-02	1.40E-02	
TOMETCD	771020	940818	771020	940818	8.5	-7.07E-02	1.80E+00	6.47E-01	0.88	-1.00E-01	-3.80E-02	prob
TOMETCU	771020	940818	771020	940818	8.6	-9.06E-02	2.50E+01	1.90E+01	1.00	-1.00E+00	8.50E-01	
TOMETHG	771020	940818	771020	930715	7.2	3.75E-05	1.90E-02	1.41E-02	1.00	-8.80E-04	9.60E-04	poss
TOMETPB	771020	940818	771020	930715	6.6	-2.99E-02	4.60E-01	1.39E-01	0.82	-4.20E-02	-1.80E-02	prob
TOMETZN	800505	940818	800505	940818	10	1.94E+00	4.30E+02	4.54E+02	1.00	-2.10E+01	2.50E+01	poss
TO-ACEN	801211	930715	860715	930715	9	-1.19E-03	7.80E-03	2.14E-03	0.54	-1.50E-03	-8.70E-04	prob
TO-ALDR	800505	930927	880715	920715	11	5.89E-06	2.90E-04	3.62E-04	1.00	-8.50E-05	9.70E-05	poss
TO-BNZA	801211	930715	860715	930715	9	-1.19E-03	7.80E-03	2.14E-03	0.54	-1.50E-03	-8.70E-04	prob
TO-CHLR	800505	930927										
TO-DIEL	800505	930927	860715	930715	13	-1.41E-04	8.90E-04	5.22E-04	0.80	-2.00E-04	-8.30E-05	prob
TO-ENDO	800505	930927										
TO-ENDR	800505	930927	860715	930715	14	2.14E-06	-3.70E-06	1.49E-05	0.93	5.70E-07	3.70E-06	prob
TO-FLRN	801211	930715	860715	930715	9	-1.19E-03	7.80E-03	2.14E-03	0.54	-1.50E-03	-8.70E-04	prob
TO-NAPT	801211	930715	860715	930715	9	-1.19E-03	7.80E-03	2.14E-03	0.54	-1.50E-03	-8.70E-04	prob
TO-TOXA	800505	930927										
TO-DDT	800505	930927	860715	930715	10	7.58E-06	4.90E-04	7.03E-04	1.00	-8.10E-05	9.60E-05	poss
TO-PCB	800505	930927	800505	930927	1.8	-7.27E-04	4.70E-02	1.53E-01	1.00	-2.30E-02	2.10E-02	

Table 8-8
Systemwide summary statistics for blue crab (code 10)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*average with BDL=DL*
TFMETAS	14	0.72	0.33	3	21	0.26	940817	0.26	940817	1	840822	0.154	0.547
TFMETCD	35	0.507	0.31	24	69	0.15	820810	0.15	820810	1.7	840725	0.347	0.437
TFMETCU	35	12	7.2	35	100	4.4	820810	4.4	820810	33	840725	12	12
TFMETHG	35	0.0729	0.04	35	100	0.02	820810	0.02	820810	0.18	940817	0.0729	0.0729
TFMETPB	35	0.7	0.1	2	6	0.6	840706	0.6	840706	0.8	820210	0.04	0.62
TFMETZN	35	40.9	12	35	100	1	800708	1	800708	57	840725	40.9	40.9
TF-ACEN	0												
TF-ALDR	22			0									0.002
TF-BNZA	0												0
TF-CHLR	22	0.0265	0.011	2	9	0.016	840814	0.016	840814	0.037	840814	0.00241	0.0115
TF-DDT	22			0									0.01
TF-DIEL	22			0									0.006
TF-ENDO	22			0									0.01
TF-ENDR	22			0									0.006
TF-FLRN	0												
TF-NAPT	0												
TF-PCB	22	0.0206	0.069	22	100	0	800708	0.15	840712	0.3	840725	0.0206	0.0206
TF-TOXA	22	0	0	0	0	0	0	0	0	0	0	0	0.1
TSMETAS	53	4.88	4.1	34	64	0.43	890901	0.43	890901	23	890901	3.13	3.48
TSMETCD	53	0.394	0.26	37	70	0.089	890901	0.089	890901	1.3	890901	0.275	0.403
TSMETCU	53	13.5	5.1	50	94	0.93	890901	0.93	890901	23	890901	12.8	13
TSMETHG	53	0.0444	0.022	28	53	0.012	890901	0.012	890901	0.097	890901	0.0235	0.0614
TSMETPB	53	0.584	0.2	6	11	0.36	890901	0.36	890901	0.9	771020	0.0661	1.98
TSMETZN	51	30.7	19	51	100	15	890901	15	890901	150	890901	30.7	30.7
TS-ACEN	18			0									20
TS-ALDR	20			0									0.18
TS-BNZA	18			0									20

(continued)

Table 8-8
(continued)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*BDL=DL*
TS-CHLR	20			0									0.902
TS-DDT	2			0									0.01
TS-DIEL	20			0									0.451
TS-ENDO	0												
TS-ENDR	2			0									0.0065
TS-FLRN	18			0									20
TS-NAPT	18			0									20
TS-PCB	20	0.035	0	1	5	0.035	781130	0.035	781130	0.035	781130	0.00175	9
TS-TOXA	18			0									10

Table 8-9
Systemwide summary time trends for blue crab (code 10)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*resid varnc*	*95% conf bounds on slope*		*trend*
TFMETAS	840627	940817	840822	940817	0.3	-0.0692	0.95	0.0408	0.015	-0.18	0.041	poss
TFMETCD	800708	940817	800708	840822	5.8	0.0902	0.27	0.292	0.887	-0.021	0.2	poss
TFMETCU	800708	940817	800708	940817	2.5	-0.178	13	7.19	0.997	-1.3	0.89	
TFMETHG	800708	940817	800708	940817	2.5	0.00284	0.064	0.0399	0.974	-0.0031	0.0088	poss
TFMETPB	800708	940817	820210	840706	0.83							
TFMETZN	800708	940817	800708	940817	2.5	0.686	39	12	0.983	-1.1	2.5	poss
TF-ACEN												
TF-ALDR	800708	840814										
TF-BNZA												
TF-CHLR	800708	840814	840814	840814	2							
TF-DDT	800708	840814										
TF-DIEL	800708	840814										
TF-ENDO	800708	840814										
TF-ENDR	800708	840814										
TF-FLRN												
TF-NAPT												
TF-PCB	800708	840814	800708	840814	5.4	0.0124	-0.014	0.067	0.935	-0.0096	0.034	poss
TF-TOXA	800708	840814										
TSMETAS	771020	890901	781130	890901	3.2	0.209	2.7	4.11	0.992	-0.58	1	poss
TSMETCD	771020	890901	771020	890901	3.1	-0.0415	0.85	0.242	0.848	-0.074	-0.0087	prob
TSMETCU	771020	890901	771020	890901	4.2	0.661	7	4.75	0.856	0.2	1.1	prob
TSMETHG	771020	890901	771020	890901	2.4	-0.000983	0.055	0.0222	0.984	-0.0041	0.0021	
TSMETPB	771020	890901	771020	890901	0.51	-0.032	0.9	0.137	0.484	-0.075	0.011	poss
TSMETZN	840823	890901	840823	890901	10	-0.458	32	18.9	0.997	-2.7	1.8	

(continued)

Table 8-9
(continued)

Analyte	*Period of record*	*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*	*trend*
TS-ACEN	840823 841001									
TS-ALDR	771020 841001									
TS-BNZA	840823 841001									
TS-CHLR	771020 841001									
TS-DDT	771020 781130									
TS-DIEL	771020 841001									
TS-ENDO										
TS-ENDR	771020 781130									
TS-FLRN	840823 841001									
TS-NAPT	840823 841001									
TS-PCB	771020 841001	781130	781130	1						
TS-TOXA	840823 841001									

Table 8-10
Systemwide summary statistics for speckled trout (code 03)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*BDL=DL*
TFMETAS	7	0	0	0	0	0	0	0	0	0	0	0	0.443
TFMETCD	34	0.2	0	1	3	0.2	810317	0.2	810317	0.2	810317	0.00588	0.347
TFMETCU	34	0.889	1.2	18	53	0.3	801223	0.3	801223	4.5	800708	0.471	0.847
TFMETHG	35	0.159	0.11	35	100	0.04	820810	0.04	820810	0.57	800708	0.159	0.159
TFMETPB	34	1	0	1	3	1	810316	1	810316	1	810316	0.0294	0.9
TFMETZN	33	4.22	0.66	33	100	2.8	830608	2.8	830608	5.9	821109	4.22	4.22
TF-ACEN	0												
TF-ALDR	15			0	0								0.00193
TF-BNZA	0												
TF-CHLR	15			0	0								0.0107
TF-DDT	15			0	0								0.01
TF-DIEL	15			0	0								0.0058
TF-ENDO	14			0	0								0.01
TF-ENDR	15			0	0								0.0058
TF-FLRN	0												
TF-NAPT	0												
TF-PCB	15	0.0137	0.042	15	100	0	800708	0.04	781130	0.17	840713	0.0137	0.0137
TF-TOXA	14			0	0								0.1
TSMETAS	1			0	0								20
TSMETCD	1			0	0								0.2
TSMETCU	1			0	0								1
TSMETHG	1			0	0								5
TSMETPB	1			0	0								2
TSMETZN	1	11	0	1	100	11	930302	11	930302	11	930302	11	11

(continued)

Table 8-10
(continued)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*BDL=DL*
TS-ACEN	1			0	0								400
TS-ALDR	1			0	0								400
TS-BNZA	1			0	0								400
TS-CHLR	1			0	0								2000
TS-DDT	0												
TS-DIEL	1			0	0								400
TS-ENDO	1			0	0								400
TS-ENDR	1			0	0								400
TS-FLRN	1			0	0								400
TS-NAPT	1			0	0								400
TS-PCB	0												
TS-TOXA	1			0	0								400

Table 8-11
Systemwide summary time trends for speckled trout (code 03)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TFMETAS	840514	940817										
TFMETCD	800708	940817	810317	810317	1							
TFMETCU	800708	940817	800708	940817	1.3	-0.067	1	1.15	0.97	-0.27	0.13	
TFMETHG	800708	940817	800708	940817	2.5	0.00509	0.14	0.107	0.99	-0.01	0.02	poss
TFMETPB	800708	940817	810316	810316	1							
TFMETZN	800708	940817	800708	940817	2.3	0.0592	4.1	0.64	0.95	-0.033	0.15	poss
TF-ACEN												
TF-ALDR	781130	840713										
TF-BNZA												
TF-CHLR	781130	840713										
TF-DDT	781130	840713										
TF-DIEL	781130	840713										
TF-ENDO	800708	840713										
TF-ENDR	781130	840713										
TF-FLRN												
TF-NAPT												
TF-PCB	781130	840713	781130	840713	2.7	0.00737	-0.013	0.0408	0.95	-0.012	0.027	poss
TF-TOXA	800708	840713										
TSMETAS	930302	930302										
TSMETCD	930302	930302										
TSMETCU	930302	930302										
TSMETHG	930302	930302										
TSMETPB	930302	930302										
TSMETZN	930302	930302	930302	930302	1							

(continued)

Table 8-11
(continued)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*	*trend*
TS-ACEN	930302	930302									
TS-ALDR	930302	930302									
TS-BNZA	930302	930302									
TS-CHLR	930302	930302									
TS-DDT											
TS-DIEL	930302	930302									
TS-ENDO	930302	930302									
TS-ENDR	930302	930302									
TS-FLRN	930302	930302									
TS-NAPT	930302	930302									
TS-PCB											
TS-TOXA	930302	930302									

Table 8-12
Systemwide summary statistics for red drum (code 16)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*average with BDL=DL*
TFMETAS	7			0	0								0.443
TFMETCD	34	0.2	0	1	3	0.2	810317	0.2	810317	0.2	810317	0.00588	0.347
TFMETCU	34	0.889	1.2	18	53	0.3	801223	0.3	801223	4.5	800708	0.471	0.847
TFMETHG	35	0.159	0.11	35	100	0.04	820810	0.04	820810	0.57	800708	0.159	0.159
TFMETPB	34	1	0	1	3	1	810316	1	810316	1	810316	0.0294	0.9
TFMETZN	33	4.22	0.66	33	100	2.8	830608	2.8	830608	5.9	821109	4.22	4.22
TF-ACEN	0			0	0								
TF-ALDR	15			0	0								0.00193
TF-BNZA	0												
TF-CHLR	15			0	0								0.0107
TF-DDT	15			0	0								0.01
TF-DIEL	15			0	0								0.0058
TF-ENDO	14			0	0								0.01
TF-ENDR	15			0	0								0.0058
TF-FLRN	0												
TF-NAPT	0												
TF-PCB	15	0.0137	0.042	15	100	0	800708	0.04	781130	0.17	840713	0.0137	0.0137
TF-TOXA	14			0	0								0.1
TSMETAS	1			0	0								20
TSMETCD	1			0	0								0.2
TSMETCU	1			0	0								1
TSMETHG	1			0	0								5
TSMETPB	1			0	0								2
TSMETZN	1	11	0	1	100	11	930302	11	930302	11	930302	11	11

(continued)

Table 8-12
(continued)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*BDL=DL*
TS-ACEN	1			0	0								400
TS-ALDR	1			0	0								400
TS-BNZA	1			0	0								400
TS-CHLR	1			0	0								2000
TS-DDT	0												
TS-DIEL	1			0	0								400
TS-ENDO	1			0	0								400
TS-ENDR	1			0	0								400
TS-FLRN	1			0	0								400
TS-NAPT	1			0	0								400
TS-PCB	0												0
TS-TOXA	1			0	0								400

Table 8-13
Systemwide summary time trends for red drum (code 16)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TFMETAS	840514	940817										
TFMETAS	840514	940817										
TFMETCD	800708	940817	810317	810317	1							
TFMETCU	800708	940817	800708	940817	1.3	-0.067	1	1.15	0.969	-0.27	0.13	
TFMETHG	800708	940817	800708	940817	2.5	0.00509	0.14	0.107	0.987	-0.01	0.02	poss
TFMETPB	800708	940817	810316	810316	1							
TFMETZN	800708	940817	800708	940817	2.3	0.0592	4.1	0.64	0.951	-0.033	0.15	poss
TF-ACEN												
TF-ALDR	781130	840713										
TF-BNZA												
TF-CHLR	781130	840713										
TF-DDT	781130	840713										
TF-DIEL	781130	840713										
TF-ENDO	800708	840713										
TF-ENDR	781130	840713										
TF-FLRN												
TF-NAPT												
TF-PCB	781130	840713	781130	840713	2.7	0.00737	-0.013	0.0408	0.95	-0.012	0.027	poss
TF-TOXA	800708	840713										
TSMETAS	930302	930302										
TSMETCD	930302	930302										
TSMETCU	930302	930302										
TSMETHG	930302	930302										
TSMETPB	930302	930302										
TSMETZN	930302	930302	930302	930302	1							

(continued)

Table 8-13
(continued)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*	*trend*
TS-ACEN	930302	930302									
TS-ALDR	930302	930302									
TS-BNZA	930302	930302									
TS-CHLR	930302	930302									
TS-DDT											
TS-DIEL	930302	930302									
TS-ENDO	930302	930302									
TS-ENDR	930302	930302									
TS-FLRN	930302	930302									
TS-NAPT	930302	930302									
TS-PCB											
TS-TOXA	930302	930302									

Table 8-14
Systemwide summary statistics for black drum (code 15)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*average with BDL=DL*
TFMETAS	19	0.509	0.36	10	53	0.22	940817	0.22	940817	1.5	940817	0.268	0.505
TFMETCD	25			0	0								0.304
TFMETCU	25	0.701	0.35	14	56	0.28	820924	0.28	820924	1.4	800708	0.392	0.654
TFMETHG	24	0.119	0.056	24	100	0.04	840725	0.04	840725	0.21	940817	0.119	0.119
TFMETPB	25			0	0								0.912
TFMETZN	25	5.12	1.4	25	100	3.2	840816	3.2	840816	8.5	840627	5.12	5.12
TF-ACEN	0												
TF-ALDR	15			0	0								0.002
TF-BNZA	0												
TF-CHLR	15			0	0								0.01
TF-DDT	15			0	0								0.01
TF-DIEL	15			0	0								0.006
TF-ENDO	15			0	0								0.01
TF-ENDR	15			0	0								0.006
TF-FLRN	0												
TF-NAPT	0												
TF-PCB	15	0.00153	0.0057	15	100	0	800708	0.023	820924	0.023	820924	0.00153	0.00153
TF-TOXA	15			0	0								0.1
TSMETAS	1	0.9	0	1	100	0.9	781130	0.9	781130	0.9	781130	0.9	0.9
TSMETCD	1			0	0								0.2
TSMETCU	1	1.9	0	1	100	1.9	781130	1.9	781130	1.9	781130	1.9	1.9
TSMETHG	1	0.03	0	1	100	0.03	781130	0.03	781130	0.03	781130	0.03	0.03
TSMETPB	1			0	0								0.4
TSMETZN	0												

No data for whole body organic analytes (TS-parameter)

Table 8-15
Systemwide summary time trends for black drum (code 15)
(Parameter abbreviation definitions in Appendix A-3)

Analyte	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start date)*	*standard error*	*residl varnc*	*95% conf bounds on slope*		*trend*
TFMETAS	840514	940817										
TFMETAS	840627	940817	940816	940817	3700	42.2	0.44	0.358	0.98	-180	260	poss
TFMETCD	800708	940817										
TFMETCU	800708	940817	800708	940817	0.99	-0.0262	0.96	0.318	0.82	-0.062	0.0093	poss
TFMETHG	800708	940817	800708	940817	1.7	0.00929	0.047	0.0253	0.20	0.0072	0.011	prob
TFMETPB	800708	940817										
TFMETZN	800708	940817	800708	940817	1.8	0.0816	4.5	1.29	0.90	-0.022	0.19	poss
TF-ACEN												
TF-ALDR	800708	840814										
TF-BNZA												
TF-CHLR	800708	840814										
TF-DDT	800708	840814										
TF-DIEL	800708	840814										
TF-ENDO	800708	840814										
TF-ENDR	800708	840814										
TF-FLRN												
TF-NAPT												
TF-PCB	800708	840814	800708	840814	3.7	-0.00123	0.0055	0.00556	0.94	-0.0042	0.0017	
TF-TOXA	800708	840814										
TSMETAS	781130	781130	781130	781130	1							
TSMETCD	781130	781130										
TSMETCU	781130	781130	781130	781130	1							
TSMETHG	781130	781130	781130	781130	1							
TSMETPB	781130	781130										
TSMETZN												

No data for whole body organic analytes (TS-parameter)

Table 8-16
Oyster (Code 04) arsenic in tissue (TOMETAS), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	20	0.909	0.22	20	100.00	0.59	870715	1.6	930715	0.909	0.909
Aransas	2471	20	1.44	0.42	20	100.00	0.65	870715	2.1	860715	1.44	1.44
Copano	2472	21	1.12	0.29	19	90.48	0.14	920715	1.7	860715	1.02	1.06
Corpus Christi	2481	46	1.44	0.43	44	95.65	0.5	840709	2.4	880715	1.37	1.39
Nueces	2482	7	0.594	0.26	5	71.43	0.26	940817	0.95	890901	0.424	0.567
Redfish	2483	0										
Inner Harbor	2484	2	1.24	0	1	50.00	1.2	890901	1.2	890901	0.62	0.87
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	860715	930715	860715	930715	2.9	0.082	0.67	0.151	0.45	0.045	0.12	prob
Aransas	2471	860715	930715	860715	930715	2.9	0.00503	1.4	0.421	1.00	-0.098	0.11	poss
Copano	2472	840626	920715	860715	920715	3.2	-0.0974	1.4	0.23	0.62	-0.16	-0.033	prob
Corpus Christi	2481	840706	930715	840709	930715	4.9	-0.00184	1.4	0.428	1.00	-0.068	0.064	
Nueces	2482	840712	940818	890901	940818	1	-0.1	0.79	0.0876	0.12	-0.17	-0.034	prob
Redfish	2483												
Inner Harbor	2484	771020	890901	890901	890901	1							
Upper Laguna	2491												
Baffin	2492												

Table 8-17
Oyster (Code 04) cadmium in tissue (TOMETCD),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	28	0.802	0.33	28	100	0.36	930715	1.9	920715	0.802	0.802
Aransas	2471	28	0.724	0.23	28	100	0.019	920715	1.1	860715	0.724	0.724
Copano	2472	25	1.31	0.51	25	100	0.44	920715	2.2	900715	1.31	1.31
Corpus Christi	2481	46	0.86	0.36	46	100	0.39	880715	1.9	870715	0.86	0.86
Nueces	2482	14	2.47	1	14	100	1.1	890901	4.1	800505	2.47	2.47
Redfish	2483	0										
Inner Harbor	2484	2	1.28	0.025	2	100	1.3	890901	1.3	771020	1.28	1.28
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	930715	820810	930715	2.6	0.00364	0.78	0.329	1.00	-0.036	0.043	poss
Aransas	2471	820125	930715	820125	930715	2.4	-0.0443	0.97	0.185	0.63	-0.067	-0.021	prob
Copano	2472	820125	920715	820125	920715	2.4	0.0373	1.1	0.494	0.95	-0.033	0.11	poss
Corpus Christi	2481	840706	930715	840706	930715	5.1	-0.0739	1.2	0.322	0.80	-0.12	-0.029	prob
Nueces	2482	800505	940818	800505	940818	0.98	-0.133	3.2	0.792	0.61	-0.24	-0.029	prob
Redfish	2483												
Inner Harbor	2484	771020	890901	771020	890901	0.17							
Upper Laguna	2491												
Baffin	2492												

Table 8-18
Oyster (Code 04) copper in tissue (TOMETCU),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	28	17.1	6.9	28	100	3.5	910715	30	830621	17.1	17.1
Aransas	2471	28	17.8	8.5	28	100	3	910715	31	830927	17.8	17.8
Copano	2472	25	29.7	13	25	100	8.9	920715	54	880715	29.7	29.7
Corpus Christi	2481	46	21.5	10	46	100	8.8	840706	48	880715	21.5	21.5
Nueces	2482	14	41.7	16	14	100	23	830310	72	940818	41.7	41.7
Redfish	2483	0										
Inner Harbor	2484	2	104	87	2	100	17	771020	190	890901	104	104
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	930715	820810	930715	2.6	-1.19	23	5.55	0.66	-1.9	-0.53	prob
Aransas	2471	820125	930715	820125	930715	2.4	-1.8	28	6.2	0.53	-2.6	-1	prob
Copano	2472	820125	920715	820125	920715	2.4	-0.0714	30	13.4	1.00	-2	1.8	
Corpus Christi	2481	840706	930715	840706	930715	5.1	0.39	20	10.3	0.99	-1	1.8	poss
Nueces	2482	800505	940818	800505	940818	0.98	2.53	28	10.3	0.42	1.2	3.9	prob
Redfish	2483												
Inner Harbor	2484	771020	890901	771020	890901	0.17							
Upper Laguna	2491					0							
Baffin	2492					0							

Table 8-19
Oyster (Code 04) mercury in tissue (TOMETHG),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No. of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	28	0.0112	0.0059	20	71	0.0018	870715	0.025	930715	0.00797	0.0137
Aransas	2471	28	0.0158	0.0061	20	71	0.0015	870715	0.027	880715	0.0113	0.0163
Copano	2472	25	0.0255	0.013	20	80	0.01	820125	0.064	870715	0.0204	0.0316
Corpus Christi	2481	46	0.0174	0.0076	43	93	0.0035	870715	0.031	880715	0.0163	0.0172
Nueces	2482	14	0.0351	0.032	10	71	0.01	830310	0.12	890901	0.0251	0.0294
Redfish	2483	0										
Inner Harbor	2484	2	0.01	0	1	50	0.01	771020	0.01	771020	0.005	0.02
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	930715	860715	930715	2.9	0.000697	0.0091	0.00568	0.94	-0.00069	0.0021	poss
Aransas	2471	820125	930715	820125	930715	1.7	0.000552	0.012	0.0059	0.95	-0.00059	0.0017	poss
Copano	2472	820125	920715	820125	920715	1.9	-0.000587	0.03	0.0133	0.99	-0.0034	0.0022	
Corpus Christi	2481	840706	930715	840709	930715	4.8	-0.000292	0.019	0.00755	0.99	-0.0015	0.00088	
Nueces	2482	800505	940818	800505	890901	1.1	0.0055	0.012	0.0248	0.60	-0.0000087	0.011	poss
Redfish	2483												
Inner Harbor	2484	771020	890901	771020	771020	1							
Upper Laguna	2491												
Baffin	2492												

Table 8-20
Oyster (Code 04) lead in tissue (TOMETPB),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	28	0.0652	0.025	20	71	0.028	870715	0.13	930715	0.0466	0.204
Aransas	2471	28	0.0737	0.027	20	71	0.029	890715	0.14	880715	0.0527	0.224
Copano	2472	25	0.0954	0.035	19	76	0.048	880715	0.18	910715	0.0725	0.213
Corpus Christi	2481	46	0.131	0.11	43	93	0.048	880715	0.7	840709	0.122	0.209
Nueces	2482	14			0	0					0	0.5
Redfish	2483	0										
Inner Harbor	2484	2	0.951	0.45	2	100	0.5	890901	1.4	771020	0.951	0.951
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	930715	860715	930715	2.9	0.00677	0.046	0.021	0.70	0.0016	0.012	prob
Aransas	2471	820125	930715	860715	930715	2.9	0.00347	0.064	0.0257	0.93	-0.0028	0.0098	poss
Copano	2472	820125	920715	860715	920715	3.2	0.00942	0.07	0.0306	0.76	0.00091	0.018	prob
Corpus Christi	2481	840706	930715	840709	930715	4.8	-0.0121	0.19	0.109	0.96	-0.03	0.0058	poss
Nueces	2482	800505	940818										
Redfish	2483												
Inner Harbor	2484	771020	890901	771020	890901	0.17							
Upper Laguna	2491												
Baffin	2492												

Table 8-21
Oyster (Code 04) zinc in tissue (TOMETZN),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	28	98.5	35	28	100	28	910715	190	930715	98.5	98.5
Aransas	2471	28	206	180	28	100	27	910715	820	890715	206	206
Copano	2472	25	198	73	25	100	58	920715	350	880715	198	198
Corpus Christi	2481	46	623	220	46	100	140	890715	1000	880715	623	623
Nueces	2482	14	1440	470	14	100	870	890901	2500	940818	1440	1440
Redfish	2483	0										
Inner Harbor	2484	1	1660	0	1	100	1700	890901	1700	890901	1660	1660
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	930715	820810	930715	2.6	-1.8	110	34.3	0.97	-5.9	2.3	
Aransas	2471	820125	930715	820125	930715	2.4	-5.72	240	179	0.99	-28	17	
Copano	2472	820125	920715	820125	920715	2.4	-3.05	220	72.3	0.98	-13	7.2	
Corpus Christi	2481	840706	930715	840706	930715	5.1	32.9	480	211	0.90	3.6	62	prob
Nueces	2482	800505	940818	800505	940818	0.98	39.7	1200	429	0.83	-16	96	poss
Redfish	2483												
Inner Harbor	2484	890901	890901	890901	890901	1							
Upper Laguna	2491												
Baffin	2492												

Table 8-22
Oyster (Code 04) PCB's in tissue (TO-PCB),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	4	0	0	4	100						
Aransas	2471	6	0	0	6	100						
Copano	2472	5	0	0	5	100						
Corpus Christi	2481	3	0	0	3	100						
Nueces	2482	6	0.175	0.27	6	100	0.044	830310	0.77	840712	0.175	0.175
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	820810	830622	820810	830622	4.6							
Aransas	2471	820125	930927	820125	930927	0.51							
Copano	2472	820125	840626	820125	840626	2.1							
Corpus Christi	2481	840706	840709	840706	840709	370							
Nueces	2482	800505	840712	800505	840712	1.4	0.0938	-0.075	0.231	0.75	-0.13	0.32	poss
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491												
Baffin	2492												

Table 8-23
Blue crab (Code 10) arsenic in whole organism (TSMETAS), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14	0	0		0	1					
Aransas	2471	0										
Copano	2472	0										
Corpus Christi	2481	14	3.82	1.8	14	100	1.5	890901	6.4	890901	3.82	3.82
Nueces	2482	3	1.72	0.32	3	100	1.5	890901	2.2	890901	1.72	1.72
Redfish	2483	2	2.96	0.55	2	100	2.4	890901	3.5	890901	2.96	2.96
Inner Harbor	2484	3	2.64	0.065	2	67	2.6	890901	2.7	781130	1.76	1.92
Upper Laguna	2491	5	10.4	7	5	100	3	890901	23	890901	10.4	10.4
Baffin	2492	5	5.82	0.86	5	100	4.6	890901	6.9	890901	5.82	5.82

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463	840823	841001									
Aransas	2471											
Copano	2472											
Corpus Christi	2481	890901	890901	890901	890901	14						
Nueces	2482	890901	890901	890901	890901	3						
Redfish	2483	890901	890901	890901	890901	2						
Inner Harbor	2484	771020	890901	781130	890901	0.19		0	2.7			
Upper Laguna	2491	890901	890901	890901	890901	5						
Baffin	2492	890901	890901	890901	890901	5						

Table 8-24
Blue crab (Code 10) cadmium in whole organism (TSMETCD), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14	0.82	0.075	5	36	0.7	841001	0.9	841001	0.293	0.614
Aransas	2471	0										
Copano	2472	0										
Corpus Christi	2481	14	0.269	0.11	13	93	0.089	890901	0.47	890901	0.249	0.252
Nueces	2482	3	0.416	0.033	3	100	0.38	890901	0.46	890901	0.416	0.416
Redfish	2483	2	0.273	0.11	2	100	0.16	890901	0.39	890901	0.273	0.273
Inner Harbor	2484	3	0.433	0.13	2	67	0.3	771020	0.57	890901	0.288	0.355
Upper Laguna	2491	5	0.536	0.4	5	100	0.12	890901	1.3	890901	0.536	0.536
Baffin	2492	5	0.267	0.092	4	80	0.16	890901	0.41	890901	0.214	0.22

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463	840823	841001	841001	841001	5						
Aransas	2471					0						
Copano	2472					0						
Corpus Christi	2481	890901	890901	890901	890901	13						
Nueces	2482	890901	890901	890901	890901	3						
Redfish	2483	890901	890901	890901	890901	2						
Inner Harbor	2484	771020	890901	771020	890901	0.17		0	0.3			
Upper Laguna	2491	890901	890901	890901	890901	5						
Baffin	2492	890901	890901	890901	890901	4						

Table 8-25
Blue crab (Code 10) copper in whole organism (TSMETCU), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14	10.8	3	11	79	5.7	841001	15	841001	8.51	9.59
Aransas	2471	0										
Copano	2472	0										
Corpus Christi	2481	14	17.5	4.6	14	100	7.4	890901	23	890901	17.5	17.5
Nueces	2482	3	13.9	3.7	3	100	11	890901	19	890901	13.9	13.9
Redfish	2483	2	18.9	2	2	100	17	890901	21	890901	18.9	18.9
Inner Harbor	2484	3	10.7	3.7	3	100	7.5	781130	16	890901	10.7	10.7
Upper Laguna	2491	5	12.4	3.9	5	100	7.7	890901	18	890901	12.4	12.4
Baffin	2492	5	10.4	6.3	5	100	0.93	890901	21	890901	10.4	10.4

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	840823	841001	840823	841001	100	39.5	7	2.72	0.83	-27	110	poss
Aransas	2471												
Copano	2472												
Corpus Christi	2481	890901	890901	890901	890901	14							
Nueces	2482	890901	890901	890901	890901	3							
Redfish	2483	890901	890901	890901	890901	2							
Inner Harbor	2484	771020	890901	771020	890901	0.25	0.682	7.7	0.761	0.04	-1.1	2.5	poss
Upper Laguna	2491	890901	890901	890901	890901	5							
Baffin	2492	890901	890901	890901	890901	5							

Table 8-26
Blue crab (Code 10) mercury in whole organism (TSMETHG),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No. of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14			0	0					0	0.1
Aransas	2471											
Copano	2472											
Corpus Christi	2481	14	0.0531	0.021	11	79	0.018	890901	0.097	890901	0.0417	0.0481
Nueces	2482	3	0.0506	0.027	3	100	0.016	890901	0.082	890901	0.0506	0.0506
Redfish	2483	2	0.0123	0	1	50	0.012	890901	0.012	890901	0.00615	0.0212
Inner Harbor	2484	3	0.0448	0.015	3	100	0.024	890901	0.06	781130	0.0448	0.0448
Upper Laguna	2491	5	0.0285	0.011	5	100	0.018	890901	0.044	890901	0.0285	0.0285
Baffin	2492	5	0.0326	0.0077	3	60	0.026	890901	0.043	890901	0.0196	0.0316

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	840823	841001										
Aransas	2471												
Copano	2472												
Corpus Christi	2481	890901	890901	890901	890901	11							
Nueces	2482	890901	890901	890901	890901	3							
Redfish	2483	890901	890901	890901	890901	1							
Inner Harbor	2484	771020	890901	771020	890901	0.25	-0.00263	0.056	0.00529	0.12	-0.015	0.0099	
Upper Laguna	2491	890901	890901	890901	890901	5							
Baffin	2492	890901	890901	890901	890901	3							

Table 8-27
Blue crab (Code 10) lead in whole organism (TSMETPB),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14			0	0					0	5
Aransas	2471											
Copano	2472											
Corpus Christi	2481	14	0.67	0	1	7	0.67	890901	0.67	890901	0.0479	0.419
Nueces	2482	3			0	0					0	0.4
Redfish	2483	2	0.391	0	1	50	0.39	890901	0.39	890901	0.196	0.396
Inner Harbor	2484	3	0.814	0.086	2	67	0.73	890901	0.9	771020	0.542	0.676
Upper Laguna	2491	5	0.458	0	1	20	0.46	890901	0.46	890901	0.0916	0.412
Baffin	2492	5	0.356	0	1	20	0.36	890901	0.36	890901	0.0712	0.391

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463	840823	841001			0						
Aransas	2471					0						
Copano	2472					0						
Corpus Christi	2481	890901	890901	890901	890901	1						
Nueces	2482	890901	890901									
Redfish	2483	890901	890901	890901	890901	1						
Inner Harbor	2484	771020	890901	771020	890901	0.17		0	0.9			
Upper Laguna	2491	890901	890901	890901	890901	1						
Baffin	2492	890901	890901	890901	890901	1						

Table 8-28
Blue crab (Code 10) zinc in whole organism (TSMETZN), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No. of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14	33	9.2	14	100	23	841001	58	840823	33	33
Aransas	2471	0										
Copano	2472	0										
Corpus Christi	2481	14	28.8	9.7	14	100	15	890901	46	890901	28.8	28.8
Nueces	2482	3	26.6	3.8	3	100	23	890901	32	890901	26.6	26.6
Redfish	2483	2	23.3	5.3	2	100	18	890901	29	890901	23.3	23.3
Inner Harbor	2484	1	33.1	0	1	100	33	890901	33	890901	33.1	33.1
Upper Laguna	2491	5	24.6	8.8	5	100	16	890901	36	890901	24.6	24.6
Baffin	2492	5	45.4	52	5	100	15	890901	150	890901	45.4	45.4

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	840823	841001	840823	841001	130	-157	45	5.13	0.31	-220	-90	prob
Aransas	2471												
Copano	2472												
Corpus Christi	2481	890901	890901	890901	890901	14							
Nueces	2482	890901	890901	890901	890901	3							
Redfish	2483	890901	890901	890901	890901	2							
Inner Harbor	2484	890901	890901	890901	890901	1							
Upper Laguna	2491	890901	890901	890901	890901	5							
Baffin	2492	890901	890901	890901	890901	5							

Table 8-29
Blue crab (Code 10) PCB's in whole organism (TS-PCB),
status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	14			0	0					0	10
Aransas	2471	0										
Copano	2472	0										
Corpus Christi	2481	0										
Nueces	2482	0										
Redfish	2483	0										
Inner Harbor	2484	2	0.035	0	1	50	0.035	781130	0.035	781130	0.0175	0.0275
Upper Laguna	2491	0										
Baffin	2492	0										

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463	840823	841001									
Aransas	2471											
Copano	2472											
Corpus Christi	2481											
Nueces	2482											
Redfish	2483											
Inner Harbor	2484	771020	781130	781130	781130	1						
Upper Laguna	2491											
Baffin	2492											

Table 8-30
Black drum (Code 15) arsenic in filet (TFMETAS), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	0										
Aransas	2471	1			0	0					0	0.5
Copano	2472	2			0	0					0	0.5
Corpus Christi	2481	3			0	0					0	0.5
Nueces	2482	11	0.509	0.36	10	91	0.22	940817	1.5	940817	0.463	0.508
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	0										
Baffin	2492	2			0	0					0	0.5

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463												
Aransas	2471	840725	840725										
Copano	2472	840627	840627										
Corpus Christi	2481	840706	840710										
Nueces	2482	840713	940817	940816	940817	3700	42.2	0.44	0.358	0.98	-180	260	poss
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491												
Baffin	2492	840817	840817										

Table 8-31
Black drum (Code 15) cadmium in filet (TFMETCD), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	0										
Aransas	2471	1			0	0					0	0.4
Copano	2472	2			0	0					0	0.4
Corpus Christi	2481	3			0	0					0	0.4
Nueces	2482	15	0	0	0	0					0	0.253
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	1			0	0					0	0.2
Baffin	2492	3			0	0					0	0.4

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463											
Aransas	2471	840725	840725									
Copano	2472	840627	840627									
Corpus Christi	2481	840706	840710									
Nueces	2482	820923	940817									
Redfish	2483											
Inner Harbor	2484											
Upper Laguna	2491	800708	800708									
Baffin	2492	840816	840817									

Table 8-32
Black drum (Code 15) copper in filet (TFMETCU), status & trends statistics by major bay regions

Summary statistics

Bay	*TNRCC seg*	*No.of obs*	*Avg >DL*	*Std devn >DL*	*No. >DLs*	*% > DLs*	*Min >0*	*date*	*Max*	*date*	*average with BDL=0*	*average with BDL=DL*
Mesquite	2463	0										
Aransas	2471	1			0	0					0	0.7
Copano	2472	2			0	0					0	0.7
Corpus Christi	2481	3	1.1	0	1	33	1.1	840706	1.1	840706	0.367	0.833
Nueces	2482	15	0.555	0.23	11	73	0.28	820924	1	940817	0.407	0.517
Redfish	2483											
Inner Harbor	2484											
Upper Laguna	2491	1	1.4	0	1	100	1.4	800708	1.4	800708	1.4	1.4
Baffin	2492	3	1.2	0	1	33	1.2	840816	1.2	840816	0.4	0.867

Time trends

Bay	*TNRCC seg*	*Period of record*		*Start date*	*End date*	*avg obs /yr*	*slope (/yr)*	*intcp (at start)*	*stnd error*	*residl varnc*	*95% conf bounds on slope*		*trend*
Mesquite	2463												
Aransas	2471	840725	840725										
Copano	2472	840627	840627										
Corpus Christi	2481	840706	840710	840706	840706	1							
Nueces	2482	820923	940817	820924	940817	0.92	0.0165	0.39	0.219	0.893	-0.019	0.052	poss
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491	800708	800708	800708	800708	1							
Baffin	2492	840816	840817	840816	840816	1							

Table 8-33
Black drum (Code 15) mercury in filet (TFMETHG), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	0										
Aransas	2471	1	0.04	0	1	100	0.04	840725	0.04	840725	0.04	0.04
Copano	2472	2	0.11	0.01	2	100	0.1	840627	0.12	840627	0.11	0.11
Corpus Christi	2481	3	0.06	0.0082	3	100	0.05	840706	0.07	840710	0.06	0.06
Nueces	2482	14	0.153	0.048	14	100	0.06	840713	0.21	940817	0.153	0.153
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	1	0.06	0	1	100	0.06	800708	0.06	800708	0.06	0.06
Baffin	2492	3	0.0763	0.017	3	100	0.06	840817	0.099	840816	0.0763	0.0763

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463												
Aransas	2471	840725	840725	840725	840725	1							
Copano	2472	840627	840627	840627	840627	2							
Corpus Christi	2481	840706	840710	840706	840710	270	1.37	0.055	0.00408	0.25	-8.7	11	poss
Nueces	2482	820923	940817	820923	940817	1.2	0.0081	0.083	0.0236	0.24	0.0052	0.011	prob
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491	800708	800708	800708	800708	1							
Baffin	2492	840816	840817	840816	840817	1100	-12.4	0.099	0.00408	0.06	-53	28	poss

Table 8-34
Black drum (Code 15) lead in filet (TFMETPB), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	0										
Aransas	2471	1			0	0					0	0.7
Copano	2472	2			0	0					0	1.8
Corpus Christi	2481	3			0	0					0	1.03
Nueces	2482	15			0	0					0	0.807
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	1			0	0					0	0.4
Baffin	2492	3			0	0					0	0.967

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope	trend
Mesquite	2463											
Aransas	2471	840725	840725									
Copano	2472	840627	840627									
Corpus Christi	2481	840706	840710									
Nueces	2482	820923	940817									
Redfish	2483											
Inner Harbor	2484											
Upper Laguna	2491	800708	800708									
Baffin	2492	840816	840817									

Table 8-35
Black drum (Code 15) zinc in filet (TFMETZN), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	0										
Aransas	2471	1	3.4	0	1	100	3.4	840725	3.4	840725	3.4	3.4
Copano	2472	2	6.4	2.1	2	100	4.3	840627	8.5	840627	6.4	6.4
Corpus Christi	2481	3	4.7	0.67	3	100	4	840706	5.6	840710	4.7	4.7
Nueces	2482	15	5.34	1.3	15	100	3.8	940816	8.2	940817	5.34	5.34
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	1	4.4	0	1	100	4.4	800708	4.4	800708	4.4	4.4
Baffin	2492	3	4.37	0.94	3	100	3.2	840816	5.5	840817	4.37	4.37

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463												
Aransas	2471	840725	840725	840725	840725	1							
Copano	2472	840627	840627	840627	840627	2							
Corpus Christi	2481	840706	840710	840706	840710	270	123	4.3	0.204	0.093	-380	620	poss
Nueces	2482	820923	940817	820923	940817	1.3	0.0795	4.7	1.19	0.884	-0.052	0.21	poss
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491	800708	800708	800708	800708	1							
Baffin	2492	840816	840817	840816	840817	1100	639	3.2	0.449	0.229	-3800	5100	poss

Table 8-36
Black drum (Code 15) PCB's in filet (TF-PCB), status & trends statistics by major bay regions

Summary statistics

Bay	TNRCC seg	No.of obs	Avg >DL	Std devn >DL	No. >DLs	% > DLs	Min >0	date	Max	date	average with BDL=0	average with BDL=DL
Mesquite	2463	2			2	100						
Aransas	2471	1			1	100						
Copano	2472	2			2	100						
Corpus Christi	2481	3			3	100						
Nueces	2482	4	0.00575	0.01	4	100	0.023	820924	0.023	820924	0.00575	0.00575
Redfish	2483	0										
Inner Harbor	2484	0										
Upper Laguna	2491	1			1	100						
Baffin	2492	2			2	100						

Time trends

Bay	TNRCC seg	Period of record		Start date	End date	avg obs /yr	slope (/yr)	intcp (at start)	stnd error	residl varnc	95% conf bounds on slope		trend
Mesquite	2463	830622	830622	830622	830622	2							
Aransas	2471	840725	840725	840725	840725	1							
Copano	2472	840627	840627	840627	840627	2							
Corpus Christi	2481	840706	840710	840706	840710	270							
Nueces	2482	820923	840713	820923	840713	2.2	-0.00424	0.0077	0.00939	0.89	-0.041	0.032	
Redfish	2483												
Inner Harbor	2484												
Upper Laguna	2491	800708	800708	800708	800708	1							
Baffin	2492	840814	840814	840814	840814	2							

9. CONTROLS AND CORRELATES

Following the compilation of a comprehensive long-term data base for key water quality parameters, and the statistical analysis of that data base to characterize the spatio-temporal variation in water quality of the Corpus Christi Bay system, the next logical step is to attempt to infer cause-and-effect relations, either between the quality variables or between a given variable and external controls on the system. A thorough exploration of cause-and-effect hypotheses would exceed the resources of this project. Indeed, the prime objective of this project is to accomplish the data compilation, which will support such cause-and-effect studies by future researchers. Nevertheless, several straightforward evaluations are possible and useful in interpreting the results of the preceding chapters.

Generally, the processes affecting a water quality indicator may be categorized as kinetics and transport. Kinetics refers to the complex of processes that directly affect the concentration of the parameter at a point in space, including physico-chemical reactions and biological interactions, also referred to as "source-sink" processes. Transport refers to the complex of processes that affect point concentration by the movement of water masses. Transport includes the various mechanisms of circulation and dispersion responsible for the intermixing of estuary and Gulf waters (the so-called "flushing" of the estuary). The more prominent of these are reviewed in the first section below, with specific attention given freshwater inflow and density variation as controls.

Any waterborne property, including the water-quality indicators of this study, is affected by transport; the concern is the additional effect of kinetics and its relative magnitude compared to transport. A relative evaluation is based upon the rate coefficients governing the kinetics to which the property is subjected, and the proximity and significance of any boundary feature which creates a gradient in concentration within the system. Table 9-1 summarizes typical magnitudes for kinetic processes affecting important or representative water-quality parameters. The higher the kinetic rate, the more important kinetic processes are inclined to be, relative to transport processes. On the other hand, in the vicinity of a steep concentration gradient—e.g., in proximity to an outfall containing high concentrations of the parameter of concern—transport processes can become locally dominant. In the present context, the emphasis is on large-scale variations in the Corpus Christi Bay complex, not the small-scale neighborhoods of point sources.

From Table 9-1, it is apparent that salinity, mercury, and PCB's are virtually conservative, while DO, temperature, coliforms, PAH's and Aldrin are very reactive. Therefore, we would expect that the horizontal gradients of salinity and metals would be governed by boundary fluxes and internal transports, while DO, temperature, coliforms, etc., are more influenced by point processes and much less by boundary fluxes. This indeed is the case. Salinity, for example, is determined by the interplay of boundary fluxes—freshwater inflow and the Gulf of Mexico salinity regime—and the various mechanisms of internal hydrographic transport. Temperature and DO, on the other hand, are dominated by seasonal

TABLE 9-1
Typical rate coefficients for representative water quality parameters, from Ward and Armstrong (1992a)

parameter	*process*	*rate coefficient (day^{-1})*
salinity	increase by evaporation	0.002
temperature	radiation	0.3
dissolved oxygen	aeration	0.5
ammonia-nitrogen	nitrification	0.1
suspended particulates	settling	
fine sand, 100 μm		300
fine silt, 10 μm		5
medium clay, 1 μm		0.05
coliforms	die-off in open water	1
mercury	aquatic metabolism	0.001
PAH's	volatilization	1
DDT	volatilization	0.1
	hydrolysis	0.01
Aldrin	volatilization	1
PCB's	photolysis	0.01

meteorology—winds, air temperature, etc.—and much less by the effect of inflow and exchange with the Gulf of Mexico. (These nominal reaction rates, it should be noted, are with respect to the vertical-mean concentration. For such averaging, true conservative parameters, such as salinity and suspended sediment, and nearly conservative parameters, such as temperature, exhibit an *effective* reaction due to vertical transport processes, as characterized by the indicated rate coefficient. For example, evaporation, a volume flux of water from the upper boundary acts as an effective source of vertical-mean salinity.)

Kinetics and transport processes may be termed "internal controls" on water/sediment concentrations, in that they operate within the interior of the estuary fluid volume. In contrast, "external controls" are those physicochemical factors that are applied around the periphery of the estuary, creating internal responses that are manifested as distributions of water/sediment indicators. Alternative terms for these external controls are "external forcing" or "boundary conditions." Interpretation of the behavior of a water/sediment constituent in any watercourse requires knowledge of both internal controls and external controls. For an

estuary, Corpus Christi Bay included, the transitional nature of the system makes external controls especially important.

9.1 External Controls

9.1.1 Overview

The two most important classes of external controls are hydrography and loadings. The former refers to the hydrodynamic forcing of the estuary. For convenience, we include climatological forcing in this category, because atmospheric variables achieve both climatological and hydrographic forcing. The latter refers to influxes of constituents that are indicators of water/sediment quality in their own right, or, through kinetic processes, have a direct influence on such indicators.

Hydrography of the Corpus Christi Bay system, like most estuaries, is principally governed by four physical factors: tides, meteorology, density currents and freshwater inflow. Each of these is highly variable in time and the character of the bay depends upon their relative predominance. Thus, the hydrography of the bay varies from season to season and year to year, and frequently on even abrupt time scales. The hydrography of Gulf coast estuaries is surveyed in Ward (1980a) and Ward and Montague (1996), and references therein, and the hydrography of Corpus Christi Bay in particular is addressed in TDWR (1981) and Orlando et al. (1993).

The most obvious marine influence is the tide. In the Texas Gulf coast area, the principal astronomical determinant for tidal variability is the declination of the moon. At great declination, the tide is predominantly diurnal and of maximum range, while at small declination, the diurnal component disappears so that the tide becomes semi-diurnal and of minimum range. Tidal range on the Gulf of Mexico shoreface in the vicinity of Corpus Christi Bay is typically on the order of 0.8 m during the diurnal mode of the tide. As the tide propagates into Corpus Christi Bay it is lagged in phase and attenuated in amplitude. The extreme constriction of the tidal passes reduces the tidal amplitude and significantly filters the semidiurnal component. Within the even more constricted areas of the interior bays, such as the Laguna Madre, even the diurnal component is significantly filtered. The tide is manifested in the inlets and lower segments of the bay as a progressive long wave. Within the bay, the effects of constraining physiography introduces a standing-wave component; indeed, in the open main body of Corpus Christi Bay, the tide becomes predominantly a standing wave.

These observations are relative to variation over a tidal cycle and do not represent the total excursion in water level in Corpus Christi Bay. During the cycle of lunar declination, there is also a storage and depletion of water within the system, with generally higher mean water levels during the semidiurnal phase, producing a fortnightly periodicity. In the Gulf there is a longer-term secular rise and fall in water levels, partly astronomical in origin, but mainly climatological. The seasonal meteorology leads to a characteristic annual variation in water levels

along the nearshore Gulf of Mexico, bimodal along the Texas coast with maxima in spring and fall, and minima in winter and summer. The winter minimum and fall maximum dominate this pattern in the Corpus Christi region, with a net range on the order of 0.3 m, but with year-to-year variability in this range. Illustrative of the western Gulf secular variation is the long-term mean range in the *monthly mean* tide record at Galveston is from -2.8 to +1.8 ft NGVD (Harris, 1981), which includes both astronomical and meteorological effects. Further, meteorological systems can induce shorter term fluctuations in Gulf water levels, so-called "wind tides" described further below.

While the tide is the most obvious marine influence on Corpus Christi Bay, the most obvious freshwater influence is the inflows of the principal rivers. The predominant source of freshwater inflow to the main body of Corpus Christi Bay is the Nueces River, comprising the majority of inflow to the system. The freshwater inflow is responsible for the estuarine character of Corpus Christi Bay, in diluting ocean water and establishing a gradient in salinity across the system. Inflow has a twofold importance to this study, in that it is a primary control on transport and mixing, and is also an important source of external loadings. Inflow is also important analytically, because there is an extended detailed time record of measurements available for the system, which can in principle be combined with the water quality data of this project. The analysis and behavior of inflow are therefore treated in more detail in Section 9.1.2 below.

In addition to tides and inflows, the atmosphere (in which we include insolation) has a significant influence on Corpus Christi Bay. The atmosphere governs the heat budget of the estuary waters, and thus the magnitude and seasonal progression of water temperatures. Evaporation from the surface, controlled by humidity, temperature and wind, is a significant element in the water budget. From a hydrographic viewpoint, wind forcing is the most important meteorological influence. Due to the broad, shallow physiography of the bay, as well as the dynamic meteorological regimes of the area, the bay is very responsive to wind forcing. This response is manifested in three general ways: the development of windwaves, the generation of internal wind-driven circulations, and the excursions in water level. Windwaves are important from the standpoint of creating intense vertical mixing, and thus vertical near-homogeneity of waterborne constituents, especially in the shallow portions of the system. Windwaves also aerate the water column. Wind-driven circulations are to be expected due to the relatively steady prevailing winds in combination with the morphology of the bay, but there is little quantitative information available concerning theses circulations. (Their existence is predicted by dynamical models, but the accuracy of these predictions is dubious without field validation.) For other Texas estuaries such wind-driven circulations have been documented by observations, for instance in Galveston Bay and Sabine Lake.

Perhaps the most dramatic meteorological effect is that of denivellation, i.e. meteorologically forced variations in water level. Indeed, in Corpus Christi Bay, it is meteorology, not the tide, which is the dominant factor governing the day-to-day excursions in water level. Part of this is the general response of the northwestern Gulf of Mexico to the imposed windstress of southeasterly winds

about the Bermuda High and northerlies associated with midlatitude synoptic disturbances, which is communicated through the inlets of Corpus Christi Bay. Within the bay, meteorological systems affect the water-level variation even more, mainly due to constrictions of land boundaries. Strong onshore winds can "setup" water levels in the upper bay. North winds, especially following vigorous frontal passages, can induce dramatic "setdown," and are capable of evacuating a significant portion of the bay volume in a few hours. (For bays on the upper Texas coast, with more open inlets, as much as half of the volume of the bay can be evacuated, see Ward, 1980a, 1980b.) Even modest weather systems significantly perturb water levels to the point that the astronomical tide is obliterated. This is especially true in the inland or isolated reaches of the bays, such as Copano Bay, Baffin Bay, and the Upper Laguna Madre.

The horizontal gradient in salinity in concert with variations in depth produce the fourth important component of estuarine circulation, the density current. This is one of the prime mechanisms for salinity intrusion into an estuary system, and is especially prominent in many dredged ship channels. Density currents are exhibited in two different forms: vertical shear in the horizontal current, and large-scale horizontal circulations. The vertical shearing density current is found particularly in deep channels that are laterally confined. A well-documented example on the Texas coast is the Houston Ship Channel above Morgans Point (see Ward and Armstrong, 1992a and references therein). Usually this kind of current is exposed by averaging vertical profiles of current velocity over a tidal cycle. This is the classical estuarine density current observed in these types of systems since the nineteenth century, whose mechanics is that of denser water underflowing and displacing lighter water. The resultant circulation is a tidal-mean influx from the sea into the estuary in the lower layer, and a return flow from the estuary to the sea in the upper layer.

The second kind of density current results from the absence of laterally confining boundaries, so that the return flow is completed in the horizontal plane, rather than in the vertical. This circulation is induced by the presence of a deep trough in open waters of an estuary, such as a talweg or dredged channel. In this case, the vertical-mean current is directed up (into) the estuary along the axis of the trough, and the return flow to sea takes place in the shallow open bay to either side. In a broad estuary with a natural bathymetry of deeper water near the center and shallower near the side, a combined circulation results with both horizontal and vertical shear, and with secondary circulations in a plane inclined intermediate between the vertical and the horizontal.

The above description of density currents did not refer to vertical stratification. Either kind of density current can occur even when the water-column salinity is homogeneous, because the driving force for density currents is the *horizontal* gradient. The confined density current, especially, will tend to develop salinity stratification, but if the vertical mixing processes are sufficiently intense, as they typically are in Corpus Christi Bay, the salinity can still be maintained nearly homogeneous in the vertical. More detailed information on estuarine density currents is given in Ward and Montague (1996). The potential rôle of a density

current in Corpus Christi Bay is addressed in Section 9.2 below in the context of salinity intrusion.

9.1.2 Freshwater inflow

The principal direct riverine inflow to the Corpus Christi Bay Study Area system, including the upper bays of Copano and Aransas and the lower bays of Baffin and the Laguna is the Nueces River. In addition, there are several smaller rivers such as the Mission and Aransas Rivers, and numerous minor tributaries which drain the watershed of the study area and can be locally important as fresh water sources. These include Copano Creek, Oso Creek, Olmos Creek, San Fernando Creek, and Petronila Creek. The key word in the first sentence above is "direct" because an important indirect riverine inflow is the combined inflow of the San Antonio and Guadalupe Rivers, which does not enter the study area *per se*, but debouches into the next bay to the north, San Antonio Bay. There is free communication between this system and the Aransas-Copano system, through Ayres-Carlos-Mesquite Bays, and there is some indication that on a long-term basis this inflow has an effect on salinities in the upper part of the study area.

As noted above, the flow of the Nueces River is important to the hydrography of the main body of Corpus Christi Bay, and the variation of this river is central to the overall effect of inflow on the bay system (see TDWR, 1981). The Nueces is also the only riverine source for which an accurate history of gauge measurements exists. (Some of the other tributaries to the system, such as Oso Creek and the Mission River, are also gauged, but the proportion of their total watershed that is gauged is much lower than that for the Nueces.) Thus one problem in analyzing freshwater inflows to the overall system is the lack of measured streamflow.

For this study, we have utilized the work in a companion CCBNEP project, the Freshwater Inflow Status and Trends Study performed by the U.S. Geological Survey (Mosier et al., 1995). USGS subdivided the watershed of the CCBNEP study area into 17 distinct subwatersheds. For each of these, the HSPF model (essentially the Stanford Watershed Model, e.g., Singh, 1989) was applied. This is a numerical runoff computation utilizing inputs of soils, land use, precipitation, wind and air temperature to compute a complete surface water budget, from which daily streamflow in the drainage channel was calculated. USGS then combined these subwatersheds into watersheds for component bays of the study area, as follows:

Copano Bay	St. Charles Bay
Redfish Bay	Corpus Christi Bay*
Upper Laguna	Baffin Bay

* including the ungauged Nueces watershed downstream from Mathis

The simulated ("synthetic") inflow records from these six component watersheds together with the gauged flow in the Nueces at Mathis comprise the total inflow to the CCBNEP Study Area. (We note two exceptions to this statement. No

accounting is made for runoff from the barrier islands to the bay, and the watershed draining into the south shoreline of Baffin Bay is not addressed. Neither of these are considered to be of importance to the overall freshwater inflow to the system.) USGS provided digital copies of the simulated daily flows for each of these component watersheds to this project. The reader is referred to the USGS report Mosier et al. (1995) for detailed information on application of the watershed model and analysis of the simulated data, as well as comparison to the Texas Water Development Board statistical model for nongauged areas TxRR (Longley, 1994).

Inflow into Corpus Christi Bay is highly variable, but the question is whether this variability has definite patterns. River flow in the Texas climate is governed by surface runoff from storm systems; this means the rivers are "flashy," exhibiting large, sudden excursions in flow. The daily flow of the Nueces, as a case in point, spans four orders of magnitude. One would therefore expect a seasonal variation, correlated with the usual climatological pattern of storms. But the details of each "season," each of which is in fact a series of quickflow spikes, will vary from year to year, and systematic variation can be extracted only by averaging over a long period of record. Flows on the upper Texas coast, e.g. the Trinity River (see Ward and Armstrong, 1992a), have a predominant pattern of an annual "flood" and an annual "drought," the flood being the spring freshet, which typically occurs in April and May, and the drought is the summer low-flow season typically extending from July through October. With distance down the Texas coast, the spring freshet diminishes in importance, due to reduced southward penetration by midlatitude disturbances. But a fall maximum, originating from tropical processes, such as the interplay of Gulf windflow with subtropical disturbances and from landfalling tropical depressions, becomes increasingly important with distance south. This is illustrated by the pattern of inflow in the Nueces.

Figure 9-1 shows the daily flow of the Nueces at Mathis averaged over the 26-year period 1968-1993. This period was employed because it corresponds to the period used by USGS for generating synthetic inflow hydrographs from the component watersheds. But this is a satisfactory data-analysis period because it encompasses the periods of most intense data collection of the water/sediment quality historical data base, cf. Figs. 5-80 *et seq.*, and is also sufficiently long to encompass a range of variation in the controlling parameters. Figure 9-1 shows the degree of smoothing achieved by longer averaging windows. On a daily basis there is little year-to-year consistency, because the occurrence of quickflows within a given season is more-or-less random, and therefore the 26-year means of daily flows are clearly influenced by individual spikes of inflow occurring in the data record. When the daily flow record is further smoothed by a sliding 11-day window centered on a given day, the spikes are diminished, see the broken trace of Fig. 9-1, but the record is still subject to random surges. For most of the analyses of this study, we employed a monthly averaging period. In Fig. 9-1, the basic bimodal character of the seasonal Nueces inflow is apparent in the late spring and early fall maxima.

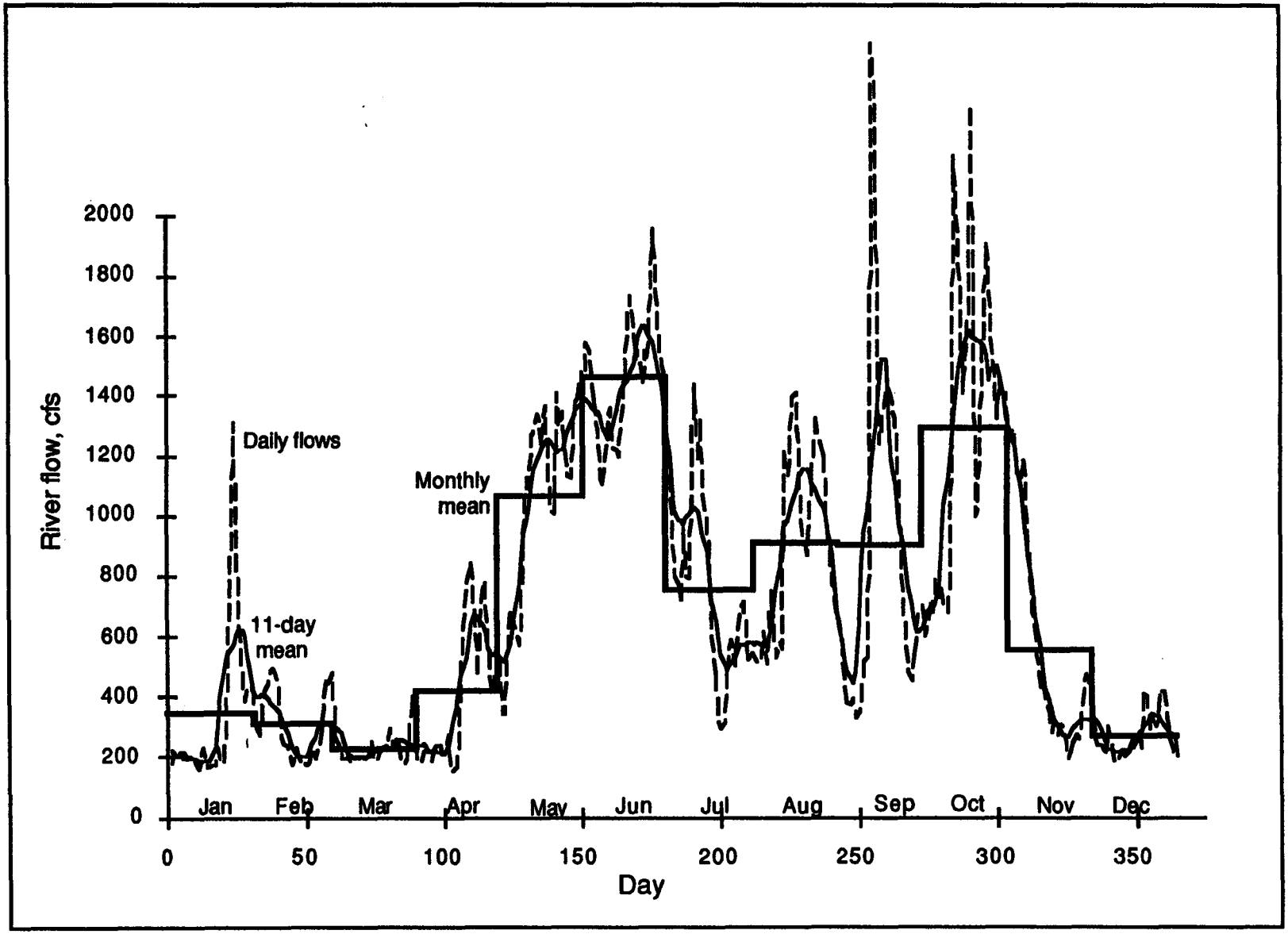


Figure 9-1. Nueces at Mathis, 1968-93, daily flow and longer-period averages

Additional features of the monthly averaged inflow record of the Nueces are shown in Fig. 9-2. In Fig. 9-2 (a), the study analysis period of 1968-1993 is compared to the longer gauge period of record of 1939-93. Despite the fact that the latter includes the 1964 drought of record and the extended drought of the 1950's, the mean annual monthly pattern is quite comparable to the 1968-93 study period. The variability of the Nueces is extreme even at a monthly averaging level, as evidenced by the standard deviation of the monthly means, shown by the vertical bars of Fig. 9-2 (a). Of course, negative values of monthly mean flow do not occur. The fact that the standard deviations extend into negative values indicates the skew in the data record toward more frequent occurrences of low monthly flows. As the monthly flow increases, so does the variance in the data record, as demonstrated by the plot of standard deviation versus monthly mean flow of Fig. 9-2 (b). This means that the coefficient of variation is fairly constant for the Nueces monthly data, and is high, about 175%. Table 9-2 presents the monthly mean and annual inflows for each of the component watersheds for the CCBNEP Study Area, including the gauged watershed of the Nueces. These same monthly flows are depicted graphically in Figs. 9-3 and 9-4, the former by individual watersheds and the latter by accumulated inflow from south to north.

The most important aspect of the year-to-year variation in annual discharge is how that is manifested in the occurrences of high flows. That is, the freshet is the central feature of the annual hydrograph. Some years exhibit a pronounced and extended freshet, while in other years freshets may be totally absent. Correspondingly, in some years the summer low-flow season may be shortened or even eliminated by unusual runoff, and in other years may be prolonged while the flows dwindle to nothing. To exhibit quantitatively the hydrologic behavior of inflows, the monthly-mean flow record for the 1968-93 period was analyzed for each of the component watersheds from the USGS simulations and the gauged flow of the Nueces. Figure 9-5 and Table 9-3 exhibit the mean annual inflow for each of the component watersheds over this period. As an approximate index to freshet behavior, it was postulated that a two-month sequence would capture the freshet in each of the watersheds, so for each year the highest two-month inflow was determined. This two-month average is also tabulated in Table 9-3. It is remarkable that for most of the inflow to the Study Area, these two months average half of the annual inflow, as shown in Fig. 9-6 and Table 9-3. The two-month average inflow for this maximal two-month sequence and the month in which it began are graphed in Figs. 9-7 and 9-8.

Several observations are noted from these analyses:

(1) The two most prolific sources of inflow are Copano Bay and the Nueces River, in that order. Corpus Christi Bay is a distant third. However, there is considerable year-to-year variation in the magnitude and order of the annual inflow. The highest inflow of the 1968-93 period occurred in 1971.

(2) According to the results of the USGS HSPF simulation, the gauged flow of the Nueces less diversions and return flows comprises on average about 75% of the

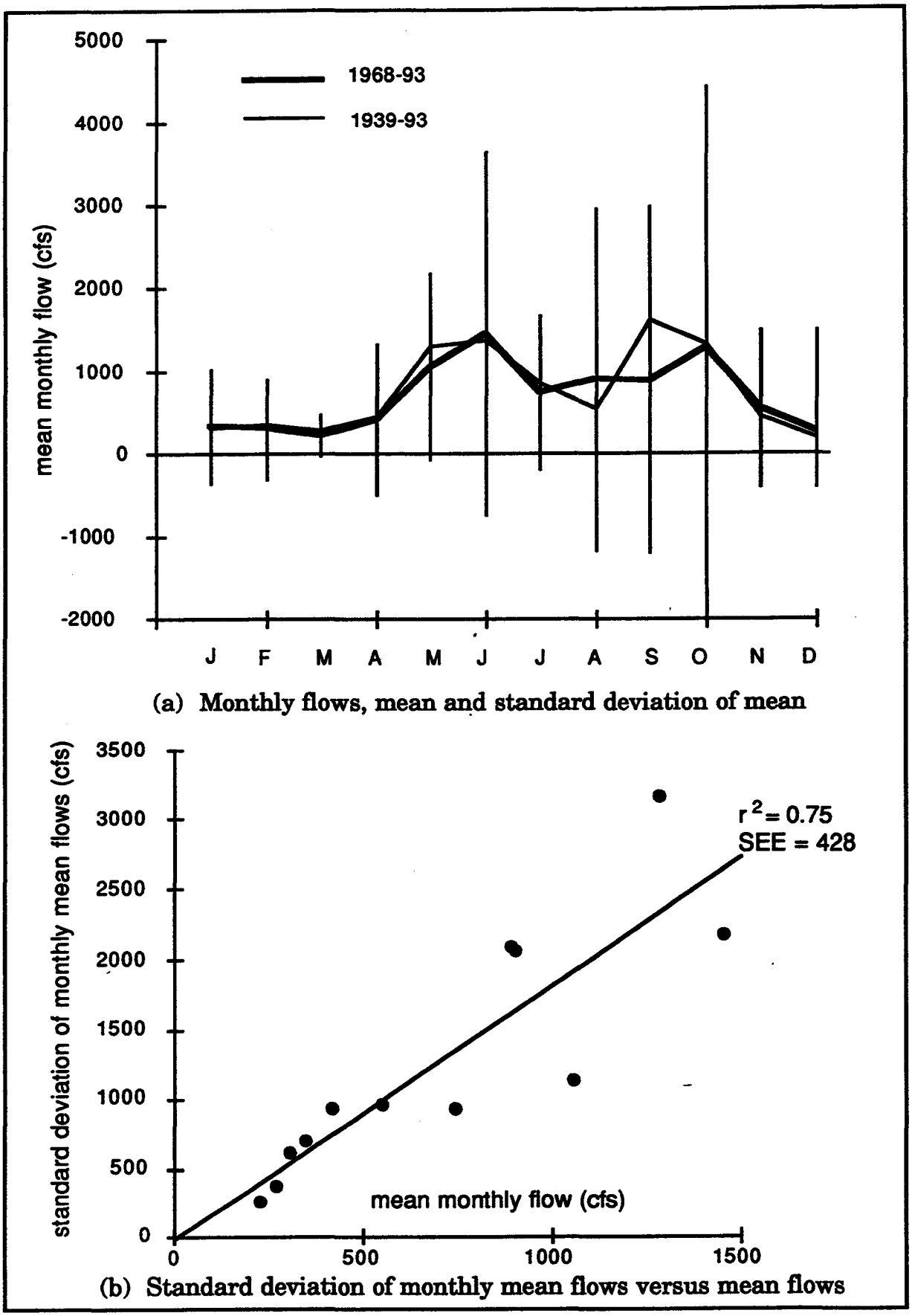


Figure 9-2. Nueces at Mathis, monthly mean flows

Table 9-2

Monthly mean flows (1968-93) for principal component watersheds in CCBNEP study area

	Baffin	*Upper Laguna*	*Corpus Christi*	*Nueces River**	*Redfish*	*Copano*	*St. Charles*	*Total*
J	141	4	150	347	15	791	113	1561
F	193	6	166	308	14	905	171	1763
M	46	4	95	227	9	441	66	888
A	29	2	80	419	9	279	29	847
M	73	5	180	1061	18	695	69	2101
J	242	12	338	1459	18	1513	97	3679
J	114	5	223	749	14	992	100	2197
A	108	6	169	905	13	479	40	1720
S	296	9	468	895	33	1988	224	3913
O	371	11	278	1288	21	1475	98	3542
N	76	4	124	551	13	690	118	1576
D	71	3	110	268	13	741	128	1334

Annual average flows

Baffin	*Upper Laguna*	*Corpus Christi*	*Nueces River**	*Redfish*	*Copano*	*St. Charles*	*Total*
147	6	198	706	16	916	104	2093

Fraction (percent) of total inflow to Study Area

7	0	9	34	1	44	5	100

* At Mathis gauge, uncorrected for diversions and return flows

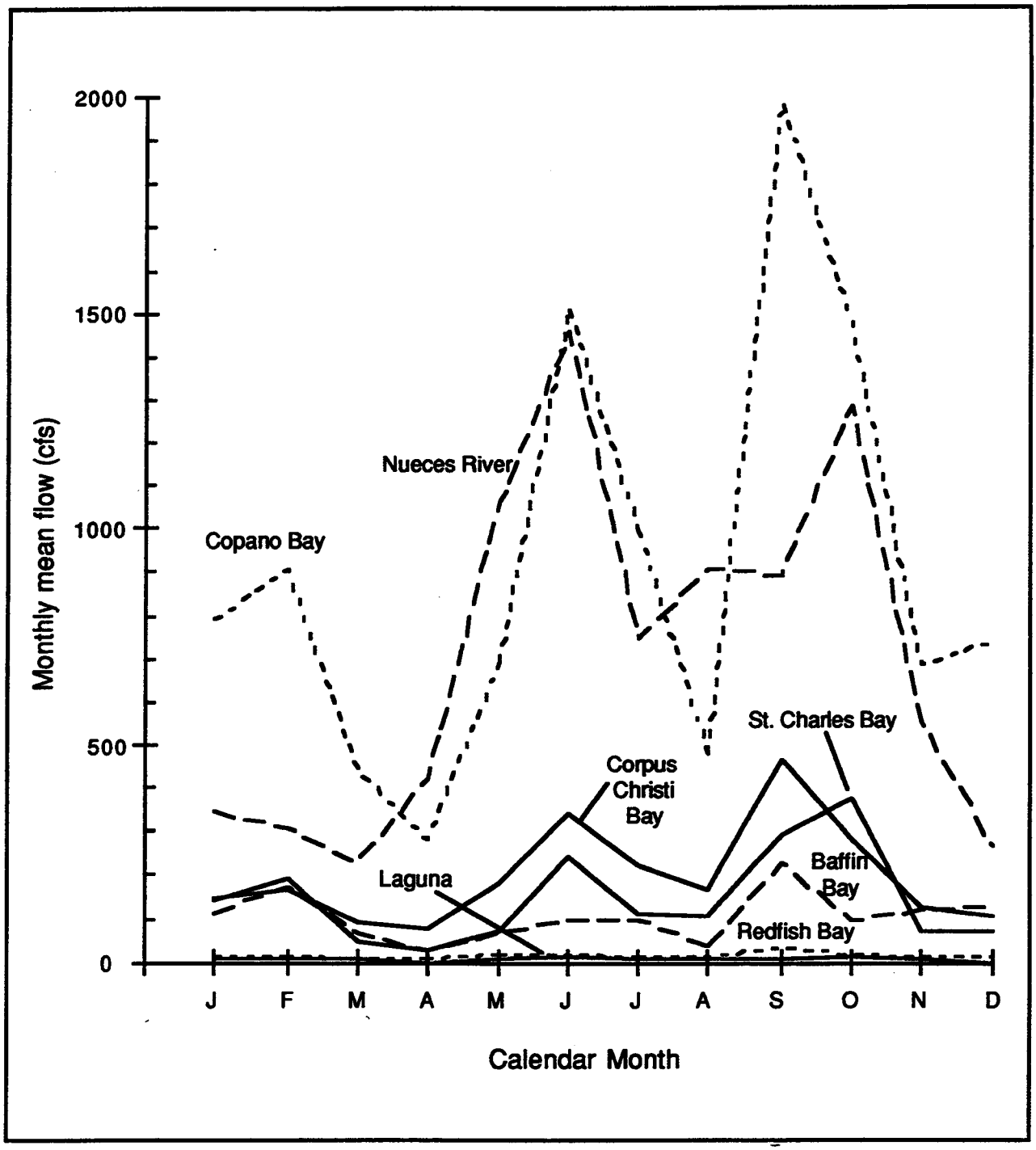


Figure 9-3. Monthly mean inflows (1968-93) for principal watersheds draining into Corpus Christi Bay Study Area

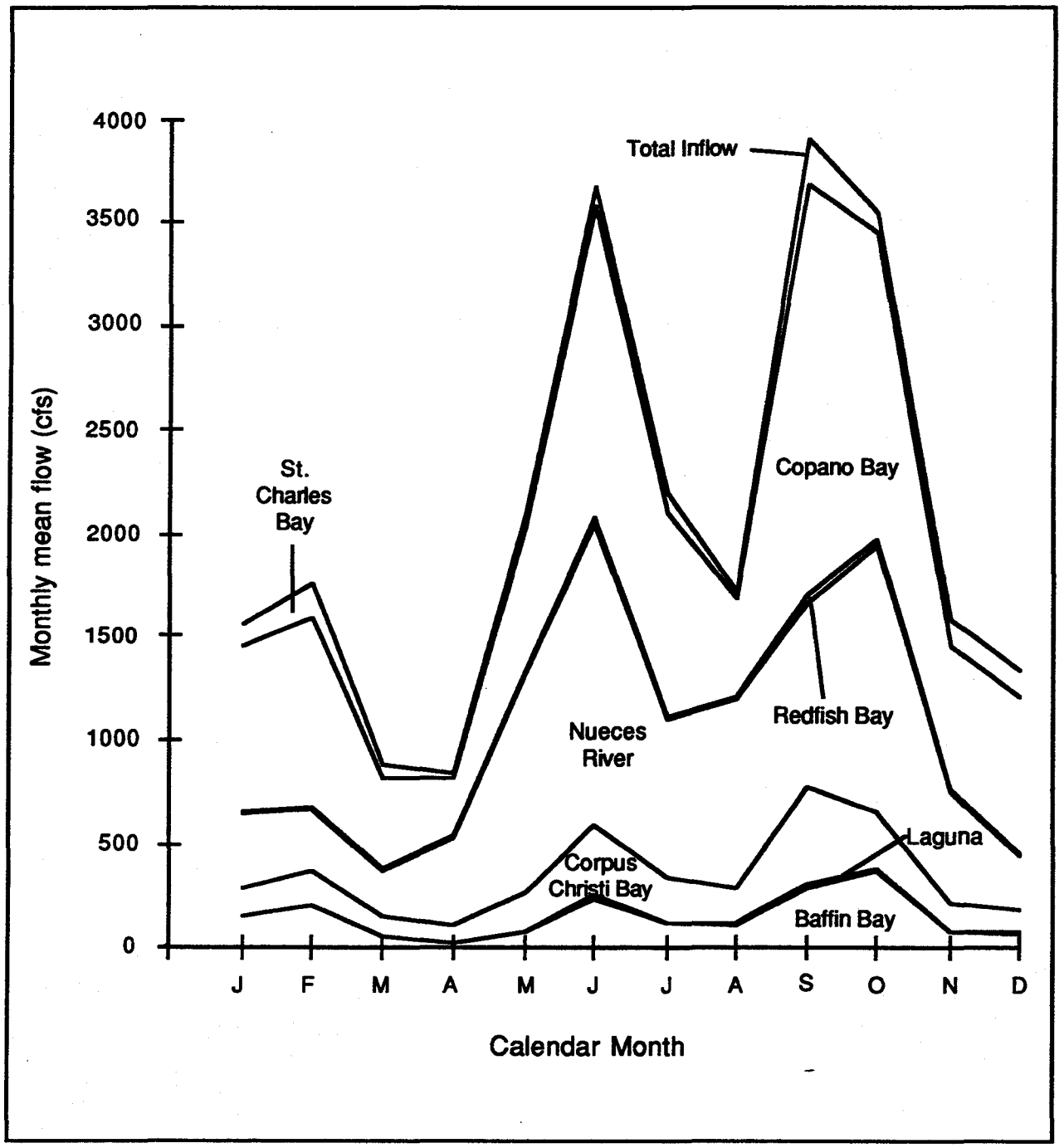


Figure 9-4. Monthly-mean inflows (1968-93) for principal watersheds draining into Corpus Christi Bay Study Area, accumulated from south to north.

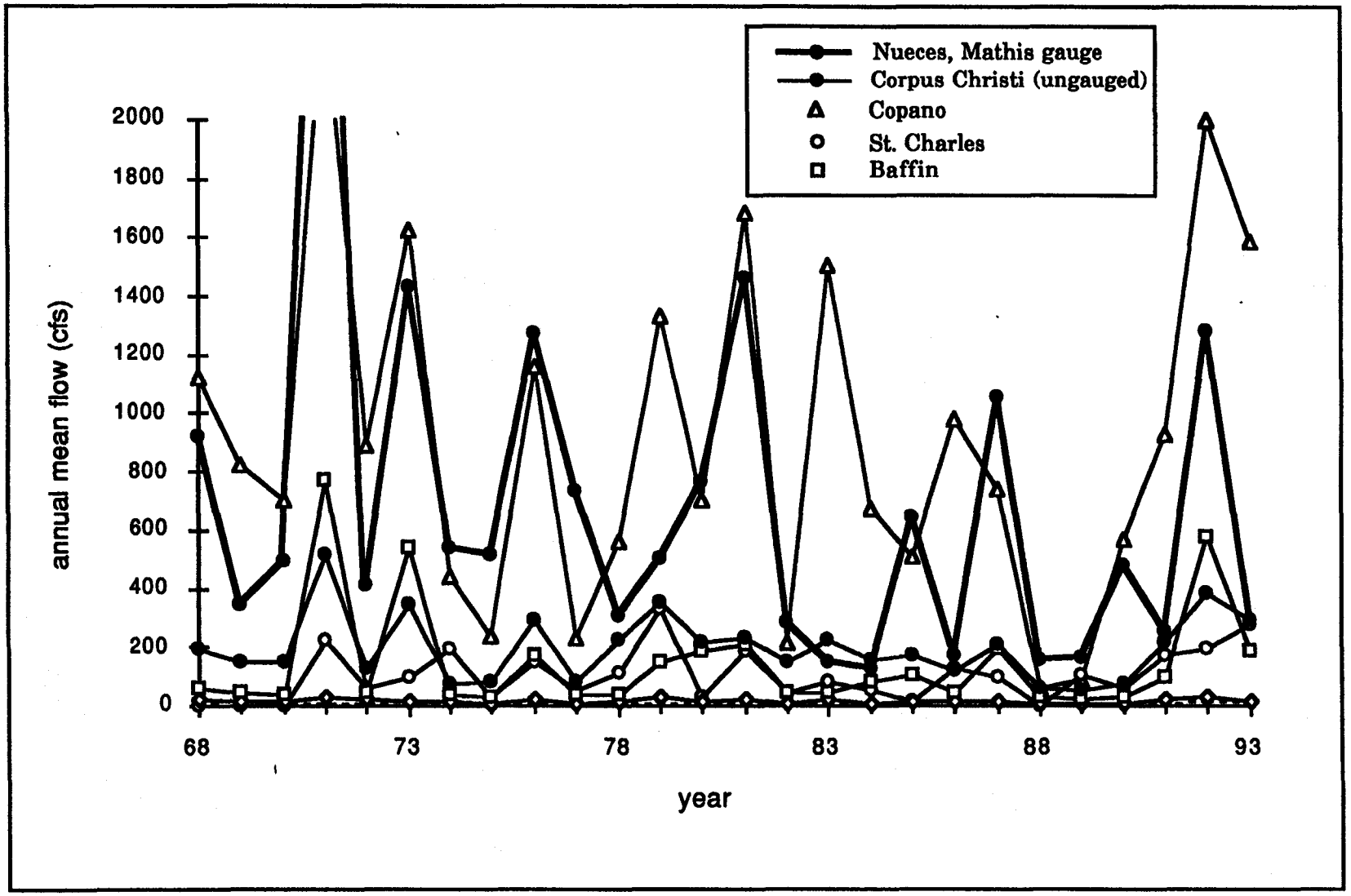


Figure 9-5. Annual mean flow for 1968-93 period by component watershed

Table 9-3
Annual inflow measures by component watershed, 1968-93, in cfs

	St Charles				*Copano*				*Redfish*			
year	*mean*	*freshet mean*	*first month*	*ratio*	*mean*	*freshet mean*	*first month*	*ratio*	*mean*	*freshet mean*	*first month*	*ratio*
68	1.2	7.1	4	1.00	1123	4118	5	0.61	19.7	45.7	5	0.39
69	0.1	0.5	11	1.00	827	2090	11	0.42	13.5	28.1	11	0.35
70	0.0	0.0	11	-	708	2377	9	0.56	18.3	66.0	9	0.60
71	226.8	597.0	11	0.44	2413	12558	9	0.87	31.7	120.5	9	0.63
72	63.3	195.1	4	0.51	895	2958	5	0.55	19.5	42.3	5	0.36
73	99.5	381.4	9	0.64	1625	4618	9	0.47	14.8	33.0	9	0.37
74	192.2	890.2	11	0.77	443	1255	9	0.47	13.6	31.3	5	0.38
75	26.9	127.4	8	0.79	240	813	9	0.57	10.1	20.5	8	0.34
76	148.0	515.7	11	0.58	1160	3159	11	0.45	22.1	40.7	11	0.31
77	51.8	149.6	5	0.48	230	813	1	0.59	9.9	16.0	4	0.27
78	115.5	532.2	9	0.77	562	2347	8	0.70	12.7	32.6	9	0.43
79	332.3	1189.2	8	0.60	1332	3617	8	0.45	27.8	71.2	8	0.43
80	29.1	130.5	8	0.75	705	2635	8	0.62	11.3	32.2	8	0.47
81	189.1	743.8	5	0.66	1687	3455	10	0.34	20.7	30.8	10	0.25
82	45.3	175.7	2	0.65	217	1129	2	0.87	6.1	13.6	2	0.37
83	85.2	250.3	9	0.49	1507	4984	9	0.55	19.4	44.0	6	0.38
84	52.3	225.7	10	0.72	671	2047	1	0.51	7.5	16.5	9	0.37
85	16.8	61.1	3	0.61	508	974	3	0.32	13.1	21.5	9	0.27
86	129.3	549.0	10	0.71	983	3038	10	0.51	12.4	23.2	9	0.31
87	96.1	219.4	6	0.38	742	1946	6	0.44	14.1	22.8	6	0.27
88	0.4	1.0	6	0.40	63	128	9	0.34	8.5	15.9	8	0.31
89	103.0	347.0	1	0.56	92	266	6	0.48	7.4	15.0	6	0.34
90	63.5	191.5	7	0.50	571	2051	7	0.60	10.1	15.5	2	0.26
91	175.9	435.4	11	0.41	927	2578	11	0.46	21.8	42.2	11	0.32
92	198.3	646.0	1	0.54	2001	6984	1	0.58	27.9	103.1	1	0.62
93	274.7	1297.7	2	0.79	1587	5412	5	0.57	15.3	35.9	2	0.39
mean	104.5	379.2	11*	0.63	916	3013	9*	0.54	15.7	37.7	9*	0.38

* Most frequent month

Table 9-3
(continued)

	Nueces River				*Corpus Christi*				*Baffin*			
year	*mean*	*freshet mean*	*first month*	*ratio*	*mean*	*freshet mean*	*first month*	*ratio*	*mean mean*	*freshet month*	*first*	*ratio*
68	920	2502	5	0.45	198.2	656.9	5	0.55	62.8	208.4	5	0.55
69	344	1167	10	0.57	153.4	382.8	11	0.42	45.4	95.7	8	0.35
70	496	2103	5	0.71	153.4	356.0	9	0.39	38.8	73.4	5	0.31
71	3487	12887	9	0.62	517.2	2550.1	9	0.82	770.8	4218.6	9	0.91
72	409	1406	5	0.57	126.2	247.3	5	0.33	45.2	94.5	5	0.35
73	1431	4405	9	0.51	345.8	1021.2	9	0.49	537.8	2333.4	9	0.72
74	540	2021	8	0.62	75.6	132.5	5	0.29	37.3	60.4	2	0.27
75	516	1795	5	0.58	82.3	230.4	8	0.47	33.2	75.0	7	0.38
76	1276	3545	10	0.46	293.3	1003.0	6	0.57	173.6	433.9	11	0.42
77	735	3008	4	0.68	83.1	146.5	4	0.29	33.9	62.1	5	0.31
78	308	940	8	0.51	222.0	585.5	6	0.44	37.5	80.9	9	0.36
79	505	1995	5	0.66	351.2	1498.5	8	0.71	147.2	563.5	9	0.64
80	767	2760	8	0.60	215.4	1015.8	8	0.79	187.3	808.8	8	0.72
81	1458	5148	5	0.59	229.7	494.8	6	0.36	206.4	927.6	6	0.75
82	287	947	5	0.55	148.6	623.6	2	0.70	46.1	156.2	2	0.56
83	148	176	5	0.20	226.0	688.7	6	0.51	43.9	73.4	6	0.28
84	129	178	4	0.23	154.7	453.7	10	0.49	81.3	341.6	10	0.70
85	646	1620	10	0.42	174.5	348.7	9	0.33	102.8	317.4	10	0.51
86	175	387	11	0.37	117.4	255.2	11	0.36	48.4	119.8	11	0.41
87	1053	5010	6	0.79	210.2	534.1	6	0.42	194.9	521.1	5	0.45
88	158	197	7	0.21	58.7	137.1	9	0.39	28.0	60.0	9	0.36
89	166	199	7	0.20	53.7	74.9	8	0.23	21.7	40.7	8	0.31
90	481	1562	7	0.54	77.8	208.8	3	0.45	30.3	54.5	3	0.30
91	252	487	5	0.32	215.7	476.2	11	0.37	94.9	356.5	11	0.63
92	1283	3094	5	0.40	379.3	1459.1	1	0.64	576.9	3144.0	1	0.91
93	296				292.6	1369.9	5	0.78	190.1	1009.0	6	0.88
mean	703	2382	5*	0.49	198.3	652.0	8*	0.48	146.8	624.3	5,9*	0.51

* Most frequent month

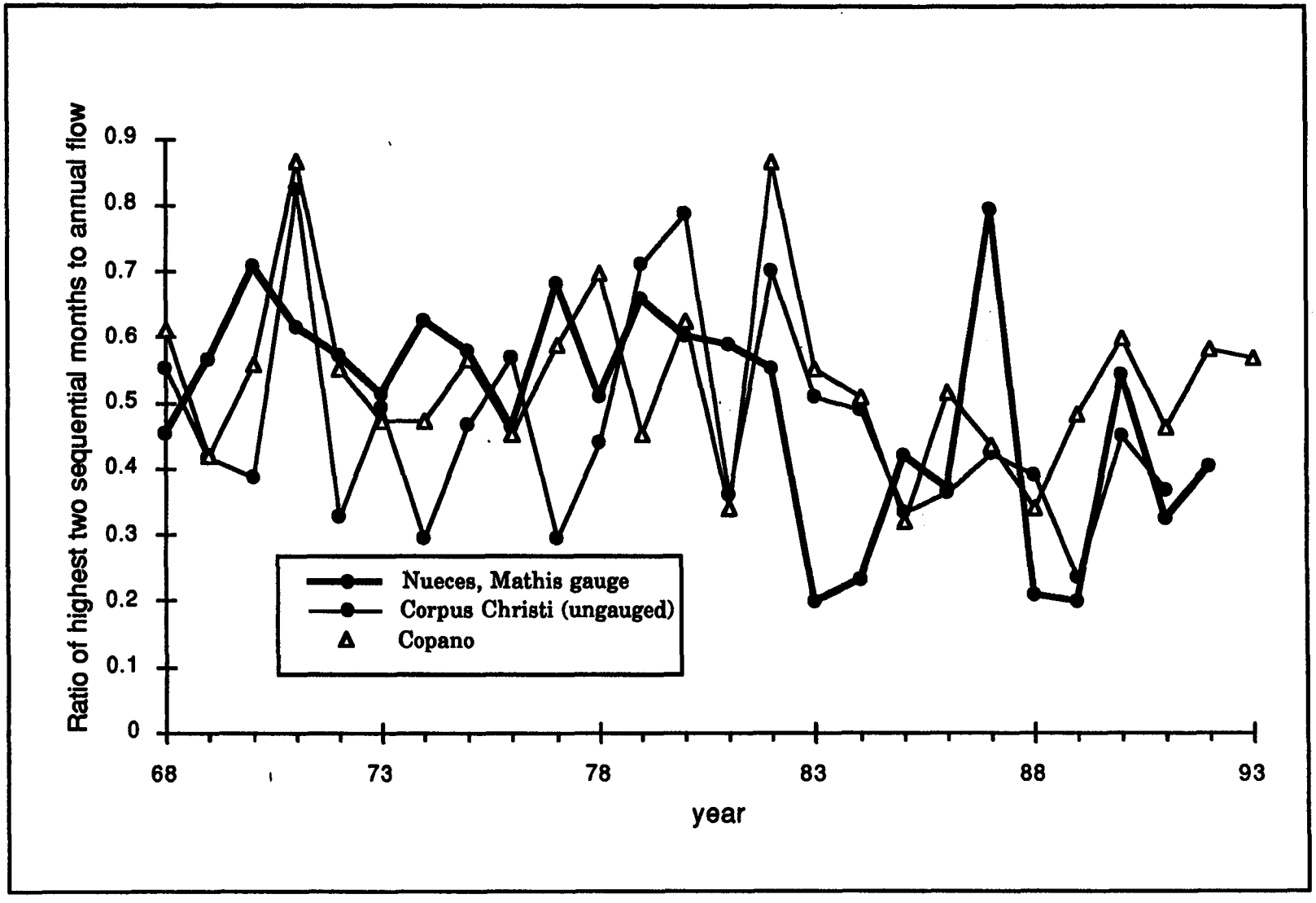


Figure 9-6. Proportion of annual flow in maximal two sequential months

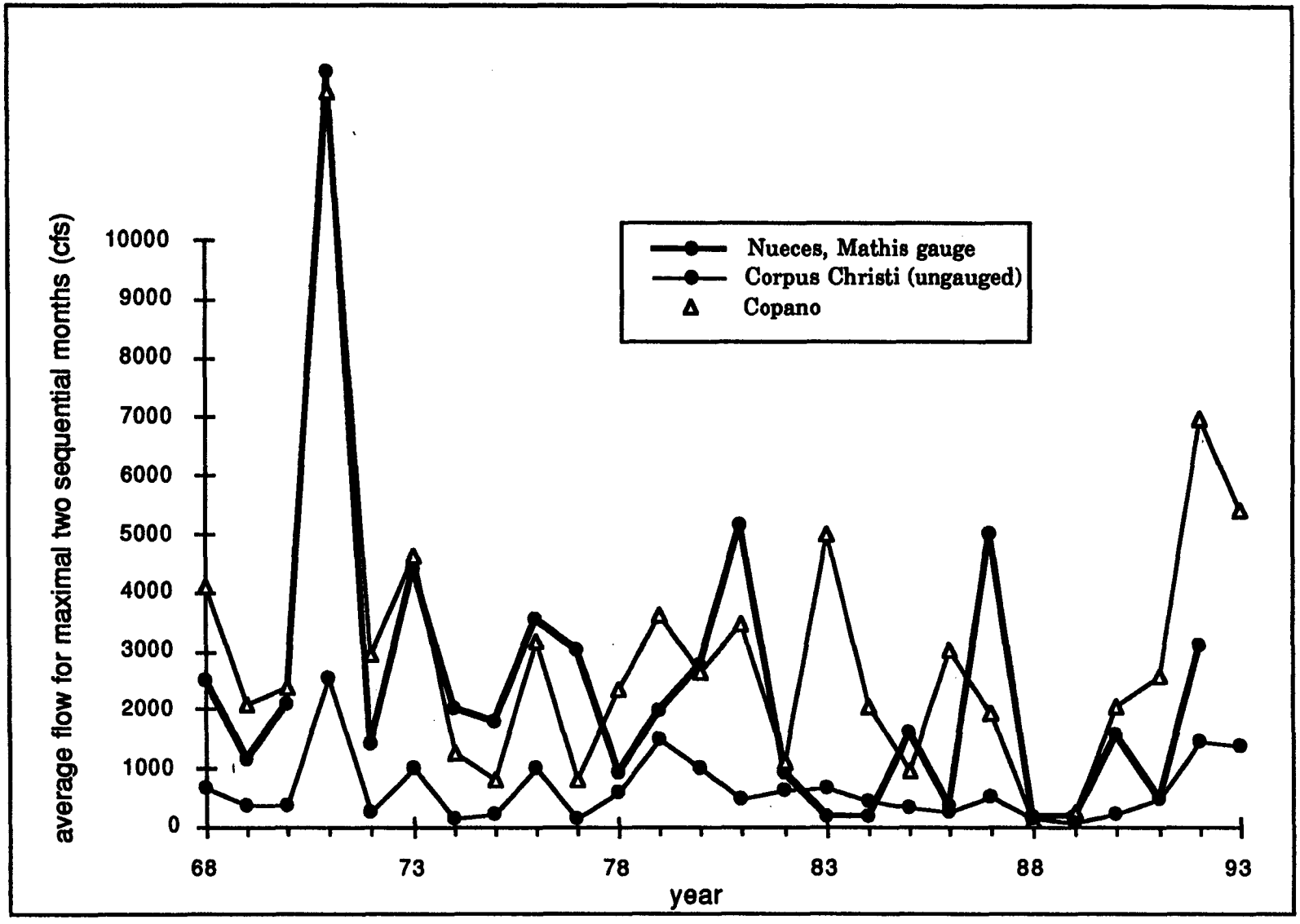


Figure 9-7. Historical variation of annual maximum flow in two sequential months

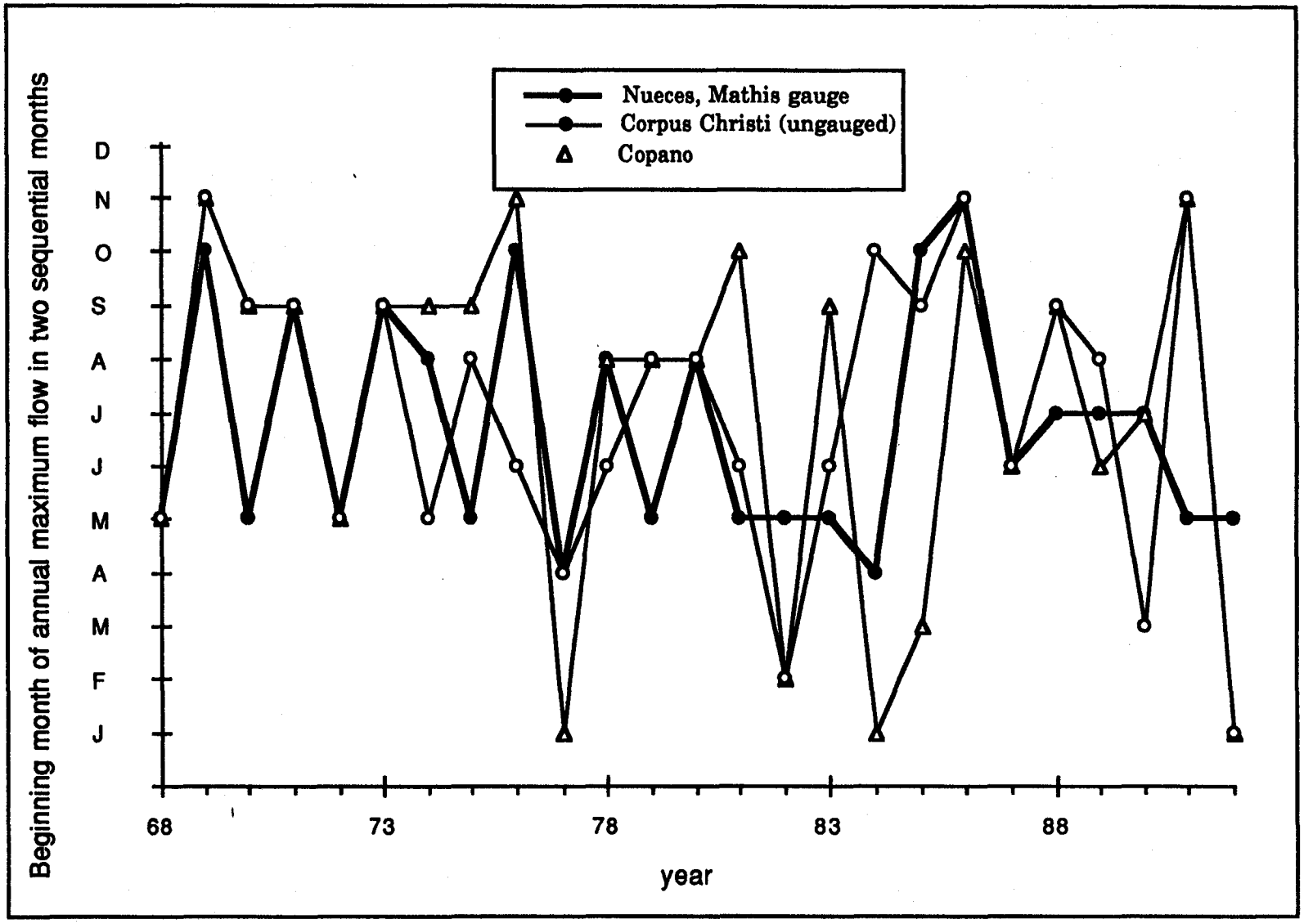


Figure 9-8. Historical variation of occurrence of annual maximum flow in two sequential months

total flow to Corpus Christi Bay *per se*. This is in general agreement with some ratios that have been promulgated recently (e.g., Copeland et al., 1994). Especially during drought periods, the Nueces proportion falls considerably below 50%.

(3) The small watersheds of Redfish Bay and the Upper Laguna render their inflows of negligible importance.

(4) The low runoff from the Baffin Bay watershed is evidence of the high aridity of this region of the Study Area.

(5) The fact that a two-month period is sufficient to "capture" the annual freshet demonstrates the flashy character of the inflows to the Corpus Christi Bay Study Area. (In contrast, for the Trinity River, Ward and Armstrong, 1992a, found that a 3-month "freshet" period—as defined here—was necessary to represent just over *half* of the annual flow of the river.)

(6) The annual flow is highly correlated with the spring "freshet," r=0.91 for Copano, r=0.98 for Nueces. High correlation is not unexpected given (5), but to be this high is unexpected and further reinforces the domination of the annual hydrographic by the freshet.

(7) For the main contributors (Copano, Nueces and Corpus Christi) there is a interannual spread of nearly two orders-of-magnitude in the freshet volume.

(8) The first month of the 2-month freshet period is most commonly late summer (August or September). The exception is the Nueces, whose freshet most commonly begins in the late spring. This emphasizes the fact that the hydroclimatology of the Nueces watershed is fundamentally different from that of the coastal plain, and tracks more closely that of the upper Texas coast.

9.1.3 Loadings

A detailed analysis of organic, nutrient, and contaminant loading to the Corpus Christi Bay system is now underway for the CCBNEP. Therefore, we do not have the advantage of quantitative results from this project for the present analyses. However, the qualitative variation in loadings over the past two to three decades is well known and suffices to anticipate responses of water and sediment quality. In summary, the influxes of conventional pollutants and most organics and metals as a mass load from both point source discharges and inflows have declined in recent years, since probably the 1970's, depending upon the specific contaminant and loading source.

Generally, loadings fall into two broad categories. Those with geographically focused sources of large magnitude are referred to as point sources. These typically originate as wastewater returns from industrial facilities or municipal sewage treatment plants. These are subject to direct regulation and are capable of being captured and "treated" by a combination of diversion, detention, filtration, and biochemical or chemical processing. In contrast, loadings whose points of

origin are diffuse in space, perhaps continuous, are referred to as nonpoint sources. Typically, these involve complex interactions between the ultimate origin of the constituent and environmental flow paths, especially runoff processes in the aquatic phase or boundary layer flows in the atmosphere. The nonpoint source loadings of greatest concern in the Texas coastal environment are those transporting mobilized constituents from the watershed by storm runoff into the periphery of an estuary. Urban areas with large proportions of impervious cover and sources of contamination associated with city activities, suburban areas high in regions of artificial landscaping, rural regions modified for agricultural production with high-technology utilization of fertilizers and pesticides, rural regions with confined animal feeding operations (CAFO's) and rural areas modified for ranching are all considered to be potential sources of nonpoint source loadings. Rivers hold an ambiguous position in this categorization. As high-volume, geographically focused influx points, they would appear to be a point source. But because the loaded constituents originate from diffuse upstream sources, and because the river load is amenable neither to regulation nor to capture and treatment, from an administrative viewpoint it is usually considered a nonpoint source.

Reduction of the magnitude of point source loadings is a consequence of implementation of advanced waste treatment, driven by state and federal regulation. In the Texas coastal zone, as a general rule, improvements in waste treatment have progressed in time from the industrial sector to the municipal sector, and from the upper Texas coast to the lower. While passage of the 1972 Federal Water Pollution Control Act Amendments (PL 92-500) is usually taken to mark the beginning of this process, in Texas this was preceded by the state initiative Operation Clean Sweep of the Texas Water Quality Board, implemented in 1969. In the Houston area, where industrial and municipal dischargers are numerous, there has been accomplished a substantial reduction in total loadings, by an order of magnitude, as summarized by EPA (1980) and Powelson (1978). In the Corpus Christi Bay area a similar proportional reduction of loadings could be anticipated in the industrial wastewater discharges, and would be most evident in the regions of concentrated wastewater returns, e.g. the Inner Harbor and La Quinta Channel. Many of the point-source loads have high organic content, especially nitrogen. One consequence of advanced waste treatment is the shift of the nitrogen species in the discharge to the oxidized forms, *viz.* reduction of ammonia accompanied by an increase of nitrates. While wastewater treatment has improved in the municipal sector within the last two decades, the level of treatment is still below that achieved in the municipalities on the upper coast. With the growth of population and industry in the coastal zone, there has been a steady increase in the *volume* of return flows. In the Coastal Bend area, this is most evident in the municipal sector.

In those cases when data analysis has been performed of the loading of major Texas rivers, there has been found a general decline in mass loading of sediments and organics, considered to be a consequence of improved waste treatment, of improved land-management practices on the watershed, and of upstream impoundments. With respect to reservoirs and the concomitant entrapment of fine-grain sediments, because many nutrients and contaminants are associated

with these finer particulates, these reservoirs are therefore considered to represent an effective sink of these constituents in the inflows. Unfortunately, the construction of most reservoirs, including Lake Corpus Christi on the Nueces, antedate the period of adequate record of riverborne chemical constituents, so the quantitative effect of these reservoirs on chemical loadings cannot be directly evaluated with a high level of reliability. For example, Ward and Armstrong (1992a) evaluated the historical silt and nitrate load on the Trinity, before and after closure of Lake Livingston (one of the more recent reservoirs in the state). While they found that both annual load and mean concentration of suspended sediments downstream from Livingston have fallen to one-third of their pre-lake level, they note that the TSS concentration exhibited a declining trend over the 20-year period prior to closure of the dam.

For the CCBNEP Study Area, there are relatively few results in the literature to draw upon. White and Calnan (1990) determined that the riverine suspended sediment load for the Nueces is much smaller for the period 1961-80 than for 1942-57, which was attributed to the construction of Wesley Seale Dam in 1958. Longley et al. (1994) compared nutrient and sediment loading from the watersheds into five major Texas bay systems, two of which, Aransas-Copano and Nueces-Corpus Christi are in the study area, finding that these two are lowest of the five in nitrogen, phosphorus and organic carbon loading, and among the lowest in sediment yield. The exception was the sediment yield from the Nueces watershed downstream from Mathis which was the highest of the watersheds analyzed (see Table 4.4.5 of Longley et al., 1994). No trends in these loadings are given.

9.2 Water and Sediment Quality Responses

9.2.1 Temperature

Temperature in Corpus Christi Bay is governed primarily by surface heat exchange, which imposes a strong seasonal signal, as shown in Fig. 6-57. Because of its smaller depths and limited exchange with the Gulf, the bays lead the Gulf by about a month in their response to seasonal heating and cooling. Therefore, in the spring to early summer, the bays are about 2-3°C warmer than the adjacent Gulf, then this relation is reversed in the fall. As noted in Chapter 6, stratification effects are nil, amounting on average to a fraction of a degree per meter positive upward (see Table 6-28). This is much too small to have any effect on buoyancy, so it is undoubtedly a result of the greater insolation near the water surface. Temperature generally increases with distance south across the study area, and is somewhat higher in the shallow tributaries and secondary bays compared to the open waters, see Figs. 6-7 through 6-11 and Fig. 6-57. This being said, these differences are minor, and the more accurate representation of temperature is that horizontal spatial structure is virtually absent. The lack of vertical stratification is an indicator of the vigorous vertical mixing which operates in Corpus Christi Bay and renders many variables vertically homogeneous. The strong seasonal variation and the lack of significant spatial structure are consistent with the domination of surface heat fluxes (so that boundary fluxes become much less important).

The one important exception to the lack of spatial structure in temperature is in Upper Nueces Bay, see Fig. 6-9. Segment NB7 (see Fig. 3-10) receives the cooling water discharge from the Central Power and Light Nueces Generating Station. This is a once-through fossil-fired steam-electric plant, which intakes cooling water from the adjacent Inner Harbor, Segment IH7. Presently, this SES is rated at 515 MW generating capacity and is permitted for a 21.9 m^3s^{-1} (775 cfs, 500 MGD) circulating flow (Mierschin, 1992). The actual generation and circulating flow is variable, depending upon the number of units in operation, load demand, and efficiency; a typical circulating flow is 18.4 m^3s^{-1} (650 cfs, 420 MGD). Ward (1982) compiled data on the heat rejection of this plant and the resulting thermal plume in Nueces Bay. The condenser temperature rise ranges nominally 4-10° C, and the resulting plume at 1°C (temperature rise over ambient) is about 200 ha (500 acres), ranging a factor of two about this value depending upon meteorology, especially wind direction. The effect of this heated water return is quite evident in the higher water temperatures in the south sections of Nueces Bay, Fig. 6-9.

One other major power plant of CP&L operates in the Corpus Christi Bay system, namely the Barney Davis Generating Station. Like the Nueces SES, Barney Davis is a fossil-fired steam-electric station with once-through cooling. Cooling water is drawn from the Upper Laguna Madre near Pita Island (Segment UL03) and discharged into Oso Bay (Segment OS3), at a circulating flow rate of nominally 19 m^3s^{-1} (670 cfs). Unlike the Nueces SES, the Barney Davis discharge is first detained in a shallow cooling pond of area $4.5x10^6$ m^2 (1.77 sq mi), the net effect of which is to reduce the temperature rise upon discharge into Oso Bay to less than 1°C. Therefore, there is no elevated temperature in upper Oso Bay that can be attributed to this power station.

The most significant observation from the analyses of Chapter 6 is the long-period decline in water temperatures, especially within the open waters of Corpus Christi and Nueces Bays, and to a lesser extent within the upper bays of Copano and Aransas, see Table 6-39 and Figs. 6-75 through 6-79. Over the three-decade period of record, the net decline for those segments with a statistically probable trend (Table 6-39) is on the order of 2°C. It is noteworthy that a similar decline in water temperature, at about the same rate, was discovered in Galveston Bay (Ward and Armstrong, 1992a). Hypotheses offered by Ward and Armstrong (1992a) possibly explaining this observed decline are the following:

(1) Long-term alterations in climatology, e.g. declines in air temperature or increases in wind speed;

(2) Long-term alterations in water temperature of the Gulf of Mexico;

(3) Alterations in the intensity of interaction of Corpus Christi Bay with the adjacent Gulf of Mexico;

(4) Sampling bias toward the earlier months of summer in more recent years.

These cannot be tested within the scope of this project. We note that a cursory examination of the sampling dates in this Corpus Christi period of record indicates little support for (4). With respect to (2) it is interesting to observe that the nearshore waters of the Gulf evidence a probable *increasing* trend, Fig. 6-80. Since the waters of the Gulf are systematically cooler than those of the estuary, and since the nearshore waters are probably more influenced by thermodynamics of the surf zone, this observation does not eliminate (3), but certainly renders it more doubtful. Hypothesis (1) is considered the most probable. Recently Kim and North (1995) employed surface air temperatures compiled by Jones et al. (1986) by 5°x5° zones to examine trends in air temperature. Kim (1996) notes that one of these 5°x5° boxes representing the Texas coastal zone shows a negative trend (but does not provide any quantitative detail).

9.2.2 Salinity

Of all of the conventional water-quality indicators, salinity has probably been more in the public view in the Corpus Christi Bay system than in any of the other estuaries of Texas. This is due to its perceived link to freshwater inflow and the intense local concern with the supply of inflow to the bay. From a broader analytical standpoint, there is probably no variable that provokes as much frustration as salinity, because for this variable there is a clear, intuitive cause-and-effect association with freshwater inflow that refuses to emerge from the statistics. Many attempts have been made by past researchers to extract a salinity-inflow relationship by statistical analysis (e.g. TDWR, 1981, Longley, 1994), none of which have been satisfactory.

Salinity in Corpus Christi Bay *is* dependent upon freshwater inflow. Without freshwater inflow to the bay, the salinities would eventually acquire oceanic values. The fallacy is to conclude from this that there is a *direct* association between a given level of inflow and the salinity at a point in the bay. The other hydrographic mechanisms, such as tides, meteorology, and density currents, all govern the internal transports of waters of different salinities in the bay, and dictate how freshwater influences salinity. Further, the salinities present at the entrance to the bay are controlled by processes in the Gulf of Mexico, especially the effects of the freshwater plumes from river basins along the northwest coast, notably the Sabine, Neches and Mississippi. In this system, evaporation plays a major rôle in the salt budget, much more so than is the case in the estuaries of the upper Texas coast.

The nature of the problem is illustrated by the salinity data of Fig. 9-9, showing the association of salinities with gauged flow of the Nueces. The locations, NB5 in lower Nueces Bay and CCC7 in the Corpus Christi Ship Channel just out from the Inner Harbor (Fig. 3-9), are characteristic of open-bay areas but still close enough to the mouth of the Nueces to presumably respond to its inflow. While there is a discernible downward slope in the relation, as we would expect, the range of salinity encompasses a significant portion of the entire estuarine range,

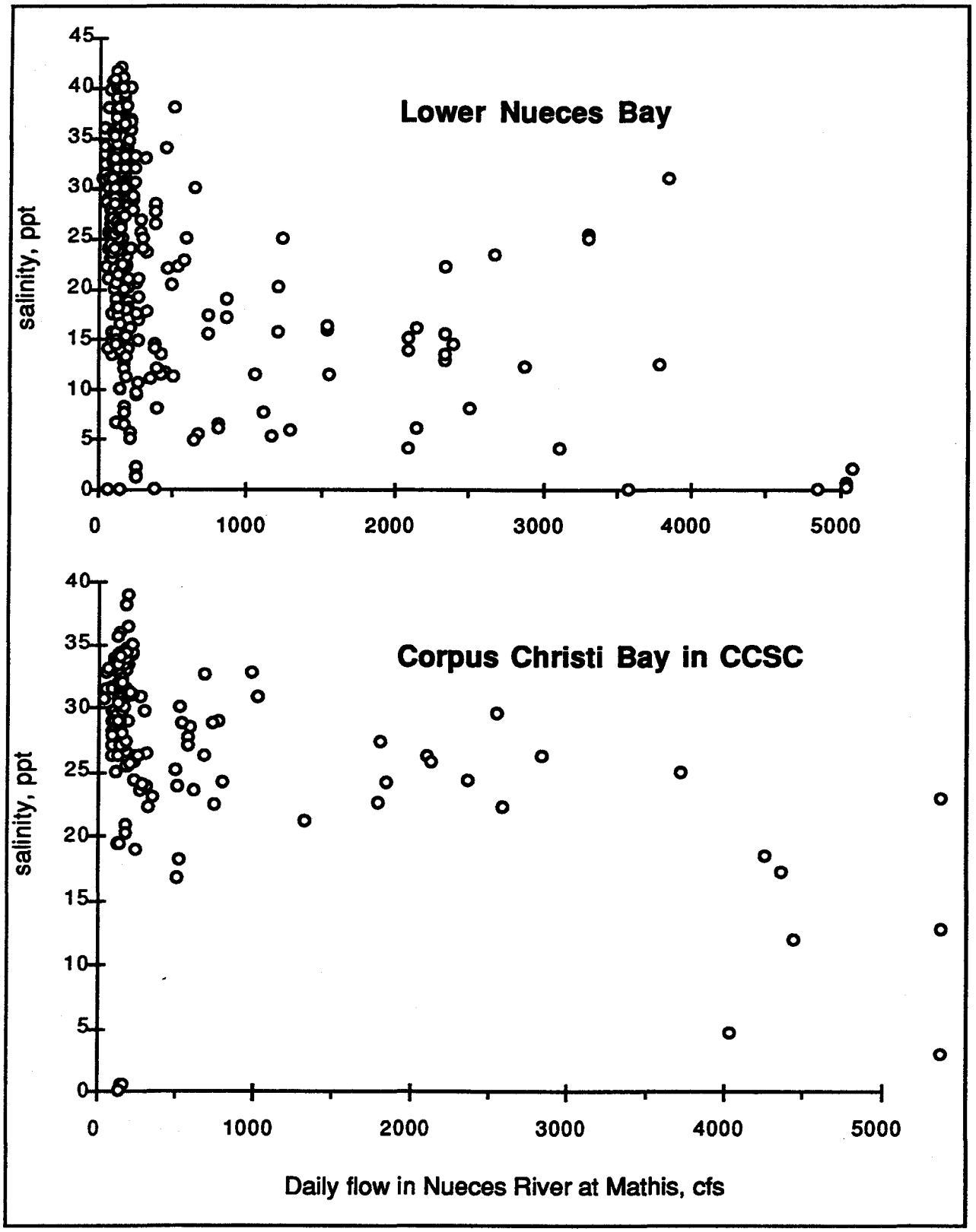


Figure 9-9. Salinity versus daily flow in two hydrographic segments, NB5 and CCC7. (Flows greater than 5000 cfs not shown.)

independent of the level of inflow. Put another way, for virtually any level of inflow (the exception being for the rare extremely high flow events) one encounters in the data a disquietingly wide range of salinity. Moreover, the relation of salinity with inflow displayed in this figure, such as it is, is eroded even more with distance from the Nueces.

This high variance is a quantitative demonstration of the complexity of the response of salinity in the bay to many factors, only one of which is freshwater inflow. First, there is a lag between the freshwater signal as measured at an inflow gauge and its effect on the bay. In addition to this lag, salinity in the bay responds more as an integrator of freshwater inflow, i.e. with a longer time scale of variation than that of the inflow itself. Moreover, the response of salinity is affected by the operative physical processes, e.g. tidal excursion, antecedent salinity gradients, semi-permanent circulation patterns and evaporation. Salinity extrusion, especially in Nueces Bay and Copano Bay is basically a mechanism of displacement by freshwater, and occurs rather rapidly when forced by freshets. Salinity intrusion, on the other hand, takes place by mixing and advection by tidal currents, interior circulations, and density currents, and intrusion into the inland or more isolated segments of the system (e.g. Baffin Bay and the Upper Laguna) generally requires a comparatively longer time.

The response of salinity as an integrator of the freshwater inflow signal can be accommodated to some degree by using a long-period average of inflow as the independent variable. Generally, the salinity at a point in the bay is better correlated with the average flow over the preceding several weeks. In Fig. 9-10 is shown the improvement in statistical association achieved by time averaging the river flow, for a range of averaging periods, at the same segments used in Fig. 9-9. While the explained variance can be nearly doubled (in this region of the bay) by this device, even with the optimal averaging not even 50% of the variance is explained by the relation to inflow. Further, the standard error of the regression is still more than 7-8 ppt, which means the regression predicts salinity at a 95% certainty within a 32 ppt range, i.e. about the normal range from fresh to oceanic. Moreover, in most areas of the open bay, the explained variance and standard error are even worse.

As observed above, the fallacy with this approach is the implicit assumption that there is a direct relation between salinity and inflow, which can therefore be extracted by the usual regression methods. Generally, the salinity at any point in the bay is in a state of dynamic response to the integrated resultant of present and earlier hydrological and hydrographic factors. The complete analysis of this behavior cannot be by statistical association alone but rather must take explicit account of the time-response character of the variates. Such an analysis is beyond the scope of the present study, but could employ either of: (1) time-series and system-identification methods; (2) detailed event-response analysis, including salt-budgeting and deterministic modeling. It is probable that similar methods may be necessary for other variates whose concentration in the bay is determined by boundary fluxes and internal transports, e.g. quasi-conservative parameters such as phosphorus and many metals.

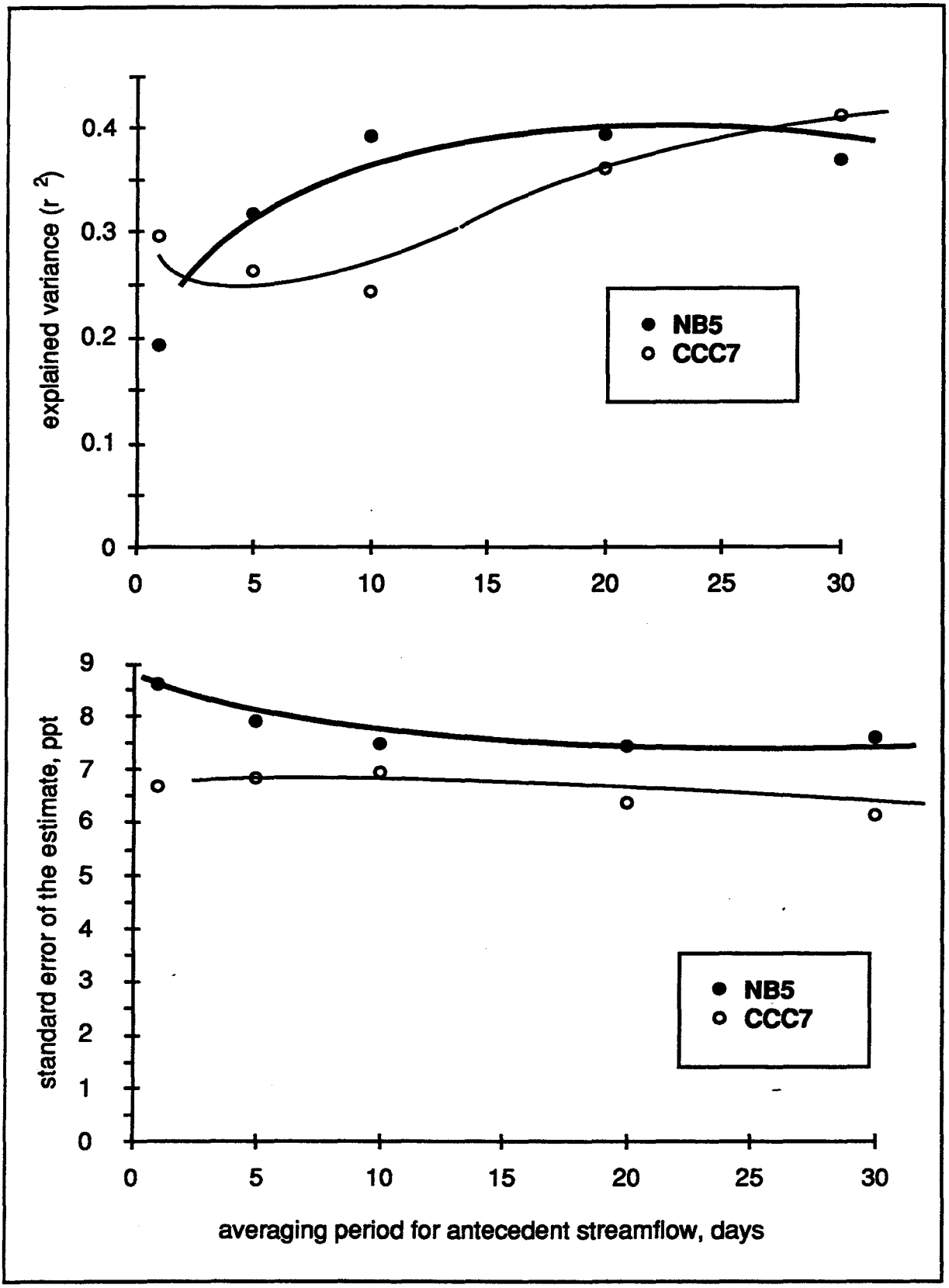


Figure 9-10. Statistical measures of regression quality versus averaging time of Nueces River flow, same data as Fig. 9-9

As noted in Chapter 6, the average salinity distribution in the Study Area is predominantly a north-to-south gradient of increasing salinity. This is undoubtedly the result of the diminishing freshwater inflow from Copano in the north to Baffin in the south, reinforced by increasing evaporation (and *net* evaporation, since precipitation also decreases from north to south). The effect of evaporation on the salt budget is amplified by the lack of exchange of the entire system with the ocean, especially for the lower bays of Baffin and the Upper Laguna, which do not exchange well even with the larger body of Corpus Christi Bay.

As remarkable as this north-to-south salinity gradient is, equally remarkable is the lack of a prominent gradient in salinity in those regions most affected by freshwater inflow. In Copano Bay, Fig. 6-1, which receives the greatest quantity of inflow, the average gradient in only about 4 ppt from the causeway to the mouths of the rivers. In Nueces Bay, even more surprisingly, the gradient from the mouth of the bay to the delta is flat, only a couple of ppt, Fig. 6-2. This is clear evidence that the effect of freshets in depressing salinity is relatively infrequent (no surprise from the hydrology of the Nueces River, discussed in the previous section) and short-lived. Another noteworthy feature of the mean salinity patterns is the absence of systematically higher salinities in the channel segments. This would suggest that, on average, the deepdraft ship channel has little additional effect on salinity intrusion. This is in direct contrast to the Houston Ship Channel in the Galveston system (Ward and Armstrong, 1992a). The reason for this is also rooted in the relative infrequency of freshets in the Corpus Christi Bay system. For a density current in a deep channel to develop, there must be a horizontal gradient in salinity. This gradient is regularly present in Galveston Bay, due to the inflow from the Trinity and San Jacinto Rivers. In Corpus Christi Bay, as shown by Fig. 6-2, the average gradient in the open bay is flat. Without such a gradient, density currents cannot develop, and the deep channel cannot become a favored pathway for salinity intrusion. When large freshets do occur, such gradients are developed and the density current becomes important in salinity intrusion, but such events are apparently so rare that they do not appear in the long-term statistics.

Trends in salinity are obscured because there is such relative constancy in salinity in the system, which makes the parameter susceptible to random variations. Despite this, regions of the study area exhibit defined trends, notably Copano Bay, St. Charles Bay, Nueces Bay and most of the open areas of Corpus Christi Bay, all of which show increasing salinities, see Figs. 6-69 through 6-71 and Table 6-38. The average rates of increase over those segments with a probable trend are: Copano, 0.081; St. Charles, 0.26; Nueces, 0.25; Corpus Christi, 0.047 ppt/yr. These are not trivial increases. Over two decades (say), these would translate to increases in average salinity of: Copano Bay, 1.6 ppt; Corpus Christi Bay, 1 ppt; and Nueces Bay, 5 ppt.

In seeking a possible explanation for these trends, the obvious control to examine is freshwater inflow. With respect to the gauged flow of the Nueces, a linear decreasing trend in the monthly mean flows is indeed disclosed, with rate 29 cfs

per year. This trend line superposed on the time series of monthly flows is shown in Fig. 9-11. Inspection of the data indicates that the greatest contributor to the declining trend is the reduced frequency of occurrence of high-inflow events.

Similar trend analyses were carried out for the synthetic flows, developed by USGS (see Section 9.1.2 above), for Copano and Corpus Christi Bay watersheds, averaged by month. (Recall that Corpus Christi Bay watershed is defined to be all of its peripheral drainage area, including the Nueces watershed downstream from the gauge at Mathis.) In its status and trends study, USGS (Mosier et al., 1995) elected not to perform trend analyses on its synthetic hydrographs principally because such trend analyses would be a reflection of trends in precipitation (all other factors being static in the model). In the present context, we are not bound by such scruple, since a declining trend in inflow driven by such a trend in precipitation is still a declining trend in inflow. The resulting linear trends superposed on the monthly mean flow data are shown in Figs. 9-12 and 9-13. For Copano a barely resolvable declining trend emerged, of 5.1 cfs/yr, and for Corpus Christi Bay a declining trend of 16 cfs/yr.

To determine whether such a declining trend in inflow could be responsible for the increasing trend in salinity would require a detailed salt budget for the system, manifestly beyond the scope of the present study. Some judgements can be proffered based on magnitudes, however. By comparison of these inflow trends to their initial values in 1968, the respective reduction in annual inflow over the 1968-93 period would be about 14% for Copano Bay, 53% for Corpus Christi Bay, and 69% for the Nueces River (at Mathis). This is substantial.

While the decline in inflow is likely to be the explanation for the increasing trends in salinity, we note that there are other hypotheses which could be contributors as well:

(1) Increased salinities in the adjacent Gulf of Mexico;

(2) Altered interaction with the Gulf of Mexico;

(3) Altered volume and timing of freshwater inflow events to augment salinity intrusion;

(4) Sampling bias due to changing seasonality, geographical distribution or vertical profiling over time;

(5) Increased diversions and/or decreased return flows.

Some of these may be locally important, even if not important on a bay-wide or system-wide scale. There is no evidence of (1) based upon the trends analyses of this project (see Fig. 6-74). The volumes of diversion and return flow in Corpus Christi Bay are smaller by an order of magnitude than the trends in inflow, so (5) appears unlikely, except, again, in some specific localities. A cursory inspection of the sampling intensity does not reveal any obvious bias in the more recent data

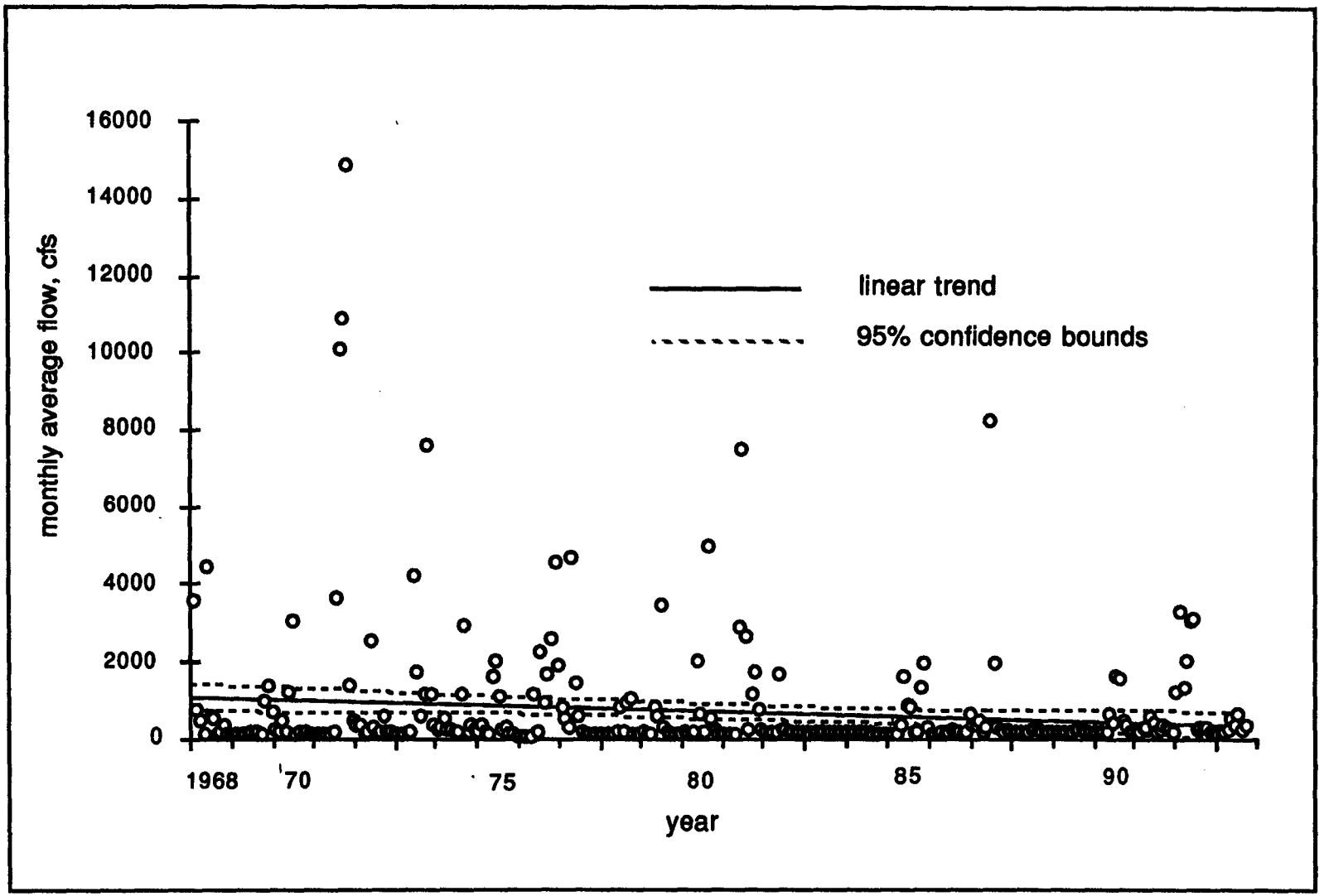


Figure 9-11. Monthly mean flow of Nueces at Mathis and linear trend line

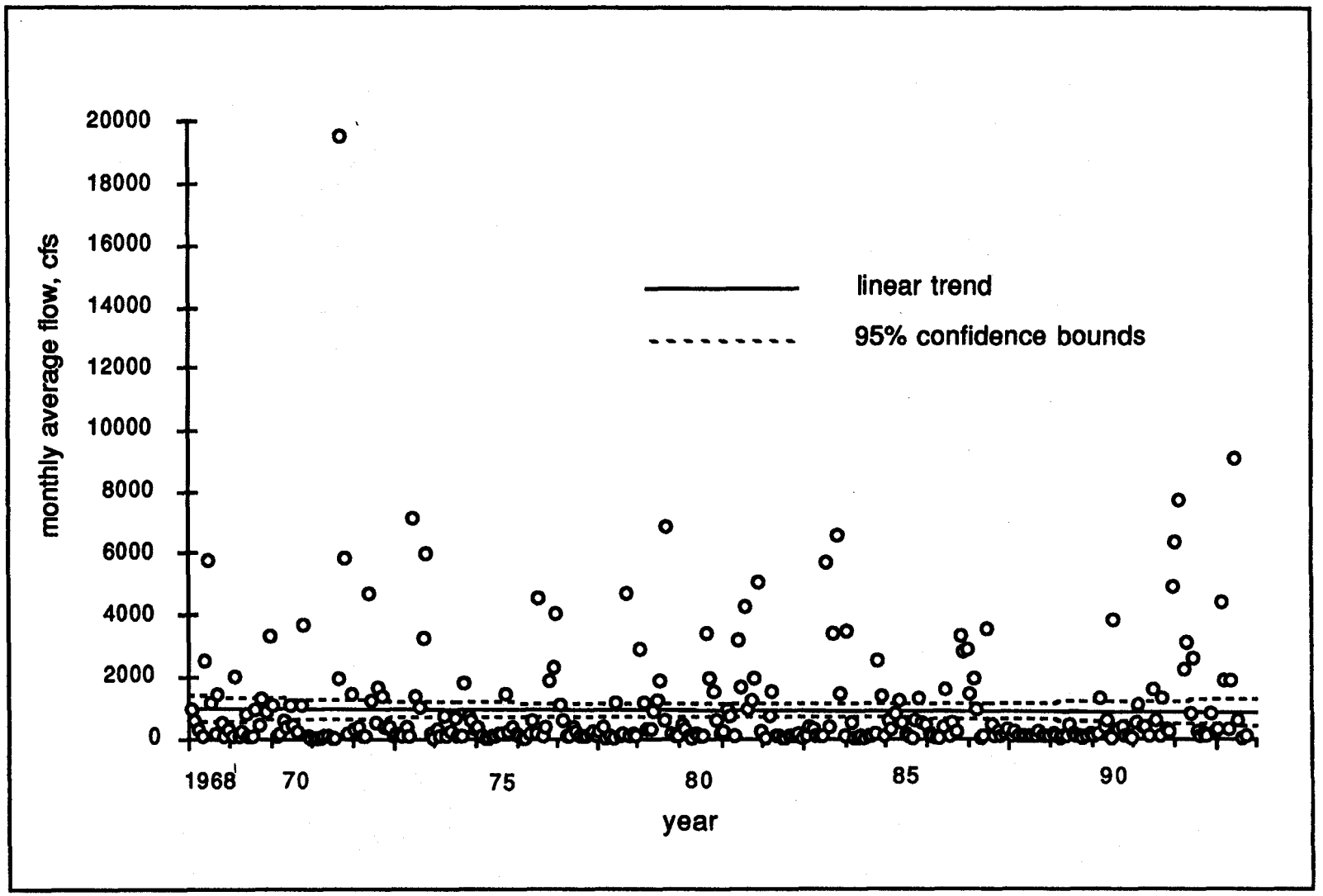


Figure 9-12. Monthly mean flow of Copano Bay watershed and linear trend line

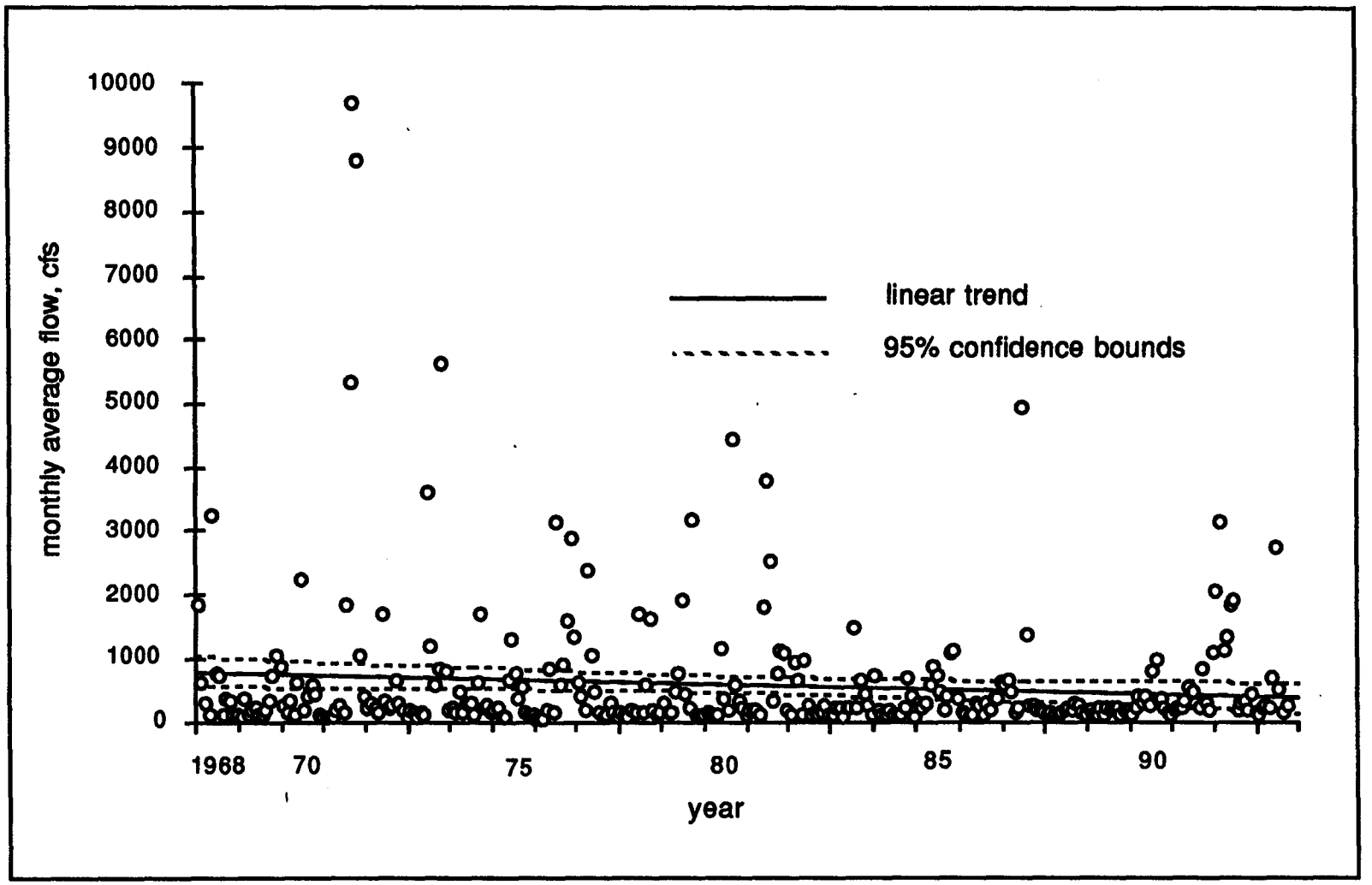


Figure 9-13. Monthly mean flow of Corpus Christi Bay watershed and linear trend line

compared to those of the 1970's, so (4) does not seem likely, at least on a baywide basis. In fact, one of the principal state programs, that of the Texas State Department of Health, has altered its sampling strategy to emphasize those conditions conducive to coliform violations, which implies that salinity data would be taken during or immediately after inflow events. If anything, this would entail a bias to lower salinities.

9.2.3 Dissolved oxygen

In the open bay, dissolved oxygen, like temperature, is most strongly affected by surface processes. A high degree of aeration is implied by the saturated conditions, which is consistent with surface-wave overtopping and vigorous vertical mixing. A relatively slight stratification in DO increasing upward, equivalently a stratification in DO deficit decreasing upward (Table 6-29), is consistent with oxygen consumption in the water column and in the bottom sediments, in conjunction with the influx of oxygen through the surface. There is no apparent correlation with depth in stratification through the system, though deeper water will evidence a greater top-to-bottom DO difference, since the gradient is multiplied by a greater depth. Even at this, the Inner Harbor, the greatest focus of oxygen-demanding waste loads in the system, averages only about 3 ppm top-to-bottom difference in DO.

Since the system is so near-saturation, systematic trends are difficult to discern. This is reflected in the statistical results, e.g. Table 6-41 and Figs. 6-81 through 6-86, which are mixed. One prominent exception is the outer bays, Copano, Aransas and Baffin, that show a systematic trend of declining DO deficit (i.e., increasing DO). One hypothesis for this trend could be as the result of improvements in waste treatment implemented by the communities on the shore of these bays. Other hypotheses include diminishing oxygen-demanding loads in runoff and altered kinetics within the bay waters themselves.

One aspect of DO behavior that is obscured by long-term statistical analyses is the prevalence of low-DO events, i.e. hypoxia. The potential impact of these events on the ecosystem may be far greater than their relative infrequency might suggest. For this reason, special attention was given to the occurrence of such depressed events by sorting and separately analyzing the data for concentrations below 2 ppm. The frequency of occurrence of such low-oxygen events in the data record, as a percent of all measurements, is summarized in Table 9-4 by hydrographic area and in Table 9-5 by component bay, following the same convention as Section 6.1. (A blank is entered in this table for those months not represented in the data record.) Only those hydrographic areas with a nonzero occurrence of low DO's in the period of record are shown in Table 9-4, so it is immediately apparent that the majority of segments in the system have never logged an occurrence of DO below 2 ppm. A quick inspection of this table shows, as expected, low DO events are much more a phenomenon of summer and the greatest systematic occurrence is in those areas affected by high organic loading and poor flushing, notably the Inner

Table 9-4
Monthly and total frequency of occurrence as percent (%)
of dissolved oxygen (WQDO) values ≤ 2 ppm
by hydrographic-area segment

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
A5	0	0	0	0	0	9.1	0	0	0	0	0	0	0.6
A6	0	0	0	0	0	0	0	0	0	0	0	7.1	0.7
A10	4.5	0	0	0	0	0	0	0	0	0	0	0	0.4
AL1	0	0	0	0	0	0	0	0	6.7	0	0	0	0.6
AL2	0	0	0	0	2.7	0	0	0	0	4.1	0	0	0.9
BF1	0	2.5	0	0	0	0	0	0	0	0	0	0	0.2
BF2	0	0	0	0	0	2.0	2.9	9.4	0	2.1	0	0	1.3
BF3	0	0	3.4	0	1.5	4.7	2.1	3.6	2.0	3.2	0	0	1.7
C01	0	0	0	0	0	0	0	3.8	0	0	0	0	0.4
C03	0	0	0	0	0	0	2.9	5.4	0	0	0	0	0.6
C04	0	0	0	0	0	0	2.8	3.2	0	2.9	0	0	1.1
C05	0	0	0	0	0	0	0	3.8	0	0	0	0	0.2
C06	0	0	0	0	0	0	2.8	7.7	1.8	5.5	0	0	1.5
C07	0	0	0	0	0	0	0	0	0	0	1.7	0	0.2
C09	0	0	0	0	0	0	0	0	0	3.9	0	0	0.4
C10	0	0	0	0	0	0	0	0	0	2.7	0	0	0.3
C11	0	0	0	0	0	0	0	1.5	0.7	0	0	0	0.2
C12	0	0	2.3	0	0	0	1.3	1.6	0	0	1.8	0	0.6
C14	0	0	0	0	0	1.4	1.9	2.8	0	0	0	1.6	0.5
C15	0	0	0	0	0	0	5.9	5.5	1.3	0.8	0	0	1.2
C16	0	0	0	0	0	0	0	0	0	10.0	0	0	1.1
C17	0	0	0	0	0	0	4.4	5.3	0	0	0	0	0.7
C21	0	0	0	0	0	0	0	0	0	2.7	0	0	0.3
CCC1	0	0	0	0	2.7	1.2	1.1	0	0	0	0	0	0.5
CCC3	0	0	0	0	0	0	0	4.1	0	2.4	0	0	0.5
CCC4	0	0	0	0	0	0	5.0	0	0	0	0	0	0.8
CCC6	0	0	0	0	0	0	0	0	0	1.7	0	0	0.2
CCC7	0	0	0	0	0	4.9	0	20.7	6.7	4.3	0	0	2.1
CCC8	0	0	0	0	0	3.4	3.7	2.8	12.9	1.5	0	0	1.8
CP02	0	0	0	0	2.3	0	0	0	0	0	0	0	0.3
CP07	0	0	0	0	0	0	0	0	0	2.3	0	0	0.3
CP08	0	0	0	0	0	3.6	0	0	0	0	0	0	0.3
CP09	0	0	0	0	0	0	0	0	4.3	0	0	0	0.3
GR2	0	0	0	0	2.7	0	0	3.7	0	0	0	0	0.5
I3	0	0	0	0	0	0	0	0	0	2.9	0	0	0.4
I5	0	0	0	0	2.7	0	0	0	0	0	0	0	0.4
I6	0	0	0	0	0	0	0	4.9	0	0	0	0	0.5
I7	0	0	0	0	0	0	0	0	0	0	2.4	0	0.2

(continued)

Table 9-4
(continued)

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
I9	0	0	0	1.9	0	0	0	0	0	0	0	0	0.2
I11	0	0	11.1	0	0	0	0	0	0	0	0	0	0.7
I12	0	0	0	0	0	0	0	2.6	0	0	0	0	0.3
I13	0	0	6.5	0	0	0	0	0	0	0	0	0	0.7
I14	0	0	37.5	0	0	0	0	0	6.3	0	0	0	3.3
I15	0	0	0	0	0	0	0	5.9	0	3.4	0	0	0.9
I16	0	0	0	0	0	7.7	0	0	0	0	0	0	1.6
I17	0	0	0	0	0	0	0	7.7	0	0	0	0	1.1
IH1	0	1.3	0	0	5.3	25.8	37.7	19.8	41.7	15.4	5.9	33.3	12.8
IH2				0				13.3				0	3.0
IH3	0	0	14.3	10.3		33.3	42.9	6.7		42.9	0	0	15.0
IH4	0			12.5	0	33.3		0		0		0	5.6
IH5	0	0	3.3	4.4	5.7	20.6	24.5	6.5	36.9	5.6	0	0	9.1
IH6	0	1.4	7.7	4.1	0	33.3	8.9	8.8	10.9	6.9	5.3	18.2	6.5
IH7	0	0	3.5	0.7	2.0	8.3	23.3	17.6	17.4	11.8	2.7	1.6	7.3
LQ1	0	0	1.2	0	0	0	3.2	2.0	0	0	0	0	0.6
LQ2	0	0	0	0	4.0	0	6.1	3.2	0	0	0	0	1.2
LS2	0	0	0	0	0	7.1	0	0	0	0	0	0	0.4
M2		0	0	0	0	6.7	0	0	0	0	0	0	1.3
NB5	0	0	0	0	0	0	2.3	0	2.7	0	0	0	0.4
NB6	0	0	4.5	0	0	0	0.9	0	0	0	0	0	0.4
NB7	0	0	12.0	0	0	0	0	0	0	2.4	0	0	0.9
NR1	0	0	31.8	0	0	0	0	0	0	18.2	0	0	7.0
NR3	0		44.4	12.1	27.3	10.0	0	0		14.3	35.7		17.5
NR4	0	0	0	0	0	0	0	0	11.8	0	0	0	1.2
NR5	0	0	0	0	0	0	15.4	0	0	0	0	0	1.7
OS1	0	11.1	0	0	0	0	0	0	0	0	22.2	0	3.9
OS3	0	0	20.0	0	0	0	0	0	0	0	0	0	1.7
PB1	0	0	0	0	4.0	0	0	0	0	0	0	0	0.6
PB2	0	6.3	0	0	0	0	0	0	0	0	0	0	0.5
RB2	0	0	0	0	0	0	0	0	7.7	5.9	0	0	1.8
RB9	0	20.0	0	0	0	0	4.3	13.6	0	3.2	5.6	0	3.3
SC1	0	0	0	0	0	4.8	0	0	0	0	0	0	0.6
SC3	0	0	0	0	1.4	0	2.6	0	0	0	0	0	0.4
UL02	0	0	12.5	0	0	0	0	0	4.5	0	0	0	1.3
UL03	0	0	0	0	2.4	0	10.0	6.7	11.1	9.1	2.9	0	4.0
UL05	0	0		0	0	6.7	0	0	0	0	0	0	1.7
UL06	0	0	7.1	0	3.7	6.3	0	7.1	0	0	0	0	1.9
GMI5	0	0	0	0	0	5.3	0	0	0	0	0	0	0.5
GMI6	0	0	0	0	0	1.9	0	0	0	0	0	0	0.2
GMO5	0	0	0	2.9	0	0	0	0	0	0	0	0	0.3
GMO7	0	0	2.9	0	0	0	0	0	0	0	0	0	0.3

Table 9-5
Monthly and total frequency of occurrence as percent (%)
of dissolved oxygen (WQDO) values ≤ 2 ppm
by principal component bay

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
Aransas Bay	0.4	0	2.9	0	0	0.6	0	1.0	0.5	0.3	0	0	0.6
Copano Bay	0	0	0	0	0.3	0.4	0	0	0.5	0.2	0	0	0.1
St Charles	0	0	0	0	0.7	0	1.3	0	0	0	0	0	0.2
Mesquite	0	0	0	0	0	0	0	0	0	0	0	0	0
Redfish	0	2.5	0	0	0	0	0.5	1.7	1.0	1.1	0.7	0	0.6
Corpus Christi	0	0	0	0	0	0.1	0.8	1.7	0.1	1.2	0.1	0.1	0.4
CCSC (bay)	0	0	0	0	0	1.0	1.0	5.0	1.3	1.7	0	0	0.7
Inner Harbor	0	0.5	5.8	4.6	2.6	25.8	27.5	10.4	26.7	13.8	2.8	7.6	8.5
Nueces Bay	0	0	0	0	0	0	0.4	0	0.5	0	0	0	0.1
Aransas Pass	0	0	0	0	0.7	0.3	0.4	0	0	0	0	0	0.1
Causeway N	0	0	0	0.6	0	0	0	0	0	0	0	0	0.1
Causeway S	0	0	3.1	0	0	0	0	0	1.1	0	0	0	0.3
Laguna (King)	0	0	5.2	0	0.5	1.0	0.8	1.7	1.3	1.0	0.2	0	1.0
Laguna (Baffin)	0	0	0	0	0	2.6	0	2.6	0	0	0	0	0.9
Baffin Bay	0	0.5	0.7	0	1.4	1.3	1.0	3.3	0.4	1.9	0	0	0.9
GOM inlet	0	0	0.5	0.5	0	1.2	0	0	0	0	0	0	0.2

Table 9-6
Monthly and total frequency of occurrence
of dissolved oxygen (WQDO) values ≤ 0.5 ppm
as percent (%) of the occurrence of hypoxic values (Table 9-4)
by hydrographic-area segment

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
C15							0	14					7
CCC3								100		- 0			60
CCC7						50		83	100	0			69
IH1					100	50	35	41	50	58	100	100	52
IH3				17		50	100			83			57
IH5				0	50	29	46	33	38	25			35
IH6				67		25	20	29	29	50	0		33
IH7			67		0	0	23	46	50	22	0		30
NR1			80							0			57
NR3			100	50	67					33	80		65
UL03									100	0			38

Harbor, La Quinta Channel, Upper Laguna, especially along the King Ranch reach and near the JFK Causeway, Redfish Bay near Ingleside, and the nearshore of Corpus Christi Bay along the urbanized south shore.

What Tables 9-4 and 9-5 do not show is the depth occurrence of these low DO events and the frequency of occurrence of near-zero events, i.e. DO that is virtually zero. A direct inspection of the data indicates, again as expected, that very low DO's occur primarily in the measurements at depth, although in the 1960's and 1970's occasional profiles of DO in the Inner Harbor show depleted DO throughout the depth. With respect to near-zero events, defined to be a DO concentration ≤ 0.5 ppm, their occurrence as a fraction (percent) of the hypoxic events is summarized in Table 9-6 by hydrographic segment. To better focus this table, we include only those segments in which at least one such occurrence is logged in the period of record, and there are at least three measurements that are hypoxic (so that the relative frequency has some meaning). Again, the Inner Harbor is the predominant low-DO environment in the system.

These tables show hypoxia and near-zero occurrences as a fraction of the total data base or the fraction of the hypoxic events, respectively (requiring at least three independent measurements to compute such a fraction), to better scale the probable frequency of occurrence of such events. What is lost in this type of presentation is the magnitude of the raw numbers of such events, both hypoxic ($DO \leq 2$) and near-zero ($DO \leq 0.5$). These are summarized in Tables 9-7 and 9-8, segments being omitted if there are no occurrences in the data record.

What emerges from these tables is that hypoxia is relatively rare in the system, and the geographical regions of consistent occurrence are those enumerated above. Near-zero DO is rarer yet, being primarily confined to the Inner Harbor and Nueces River. In the time domain, most of the occurrences of hypoxia in the Corpus Christi Bay main body were logged in the 1960's and 1970's, especially in the Inner Harbor. In the outer bays of Copano, Aransas, the Upper Laguna and Baffin, most of the occurrences have been in the late 1980's and early 1990's.

Recently, the occurrence of near-bottom near-zero DO has been reported in the region north of the JFK Causeway (Montagna, pers. comm., 1996), Hydrographic Segment C14 (Fig. 3-11). These measurements are not included in the present compilation because they were received too late in the data-compilation process. However, by comparison with the rest of the data, this region evidences no proclivity for the occurrence of hypoxia, so we must regard this recent occurrence as probably localized and transient.

9.2.4 Suspended Solids and Turbidity

Suspended solids in Corpus Christi Bay have a close geographical association with regions of inflow and, to a lesser extent, with regions of shipping, see Figs. 6-33 through 6-37. The former is no doubt due to the riverine inflow and waste

Table 9-7
Number of hypoxia occurrences in data base, dissolved oxygen values ≤ 2 ppm by month and hydrographic-area segment

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
A5						1							1
A10	1												1
AL1									1				1
BF1		1											1
BF2								1		1			2
BF3					1		1	1		2			5
C01								1					1
C03								2					2
C04							1	1		2			4
C05								1					1
C06							1	1	1	2			5
C07											1		1
C10										2			2
C11								1	1				2
C12				1				1	1		1		4
C14							2	1					3
C15							6	7	1				14
C16										1			1
C17							1	2					3
CCC1					2	1							3
CCC3								3		2			5
CCC6										1			1
CCC7						2		6	5	3			16
CCC8						1	1	2	4	1			9
CP02					1								1
CP08						1							1
CP09									1				1
GR2								1					1
I3										1			1
I5					1								1
I6								2					2
I7											1		1
I9				1									1
I11				1									1
I12								1					1
I14									1				1
I15								1		1			2
I16						1							1
I17								3					3

(continued)

Table 9-7
(continued)

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
IH1		1			4	8	20	17	14	12	3	2	81
IH2								1					1
IH3			1	6		6	3	1		6			23
IH4				3		1							4
IH5			1	3	4	7	13	6	24	4			62
IH6				3		4	5	7	7	4	2	1	33
IH7			3	1	2	7	13	13	10	9	2		60
LQ1							2	1					3
LQ2					1		3	2					6
M2						1							1
NB5									2				2
NB6			1				1						2
NB7			3							1			4
NR1			5							2			7
NR3			4	4	3	1				3	5		20
NR4									2				2
NR5							2						2
OS1		1									2		3
OS3			1										1
PB1					1								1
PB2		1											1
RB2									1	1			2
RB9							1	3		1	1		6
SC1						1							1
SC3					1								1
UL02									1				1
UL03					1		1		3	2	1		8
UL05			1										1
UL06						1							1
Aransas Bay	1					1		4	1	1			8
Copano Bay					1	1			1				3
St Charles					1								1
Mesquite													0
Redfish							1	3	1	2	1		8
Corpus Christi							5	10	2	7	1		25
CCSC (bay)						2		9	5	6			22
Inner Harbor		1	5	16	10	33	54	45	55	35	7	3	264
Nueces Bay									2				2
Aransas Pass					2	1							3
Causeway N				1									1
Causeway S									1				1
Laguna (King)			2		1	1	1	2	4	3	1		15
Laguna (Baffin)						1		3					4
Baffin Bay		1			1		1	3		3			9

Table 9-8
Number of near-zero occurrences in data base, dissolved oxygen values ≤ 0.5 ppm by month and hydrographic-area segment

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
A10	1												1
AL1									1				1
BF1		1											1
BF2								1		1			2
BF3					1					2			3
C01								1					1
C03								2					2
C04							1			2			3
C06							1		1	1			3
C07											1		1
C10										2			2
C11									1				1
C12			1				1				1		3
C14							2	1					3
C15							6	6	1				13
C16										1			1
C17							1	2					3
CCC1					2	1							3
CCC3										2			2
CCC6										1			1
CCC7						1		1		3			5
CCC8						1	1	2	4	1			9
CP08						1							1
CP09									1				1
I3										1			1
I5					1								1
I6								2					2
I7											1		1
I9				1									1
I11			1										1
I14									1				1
I15										1			1
I16						1							1
I17								3					3
IH1						4	13	10	7	5			39
IH2								1					1
IH3				5		3		1		1			10
IH4				3		1							4
IH5			1	3	2	5	7	4	15	3			40
IH6				1		3	4	5	5	2	2		22
IH7			1	1	2	7	10	7	5	7	2		42

(continued)

Table 9-8
(continued)

segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*all*
LQ1							2	1					3
LQ2					1		3	2					6
M2						1							1
NB5									2				2
NB6							1						1
NB7										1			1
NR1			1							2			3
NR3				2	1	1				2	1		7
NR4									2				2
NR5							2						2
OS1											2		2
RB2									1	1			2
RB9								2		1	1		4
UL02									1				1
UL03					1		1			2	1		5
UL05			1										1
UL06						1							1
Aransas Bay	1												1
Copano Bay													0
St Charles													0
Mesquite													0
Redfish													1
Corpus Christi													1
CCSC (bay)										1			2
Inner Harbor				2	1	3	5	4	5	3	1		23
Nueces Bay													0
Aransas Pass					1								1
Causeway N													0
Causeway S													0
Laguna (King)													1
Laguna (Baffin)								1					1
Baffin Bay										1			1

discharges as sources of TSS, particularly very fine grained particulates that are easily maintained in suspension. The latter is probably due to resuspension by dredging activity and—especially—by ship traffic. Stratification in TSS is consistent and widespread, though not especially high, generally several ppm per m, decreasing upward. This vertical stratification is expected, for two reasons. First, because the particulates are subject to gravitational settling, there is expected to be an accumulation toward the bottom. Second, mobilization of bottom sediments are expected to be a primary source for suspended particulates, so the resultant concentrations will be greater near the source, *viz.* near the bed.

One of the surprising findings of this study is the general declining trend in suspended solids throughout the bay, see Table 6-50 and Figures 6-97 through 6-101. In the upper bays and the main body of Corpus Christi Bay, this rate of decline is on the order of 0.5 ppm/yr. This rate of decline over the past two decades has resulted in reducing TSS concentrations by approximately one-fourth. (This trend was based upon the proxy relations, by which turbidity measures were expressed as equivalent TSS. To verify that this trend was not a statistical artifact, separate trends were determined for TSS measurements and the individual turbidity measurements. All were found to be in basic agreement.) In the lower bays of the Upper Laguna and Baffin, the declining trend was even more prominent, being almost uniformly statistically probable, see Figs. 6-100 and 6-101, and at rate of decline over twice that of the upper bays. Over the period of record this has led to roughly *halving* the TSS concentrations in these bays. It is interesting to note that Ward and Armstrong (1992a) found exactly the same result in the analysis of data from Galveston Bay.

Hypotheses that could account for this decline are:

(1) Reductions in TSS loading due to advanced waste treatment;

(2) Reductions in TSS loading due to reductions in river inflow;

(3) Reductions in TSS loading due to declines in riverine transport, in turn a consequence of

  (a) reservoir construction

  (b) better land-use practices on the watersheds

  (c) natural modifications to watershed solids runoff;

(4) Reductions in TSS loading of peripheral runoff, due to alterations in land use around the bay;

(5) Declines in the mechanical resuspension of particulates within the bay;

(6) A laboratory artifact due to improved methods of filtration and analysis in the more recent data.

Among most workers (1) and (3a) would be considered the frontrunners by a considerable margin. This may explain the declines in Nueces and Corpus Christi Bay, but does not account for those in the upper and lower bays. Noting that there is a general association of regions of increasing salinity and regions of declining TSS in Corpus Christi, Nueces, Aransas and Copano Bays, and the probable effect of reduced inflow on salinity (see 9.2.2 above) lend weight to (2), perhaps in concert with (3b) or (3c). Again, this does not explain the substantial decline in the lower bays. Hypothesis (5) implies a longer-term climatological change, perhaps an alteration of wind predominance or windwave production.

In our view, the only one of these which lacks plausibility is (6). This is because actual TSS measurements make up a minority of the proxied data base, and the same decline is evidenced in the alternative measures of turbidity. It is too much of a stretch to claim methodological bias in all of these measures.

9.2.5 Nutrients and chlorophyll

Ammonia nitrogen is generally higher in regions affected by waste discharges, especially the Inner Harbor, while nitrate is typically highest in regions affected by runoff and inflow. Generally where these are high in concentration, they exhibit a declining trend. The exception to this statement is the occurrence of elevated nitrate in the Inner Harbor, which does not evidence a clear decline. Phosphorus is generally higher in regions affected by runoff, i.e. near the inflows of rivers and tributaries, but its distribution in the system is generally opposite to that of volume of flow, increasing in concentration from Copano in the north to Baffin in the south. Total organic carbon (TOC) is higher in the regions more influenced by inflows, namely the upper bays and Corpus Christi Bay, and in these systems the trend is toward declining concentrations. The sediments also exhibit declining trends of TOC in areas of higher concentrations, see Fig. 7-51.

Hypotheses explaining these observations include the following:

(1) The prominent source of ammonia is waste loads, and is declining due to improved waste treatment;

(2) Nitrate is introduced both in runoff and in waste loads, however improvements in waste treatment are not achieving a decline in nitrate in the Inner Harbor because the ammonia in the waste stream is being oxidized to nitrate;

(3) Declines in nitrate in the upper bays are due to reduced riverine loading, in turn a consequence of:

  (a) reservoir construction

  (b) better land-use practices on the watersheds

(4) TOC is declining due to reduced organic loads in the rivers;

(5) TOC is declining due to reduced biomass production in the open waters.

Whether (5) is a viable hypothesis could be judged by whether a similar trend is indicated for chlorophyll-a. Unfortunately, the data holdings are too sparse and noisy for reliable trend analysis. (In Nueces Bay, the trend are opposite, declining for TOC but increasing for chlorophyll-a.) It is noteworthy to contrast this situation with the analysis for Galveston Bay (Ward and Armstrong, 1992a), where a much more substantial data base for chlorophyll-a allowed determination of a general decline in concentration throughout the system.

9.2.6 Contaminants

The association of BOD concentration with waste discharge sources is evident in two respects: the geographical distribution of BOD, with higher concentrations in regions affected by inflows and waste discharges, and a tendency for decline in BOD concentrations over time in the same regions. Unfortunately, measurement of BOD seems to have gone out of fashion in recent years, so most of our knowledge about the distribution of BOD in the system applies only to the 1970's for most areas, and the early 1980's for the others. The high concentrations indicated in Baffin (Fig. 6-21) are based on data from the 1960's and 70's. Similarly, the declines in Inner Harbor values would probably be much more pronounced (and better defined) had we any data from the most recent decade. Thus while we do not need to look far for a causal hypothesis explicating the observed behavior of BOD in Corpus Christi Bay, since it is clearly a direct measure of organic loads, both from waste discharges and from peripheral runoff (including inflows), its association with more recent trends in the system, e.g. nutrients and increasing salinities, is unknown. Other alternative indicators of organic contaminants such as volatile suspended solids and oil & grease suffer from the same problems of limited measurements. Volatile suspended solids are high in the water and volatile solids are high in the sediment in the Inner Harbor. These are also high in Copano Bay and Nueces Bay. For VSS, however, the data record extends to the present, and evidences a probable declining trend almost everywhere in the system (where data exist).

Fecal coliforms exhibit lower concentrations in open-bay areas and higher concentrations in areas affected by inflow, runoff, and waste discharges, Table 6-20. High values are found in the nearshore regions along the urbanized south shore of Corpus Christi Bay. The most widespread trend is for increasing concentrations, but this is at a low level of statistical confidence. This would seem to run counter to the above hypotheses of improved waste treatment, and diminished runoff loads. Certainly, the noisy character of this measure erodes the statistical confidence in the analysis, and many of the apparent trends may be statistical artifacts. The obvious hypothesis of coliform behavior is that it is a highly transient indicator responding to environmental factors that operate on much shorter time frames than implicit in a long-term data base. This means

that apparent statistical behavior of the data base may be more a function of where and when it is sampled than in any intrinsic variation of the parameter. The fact that coliforms respond to many variables other than human enteric wastes has been remarked by many investigators, as well. The observed behavior of coliforms might profit from detailed response-type analysis including storm events, hydrographic fluctuations, and postulated attrition kinetics; such an analysis is beyond the scope of this study.

Metals, in general, behave in a quasi-conservative manner in the water column (cf., Table 7-1) and their *variability* in Corpus Christi Bay would be expected to be high, in response to all of the factors effecting mass transport (analogous to that of salinity). This would make inferences difficult in itself. The problem is compounded by the relatively sparse data set and the great majority of measurements reported as "below detection limits," all of which translates to a high degree of uncertainty. It is clear, however, that the regions in and around the Inner Harbor exhibit consistently high metals in the water. Nueces Bay is a region consistently high in metals, in both the water column and the sediment, as are Baffin Bay, Copano Bay, a region of the Upper Laguna around Pita Island, the La Quinta Channel, and Redfish Bay near Aransas Pass.

The existence of the CP&L Nueces Generating Station means there is a direct transport of water from the Inner Harbor to Nueces Bay (see 9.2.1 above), in that the plant continuously circulates a flow at a nominal rate of 18 m^3s^{-1} (650 cfs), which is approximately equal to the mean inflow of the Nueces River (Table 9-3). One hypothesis for the elevated metals in Nueces Bay, therefore, is that they are due to this influx of water (and suspended sediments) from the Inner Harbor. This hypothesis cannot, however, be the entire explanation, because there are too many parameters whose concentrations are inconsistent between Nueces Bay and the Inner Harbor, such as ammonia, suspended solids, and lead, nor are the trends consistent. A second hypothesis is that the metals are associated with oil and gas activities, a feature which Nueces Bay has in common with Copano Bay and Baffin Bay. This may also be supported by the relatively high sediment concentrations of PAH's (Table 7-9) some of which, such as acenapthene, are not shared with the Inner Harbor. For the metals for which a reliable trend determination can be made, most are declining in the Inner Harbor. This is in general conformity to the hypothesis of improved water quality due to advanced waste treatment. One curious exception is lead in the water phase, which shows probable increasing trends consistently in all of the segments of the Inner Harbor. This statement is not true for the sediment metals, in that no positive trends are indicated in the Inner Harbor for any of the metals.

Elsewhere in the bay, metals data for the water phase are too sparse to allow general statements. In the sediments, the open deeper waters of Corpus Christi Bay tend to be higher in concentration than the nearshore waters for most metals. This seems to be obeyed as well in the other systems, especially Baffin, but is most obvious in Corpus Christi Bay because of the high range of concentrations. On the other hand, the deepest sections of Corpus Christi Bay, namely, the Corpus Christi Ship Channel hydrographic segments, are systematically lower in metals than the sediments to either side, see Figs. 7-15, 7-21, 7-26, 7-30, and 7-36. This

general pattern offers clear evidence of the association of metals with sediments, especially the finer grain sediments, and how they are influenced by transport, deposition and dredging. Trends in sediment concentrations are inconsistent geographically and from metal to metal, so without further detailed analysis, it is difficult to determine possible causes. We note a general probable decline in mercury in the open bay waters, and some tendency for increasing zinc, especially in the Baffin and Corpus Christi systems, but this is statistically less reliable.

Two hypotheses regarding in the interaction of water and sediment metals, and their ultimate transport and fate are:

(1) The pathway of metals is to the sediments due to settling of solids and then to the overlying water by resuspension and reworking; that is, metals in the water column are driven principally by concentrations in the sediments and continual scour and resuspension;

(2) The pathway of metals is to the water column first, followed by transport with the main currents and settling with solids; that is, concentrations in the sediments are driven by the TSS-sorbed metals in the overlying water and zones of relative stagnation where settling is enhanced;

With respect to the observed distributions and probable sources, the following hypotheses are proffered:

(3) The principal sources of metals in Corpus Christi Bay are in the industrial and outer bay areas, in turn originating from

  (a) waste discharges

  (b) runoff from industrialized areas

  (c) shipping activity

  (d) oil & gas production activities

(4) The decline in metals concentrations in water and sediment results from advances in waste treatment, in turn from

  (a) reductions in TSS and the associated affinity of metals for fine-grained solids

  (b) assimilation and/or bonding during high-detention secondary treatment

(5) The decline in metals concentrations in water and sediment results from better runoff controls in the watershed;

(6) The decline in sediment metals in the Inner Harbor and trans-bay reach of the Corpus Christi Ship Channel is due to increased dredging, removing contaminated sediments from the bay system to upland or offshore sites, or sidecasting into areas remote from the channel; if the pathway is from sediments to water (1), this would imply a reduced concentration in the water column, as well.

These hypotheses are not mutually exclusive. Clearly, the observed decline in suspended solids and in many metals is considered to be more than just a statistical association, because there is a well-established physical relation in the affinity of metals for fine-grained solids. Therefore, any insight into the cause of the reduction in TSS would yield information on the dynamics of metals. The alternative pathways of (1) and (2) would be moot if the reduction in metals were tied to waste-treatment or runoff control, since the net effect of either pathway would ultimately be the same. On the other hand, (1) would imply maximum concentrations in areas of strong currents and intense shipping, perhaps offering an explanation for the higher concentrations of some metals in the Port Aransas Entrance Channel regions.

The sparse data base and rarity of measurements above detection levels prevent any statements about coherent behavior of pesticides, PAH's and PCB's in Corpus Christi Bay, other than a proclivity for higher concentrations in regions of increased urban activity, especially the Inner Harbor.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 The data base

A primary objective of this study was the compilation of a digital data base composed of water-quality, sediment-quality and tissue-quality data, which was assembled from 30 data collection programs performed in Corpus Christi Bay. This compilation included data from the three most important ongoing monitoring programs in Corpus Christi Bay: the Texas Natural Resource Conservation Commission (TNRCC) Statewide (a.k.a., Stream, a.k.a. Surface-water) Monitoring Network (SMN), the Texas Parks and Wildlife Department hydrographic observations from its Coastal Fisheries program, and the hydrographic and biochemical data of the Texas Department of Health Seafood Safety (née Shellfish Sanitation) Division program. The important surveys and research projects sponsored by the Texas Water Development Board and maintained in its digitized Coastal Data System are included. This compilation also entailed keyboarding of other major data sets, many of which exist in limited hardcopy and are virtually unobtainable, including the Galveston District U.S. Corps of Engineers (USCE) O&M water and sediment surveys of the 1970's, data of the Texas Game Fish & Oyster Commission from the 1960's, the Reynolds-sponsored "baseline" surveys of the early 1950's, the Submerged Lands Project of the Bureau of Economic Geology, and the data collections by the now-defunct Ocean Science and Engineering Laboratory of Southwest Research Institute. Other entries in this compilation include research projects whose data are published only in limited technical reports or academic theses, all of which were keyboarded. A major data compilation effort of the project was devoted to determination of latitude/longitude coordinates based upon historical sampling station location information, so that all of the data could be unambiguously georeferenced. In addition to supporting the spatial-distribution analyses of this study, this georeferencing data will facilitate incorporation of the data base into GIS systems.

All told, the digital compilation is the most extensive and detailed long-term record of water and sediment quality ever assembled for Corpus Christi Bay. Each measurement record includes the date, sample depth, latitude and longitude of the sample station, measured variable, estimated uncertainty of measurement expressed as a standard deviation, and a project code identifying the origin of the data. For tissue data, the sample depth field is replaced by a code identifying the organism.

Spatial aggregation of the data was accomplished by two separate segmentation systems for Corpus Christi Bay, the TNRCC Water Quality Segmentation of 27 segments, and a system of 178 hydrographic segments devised by this project and designed to depict the effects of morphology and hydrography on water properties. (The 27 TNRCC segments include the original 15 specified by the Scope of Work, to which we added 5 classified segments and 7 unclassified.) Each segmentation system was codified by a network of nonoverlapping quadrilaterals by which the

data records could be sorted using latitude/longitude coordinates of sampling stations.

Detailed statistical analyses were performed of 109 water-quality parameters and 83 sediment-quality parameters, in addition to several supplementary (e.g., DO deficit), screened (e.g., near-surface values), or transformed (e.g., proxied TSS) variables. Each statistical analysis included basic sampling density information, means and standard deviations, with three different treatments of measurements below detection limits (BDL), and a linear trend analysis over the period of usable record, with confidence limits on the slope. Therefore, statistical analyses addressing water/sediment quality were performed of about 200 parameters in about 200 (exactly, 27 + 178) different segments, a total of about 40,000 independent statistical analyses, since each parameter/segment comprises an independent data set. For tissue data, an even more extensive suite of analytes were compiled, but the statistical analyses were confined to a subset of these analytes because of the sparsity of the data base. In addition to sediment/parameter differentiation, tissue data had to be further separated according to organism, portion of organism analyzed (i.e., whole versus fileted), and reporting by dry- or wet-weight, each combination of which represented an independent statistical analysis. The results of these analyses are given in the Appendices to this report.

It is appropriate to note several deficiencies of this data set, as they relate to the interpretation of water and sediment quality, and as motivation for recommendations proffered in the concluding section. Despite the hundreds of thousands of separate measurements compiled in this study, from extensive and overlapping routine monitoring and survey programs by several state agencies and numerous special surveys, when these data are subdivided by specific parameters, each of which measures a different aspect of the water quality "climate," aggregated by region of the bay (segments) and distributed over time, the data record is seen to be rather sparse. Generally, Corpus Christi Bay is undersampled. This is relative to the high degree of variability of the bay. Unlike a lake or a river, which can be fairly stable in time and fairly homogeneous over large areas, an estuary such as Corpus Christi Bay is subject to a variety of external controls, all of which contribute to variation in space and time. The intermixing of fresh and oceanic waters imposes spatial gradients in both the horizontal and the vertical. The effects of tides, meteorologically driven circulations, and transient inflows all contribute to extreme variability in time. Superposed upon all of this are the time- and space-varying influences of human activities.

Adequacy of a data base is judged relative to the ability to resolve the various scales of variation, and therefore in this respect the data base for Corpus Christi Bay is sparse. Continuity in space of the data base is undermined by too few stations, and by inconsistency in the suite of measurements at different stations. Continuity in time is undermined by infrequent sampling, and the replacement of one parameter by another without sufficient paired measurements to establish a relation. Past and present sampling practice does not permit analysis of time scales of variation shorter than a few days. Ability to resolve long-term trends in the face of high intrinsic variability requires data over an extended period. The

extant period of record for Corpus Christi Bay, with adequate continuity for trends analysis, extends back only to about 1965, except for some traditional parameters and for certain areas of the bay, for which the record can be extended back to the 1950's. As salinity and temperature are the most easily measured variables, they represent the densest and longest data record. For metals and for complex organics, the period of record may extend back only a decade or so. Many of these measurements are below detection limits. For sediment, the data base is even more limited, amounting to one sample per 50 square miles per year, and extending back in time at most to the 1970's.

Data management is generally poor. Reference is made to the conclusions of Ward and Armstrong (1992a) concerning data management practices and data loss in general. Most of the same problems encountered in the Galveston Bay Status & Trends Project were met in this one as well. A new mainframe data management system, and the link through the Internet have greatly improved the dissemination process at TNRCC relative to the situation five years ago. Also this agency is now observing paper-copy back-up for its holdings, so that errors or missing information can be tracked down. On the other hand there remain problems with the older data including data-entry errors, position errors, and incorporation of BOGAS measurements (see Sections 2.1 and 5.3.2) into the data base. The most pressing management problem for historical data in the Corpus Christi area, as well as in other areas of the Texas coast, is preservation of the older data. Much irreplaceable and invaluable information on the Corpus Christi Bay system has been lost.

10.2 The water and sediment "climate"

Salinity acts as a water mass tracer and general habitat indicator for Corpus Christi Bay waters whose concentration is primarily determined by boundary fluxes at the inflow points and at the inlets to the sea, and internal transport and mixing. It is technically a conservative parameter, but viewed from a water-column perspective, it behaves nonconservatively much of the time because of the major rôle evaporation plays in the bay's salt budget. In contrast to the estuaries on the upper Texas coast, substantial gradients across Corpus Christi Bay from the sea to the regions of inflow are not a normal feature of salinity structure. These gradients are on average rather flat. The most significant gradient of salinity in the project Study Area is, rather, from north to south, from Copano Bay to Baffin Bay. This is clearly the combined result of diminishing inflow with distance to the south and increasing evaporation. However, variability about the mean salinity is high, in some areas encompassing tens of parts per thousand, and exceeding seawater concentrations sometimes by large amounts, especially in the lower bays (the Upper Laguna and Baffin Bay). Vertical stratification of bay waters is slight, by estuarine standards, generally averaging less than 0.6 ppt/m, and averaging less than 0.3 ppt/m over about half of the study area, with no correlation with water depth. In particular, there is no apparent correlation between mean salinities and ship channels, suggesting that density currents as a mechanism of salinity intrusion are rarely important in Corpus Christi Bay.

This is consistent with the lack of horizontal salinity gradient along the ship channels.

While freshwater inflow is the ultimate control on salinity, inflow proves to be a poor statistical predictor of salinity, achieving less than 50% explained variance in those areas in proximity to sources of inflow, and even less elsewhere, even with long-term averaging of the inflow. This illustrates that the variability of salinity is influenced by factors other than simply the level of inflow.

In the bays generally more influenced by freshwater inflow, *viz.* the Copano system, the main body of Corpus Christi Bay and Nueces Bay, there has been a general increase in salinity over the three-decade period of record, on the order of 0.1 ppt per year. During the same period there has been a declining trend in monthly-mean inflow to these same bays, over 50% in Corpus Christi and Nueces Bays, less in Copano (which also logged a smaller increase in salinity). Our favored hypothesis (whose testing would require detailed salt budgeting for the system, and exceeded the scope of this study) is that this decline in mean inflow is responsible for the increase in salinity. No clear trends in salinity emerged for the Upper Laguna or Baffin Bay.

The parameter pH is rather uniform, with its higher values, in excess of 8, in the more saline regions of the bay, an expression of the high buffering capacity of sea water. Because of its variability within a rather narrow range, no reliable trends were detectable, though in the open waters of Corpus Christi there is a proclivity to declining values. It is noteworthy that the (smaller) data set for alkalinity shows statistically probable declining trends almost everywhere.

Temperature in Corpus Christi Bay is primarily controlled by surface fluxes, especially the seasonal heat budget, and much less—if at all—by peripheral boundary fluxes and internal transports. The horizontal gradient across the study area is from north to south, ranging 2-4°C. There is little systematic stratification, though on average a slight stratification on the order of 0.1°C/m is indicated. This stratification is due to near-surface heat absorption, rather than density effects. The seasonal signal is, of course, the principal source of variation in water temperature, ranging about 14 to 30°C from winter to summer. Over the three-decade period of record, water temperature in the upper bays and main body of Corpus Christi Bay, especially in the open waters, has declined at a nominal rate of 0.05°C/yr. There are no clear trends in the lower bays. It is interesting to note that the same decline in temperature, at approximately the same rate, was discovered in Galveston Bay (Ward and Armstrong, 1992a). Our favored hypothesis for this decline is an alteration in climate (e.g., air temperature, wind, cloud cover), though this could not be tested within the scope of this project.

Dissolved oxygen is generally high throughout the CCBNEP Study Area, averaging near (and above) saturation through most of the system, with frequent occurrence in the data record of substantial supersaturation. Exceptions to this are in poorly flushed tributaries and areas influenced by wasteloads, especially the Inner Harbor. These near-saturated conditions are a manifestation of the intense vertical mixing processes in Corpus Christi Bay, which enhance

mechanical surface aeration, as well as a manifestation of photosynthetic productivity. The most important variation in DO is due to seasonal changes of solubility. In the open, well-aerated areas of the bay, vertical stratification is on the order of 0.1 ppm/m. This stratification is considered to be the result of DO influx across the surface in concert with water-column and sediment biochemical oxygen consumption. The occurrence of hypoxia (which we define to be DO $\leq$ 2 ppm) is rare, occurring at most in several percent of the data in a minority of regions of the bay and those in measurements near the bottom in deeper water. The exception is the Inner Harbor, where hypoxia has occurred in about one-fourth of the measurements, primarily near-bottom. We note a large area in the central region of Corpus Christi Bay with coherent increasing values of DO deficit, on the order of 0.05 ppm/yr.

Conventional water-phase organic contaminants as measured by BOD, oil & grease, VSS and volatile solids, are generally highest in the Inner Harbor. However, the data base is too limited for reliable trend determination. (In fact, the frequency of measurement of these parameters has declined in recent years.) In the open waters of Corpus Christi Bay, BOD seems to be declining, and wherever adequate data for analysis exist, VSS is declining. This is probably the result of the institution of advanced waste treatment. Analogous measures in the sediments, volatile solids and oil & grease, are not especially elevated, even in the Inner Harbor, but the highest concentrations in the system are found in the Mesquite-Carlos-Ayres Bay region.

Like all of the Texas bays, Corpus Christi is turbid. Long-term average suspended solids range 20-100 ppm throughout most of the Study Area, higher in the bays influenced by freshwater inflow, i.e. Nueces, Copano and Corpus Christi Bay, as well as in Baffin. Stratification in TSS is noisy, but on the order of 5 ppm/m declining upward, which is consistent with settling of larger particles to the bottom as well as a near-bottom source of particulates from scour of the bed sediments. The highest TSS concentrations and highest stratification are found in Nueces Bay.

The remarkable feature of TSS in Corpus Christi Bay is its decline throughout the system, increasing in significance from north to south in the Study Area. This is consistent with the findings for Galveston Bay (Ward and Armstrong, 1992a) but the rate of decline is about a factor of two to four smaller in Corpus Christi Bay. Still, it is sufficient to have reduced the average concentration by about 25% in the upper bays and by about 50% in the lower bays over the last two decades. This could be caused by several factors, including a general reduction of TSS loading to the bay or altered mobilization within the bay system itself. The usual hypotheses of improved waste treatment and/or TSS entrapment within reservoirs are not adequate to account for the substantial reductions in the lower bays, though they may explain the alterations in Nueces Bay.

Nitrogen and phosphorus nutrients in the water column are noisy and highly variable through the Corpus Christi Bay study area. Ammonia nitrogen is generally higher in regions affected by waste discharges, especially the Inner Harbor, while nitrate nitrogen and phosphorus are typically highest in regions

affected by runoff and inflow. Generally where the nitrogen species are high in concentration, they exhibit a declining trend. No clear trends are apparent in the phosphorus data. In the sediment phase, concentrations of Kjeldahl nitrogen are elevated but not excessive in the Inner Harbor region, and the highest concentrations in the system occur in the Upper Laguna along the King Ranch. Sediment phosphorus is relatively uniform throughout the system with no relative elevation in the Inner Harbor or in areas affected by inflow.

The levels of concentration of total inorganic nitrogen in the water are about 0.1 ppm in most sections of the system, except much higher, around 0.5 ppm in Copano and in the Inner Harbor (the latter due to high ammonia concentrations). Total phosphorus in water is about 0.05 ppm through the system, except around 0.15 ppm in regions affected by tributary inflow, notably Nueces Bay, Copano Bay and Baffin Bay. These mean concentrations in Corpus Christi Bay are more-or-less typical of other Texas bays (e.g., Longley, 1994), though total inorganic nitrogen is about half the levels found in Galveston Bay and total phosphorus is about one-fourth (Ward and Armstrong, 1992a).

Generally water-phase TOC values are about a factor of two higher in the upper bays, decreasing from 20-30 ppm in Copano to 5-15 ppm in Baffin and the Laguna, with a seasonal peak in early summer. Much larger values (about an order of magnitude) are found in the Inner Harbor. Water-phase and sediment TOC distributions generally run counter to each other. TOC in sediments *increase* southward across the study area with the *lowest* values of sediment TOC in the Inner Harbor. Nueces Bay shows substantially depressed values of TOC in both water and sediment. There is a widespread declining trend in water-phase TOC at a rate sufficient to reduce the concentrations by about one-fourth over two decades. (The prominent exception to this is in the Inner Harbor, where average TOC is the highest in the study area, and is increasing in time.) Where sufficient sediment TOC data exist to establish a trend, this trend generally is also declining in time. Unfortunately, the data for chlorophyll-a is too sparse and noisy to determine whether any correlated time trends occur in it as well, so we cannot judge whether the decline in TOC is due to reduced primary production or to reduced loadings.

Contaminants such as coliforms, metals and trace organics (pesticides, PCB's) show elevated levels in regions of runoff and waste discharge, with generally the highest values in the Inner Harbor, and generally low values in the open bay waters. Given this general statement, some exceptional situations should be noted. The highest average coliforms in the system occur in the nearshore segments of Corpus Christi Bay from Corpus Christi Beach to Oso Bay. Much higher values are represented in the fecal coliforms in this region than the older total coliform determinations from the same area. Apart from the Inner Harbor, Nueces Bay is a region consistently high in metals, in both the water column and the sediment, as are Baffin Bay, Copano Bay, a region of the Upper Laguna around the Bird Islands, the La Quinta Channel, and Redfish Bay near Aransas Pass. We expect metals concentrations in both water and sediment to be closely linked to suspended sediments, which act as carriers for metals, but to also be influenced by local sources, and perhaps sources from the watersheds brought in

by runoff. The only apparent commonality to all of these regions is concentrations of petroleum production facilities.

Curiously, while concentrations in the water phase of arsenic, cadmium (except for Nueces Bay), iron, mercury in the CCBNEP Study Area in general are substantially less than those in Galveston Bay, concentrations of copper, chromium, lead, manganese, nickel and zinc are about the same. Considering that Galveston Bay is a smaller area, is more directly influenced throughout by human activities, and is generally considered to have much higher point-source loads of metals, one would expect the Corpus Christi Bay study area to have lower concentrations. That it does not would suggest a source other than point source loadings for these metals. The metals copper, nickel and zinc, in particular, have elevated concentrations generally throughout Corpus Christi Bay where data exist (relative to the values presented in Moore and Ramamoorthy, 1984b, typifying "uncontaminated" coastal and marine waters). With respect to sediment metals, arsenic, cadmium, mercury, and zinc are on the same order as Galveston Bay, while copper, iron and lead are much lower (except for the Inner Harbor, which is similar to the upper Houston Ship Channel in all of these metals, save zinc, for which its sediments are an order of magnitude *higher* than those of the Houston Ship Channel).

The water-phase metals data were so sparse and noisy that reliable trends could not be generally established. For sediment metals in the principal components of the system, where a trend can be reliably established it is generally declining. For the Inner Harbor, which was found to be the site of greatest metals concentrations, a probable declining trend is consistently indicated. Other trends throughout the system vary depending upon the specific metal. It is noteworthy that Copano Bay, which shows among the highest concentrations in the study area (apart from the Inner Harbor) for chromium and nickel, also exhibits increasing probable trends for these metals, as well as for copper and zinc. Another exception to the general declining trends is sediment zinc, for which widespread *possible* increasing trends are indicated in large areas of the open waters of Corpus Christi Bay and Baffin Bay. However, the strength of these statements is blunted by the fact that metals data in the upper bays tends to be much older, with relatively little information from the most recent decade.

No definitive statements can be made about water-phase volatile organics such as pesticides and PAH's, because data is sparse, and very few measurements are uncensored, most being simply reported as below detection limits. For example, the best-monitored pesticide is DDT, for which most areas of the bay do not have data. Only four non-zero average values occur in the entire study area, two in the GIWW at Ayres Bay, one in Nueces Bay, and one in Baffin Bay. For toxaphene, only one non-zero value occurs, in Nueces Bay. The situation is similar for the other organics, with only one or a few non-zero values, and inadequate data to determine any trends or spatial variation.

The situation is a little better for sediment-phase data, but still most of the system is unsampled, and much of the data which do exist are below detection limits. The highest concentrations of the common pesticides are found in Baffin Bay and

Copano Bay. Concentrations of sediment pesticides in Nueces Bay are not especially high, except for toxaphene. PCB's and PAH's follow a very different distribution, with very high concentrations (as expected) in the Inner Harbor. Elevated concentrations of PCB's also occur in Redfish Bay. There are consistent elevated concentrations of some of the PAH compounds in Nueces Bay, Copano Bay, and Mesquite Bay, but not in the Upper Laguna.

10.3 Tissue quality

Considering the effort required to obtain, digitize and compile the tissue data for the CCBNEP study area, the information yield is disappointing. Pooling and analysis of the data are hampered by the noncomparable attributes of organism sampled, portion of organism analyzed (whole versus edible portions), and reporting convention (wet-weight versus dry-weight), in addition to the usual discriminants of analyte and geographical position. The most-sampled organism is the American oyster, with most samples from Nueces and Aransas Bays, followed by the blue crab, speckled trout, red drum and black drum. One sample each of brown shrimp and white shrimp appears in the entire data base. By far, the greatest quantity of analyses have been performed for the metals. Of the organic analytes, the greatest number of determinations have been performed for the pesticides, especially the common commercial mixtures such as chlordane and toxaphene, and for PCB's. Most of the organic analytes have never been detected in the tissues of organisms. In particular, the data base of *detected* PAH's and related hydrocarbons is negligible. For only a few, such as pyrene, have there been detects logged in the data.

For the oyster, the upper bays and the main body of Corpus Christi show somewhat elevated concentrations of arsenic with no clear time trends. Nueces Bay and Copano Bay exhibit systematically elevated metals in the tissue, Nueces Bay having the highest mean tissue concentrations for cadmium, copper, lead and zinc, and Copano Bay exceeding Nueces Bay slightly for mercury. This conclusion generally agrees with the relative concentrations in the sediments, if the Inner Harbor and tertiary bays are discounted. Blue crab data in Redfish Bay and Baffin Bay show elevated levels of most metals. Elevated arsenic concentrations in particular are noted in the Upper Laguna and Baffin Bay. Statistical analysis of the black drum data base was possible only for Nueces Bay, which indicated some elevated metals concentrations, especially for mercury and zinc, and where a time trend could be resolved, it is increasing. These statements notwithstanding, the limited data base in general renders any statistical judgments tenuous.

10.4 Problem areas

With the marshalling of the data of this project, one central concern is whether there are indicated any regions of the Corpus Christi Bay study area exhibiting degraded quality or exhibiting a trend of degradation that could bode an incipient problem. "Quality," of course, is a relative term; here it refers to the suitability of

the watercourse to sustain biological activities and a viable ecosystem, and to support quality-limited human uses typical of the nature of the watercourse, e.g. recreation but (for an estuary) not water supply. This is quantified by standards and criteria applicable to Corpus Christi Bay. For water quality, the sources are the Texas Surface Water Standards (TWC, 1991) and the EPA "Gold Book" (EPA, 1986). These are summarized by parameter in Table 10-1. It should be noted that the Texas Standards, as *standards*, apply both to a parameter and to a region of the bay (specifically identified by its TNRCC segment), while the EPA criteria pertain to a parameter in the marine or estuarine environment, without regional specificity, and therefore subject to revision as warranted by local conditions and organisms. A similar qualification is necessary with respect to how the standards or criteria are applied. In many cases, our use here does not conform to how the standards are applied in regulatory practice. Thus, we flag the use of the term "violation" by which we mean simply that the point measurement exceeds (or, in the case of DO, is less than) the numerical criterion.

In the present context, we regard these criteria as convenient quantifications of parameter levels which *may* be indicative of degraded water quality. As our principal concern is the "present" quality of Corpus Christi Bay, we have focused on data collected since 1985. A comparison of the actual concentrations measured in the Corpus Christi Bay system with the criteria of Table 10-1 is given in Tables 10-2 through 10-7, for various classes of waterborne parameters. Tables 10-2 through 10-4, for temperature, dissolved oxygen and coliforms, further analyzes these comparisons on a monthly basis, since there is some reason to anticipate a seasonal exposure to violation of the standard.

For temperature, Table 10-2, the single instantaneous standard of 35°C (95°F) applies throughout the system. The first column to examine in Table 10-2 is the rightmost, for the entire data set for each segment, giving the frequency of exceedance of 35°C. Then the distribution by month should be examined, the frequencies of occurrence being relative to total data holdings for each month. One must recognize that the TNRCC temperature standard of 35°C is applied uniformly to the entire Texas coast, without cognizance of the natural gradient of increasing temperatures toward the south, a gradient to which the indigenous organisms would have presumably acclimated. Clearly, the shallow, poorly circulated sections of the Corpus Christi Bay system are most prone to higher temperatures, especially those in the lower bays, and violations occur, mainly in the summer, at a low rate–only a couple of percent. Only two regions have substantially higher frequencies of violation; these are in Nueces Bay and Oso Bay, both affected by return flows from power plants. Coupled with the general decline in water temperatures in time, this low frequency of violation indicates that hyperthermality is not a problem in Corpus Christi Bay.

The state standard for dissolved oxygen requires special comment. Prior to 1984, standards attainment was established by comparison with a surface measurement of DO. With the 1984 revisions, attainment was based upon a vertical profile of DO, either depth-integrated or "under conditions of density stratification, a composite sample collected from the mixed surface layer." This

Table 10-1
Standards and Criteria for Water Quality

parameter	*State of Texas Standard**	*EPA criterion (chronic) fresh*	*marine*
WATER QUALITY INDICATORS:			
Temperature (°F)	95		
Dissolved oxygen (mg/L)	5.0 4.0 in 2001, 2003 & 2492 3.0 in 2484	4[m]	
Fecal coliforms (org/100mL)	14[a] 200[a] in: 2001, 2003, 2101, 2484	126(406)[c]	14[s]
METALS (dissolved):			
Arsenic (µg/L)	78	190	36
Cadmium (µg/L)	10.02	1.1	9.3
Chromium (µg/L)		11	50
Chromium (hex) (µg/L)	50		
Copper (µg/L)	4.37	12	
Lead (µg/L)	5.6	3.2	5.6
Mercury (µg/L)	1.1	0.012	0.025
Nickel (µg/L)	13.2	96	7.1
Selenium(µg/L)	136	35	54
Silver (µg/L)	0.92	0.12	
Zinc (µg/L)	89	47	58

* for metals, the marine chronic standard is given
[m] one-day minimum
[a] 30-day geometric mean
[s] shellfish harvesting, median w/<10% exceeding 43
[c] light contact recreation, 406 single-sample max

Table 10-1
(continued)

parameter	*State of Texas Standard†*	*EPA criterion (chronic) fresh*	*marine*
PESTICIDES AND RELATED PARAMETERS:			
DDT, Total (µg/L)	0.001	0.0010 (1.1)**	0.0010 (0.13)
DDE, Total (µg/L)		0.0010 (1.1)	0.0010 (0.13)
DDD, Total (µg/L)		0.0010 (1.1)	0.0010 (0.13)
Chlordane, Total (µg/L)	0.004	0.0043 (2.4)	0.0040 (0.09)
Dieldrin (µg/L)	0.0019	0.0019	0.0019
Endosulfan (µg/L)	0.0087		
Endosulfan-I (µg/L)		0.056	0.0087
Endrin (µg/L)	0.0023	0.0023	0.0023
Toxaphene (µg/L)	0.0002	0.013	
Heptachlor (µg/L)	0.0036	0.0038	0.0036
Methoxychlor (µg/L)	0.03	0.03	0.03
PCB's, Total (µg/L)	0.03	0.014	0.030
Malathion (µg/L)	0.01	0.1	0.1
Parathion (µg/L)		0.04	0.04
2,4,5 Trichlorophenol	12		
Hexachlorobenzene (µg/L)		30	129
PAH, Total (µg/L)			300*
Napthalene (µg/L)		620	
Acenaphthene (µg/L)		520	500
Fluoranthene (µg/L)			16

† marine chronic standard
* acute toxicity
** instantaneous values in parentheses

Table 10-2
Violations of temperature standard (Table 10-1), upper 1 m, post-1984
Relative frequency (percent) by hydrographic area segment and month
(only segments logging violations are shown)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
A13	10.0	0	0	0	0	0	0	0	0	0	0	0	1.0
BF3	0	0	0	0	0	0	0	0	0	3.3	0	0	0.3
C14	0	0	0	0	0	0	2.4	5.6	0	0	0	0	0.6
C17	0	0	0	0	0	0	6.7	0	0	0	0	0	0.5
C25	*	0	0	0	0	50.0	*	25.0	0	0	0	0	3.5
GR2	0	0	0	0	0	0	0	8.3	0	0	0	0	0.5
I8	0	0	0	0	0	0	33.3	0	0	0	*	*	3.3
I13	0	0	0	0	0	0	0	0	0	14.3	0	0	1.1
NB1	0	0	0	0	0	0	8.3	0	0	0	0	0	0.6
NB6	0	0	0	0	0	0	18.6	0	3.4	0	0	0	7.8
NB7	0	0	0	0	0	0	11.8	0	8.5	0	0	0	4.2
ND4	0	0	0	0	0	4.0	0	0	0	0	0	0	0.3
OS5	0	*	0	0	0	0	66.7	0	0	0	0	0	7.1
OS7	0	0	0	0	0	0	12.5	0	0	0	0	0	1.2
UL02	0	0	0	0	0	0	0	0	14.3	0	0	0	1.5
UL03	0	0	0	0	0	0	0	0	9.1	0	0	0	0.8
UL05	0	0	0	0	0	9.1	0	0	7.7	0	0	0	2.9
UL07	0	0	0	0	0	0	33.3	0	0	0	0	0	2.0

* No data

Table 10-3
"Violations" of dissolved oxygen standard (Table 10-1), upper 1 m, post-1984
Relative frequency (percent) by hydrographic area segment and month
(only segments logging violations are shown)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
A1	0	0	0	0	0	0	0	33.3	50.0	0	0	0	4.3
A5	0	0	0	0	0	50.0	0	0	*	0	0	0	3.4
A6	0	0	*	0	0	16.7	*	0	33.3	0	0	0	3.4
A8	0	0	0	0	0	0	0	100.0	0	0	0	0	6.3
A9	0	0	50.0	0	0	0	0	50.0	0	0	0	0	7.1
A10	0	0	0	0	0	0	0	0	20.0	0	0	0	1.7
A11	0	0	0	0	11.1	0	33.3	0	0	0	0	0	3.2
A12	0	0	0	0	0	0	33.3	0	10.0	0	0	0	2.4
A13	0	0	0	0	0	0	0	0	12.5	0	0	0	1.6
AL1†	0	0	0	0	0	0	0	0	9.1	5.0	0	0	1.4
AL2†	0	0	0	0	4.3	5.9	0	10.0	5.6	0	0	0	2.0
BF1†	0	0	0	0	4.0	0	0	0	0	0	0	0	0.5
BF2†	0	0	0	0	7.7	0	37.5	22.2	0	5.9	0	0	4.7
BF3†	0	6.3	7.1	0	3.4	11.8	25.0	20.0	15.4	18.5	3.8	0	8.1
C01	0	0	0	0	0	0	0	50.0	0	*	0	*	5.3
C02	0	0	20.0	0	0	0	0	0	0	0	0	0	1.7
C03	0	0	50.0	33.3	0	0	*	0	16.7	0	0	0	7.7
C04	0	50.0	100.0	0	0	*	*	50.0	0	0	0	0	23.1
C06	*	100.0	0	0	*	*	*	0	*	*	0	*	11.1
C08	0	0	50.0	*	0	*	0	0	0	0	0	0	5.3
C09	0	0	0	0	4.2	5.0	12.5	0	5.9	3.3	9.1	0	3.3
C10	0	0	14.3	0	0	0	0	0	0	0	0	0	1.5

(continued)

* No data † DO standard = 4 ppm †† DO standard = 3 ppm

Table 10-3
"Violations" of dissolved oxygen standard (Table 10-1), upper 1 m, post-1984
(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
C12	5.0	0	5.3	0	0	0	0	0	2.8	0	4.3	0	1.5
C14	5.3	0	13.3	2.7	3.1	0	5.6	0	5.0	0	0	0	3.0
C15	0	0	4.8	0	4.3	0	0	0	7.1	0	0	0	1.6
C17	0	0	7.1	0	0	0	0	0	7.7	0	0	0	1.4
C20	0	0	33.3	*	0	*	*	0	0	0	0	0	6.3
C23	50.0	0	33.3	20.0	0	0	*	0	0	0	0	0	8.1
C24	0	0	12.5	0	12.5	0	12.5	20.0	22.2	0	6.7	0	8.0
CB	0	0	0	0	0	9.1	25.0	66.7	0	0	0	0	5.2
CCC1	0	0	8.3	0	0	0	0	0	0	0	0	0	1.0
CCC3	0	0	8.3	0	0	0	0	0	0	0	0	0	0.8
CCC5	0	0	20.0	0	0	*	0	0	0	0	0	0	2.3
CCC6	0	16.7	*	0	0	0	0	0	*	0	0	0	2.7
CCC7	0	0	16.7	0	0	0	0	0	0	0	0	0	0.7
CCC8	0	0	50.0	12.5	20.0	0	0	0	25.0	0	0	0	6.6
CP01	0	0	*	0	0	0	0	*	0	14.3	0	0	3.7
CP02	0	0	0	0	11.8	0	0	16.7	4.8	0	0	0	4.5
CP03	0	0	0	0	0	7.7	0	0	0	0	0	0	0.8
CP04	0	0	0	0	0	33.3	25.0	0	0	0	0	0	2.9
CP07	0	0	0	0	0	0	0	0	0	25.0	0	0	2.2
CP08	0	0	0	0	0	14.3	0	0	6.3	9.1	0	0	3.1
EF	0	0	0	0	12.5	0	0	0	0	0	66.7	*	7.0
GR2†	0	0	0	14.3	5.0	0	0	0	12.5	0	8.3	0	4.3
HI1	0	0	0	50.0	0	0	0	0	0	0	0	0	4.5
HI2	0	0	0	0	0	0	0	50.0	0	0	0	14.3	3.3

(continued)

* No data † DO standard = 4 ppm †† DO standard = 3 ppm

Table 10-3
"Violations" of dissolved oxygen standard (Table 10-1), upper 1 m, post-1984
(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
I2	0	0	0	0	0	0	50.0	100.0	0	0	0	0	5.4
I3	0	0	0	0	0	0	0	0	0	42.9	0	0	7.7
I6	0	0	0	0	0	0	25.0	0	0	0	0	0	1.8
I7	0	0	0	0	0	0	14.3	*	16.7	0	0	0	3.3
I8	0	0	0	0	0	0	33.3	0	0	0	*	*	3.3
I9	0	0	14.3	25.0	20.0	0	33.3	0	12.5	40.0	12.5	0	15.2
I10	*	0	0	0	0	0	0	0	33.3	*	*	0	6.3
I11	0	0	0	0	0	0	0	0	0	12.5	0	0	1.7
I12	0	0	0	14.3	0	0	0	22.2	0	0	37.5	0	7.8
I13	0	0	25.0	0	22.2	0	12.5	50.0	9.1	25.0	0	0	11.1
I14	0	20.0	50.0	0	10.0	33.3	20.0	0	23.1	0	11.1	0	14.1
I15	0	0	0	25.0	25.0	33.3	42.9	100.0	0	10.0	16.7	0	18.8
I16	50.0	33.3	25.0	0	42.9	11.1	0	0	0	0	50.0	0	20.8
I17	0	12.5	100.0	0	0	0	0	0	50.0	0	0	0	5.4
I18	*	0	*	0	0	0	*	0	0	0	50.0	50.0	9.1
IH1††	0	0	*	0	0	*	0	0	66.7	0	0	*	5.1
IH5††	0	0	*	0	0	*	0	0	50.0	0	0	*	2.6
IH6††	0	0	*	0	0	*	0	0	25.0	0	0	*	4.4
LS1†	*	0	0	*	0	0	0	100.0	*	0	*	0	7.7
LS2†	0	0	0	0	0	33.3	0	0	0	0	10.5	0	2.6
M2	0	0	0	0	0	15.4	50.0	0	50.0	0	0	0	6.5
MB1	0	0	0	11.1	0	0	0	*	0	0	0	0	1.0
MB2	0	0	0	0	0	0	14.3	0	5.9	0	0	0	2.1

(continued)

* No data † DO standard = 4 ppm †† DO standard = 3 ppm

Table 10-3
"Violations" of dissolved oxygen standard (Table 10-1), upper 1 m, post-1984
(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
NB1	50.0	10.0	64.3	42.9	0	0	0	0	0	0	0	0	12.3
NB2	66.7	0	33.3	0	0	16.7	100.0	0	0	11.1	0	0	9.9
NB3	0	0	16.7	14.3	16.7	0	0	0	0	0	0	0	4.5
NB4	15.0	0	21.4	0	0	0	0	0	0	0	0	0	2.5
NB5	15.0	0	31.3	0	0	0	0	0	6.7	0	0	0	2.7
NB6	0	0	40.0	0	0	0	9.4	0	8.0	0	0	0	8.4
NB7	0	0	0	0	0	0	21.1	7.1	13.6	7.7	0	0	11.6
NB8	0	*	50.0	0	0	0	*	0	0	0	0	0	4.5
NB9	0	0	100.0	0	0	0	0	0	0	0	0	0	2.2
ND4	3.3	0	0	0	4.0	0	16.0	28.0	22.6	15.6	0	0	7.7
NR4	0	0	0	0	0	20.0	0	14.3	42.9	0	0	0	7.2
OS1	0	0	*	0	*	*	100.0	0	0	20.0	0	*	9.5
OS4	0	0	0	25.0	0	20.0	0	50.0	0	0	0	0	6.0
OS6	0	11.1	0	10.0	0	25.0	0	12.5	0	0	0	0	6.8
OS7	0	0	0	0	0	0	0	12.5	11.1	14.3	33.3	0	4.8
PB1	0	0	0	0	0	0	0	22.2	0	0	0	0	2.4
PB2	0	12.5	0	0	0	16.7	28.6	25.0	0	0	0	0	4.3
RB1	0	0	0	9.1	0	12.5	100.0	0	60.0	0	0	0	8.2
RB2	0	0	0	0	0	0	0	25.0	10.0	7.1	0	0	4.1
RB3	0	0	0	0	12.5	0	0	14.3	0	0	0	0	2.4
RB4	0	0	0	0	0	0	0	0	0	5.9	0	50.0	3.3
RB5	0	0	0	0	0	0	22.2	16.7	16.7	6.7	0	0	4.7
RB6	0	0	0	0	0	16.7	0	0	0	0	0	0	1.9
RB8	0	0	0	0	0	0	0	14.3	25.0	0	0	0	2.7

(continued)

* No data † DO standard = 4 ppm †† DO standard = 3 ppm

Table 10-3
"Violations" of dissolved oxygen standard (Table 10-1), upper 1 m, post-1984
(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
SC2	0	0	0	0	5.0	0	7.1	30.0	9.1	6.7	0	0	5.0
SC3	0	0	0	0	4.3	14.3	0	14.3	0	0	0	0	3.0
UL01	33.3	0	0	0	0	20.0	0	0	0	28.6	0	0	9.1
UL02	0	0	33.3	0	9.1	11.1	0	25.0	14.3	0	0	0	7.7
UL03	66.7	0	0	16.7	47.1	15.4	75.0	75.0	44.4	60.9	20.0	0	37.1
UL04	0	0	*	0	25.0	*	0	0	0	0	0	0	2.3
UL05	0	0	100.0	0	0	0	0	33.3	0	0	0	0	2.9
UL06	0	14.3	33.3	12.5	30.8	25.0	83.3	37.5	44.4	12.5	50.0	16.7	30.1
UL07	0	0	0	0	16.7	0	0	0	7.7	0	0	0	3.9
UL08	0	0	50.0	12.5	40.0	60.0	100.0	100.0	25.0	0	0	50.0	26.8
UL09	20.0	0	16.7	0	0	28.6	0	37.5	0	25.0	0	0	12.0
UL10	0	0	0	0	0	0	16.7	0	16.7	0	0	0	4.0
UL11	100.0	100.0	*	*	0	*	100.0	100.0	*	0	*	0	40.0
GMI1	0.0	*	*	*	0.0	22.2	0.0	0.0	0.0	0.0	0.0	*	5.6
GMI2	0.0	0.0	0.0	0.0	0.0	9.5	33.3	20.0	6.7	0.0	0.0	0.0	9.3
GMI3	0.0	0.0	0.0	0.0	0.0	20.0	12.5	16.7	8.3	0.0	0.0	0.0	5.5
GMI4	0.0	0.0	0.0	0.0	0.0	25.0	13.3	35.7	27.3	0.0	0.0	0.0	10.3
GMI5	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	7.1	0.0	21.1	0.0	4.0
GMI6	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	*	0.9
GMI7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.9
GMI8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.6
GMO7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	1.3

* No data † DO standard = 4 ppm †† DO standard = 3 ppm

Table 10-4
"Violations" of fecal coliform standard (Table 10-1) post-1984
Relative frequency (percent) by hydrographic area segment and month
(only segments logging violations are shown)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
A1	3.4	0	5.9	0	0	*	*	*	*	0	3.8	0	2.2
A2	25.0	100.0	0	0	0	*	*	*	*	0	0	30.0	15.2
A3	0	0	5.6	0	0	*	*	*	*	8.3	0	0	2.1
A4	0	0	11.1	0	0	*	*	*	*	0	20.0	11.1	6.5
A6	25.0	0	12.5	0	0	*	*	*	*	0	0	12.5	9.5
A8	0	0	0	0	0	*	*	*	*	0	20.0	14.3	4.7
A10	0	0	0	0	0	*	*	*	*	8.3	0	5.9	2.2
A13	16.7	0	0	0	0	*	*	*	*	0	0	0	2.6
AR1†	*	*	*	0	0	*	*	*	0	0	0	*	0.0
BF3	0	50.0	*	0	0	*	0	0	*	0	0	*	5.6
C01	16.7	9.1	70.6	55.0	31.3	56.7	32.3	40.7	55.9	32.0	0	42.9	42.2
C02	0	13.3	25.0	41.7	30.0	62.5	35.7	46.2	0	35.7	40.0	30.8	31.2
C03	42.9	42.9	57.1	62.5	14.3	33.3	27.3	45.5	40.0	11.1	28.6	57.1	37.9
C12	0	0	0	0	0	*	0	*	*	0	8.3	0	1.4
C15	7.7	11.1	35.3	37.9	15.6	36.1	31.7	26.7	9.5	28.6	15.8	16.7	25.0
C17	20.0	16.7	0	0	0	*	0	*	*	0	0	0	5.6
C19	0	0	0	0	0	*	0	*	*	0	16.7	0	2.8
C20	0	0	0	0	0	*	0	*	*	0	16.7	0	2.8
CCC3	0	16.7	0	0	0	0	0	*	0	0	0	0	2.1
CCC4	0	0	0	0	0	*	0	*	*	0	16.7	0	2.8
CCC8	8.3	13.3	15.4	33.3	15.4	40.0	38.5	23.1	40.0	20.0	18.8	20.0	22.4
CP02	33.3	25.0	40.0	0	0	*	*	*	*	0	60.0	20.0	26.5
CP03	19.0	0	17.9	33.3	0	*	*	*	*	0	52.4	31.3	21.8

(continued)

* No data

† fecal coliform standard = 200 org/100 mL

Table 10-4
"Violations" of fecal coliform standard post-1984, relative frequency (percent)
(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
CP04	0	0	15.0	0	0	*	*	*	*	0	21.4	9.1	7.8
CP05	14.3	0	11.1	0	0	*	*	*	*	0	28.6	16.7	11.4
CP06	0	0	33.3	0	*	*	*	*	*	0	0	0	10.5
CP10	6.3	0	10.5	0	0	*	0	0	*	6.7	0	0	3.7
I4	22.2	25.0	14.3	0	0	*	*	*	*	0	20.0	12.5	13.6
I6	0	0	0	7.7	0	*	0	*	*	0	0	0	1.0
I10	*	0	100.0	28.6	57.1	72.7	40.0	50.0	60.0	40.0	*	*	52.5
I12	0	0	*	0	100.0	*	0	0	*	0	0	*	5.9
IH1†	0	0	*	0	0	*	0	0	0	0	0	*	0.0
IH5†	0	0	*	0	50.0	*	0	0	0	0	0	*	5.3
IH6†	0	0	*	0	0	*	0	0	0	0	0	*	0.0
LQ1	0	*	50.0	0	*	0	0	*	0	*	0	100.0	18.2
LQ2	0	50.0	50.0	0	0	0	50.0	0	*	0	0	100.0	15.4
M2	0	0	16.7	16.7	0	33.3	*	*	*	14.3	0	50.0	14.3
MB1	9.1	20.0	10.0	0	50.0	*	0	*	0	16.7	0	33.3	11.8
MB2	7.1	0	25.0	0	*	*	*	*	*	0	0	20.0	6.9
NB2	40.0	14.3	20.0	0	50.0	*	*	*	*	50.0	33.3	0	25.7
NB4	0	*	*	100.0	*	*	100.0	*	*	*	100.0	*	80.0
NB5	0	0	*	25.0	0	*	0	0	*	0	33.3	*	12.5
NB6	16.7	14.3	16.7	0	0	*	*	*	*	50.0	33.3	0	18.9
NB7	12.5	15.0	33.3	25.0	42.9	*	0	0	*	25.0	36.4	7.7	23.5
NB8	60.0	50.0	20.0	100.0	0	*	*	*	*	25.0	33.3	25.0	39.4
NB9	16.7	18.2	27.3	25.0	0	*	*	*	*	25.0	16.7	0	17.6

(continued)

* No data

† fecal coliform standard = 200 org/100 mL

Table 10-4
"Violations" of fecal coliform standard post-1984, relative frequency (percent)

(continued)

Segment	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total data set*
NR1†	*	*	*	*	0	0	33.3	0	0	100.0	*	*	0.0
NR4†	50.0	25.0	0	25.0	33.3	50.0	100.0	0	0	0	0	50.0	25.9
OS1	100.0	100.0	*	100.0	*	*	*	100.0	100.0	100.0	100.0	*	100.0
OS6	0	0	*	62.5	*	*	0	66.7	0	0	100.0	50.0	42.9
OS7	50.0	50.0	*	16.7	*	*	*	66.7	*	0	0	0	29.4
PB1†	*	0	*	0	0	*	*	0	*	0	*	*	0
RB4	50.0	*	*	*	*	*	*	*	*	0	*	*	33.3
RB8	33.3	33.3	*	0	0	*	33.3	0	0	0	*	0	12.5
SC2	25.0	75.0	11.1	25.0	0	0	*	*	*	0	33.3	16.7	20.3
SC3	0	50.0	*	50.0	0	*	0	50.0	*	50.0	*	0	35.7
UL01	*	0	66.7	62.5	62.5	45.5	30.0	33.3	80.0	33.3	*	*	47.5
UL04	50.0	0	*	0	0	*	0	0	*	0	0	*	5.9
GMI6	*	0	*	25.0	*	*	*	*	*	0	*	*	14.3

* No data

† fecal coliform standard = 200 org/100 mL

Table 10-5
"Violations" of metals standards (Table 10-1) post-1984
Relative frequency (percent) by hydrographic area segment
(only segments are shown for which metals data exist)

segment	*wqmetagt*	*wqmetast*	*wqmetcdt*	*wqmetcrt*	*wqmetcut*	*wqmethgt*	*wqmetnit*	*wqmetpbt*	*wqmetset*	*wqmetznt*
C07	*	0	0	0	0	0	0	0	0	100.0
C08	*	0	0	0	0	0	0	0	0	100.0
C14	*	0	0	0	0	0	0	0	0	0
C18	*	0	0	0	0	0	0	0	0	100.0
C22	*	0	0	0	0	0	0	0	0	100.0
CBH	0	0	0	0	0	0	0	0	0	0
CCC2	*	0	0	0	0	0	0	0	0	0
CCC3	0	0	80.0	20.0	20.0	0	80.0	0	0	20.0
CCC4	0	0	0	0	0	0	0	0	0	0
CCC5	0	0	0	0	0	0	0	0	0	25.0
CCC6	0	0	0	0	8.7	0	0	0	0	21.7
CCC7	0	0	0	0	0	0	0	0	0	30.0
CCC8	0	0	0	0	28.6	0	16.7	0	0	16.7
HI1	0	0	0	0	0	0	0	0	0	0
I1	*	0	100.0	0	0	0	0	0	0	0
I2	*	0	100.0	0	0	0	0	0	0	0
I3	0	0	0	0	0	0	33.3	0	0	16.7
I4	0	0	6.1	0	0	0	48.5	0	0	12.1
I5	0	0	0	0	0	0	11.8	0	0	0
I6	*	0	0	0	0	0	0	0	0	0
I9	*	0	0	0	0	0	0	0	0	0
I10	*	0	0	0	0	0	0	0	0	0

(continued)

* No data

Table 10-5
Relative frequency (percent) of "violations" of metals standards
(continued)

segment	*wqmetagt*	*wqmetast*	*wqmetcdt*	*wqmetcrt*	*wqmetcut*	*wqmethgt*	*wqmetnit*	*wqmetpbt*	*wqmetset*	*wqmetznt*
I11	*	0	0	0	0	0	0	0	0	0
I13	*	0	0	0	0	0	0	0	0	0
I14	*	0	0	0	0	0	0	0	0	0
I15	*	0	0	0	0	0	0	0	0	0
I16	*	0	0	0	0	0	0	0	0	0
I17	*	0	0	0	0	0	0	0	0	0
I18	*	0	0	0	0	0	0	0	0	0
IH1	0	0	0	0	66.7	0	0	0	0	0
IH2	0	0	0	0	0	0	0	0	0	0
IH3	0	0	0	0	0	0	0	0	0	0
IH4	0	0	0	0	0	0	0	0	0	0
IH5	0	0	0	0	50.0	0	0	0	0	0
IH6	0	0	0	0	28.6	0	25.0	0	0	0
IH7	0	0	0	0	33.3	0	33.3	0	0	0
INL	0	0	0	0	0	0	0	0	0	0
LQ1	0	0	41.7	8.3	0	0	41.7	0	0	8.3
LQ2	0	0	54.5	18.2	18.2	9.1	54.5	0	0	18.2
NB7	0	0	25.0	0	50.0	0	0	50.0	0	25.0
RB3	0	0	0	0	0	0	0	0	0	0
RB8	0	0	0	0	0	0	0	0	0	0
GMI6	*	0	0	0	0	0	0	0	0	0
GMO6	*	0	0	0	0	0	0	0	0	0

* No data

Table 10-6
"Violations" of pesticide standards (Table 10-1) post-1984
Relative frequency (percent) by hydrographic area segment
(only segments are shown for which pesticides data exist)

segment	*WQ-245T*	*WQ-CHLR*	*WQ-DDD*	*WQ-DDE*	*WQ-DDT*	*WQ-XDDT*	*WQ-DIEL*
C07	*	0	*	*	*	0	*
C08	*	0	*	*	*	0	*
C14	*	0	*	*	*	0	*
C18	*	0	*	*	*	0	*
C22	*	0	*	*	*	0	*
CBH	*	0	*	*	*	0	*
CCC2	*	0	*	*	*	0	*
CCC3	*	0	*	*	*	0	0
CCC4	*	0	*	*	*	0	0
CCC5	*	0	*	*	*	0	*
CCC6	0	10	*	*	*	0	0
CCC7	*	0	*	*	*	0	*
CCC8	*	0	*	*	*	0	*
HI1	*	0	*	*	*	0	*
I1	*	0	*	*	*	100	*
I2	*	0	*	*	*	100	*
I3	*	0	*	*	*	0	*
I4	*	0	*	*	*	0	*
I5	*	0	*	*	*	0	*
I6	*	0	*	*	*	0	*
I9	*	0	*	*	*	0	*
I10	*	0	*	*	*	0	*
I11	*	0	*	*	*	0	*
I13	*	0	*	*	*	0	*
I14	*	0	*	*	*	0	*
I15	*	0	*	*	*	0	*
I16	*	0	*	*	*	0	*
I17	*	0	*	*	*	0	*
I18	*	0	*	*	*	0	*
IH1	*	0	*	*	*	0	*
IH2	*	0	*	*	*	0	*
IH3	*	0	*	*	*	0	*
IH4	*	0	*	*	*	0	*
IH5	0	0	*	*	*	0	0
IH6	*	0	*	*	*	0	*
IH7	*	0	*	*	*	0	*
INL	*	0	*	*	*	0	*
LQ1	*	0	*	*	*	0	0
LQ2	*	0	*	*	*	0	0
RB3	*	0	*	*	*	0	*
RB8	*	0	*	*	*	0	*
GMI6	*	0	*	*	*	0	*
GMO6	*	0	*	*	*	0	*

* No data

Table 10-6
"Violations" of pesticide standards (Table 10-1) post-1984
Relative frequency (percent) by hydrographic area segment
(continued)

segment	*WQ-ENDO*	*WQ-HEPT*	*WQ-MALA*	*WQ-MTHX*	*WQ-PARA*	*WQ-TOXA*
C07	*	*	*	*	*	0
C08	*	*	*	*	*	0
C14	*	*	*	*	*	0
C18	*	*	*	*	*	0
C22	*	*	*	*	*	0
CBH	*	*	*	*	*	0
CCC2	*	*	*	*	*	0
CCC3	0	0	*	0	*	0
CCC4	*	0	*	*	*	0
CCC5	*	*	*	*	*	0
CCC6	*	0	0	0	0	0
CCC7	*	*	*	*	*	0
CCC8	*	*	*	*	*	0
HI1	*	*	*	*	*	0
I1	*	*	*	*	*	0
I2	*	*	*	*	*	0
I3	*	*	*	*	*	0
I4	*	*	*	*	*	0
I5	*	*	*	*	*	0
I6	*	*	*	*	*	0
I9	*	*	*	*	*	0
I10	*	*	*	*	*	0
I11	*	*	*	*	*	0
I13	*	*	*	*	*	0
I14	*	*	*	*	*	0
I15	*	*	*	*	*	0
I16	*	*	*	*	*	0
I17	*	*	*	*	*	0
I18	*	*	*	*	*	0
IH1	*	*	*	*	*	0
IH2	*	*	*	*	*	0
IH3	*	*	*	*	*	0
IH4	*	*	*	*	*	0
IH5	*	0	0	0	0	0
IH6	*	*	*	*	*	0
IH7	*	*	*	*	*	0
INL	*	*	*	*	*	0
LQ1	0	0	*	0	*	0
LQ2	0	0	*	0	*	0
RB3	*	*	*	*	*	0
RB8	*	*	*	*	*	0
GMI6	*	*	*	*	*	0
GMO6	*	*	*	*	*	0

Table 10-7
"Violations" of PAH's and other organics standards (Table 10-1)
Relative frequency (percent) post-1984 by hydrographic area segment
(only segments are shown for which pesticides data exist)

segment	*WQ-ACEN*	*WQ-ENDR*	*WQ-FLRA*	*WQ-NAPT*	*WQ-PAH*	*WQ-PCB*	*WQ-HEXA*
C07	0	*	0	0	0	0	*
C08	0	*	0	0	0	0	*
C14	0	*	0	0	0	0	*
C18	0	*	0	0	0	0	*
C22	0	*	0	0	0	0	*
CBH	0	*	0	0	0	0	*
CCC2	0	*	0	0	0	0	*
CCC3	0	0	*	0	*	*	*
CCC4	0	*	0	0	0	0	*
CCC5	0	*	0	0	0	0	*
CCC6	0	0	0	0	0	0	0
CCC7	0	*	0	0	0	0	*
CCC8	0	*	0	0	0	0	*
HI1	0	*	0	0	0	0	*
I1	0	*	0	0	0	0	*
I2	0	*	0	0	0	0	*
I3	0	*	0	0	0	0	*
I4	0	*	0	0	0	0	*
I5	0	*	0	0	0	0	*
I6	0	*	0	0	0	0	*
I9	0	*	0	0	0	0	*
I10	0	*	0	0	0	0	*
I11	0	*	0	0	0	0	*
I13	0	*	0	0	0	0	*
I14	0	*	0	0	0	0	*
I15	0	*	0	0	0	0	*
I16	0	*	0	0	0	0	*
I17	0	*	0	0	0	0	*
I18	0	*	0	0	0	0	*
IH1	0	*	0	0	0	0	*
IH2	0	*	0	0	0	0	*
IH3	0	*	0	0	0	0	*
IH4	0	*	0	0	0	0	*
IH5	0	0	0	0	0	0	0
IH6	0	*	0	0	0	0	*
IH7	0	*	0	0	0	0	*
INL	0	*	0	0	0	0	*
LQ1	0	0	0	0	0	0	*
LQ2	0	0	0	0	0	0	*
RB3	0	*	0	0	0	0	*
RB8	0	*	0	0	0	0	*
GMI6	0	*	0	0	0	0	*
GMO6	0	*	0	0	0	0	*

* No data

was motivated by the increasing use of mathematical models in waste allocation, because these models predict vertical-mean DO rather than surface values. Since the numerical value of the DO standard concentration was unchanged, this revision amounted to a stringent upgrade in the DO standard. For present purposes, we use the older convention of the surface measurement as a basis for comparison, for simplicity and uniformity of analysis. Also, the standards given in Table 10-1 apply to 24-hour mean DO values, from which a further depression of 1 pm in instantaneous concentration is allowable. We do not make these distinctions in this evaluation, but rather compare the instantaneous near-surface values to those given in Table 10-1. (For simplicity, we also do not discriminate the data analysis by flow condition.)

Despite the fact that average DO is near saturation throughout the system, Table 10-3 shows that most areas of the bay have a violation frequency of the applicable standard of a couple of percent, almost always in the summer or early fall. There are scattered higher frequencies of violations, especially in proximity to sources of inflow and wasteloads. A prominent example is C04 out from the Inner Harbor. The violation frequency is even higher in the shallow, poorly-circulating areas near the barrier island, and is especially high in the Upper Laguna. While most of these probably evidence DO depletion due to oxygen-demanding organics, this is more properly regarded as a compounding of low antecedent DO's that are a result of natural hydrography, rather than evidence of excessive waste loading. The apparent contradiction between the observation that the system is at or above saturation much of the time, yet has a nonnegligible frequency of standard violation, 10-20% in some areas, is reconciled by noting that much of the year the standard is very close to the saturation concentration. Considering the high natural temperatures and salinities in these areas, the 5 ppm "standard" is only about 1 ppm below saturation, and occasional excursions of more than 1 ppm below saturation are not unexpected. (In fact, if one examines violations of a 4 ppm DO level instead, many of the 1-3% occurrences vanish, and most, including those in the Upper Laguna, are halved.)

It is difficult to judge whether such frequencies of "depressed" DO evidence a serious or systematic water quality problem, because there seems to be little basis for the appropriateness of the 5 ppm standard in this estuary. Like the 35°C TNRCC temperature standard, the DO standard is applied uniformly to most of the Texas bays from Sabine Lake to South Bay, without discrimination to account for the decreasing solubility with distance south. Certainly, there is a desirability for re-evaluating the applicability of the 5 ppm average DO standard to waters with such low solubility. We note that there is a prominent exception to the uniform application of the 5 ppm DO standard, that one bay is assigned a lower open-water DO standard by TNRCC, namely the 4 ppm standard for Galveston Bay.

The 5 ppm criterion does serve to caution that–whatever the appropriate standard may be–the clearance between physical saturation and the threshold level of DO entailing biological stress is small throughout much of the Corpus Christi Bay study area for a major portion of the year. These regions will therefore have a low assimilative capacity, and this should be carefully considered in any proposed

waste discharges or increased wasteloading. Moreover, the time-trend analysis discloses increasing deficits in some of these same areas of low assimilative capacity, notably the Upper Laguna Madre and the open waters of Corpus Christi Bay south of the CCSC.

The state coliform standard strictly applies to a geometric mean of at least five samples "representative" of a 30-day period. The 14 col/100 mL criterion derives from the requirement for "oyster waters" (TWC, 1991, Section 307.7), which further limits the frequency in individual samples to no more than 10% over 43 col/100 mL. Our purpose here is not to strictly apply these conditions (indeed, the temporal density of most of the data will not allow computation of a 5-sample geometric mean within 30 days), but to use them as a guide to identify regions of potential bacterial contamination. The simple frequency of exceedance of the applicable numerical value is given in Table 10-4. Those areas with a frequency of occurrence of less than about 10% would probably vanish altogether if a geometric mean of several independent measurements could be made. The areas of concern to us are those exceeding 10%. These are primarily the upper bays in proximity to sources of inflow and runoff, especially in urbanized areas, specifically:

- Copano Bay near the mouths of inflows
- St. Charles Bay
- Nueces Bay and near its entrance in Corpus Christi Bay
- Corpus Christi Bay along the south shore from Corpus Christi Beach to Demit Island
- Bulkhead Flats and the Upper Laguna around the JFK Causeway
- Lower Oso Bay

If the raw data are screened for those sections exceeding 43 col/100 mL more than 10% of the time, these same areas emerge. While statistical trends in data as noisy and spikey as coliforms are difficult to establish reliably, the present analysis certainly provides no indication that the coliform concentrations are declining. (At the same time, it should be noted that these concentrations are considerably smaller than the standard for contact recreation, 200 col/100 mL.) All of these areas are presently closed for shellfish harvesting (Jensen et al. 1996). To the extent that these elevated coliform levels represent a problem area, the state has already implemented appropriate action.

The state standards for metals and pesticides strictly apply to the dissolved parameter. Those values given in Table 10-1 are the chronic marine criteria. The direct applicability of these and the EPA criteria for metals (which are developed for "acid-soluble" metal concentrations) to the Corpus Christi Bay data base is problematic, because there are so few measurements of dissolved fractions from Corpus Christi Bay (see Section 2.6), and these are generally below detection limits. Therefore, we have applied these criteria to the Corpus Christi Bay data base for "total" (i.e., unfiltered) metals, which will be greater in concentration than the "dissolved" metal by as much as an order of magnitude, depending upon the specific metal and the nature of suspended matter in the sample. The values in Table 10-1 are almost certainly too conservative applied in this way, but again our purpose is to use these to identify potential areas of concern, realizing that

they may indicate a water-quality problem that does not exist. The order of applicability was the state standard when available, otherwise the EPA marine criterion if available, and the freshwater criterion otherwise. (The EPA values in Table 10-1 for mercury are especially stringent, as these are based upon final residue values for methylmercury rather than final chronic values for mercury -II, due to high biomagnification potential in certain fish and shellfish. Moreover, some of these EPA criteria, e.g. cadmium, lead, mercury, and nickel, are less than the detection limits in the data set.)

The violation frequency of of these criteria for total metals, based on measurements since January 1985, are summarized in Table 10-5. (Monthly breakdowns are not presented, because a seasonal effect is not expected and because the data are so sparse that too few measurements would be available for each month to be meaningful.) Inspection of this table immediately discloses the relative infrequency of violations of these criteria. Some metals are within the criteria limit everywhere, namely silver, arsenic and selenium, while others are violated in only one segment in the system, namely mercury and lead. The metal with the greatest frequency of violation is zinc, whose violations are fairly widespread within Corpus Christi Bay *per se*, especially in and around the CCSC and the La Quinta Channel. The La Quinta Channel and the adjacent CCSC near Ingleside (Segment CCC3) is a region of violations of several metals.

Ward and Armstrong (1992a) observed that in Galveston Bay metals concentrations in excess of the criteria are generally associated with shipping in the bay, i.e. along the Houston Ship Channel, in both its open-bay and landlocked reaches, along the GIWW, and in the turning basins. They added that this may be due in part to the concentration of urban activity and waste discharges in these same areas, but also to the fact that shipping regions are generally sampled more intensively due to dredging activity, thus allowing a greater opportunity for occasional high measurements. In the case of Corpus Christi Bay, not all, but the great majority of the water-phase metal samples have been taken from areas of shipping, including *all* of those since 1985, so we cannot draw any conclusions about the relative frequency of metals violations in these regions in comparison to other areas of the bay. However, the three metals with the highest frequency of violation in Table 10-5, namely zinc, copper and nickel, are also the three identified above as exhibiting elevated concentrations generally throughout Corpus Christi Bay (where data exist) relative to the values presented in Moore and Ramamoorthy (1984b). It is also interesting to recall that zinc concentrations in the sediments of the Inner Harbor are an order of magnitude larger than those in the Houston Ship Channel. This raises the speculation of whether the Inner Harbor could be the ultimate source for elevated zinc in the system. We also observe that high zinc levels have been found in some of the tissue analyses, notably oyster and black drum, especially in Nueces Bay.

We emphasize that dissolved metals—if we had a sufficient data base available—would exhibit lower frequencies of violations than these total-metals measurements. Even the applicability of dissolved standards such as those of Table 10-1 without taking account of the speciation of the metals is questionable. Therefore in terms of posing a threat to aquatic life, no strict conclusions can be

Table 10-8

Ranges of sediment metals (mg/kg) typifying "pollution"
compiled from Thomas (1987), see also Baudo and Muntau (1990)

Element	*non-polluted*	*heavily polluted*
Total Hg	<1.0	>1.0
Pb	<90	>200
Zn	<90	>200
Fe	<17,000	>25,000
Cr	<25	>75
Cu	<25	>50
As	<3	>8
Cd		>6
Ni	<20	>50
Mn	<300	>500
Ba	<20	>60

drawn from the comparisons of Table 10-5, but it seems safe to judge that the possibility is unlikely.

Concentration ranges considered to be representative of heavy metal pollution compiled from the recent professional literature are presented in Table 10-08. These are, at very best, qualitative indicators, many being applicable strictly to freshwater rather than estuarine systems, but at least these serve as an indication of how the sediments in Corpus Christi Bay could be judged. By these criteria, copper throughout the system, and zinc in the Inner Harbor and Nueces Bay would be characterized as evidence of "heavy pollution."

With respect to pesticides and trace organics, the data base is even sparser. Violations since 1985 are shown in Tables 10-6 and 10-7. Violations of the criteria of Table 10-1 occur for only proxied DDT and chlordane, as follows:

parameter	*segment*	*violations/ measurements*
DDT (extended: WQ-XDDT)	I1	2/2
	I2	2/2
chlordane (WQ-CHLR)	CCC6	2/20

Of course, virtually all measurements are below detection limits, hence the rarity of criteria violation.

For sediment, the information base for standards and criteria is not nearly so great as for water quality. First, the expression of sediment criteria for biological and human activities is still in the research and development stage. Second, what information is available applies only to a few pesticides and PAH's, and is tentative. The concentration in sediment of a contaminant does not properly characterize its potential biological effects, because these are modulated by the bioavailability of the constituent, which is in turn a function of the partitioning of the constituent between the particulate and interstitial water components of the sediment, and the make-up of the sediment itself. EPA has adopted the Equilibrium Partitioning approach to determination of sediment quality. The EqP model is a means of deriving equivalent sediment quality impacts from already-extant results for water quality, and in particular models the partitioning and bioavailability of the contaminant by its behavior with respect to sediment organic carbon. . The most promising method at present relies upon normalizing sediment concentration to organic carbon for hydrophobic organics (pesticides, PAH's, PCB's and related compounds) and normalizing sediment concentration to acid volatile sulfides (AVS) for metals, see Shea (1988), Di Toro et al. (1992), and Adams et al. (1992) for overviews. Although a general distribution of organic carbon in the bed sediments of Corpus Christi Bay has been compiled (Appendix C), the extreme heterogeneity of TOC requires that the contaminant and TOC analyses be performed on the same sample. Data on sediment AVS is not available, and, in any event, the method would require simultaneously extracted metals from the same sample. (We note that the utility of the AVS is much better demonstrated in freshwater systems than in estuaries, and will be of doubtful applicability in environments of high sediment oxidation.)

One implication of the EqP formulation is that for a given hydrophobic organic concentration in the sediment, regions with a lower TOC will have potentially enhanced bioavailability. While there is no indication in any of the sediment data that there are excessively high concentrations in the study area, we note that the regions of low sediment TOC, namely the upper bays and Nueces Bay, have evidenced elevated levels of some of the PAH's and are probably more susceptible to nonpoint source loadings of pesticides.

From a systemic point of view, the most significant potential problems affecting the bay as a whole are related to the parameters for which there is no regulatory standard or criterion of optimality, namely, suspended particulates, nutrients and salinity. With respect to the first two, the potential problem may not be too high a concentration, but too low. The statistical analyses of TSS in Corpus Christi Bay disclosed a decline widespread throughout the system, increasing in significance from north to south. The rate of decline is sufficient to have reduced the average concentration by about 25% in the upper bays and by about 50% in the lower bays over the last two decades. Suspended sediment is an intrinsic and important aspect of the Corpus Christi Bay environment; its decline is not necessarily beneficial.

Where inorganic nitrogen is higher in the system, declining trends were found to be typical, especially in the upper bays; no clear trend in phosphorus was evident. It is interesting to compare this result with Galveston Bay, for which declining trends were much more evident in the statistics (Ward and Armstrong, 1992a). This may be due to the fact that the concentrations of these nutrients are higher in Galveston Bay, inorganic nitrogen and phosphorus levels being respectively twice and four times those of Corpus Christi Bay, but it may also be due to the fact that the data base for Galveston Bay, especially considered on a areal basis, is much greater than that available to us in Corpus Christi Bay. A widespread declining trend was, however, determined in water-phase TOC at a rate sufficient to reduce the concentrations in the Corpus Christi Bay study area by about one-fourth over two decades. It is not clear from the data whether this indicates a decline in organic loading or a decline in productivity. More importantly, whether a decline in any of these nutrients is a problem or an improvement depends upon determining the optimum levels for Corpus Christi Bay. Much more research is needed on the total ecosystem to establish these optima.

As noted above, there is no regulatory standard or established optimal level for salinity. Salinity of Corpus Christi Bay has been a major source of controversy, especially within the past decade, because of its perceived value as a habitat indicator that also measures freshwater inflow. At this writing, the City of Corpus Christi water supply in the Nueces reservoirs of Choke Canyon and Lake Corpus Christi is threatened by a continuing drought, and the conflict between human water-supply requirements and the needs of the estuary ecosystem has been brought into sharp relief. One result of the present study, disclosing increasing trends in salinity that seem to be associated with declining trends in mean inflow, certainly suggests that salinity will continue to be at the center of management issues and strategies for this system, even after the current drought has abated. Certain areas of the system, notably Baffin Bay and the Upper Laguna Madre, are chronically hypersaline environments. This is the result of a combination of low freshwater inflow (as these areas are naturally arid) and poor exchange with Corpus Christi Bay and the Gulf of Mexico. Man's intervention cannot easily alter the former, but it can the latter, and, again, we can expect salinity to be a central issue in debates about physiographic alterations in this part of the study area.

10.5 Recommendations

The obvious recommendation to reduce the deficiencies identified in the Corpus Christi data base in Chapter 5 is to sample at more locations, more frequently, for more parameters. Clearly, the ability of any agency to accomplish this is dictated by available resources and the relative importance of that agency's missions (hence, allocation of resources). It seems of more immediate value to the development of a Comprehensive Management Plant for Corpus Christi Bay to present specific recommendations that will substantially improve the data base with little additional expenditures. Suggestions are offered in this section on alterations in procedures for monitoring in future programs to assist filling data gaps or repairing data deficiencies. Emphasis is on procedural modifications

that can be implemented with little or no cost, and that will not interfere with the objectives of the primary agency but will greatly augment the value of the data.

10.5.1 Data-collection precepts

The primary requirement of any data collection program is to perform measurements targeted at the principal question or function that program addresses. For research studies, the data-collection strategy is tailored to the scientific hypothesis to be tested. Many state and federal agency programs have statutorily defined missions, that in turn dictate their sampling strategies. Therefore, to the extent that any given survey is properly designed to achieve its mission, our recommendations for its performance are superfluous. On the other hand, few programs can afford the investment of long-term, intensive data collection in a system such as Corpus Christi Bay. To address scientific and management questions that require such massive data bases, we must depend upon the use of data collected by different agencies for perhaps different purposes.

Each such data-collection agency must recognize that the value of its data transcends its immediate application in achieving the purpose of that agency. In this sense, data collection should be regarded as a collective enterprise, and its design should reflect a certain degree of scientific altruism, to ensure maximal utility of the data without unduly hampering the measurement procedures or project resources. It is in this spirit that we offer several concrete recommendations. In summary, these recommendations argue that data programs should be somewhat more careful, collect somewhat more measurements, and facilitate somewhat better their data dissemination, than strictly required for the mission at hand.

Ward and Armstrong (1992a) in addressing the problems of data collection in Galveston Bay proposed four precepts of data collection. They observe that it is the violation of these precepts which contribute to data deficiencies that are avoidable or correctable at little cost. These are repeated here, because they are equally applicable to the Corpus Christi Bay situation:

(I) Continuity of record in space and time should be of paramount importance.

(II) Benefit versus *incremental* cost should be a governing criterion for delineation of a suite of measurements.

(III) Basis for selection of parameters to be measured should include potential analyses the measurements will support as well as historical perspective of measurement continuity.

(IV) Recording and processing of the data ("data recovery") as well as archiving should be performed with great sensitivity to and avoidance of potential loss of information.

The reduction in space/time density of data collection within roughly the last decade has significantly diminished the utility of modern data collection at least for the types of analyses performed here. Precept I listed above emphasizes maintenance of continuity. Corpus Christi Bay, like each of the Texas estuaries, is a highly variable environment, subject to many external factors, each of which contributes a degree of "noise" in any measured parameter. To filter this noise, and expose variations in time and space, requires that sufficient independent measurements be available over the range of variation of the external factors. For time variability, continuity of data record is an all-important property of any data base. For space variability, a high density of sampling stations repeatedly sampled is necessary. (The actual intensity of sampling is determined by the intrinsic variability of the parameter of concern.)

Several data collection programs are underway simultaneously in Corpus Christi Bay. Yet these seem to be uncoordinated. The obvious reason is that each of the programs has a single, often narrow, objective, and the program is designed to meet that objective. Generally, a large investment is required to obtain the basic sample. This cost is dominated by operations: putting a sampling crew (and usually a boat) on a specific station, or installing an automatic data logger on a platform in the bay. Precept II advises that the incremental cost in acquiring additional measurements (including loss of efficiency) must be weighed against the cost of occupying the station, in specifying the suite of parameters to be obtained. Whether additional parameters have direct application in the project objective is unimportant; they may be peripheral or irrelevant to the objective of the project, but have great value for other objectives and therefore justify the small incremental cost for their acquisition. For example, when a water sample is pulled for coliform determination, the additional cost to measure salinity is negligible. Though salinity has no bearing on the use of the data for public health purposes, it would add to the general base of information on salinity structure, perhaps from a region that is poorly sampled otherwise. The same principle of incremental cost versus benefits should be considered in specifying laboratory analyses. Many procedures, e.g. mass spectrometry or grain-size by settling tube, are cost-loaded in technician training and sample preparation, and can admit additional parameters or greater resolution with minor incremental cost. Again, a certain altruistic philosophy is necessary in the sampling agency, to acquire measurements that may be superfluous to the immediate objective, but from which others will benefit.

Not only should sample programs be coordinated among themselves to maximize the total benefit, those programs should be coordinated with historical practice, as indicated by Precept III. Extending a past data record may be sufficient to justify including a parameter, even if modern analysis and technology suggest a more useful variate. In particular, when a new parameter is inducted into an ongoing survey to replace a less satisfactory parameter, measurements of both the new and the old parameters should be performed in order to establish (or falsify) the relation between them.

One might expect Precept IV to be so patently obvious that it need not even be stated. Any data collection program should include procedures of data screening and data-entry verification, from the original lab sheets to the digital data file. While this may seem trivially obvious, the occurrence of equally obvious errors in all of the state data bases (to say nothing of inobvious errors) indicates that present procedures are inadequate. We argue in Precept IV for a heightened awareness to the possibilities of data loss, even for the cultivation of agency paranoia. When the data entry is recent and the raw data sheets are still available, errors are easiest to detect and correct. Error correction at the data-entry step may very well track back to the recording and/or acquisition of data. This opportunity decays rapidly in time. For this reason, data entry should be performed in a timely manner, not months after the event.

Data-checking procedures represent the obverse face of Precept III. At present, in the culture of many of the agencies (including academic research projects) their implementation seems to be viewed as a redundant cost item in data acquisition, perhaps absorbing funds that might be better spent in a boat or diverting energies from more productive professional activities. Such a view is myopic, because the expense of data checking shrinks to negligibility compared to the unit cost of acquiring and analyzing a water sample. One can not afford to lose that considerable investment because of an errant keystroke. Moreover, the place that a water sample potentially holds in a space or time trend may be invaluable. Data checking is an absolutely indispensable investment to preserve the information in a measurement.

10.5.2 Data collection recommendations

The obvious recommendation to reduce the deficiencies identified in the Corpus Christi data base is to sample at more locations, more frequently, for more parameters. Clearly, the ability of any agency to accomplish this is dictated by available resources, and is more a matter of trade-offs to most efficiently meet that agency's mission. It seems of more immediate value to the development of a Comprehensive Management Plant for Corpus Christi Bay to present specific recommendations that will substantially improve the data base with little additional expenditures. Therefore, suggestions are offered below on alterations in monitoring procedures to assist filling data gaps or repairing data deficiencies, with emphasis on those that can be implemented with little or no cost, and that will not interfere with the objectives of the primary agency but will greatly augment the value of the data. In summary, data programs should be somewhat more careful, collect somewhat more measurements, and facilitate somewhat better their data dissemination, than strictly required for the mission at hand.

We re-emphasize that Corpus Christi Bay is a highly variable environment, subject to many external factors, each of which contributes a degree of "noise" in any measured parameter. To filter this noise, and expose variations in time and space, requires that sufficient independent measurements be available over the range of variation of the external factors. For time variability, continuity of data record is an all-important property of any data base. For space variability, a high

density of sampling stations repeatedly sampled is necessary. Specific recommendations, as well as some amplification of these above precepts, are as follows:

(1) When the major investment of time and expense is to place a boat crew on station, a few *in situ* measurements should be standard procedures. Salinity should *always* be measured. If the crew is equipped with electrometric over-the-side probes, a vertical profile instead of a single depth should be routine. (Yet there are manifold examples of violation of this practice.) Some limited water sampling may also be simply accommodated, perhaps just surface grab samples for straightforward lab analyses. Notation should always be made of conditions, sampling location, and time and date. (This seems trivial, but there are numerous examples of omission of some or all of these.)

(2) We suggest that short lists be formulated of "recommended" parameters, to be included within suites of measurements of various classes (e.g, *in situ* parameters, non-fixed water samples, sediment sampling for chemical analysis, etc.), to provide guidance to anyone undertaking a sampling project.

(3) The same principle of incremental cost versus benefits should be considered in specifying laboratory analyses. Many procedures, e.g. mass spectrometry or grain-size by settling tube, are cost-loaded in sample preparation, and can admit additional parameters or greater resolution with minor incremental cost.

(4) Necessity for both continuity in time and continuity in space must be recognized, as well as the need for maintenance of a long period of sampling (Precepts I and III). There are numerous examples in the data record when a parameter is suspended from further measurement. In many cases, this has involved a replacement of the old parameter with a new one, e.g. JTU's replaced by NTU's. As another example, in recent years, there has been a shift of emphasis from rather gross and imprecise measurements such as BOD, oil & grease, volatile solids and total PAH's, to specific organic and hydrocarbon parameters. While the more precise measures are welcome, the termination of the record of the others is lamentable. When a new, more accurate parameter is considered to replace another, there should be a continuation of data for the older variable together with the new parameters to at least establish an empirical relation. It may be more important to continue the measurement of the older parameter, to preserve the continuity of record, even if the utility of that parameter is limited compared to the new one.

(5) One important implication of Precept I is that the density of independent measurements of a parameter should be commensurate with the space and time variability of that parameter. We note that the intratidal-diurnal scale of variability is virtually unsampled in Corpus Christi Bay by routine monitoring programs. The use of robot data collection, based on electrometric sensing and automatic data logging, has been instituted by the TWDB and, more recently, by Conrad Blucher Institute at Texas A&M University–Corpus Christi. We strongly recommend continuation of this work, but with increased attention given to Q/A procedures, data scrubbing and reconciliation, and drift control. *NB*, such data

acquisition should not replace routine sampling, since routine sampling provides far better spatial continuity than is practical to achieve with robot monitors.

(6) Some measure of suspended solids (e.g. turbidity) should be included in routine monitoring. For nutrients, metals, organic pesticides, PAH's or similar constituents that have an affinity for particulates, suspended solids *per se* should be routinely determined as part of the suite of measurements. Further, the analysis should include grain-size distribution or at least a simple filtration to determine partitioning of clays-and-finer and silts-and-coarser. (Technology such as a Coulter Counter can considerably improve resolution and precision, but can be expensive.)

(7) A ubiquitous deficiency of the sediment data base is that there are almost no paired measurements of chemistry and sediment texture (i.e., grain-size distribution). Analysis of the variability of many of the parameters of concern in environmental management, such as heavy metals and pesticides, must consider the grain-size fractions. We recommend that texture analysis be instituted as a routine aspect of any chemical analysis of a sediment sample. As laboratory analyses go, sediment texture is a cheap measurement. This is an excellent example of how the value of the data may be enhanced by a relatively economical additional measurement.

(8) Because of the future potential rôle sediment organic carbon may play in evaluating sediment chemistry with respect to a standard, presuming the EPA EqP approach (Adams et al, 1992) is adopted, we recommend that organic carbon be instituted as a routine aspect of any chemical analysis of sediment involving non-ionic organic contaminants, especially organohalogens.

(9) Too much information is sacrificed by the present practice of censoring analytical data. We recommend that chemical laboratories report both the actual instrumental determination and the computed detection limit. This will leave the decision to the user of the data of whether or how to use the instrumental value when it falls below the detection limit. Note that this recommendation requires no additional expense or action on the part of the laboratory, but rather dispenses with the last step of the reporting procedure of replacing instrumental values with the flag for "below detection limits." (With present procedures, the applicable detection limits should be reported already, independent of the magnitude of the instrumental result.)

10.5.3 Data management recommendations

(1) Data entry (i.e., transcription) errors are a prime cause of information loss, and any data-entry procedure should include a process of verification. It is perplexing that an agency will commit major funding to support field crews and state-of-the-art analytical equipment and analyses, then entrust the resulting data to unsupervised, nontechnical, poorly trained, and uncaring data-entry clerks.

(2) Any process that reduces or replaces measurements (including units conversions) may be losing data unless carefully performed. Precept IV urges a sensitivity to this potential, that seems to be largely lacking in present agency procedures. Replacing a series of raw measurements over time or space by an average, modifying the spatial position data, failing to preserve information on sampling time, position or conditions, or intermixing actual measurements with "estimated" (BOGAS) values without any means of separation, all represent losses of information, and are all practices that can be avoided with care and forethought. We recommend following the same philosophy observed here (see Section 4.1) of differentiating a source data base from a derivative data base. The raw data in original units with all supporting and ancillary information should be maintained as a source data file. Any alterations, including units conversions and averaging, should be implemented in a separate data base.

(3). We recommend that a clear separation be made between a data base that serves the archival function and a data base that is used for analytical purposes. One particularly ubiquitous practice is to combine measurements from one's own data collection with data drawn from other sources, perhaps subsampled or processed. At present, several agencies, e.g. TNRCC and TWDB, intermix such data in a single data base. This is ubiquitous because of the use of combined data bases in scientific analysis, exactly as carried out in this project. This intermixing may be compounded by further processing, e.g. averaging together. The danger lies in not maintaining a separate and uncorrupted file of the original measurements. We recommend adherence to the same principle of preservation of data integrity observed in this project. Agencies should differentiate between the data record of observations obtained by that agency, and a compiled data record of those and other external measurements, possibly further processed.

(4) We recommend the implementation of well-structured data management procedures utilizing modern computer capabilities, including streamlined access and dissemination protocols. Even small-scale research projects can take advantage of spreadsheet software for permanent data base maintenance. It is remarkable how many data sources for this study maintain data only have hard-copy field or laboratory sheets, or (worse) type the data without retaining a magnetic copy. We recommend multiple backups of the data files, utilizing robust formats (e.g. flat-ASCII files).

10.5.4 Data preservation and archiving recommendations

Data-dissemination problems transform themselves with the passage of time into data-preservation problems. The management of historical data needs a twofold thrust: the implementation of actions to improve preservation and dissemination of current data-collection programs, and institution of actions necessary to preserve existing data. The former was addressed in Section 10.5.3 above. In this section we consider the latter. With respect to data from past programs, the primary need is preservation, which must be based upon the recognition that older data can play a central rôle in water quality management. A secondary need is to transform the data into a more utilitarian format as soon as practicable.

In Section 5.3.3 above, seven factors were enumerated that are considered to contribute to the loss of historical data from Corpus Christi Bay. These apply not only to water/sediment quality data but to all categories of environmental data from the Corpus Christi Bay system. The important observation about all of these factors is that they are self-exacerbating and mutually reinforcing. The existence of only one or a few copies of a data set, and its possession by one or a few individuals increase the potential of loss due to natural or technological hazards. (These problems are particularly evidenced in the academic area, where each faculty member is responsible for the storage and tracking of his own materials, and there is little or no provision for preservation of those of a retired or resigned faculty.) Low priority of data management implies poor housing and careless data management practices, and increases the exposure to discard due to agency instability. All of these factors are continuing to work at present, and are creating the potential for further loss of data, which will be lamented in the future. In our view, the problem is critical.

The facile–and fatuous–recommendation to correct the situation would be to eliminate the above seven factors. We proffer the following specific recommendations, which we believe to be more pragmatic and to lie within the purview of the National Estuary Program or its participating agencies.

(1) All sponsored research projects (including consulting contracts and interagency contracts) should include a *requirement* for preparation of a data report documenting the *raw* measurements of the project. If a digitized version of the data base is part of the project, transmittal of a copy on an appropriate digital medium should also be required, with written (hard-copy) documentation of formats and software operation. Compliance with this requirement should be a condition for any future contracts. For public agencies, the data so transmitted should then be subjected to the requirement of public distribution given in (3) below.

(2) All projects internal to an agency, performed by an agency staff, involving observations and measurements should require preparation of a data report. If a digitized version of the data base is part of the project (which we recommend, but this may not always be practical), a copy on the appropriate digital medium should also be required, with written (hard-copy) documentation of formats and software operation. For public agencies, the data so transmitted should then be subjected to the requirement of public distribution given in (3) below.

(3) In public agencies, the release of the data report and digital copy should be made mandatory after a certain calendar period, e.g., six months. (If the data is still under review, it should be so marked, but being under review should not be used as a reason for delaying release.) Reimbursement for the expense of copying is appropriate, but the price should be reasonable. After all, the public has already paid for it once. Maximum advantage should be made of the Internet for dissemination.

(4) All agency files and materials should be marked with a destruction schedule by its originator. For measurements and raw data, at least, the files should be marked "permanent storage, not for destruction." In some agencies, smaller but equivalent words may be desirable.

(5) At least one hard-copy record of every data set should be maintained. This might be raw data sheets, or might be a print-out of a digital data record. Also, even when a data set exists in a digitized data-management format (e.g., a data base management software form such as Lotus or dBase), a separate version in general encoding format (e.g., ASCII) should be maintained.

(6) Data Inventory and Acquisition Projects should be sponsored as soon as practicable, either internal to an agency, or through external contract, to extend the present activity for Corpus Christi Bay, and to secure similar data sets for the other Texas embayments and for the Texas coast. In particular, holdings in the following agencies and sites should be retrieved, organized and, where appropriate, digitized:

- the Texas Parks and Wildlife Olmeto warehouse
- the U.S. Corps of Engineers: Galveston District, the Texas area offices and the Waterways Experiment Station
- the National Marine Fisheries Service laboratories in Galveston
- research universities in the Texas coastal zone
- private engineering and surveying companies

(7) Some centralized, cooperative data storage and management facility is needed, one which is divorced from the separate mission-oriented state and federal agencies. Emphasis should be on competence of staffing and an appropriate delineation of scope. The Texas Natural Resources Information System could become this entity, but it suffers from many problems, not the least of which is adequate and stable funding, which presently prevent its serving this function. This recommendation, of course, exceeds the jurisdiction of the CCBNEP agencies, but could profit from the strong unanimous support of these agencies. It is, however, the only long-range solution that is evident to us.

(8) Digital preservation technology has improved in recent years, and many of the long-term aging problems associated with re-writable magnetic media can now be avoided. In particular, we recommend preservation of historical data bases using CD-ROM technology, which is now sufficiently reliable and economical to be a viable alternative to tape. Again, the use of robust formats is preferable to software-specific or proprietary formats.

10.5.5 Recommendations for additional studies of water and sediment quality

On a more strategic level, regarding our understanding of water and sediment quality and information needed for effective management of the Corpus Christi Bay resources, we recommend the following:

(1) The data base assembled in this project is capable of many more analyses. In particular, it may be useful to examine the effects of varying temporal sample density on statistical bias, to normalize the data to uniform periods of record, and to carry out more sophisticated statistical examinations than could be mounted within the scope of this project. Detailed mass-budgeting studies are needed to determine the probable cause of the apparent declines in particulates and nutrients, perhaps in concert with hydrographic analyses or deterministic models, using the data base compiled in this project. Event-scenario analysis as well as time-series studies could both provide insight. This should be extended to include numerical modeling, as an "interpolator" in space and time.

(2) Additional analyses of chlorophyll-a and related measurements from Corpus Christi Bay, in association with *in situ* productivity studies are needed. These studies should include detailed examination of phytoplankton dynamics in Corpus Christi Bay, and its dependence on water quality.

(3) Metals remain a major concern. The present analysis was significantly delimited by the sparsity of data and the precision of measurement. Clearly, more and better measurements are necessary to assess and monitor this suite of variables. On the other hand, the investment in complex and demanding analyses does not at the moment seem highly critical to the management of Corpus Christi Bay, apart from the present state and federal activity in wasteload regulation. While monitoring should continue, we do not believe that merely intensifying that monitoring will yield information in proportion to investment. We recommend a research focus on:

(a) improved measurement methodology, including relations with and among older methods, for interpretation of historical data, and better determination of precision and accuracy,
(b) bioaccumulation of metals and trace organics,
(c) detailed studies on kinetics and fluxes in carefully selected regions of the bay subject to identifiable and quantifiable controls, especially addressing the metals identified in this study as being elevated,
(d) exploration of suitable tracers and their measurement, such as aluminum, to separate natural and anthropogenic sources of metals.

While information is needed on open-bay environments in general, the greater effort should be invested in those regions already manifesting a proclivity for elevated metals, i.e. in regions of runoff, inflow, waste discharges and shipping. We note that in the upper bays, Copano and Aransas in particular, recent data collection has been especially deficient.

(4) In an estuary as turbid as Corpus Christi Bay, the rôle of sediments in suspension and in the bed is quintessential. Every element of the sediment transport process is imperfectly understood, as manifested in our inability for quantification, from riverine loads to exchange with the Gulf, from scour and deposition on the estuary bottom to shoreline erosion. The affinity of many key pollutants for particulates, especially metals, and the dynamics of transport and exchange within the estuary, render an understanding of sediments absolutely indispensable to the management of water quality in general. This is compounded by the activity in Corpus Christi Bay of dredging, shoreline alteration, and trawling, as well as the declines in suspended sediments in recent years. In our view, sediment dynamics should be the focus of a renewed research effort in the bay, ranging from more detailed observation on grain-size spectrum and its effects, to biokinetic processes operating within the sediment itself.

(5) The observed decline in temperature is probably not a serious concern from the water-quality management standpoint, but additional examination of its cause, especially if of climatological origin, may provide insight into other processes. We recommend some modest examination of long-term variability in the climatological controls of the surface heat budget. Since the same trend in temperature was also discovered in Galveston Bay, this suggests that the scope of research should be extended to encompass the entire Texas coast.

(6) The salinity data base assembled in this project is the most comprehensive available for Corpus Christi Bay and will support analytical studies of salinity response heretofore not possible. In view of the mandatory releases from the Nueces River reservoirs, and the controversy surrounding the ecological value of these releases, detailed studies of the response of salinity to inflow events are highly recommended. In particular, it is recommended that salinity variability in Corpus Christi Bay be examined using sophisticated methods of time-series and response analysis to better delineate the rôle of inflow and other hydrographic factors on salinity. This would be valuable, not only because of the intrinsic importance of salinity as a hydrographic and ecological variable, but to yield insight into the time-response behavior of other, less intensely sampled parameters whose concentrations are dominated by internal transports.

(7) The significant observed increase in salinity underscores the gaps in our understanding of even as fundamental a parameter as this. While inflow has been identified as a probable causative factor, other elements of the salt budget, notably evaporative deficit and exchange with the Gulf of Mexico, could be of equal or greater importance. We recommend additional studies of the external controls on salinity. This could probably be most usefully pursued, at least at the outset, by detailed salt budgeting, combining the data base of the present study with the time-intense robot data records from TDWB and TAMU–CBI. Pursuant to this we recommend that the data records at TWDB be subjected to review and correction for drift, calibration error, and sensor faults, so to be available as a resource for such studies. As with nutrient and particulate loading, we believe event-scenario and time-series analysis to be the most promising approaches. There is also a place for hydrodynamic modeling, but only after the essential controls and responses of the system are much better defined.

(8) There seems to be little basis for the appropriateness of the 5 ppm standard in this estuarine system, given the low saturation concentrations at high temperatures and salinities. We recommend re-evaluating the applicability of the 5 ppm average DO standard to waters with such low solubility. (We note that there is a prominent exception to the uniform application of the 5 ppm DO standard along the Texas coast—that one bay is assigned a lower open-water DO standard by TNRCC—namely the 4 ppm standard for Galveston Bay.) At the same time, these low solubilities mean a concomitantly constrained assimilative capacity for oxygen-demanding constituents. While DO does not appear to be a problem in the study area at present, we recommend renewed research on the DO requirements of organisms, methods appropriate for evaluating assimilative capacity (for evaluation of waste discharges, particularly), and the factors leading to episodes of depressed DO in the study area, especially in poorly flushed regions.

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