

**City of New York
Department of Environmental Protection
Bureau of Environmental Engineering**

NATIONAL PARK SERVICES
GNRA JAMAICA EAY
RESOURCES LIBRARY

Use and Standards Attainment Project

**JAMAICA BAY
FIELD SAMPLING AND ANALYSIS PROGRAM
YEARS 2000-2001**

Component 1: Waterbody Biology

DRAFT

**September 2000
Project No: NYDP5005**

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JAMAICA BAY AND ITS TRIBUTARIES

FIELD SAMPLING AND ANALYSIS PROGRAM

1.0 INTRODUCTION AND PURPOSE

This Field Sampling and Analysis Program (FSAP) has been developed for evaluating the potential for New York Harbor waters to support recreation (e.g. fishing, swimming, boating, nature study), fish survival and fish propagation. HydroQual, Inc. is implementing the Use and Standards Attainment (USA) Project for the New York City Department of Environmental Protection (DEP). Over a four-year period, sequential studies of twenty-three waterbodies will be conducted. Currently, pursuant to the U.S. Environmental Protection Agency's (EPA) Clean Water Act (CWA), most of these waterbodies have use classifications of either "SB" or "I." The best usages of Class SB waters are primary and secondary contact recreation and fishing; these waters shall be suitable for fish propagation and survival. The best usages of Class I waters are secondary contact recreation and fishing; these waters shall be suitable for fish propagation and survival. Connected with these classifications are narrative and numeric water quality criteria. Periodically, the use classifications must be re-evaluated, the goal being to make all waters "fishable" or "swimmable," upgrading their use classifications to higher standards if at all possible. The two most important standards, for purposes of the USA Project, are bacterial counts (e.g. coliforms) and dissolved oxygen (DO) concentrations in the waterbodies. In the case of Jamaica Bay, input of nitrogen (N_2) and Phosphorus (P) can cause algae blooms, increases in turbidity and sedimentation, which could lead to further oxygen demands, and an overall degradation in water quality.

Presently, many waterbodies fail to meet their currently assigned standards in segments of their basins and/or during portions of the year. Some are considered "impaired," and they have been listed as such by DEC pursuant to CWA §303(d). This may be due to point- or nonpoint- source contaminants, historical impacts on habitat, or a combination of impacts. Combined Sewer Overflow (CSO) is one form of point-source contamination; landfilling or excavation of wetlands is a form of habitat destruction. The DEP is in the process of constructing CSO facilities that will minimize discharges of floating debris ("floatables"), bacteria, and pollutants that deplete DO. The USA Project is being performed to assess the relative contribution of habitat vs. water quality impairment to limitations on uses, and to help decide how much, where, when and how to satisfy regulatory

requirements vis-à-vis present or potential future use classifications. Statutory options under the CWA can include definition of mixing zones (wherein dilution is permitted within some area around the outfall), development of site-specific criteria or special use designations, or a scientific determination that attainability of higher uses is not possible (if CSO effluent is not singularly limiting to uses and cost-effective solutions are not at hand). The latter demonstration requires performance by DEC, of a Use Attainability Analysis (UAA).

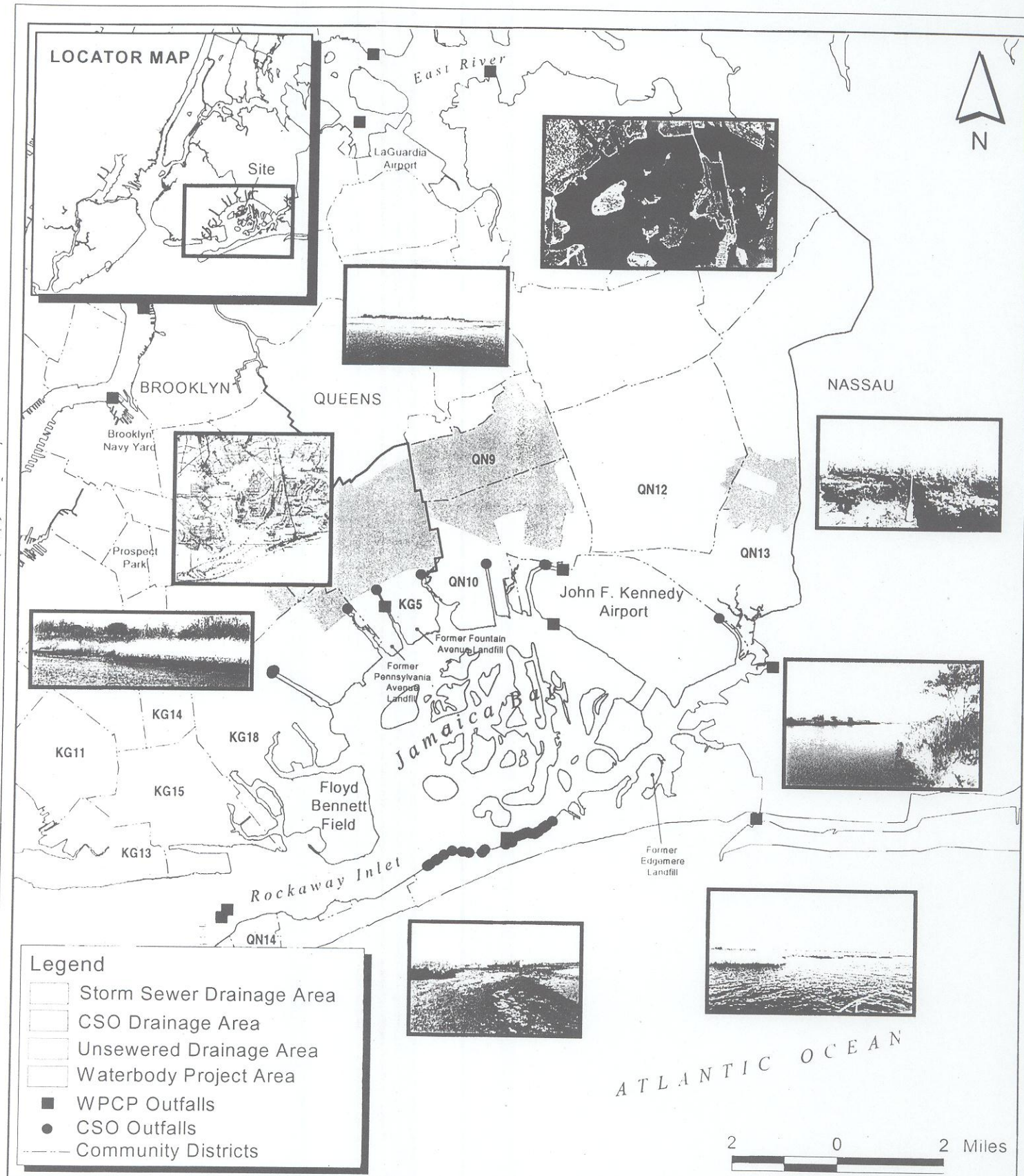
2.0 WATERBODY DESCRIPTIONS AND USA PERSPECTIVES

This section provides a brief description of Jamaica Bay (proper) and its tributary systems of concern, and a recapitulation of past, ongoing or planned studies that would complement USA Project studies scheduled for the year 2001. In addition, possible uses (and current limitations on such uses) of these waterbodies are introduced; salient UAA questions are posed; and data gaps helpful in focusing the FSAP consistent with stakeholder interests and scientific UAA guidance are identified.

2.1 Waterbody Descriptions

2.1.1 Jamaica Bay Proper

Jamaica Bay, though not as pristine as it was in the pre-European settlement period, remains New York City's largest and most important saltwater embayment (Figure 1). Originally circular with about 25,000 acres of open water and tens of thousands of acres of wetlands, the bay now has only 13,000 acres of open water and some 20,000 fewer acres of marshes. Both were sacrificed to dredging and filling associated with urban expansion along the north shore of the bay and John F. Kennedy International Airport, which deepened the bay, destroyed fringing wetlands and created artificial islands; and solid waste disposal. Natural freshwater input was replaced by larger volumes of contaminated sewage and storm sewer discharge, and what was a well-flushed tidal system became a sediment trap with much poorer circulation. This was particularly true of Grassy Bay on the eastern end of Jamaica Bay, which was deepened up to 50 feet (on its south end) and cut off from the predominant flushing pattern by Broad Channel as well as the JFK International Airport runway extension, while at the same time receiving a greater load of silt, organic compounds and heavy metals from wastewater treatment plants, urban runoff, and airport runoff. The open waters of Jamaica Bay were designated in 1948 as a city wildlife refuge [the Jamaica Bay Wildlife Refuge (JBWR)] which, in 1972, became part of Gateway National Recreation Area (GNRA), and the bay remains a viable natural resource of vital importance to New Yorkers.



New York City Department of
Environmental Protection

JAMAICA BAY FIGURE 1

USE AND STANDARDS ATTAINMENT PROJECT
OPEN WATER PROJECT AREAS



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Notwithstanding its current pathogen and CSO-related listing under CWA §303(d) and consumption advisories for eels, bluefish and striped bass, coliform counts in Jamaica Bay were an order-of-magnitude lower than those observed in the rest of New York Harbor during the 20 year period ending in 1991. The bay is classified SB, and with the exception of the Grassy Bay sub-basin, DO levels generally meet standards. Of concern, however, is the fact that the difference between surface and bottom concentrations of DO has widened over the years, suggestive of stratification and continuing eutrophication from nitrogen and phosphorus input.

From a habitat standpoint, deeper channels and the Grassy Bay sub-basin have supplanted shallow water habitats and seagrass beds [as of 1991 there was an almost complete absence of *Zostera marina* (eelgrass)], and artificial islands with steeper intertidal slopes have replaced more natural marshes. Shellfishing, once a thriving industry, was a concern relative to pathogens as early as 1904 and was banned in 1921. Bottom substrate and lack of significant sources of natural, clean freshwater input to the system will likely limit oyster production into the foreseeable future. Benthic communities are now dominated by polychaete worms, and amphipods. The most abundant species of amphipods found in the bay is *Ampelisca abdita*, which is considered an important forage species for birds and fish. The quahog clam population (*Mercenaria mercenaria*) has increased and species distribution and abundance in the 1980s appeared similar to that of at least one cleaner estuary in southern New Jersey (Franz and Harris, 1985). Baitfish (menhaden, anchovy, silverside, mummichog, butterfish, mullet) are found along with sport species such as winter and summer flounder, weakfish, bluefish, scup, tautog, striped bass, puffer and sea bass but (for various reasons) most are not as abundant in a typical year as they used-to be. Studies done in the lower Battery during the late 1930s found over 100 species of fish; those done in JBWR by the National Park Service (NPS) in the 1980s revealed some 60 species; and those performed by the New York State Department of Environmental Conservation (DEC) in the 1980s took less than 40 species. The DEC studies were based solely on seine net hauls, whereas NPS surveys also employed gill nets and otter trawls. West-Valle et al. (1992) concluded that "in addition to controlling the quality of sewage, sewer and CSO effluents to the bay... curbs on discharge of toxins were required to protect fish larvae and juveniles, and restrictions had to be placed on commercial and recreational fishing." Solutions proposed by the USACE (1997) include restoration of original depth contours and re-establishing prototypical wetlands, about which there is some present concern over losses due to sea level rise (Hartig, et. al., unpublished manuscript).

Twenty-four of 35 species of indigenous reptiles and amphibians were, as of 1992, extinct or endangered. JBWR lists nine species of reptiles; seven species of amphibians, 17 species of terrestrial

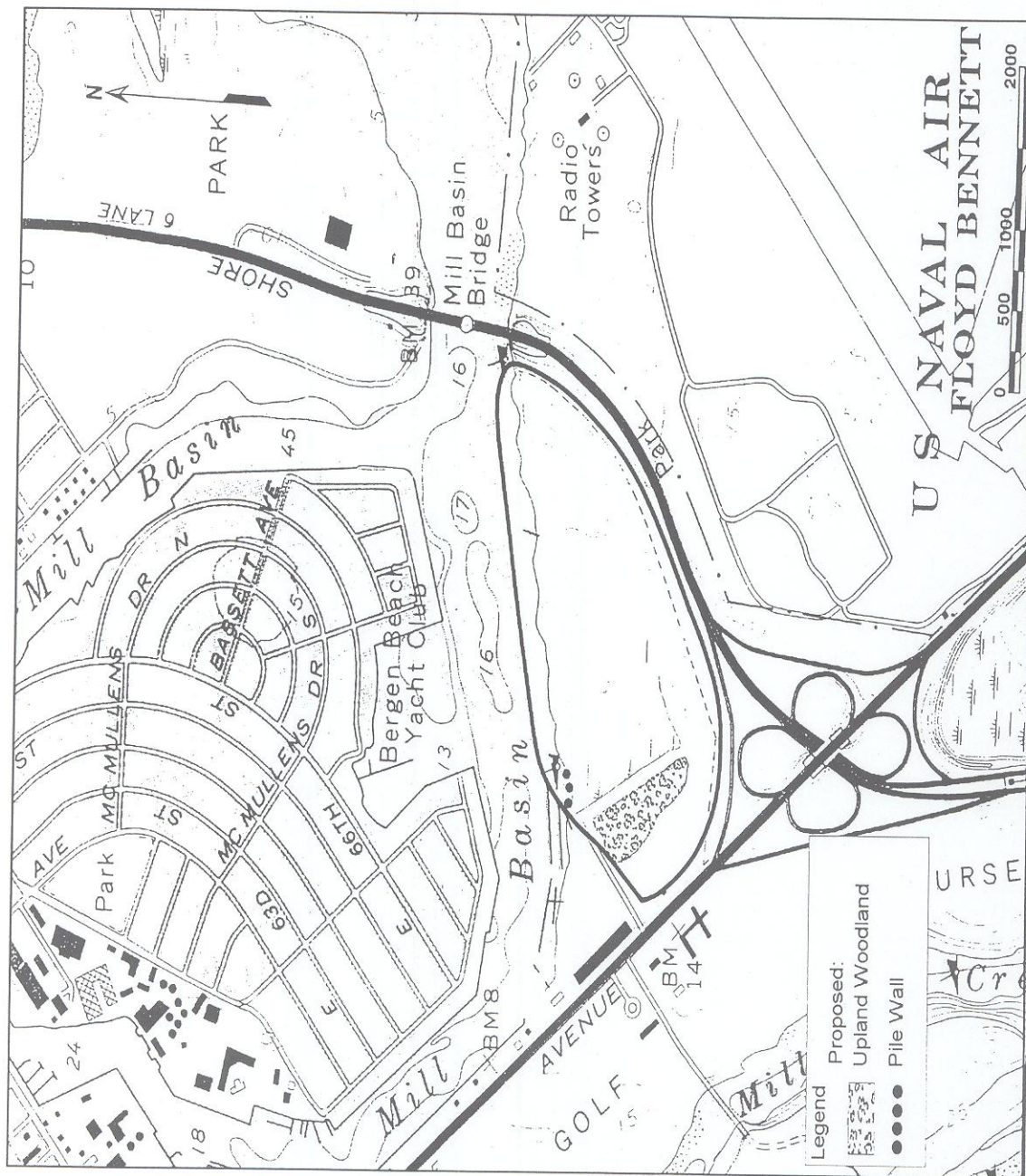


Figure 2. Restoration Concept 1-Four Sparrow Marsh
U.S. Army Corps of Engineers, 1997

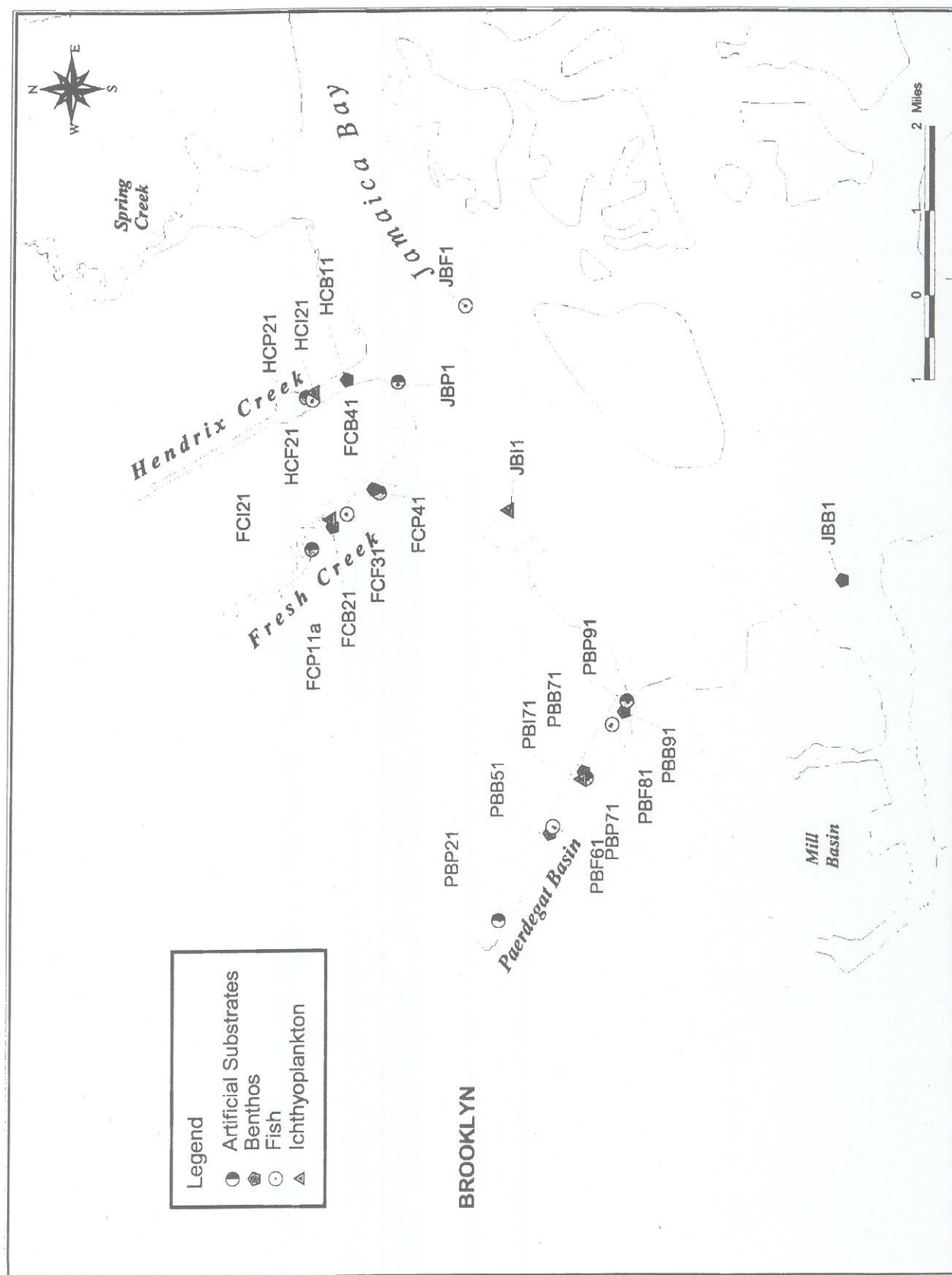


Figure 3. Sampling Locations for Paerdegat Basin FSAP

2.1.4 Fresh, Hendrix, and Spring Creeks

Sampling of water and sediments, invertebrates, fish and ichthyoplankton in Fresh and Hendrix Creeks started in conjunction with the Paerdegat Basin FSAP. DEP is currently performing CSO facility planning for Fresh and Hendrix Creeks.

Fresh Creek is approximately a mile long, ranging in width from 650 feet at its widest point to approximately 125 feet at its narrowest point. Depths at MLW range from 3 to 19 feet. Fresh Creek is not a §303(d)-listed waterbody, but given that more than 30 percent of DEP's monitoring samples have contained less than 4 mg/L DO, and wet weather samples exceed coliform bacteria standards, it still is not fully compliant with Class I standards. USACE (1997) studies technically supported re-establishment of submerged aquatic vegetation (SAV) for fish and invertebrate habitat, and replacement of monotypic upland stands of "mugwort" with better (hardwood) habitat for wildlife (Figure 4).

Hendrix Creek has been greatly affected by channelization and filling (Blanchard, 1992). The width of the creek has been made a uniform 60 to 80 feet; and its depth (at low tide) reduced 2 to 5 feet. It is a §303(d)-listed waterbody; it does not meet the DO standard of 4 mg/L for a Class I waterbody; and coliform bacteria data indicates an exceedence of the standard. The 26th Ward Wastewater Treatment Plant (WWTP) occupies a large portion of the western shore. In addition, the Pennsylvania and Fountain Avenue landfills occupy the east and west shores near the mouth of the creek. The USACE (1997) has suggested that tidal marsh restoration may be possible, which would improve the habitat diversity for fish and wildlife (Figure 5). Final closure of the landfills should retard leaching of contaminants to the creek.

Spring Creek, the easternmost of the three waterbodies, is actually tributary to Old Mill Creek, which opens to Jamaica Bay. Ralph Creek is tributary to Spring Creek. In sequence of their original stream orders, Ralph Creek is the shortest and narrowest (2,100 feet x 100 feet); Spring Creek per se is 3,800 feet by an average of 180 feet; and Old Mill Creek is a mile long and between 200 and 2,300 feet in width. Depths throughout the system range from 3 to 12 feet at MLW, and extensive areas of low and high marsh exist in Old Mill Creek up-basin from its junction with Spring Creek. Though the system as a whole has been altered to the point where freshwater input is wholly derived from CSO and storm sewer discharge, Spring and Ralph Creeks have retained some semblance of their original channel configuration. The system is classified as a Class I waterbody, but it is not on the §303(d) list and DO deficits are not as frequent or significant as those of other

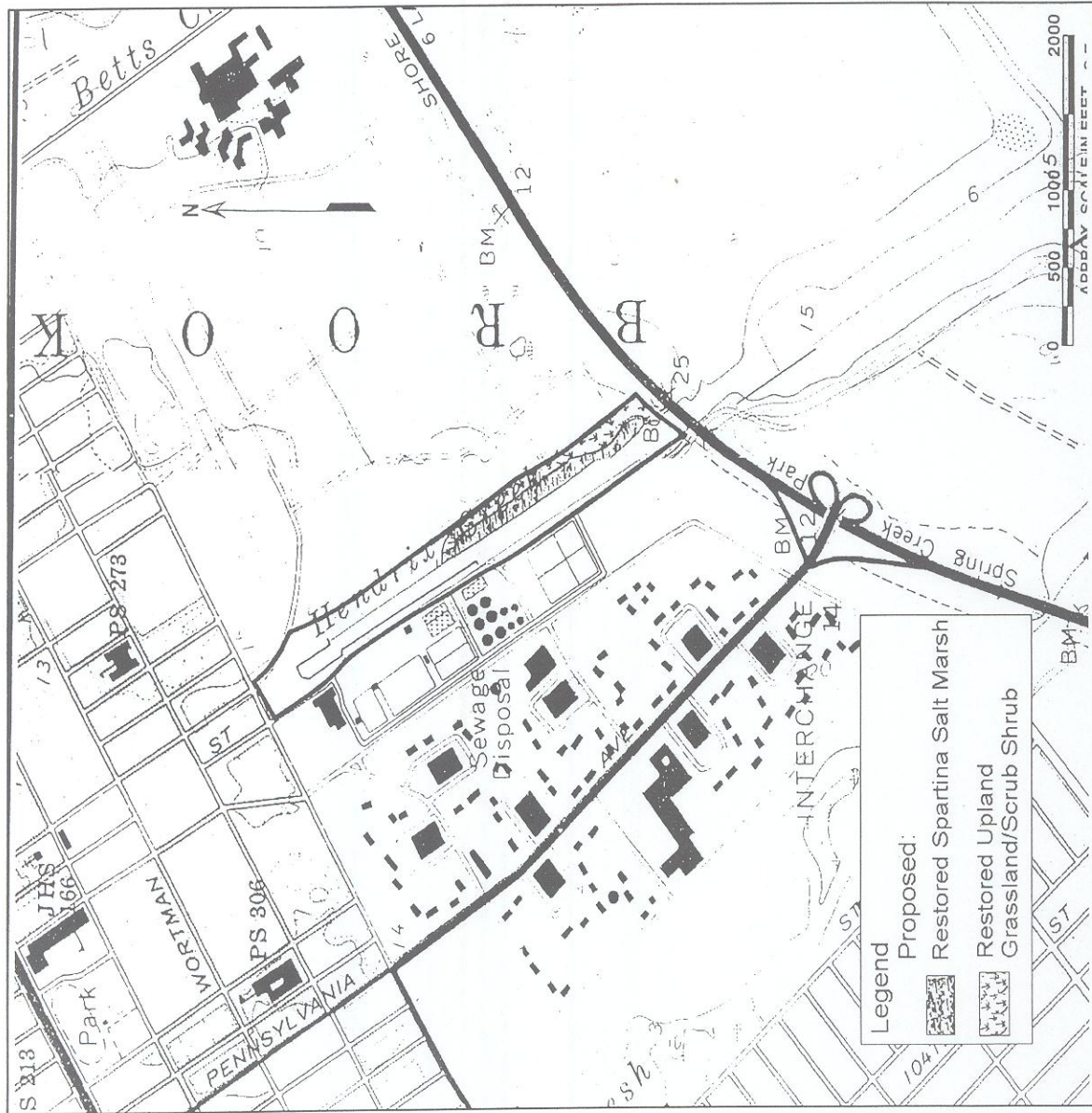


Figure 5. Restoration Concept 1-Hendrix Creek
U.S. Army Corps of Engineers, 1997

tributaries to Jamaica Bay. A DEP CSO retention facility overflows to the head end of Old Mill Creek. Upland habitat is dominated by plants characteristic of disturbed habitat (mugwort and common reed). The USACE (1997) has recommended creation of additional marsh habitat and upland woodlands (Figure 6), and the DEP will have upgraded its CSO facility by 2004.

2.1.5 Shellbank Basin

Shellbank Basin is mostly bulk-headed and is around 5,200 feet long and on average, 250 feet wide. The depths in the basin range from 10 feet to 52 feet at MLW. The basin is wider and deepest at the head rather than at the mouth, which severely limits circulation and results in near-zero oxygen concentrations in bottom waters (as early as late winter). There have been occasional reports of unpleasant odors probably due to the release of hydrogen sulfide from the sediment bed under anoxic conditions. Shellbank Basin is on the §303(d) list with parameters of concern being organic enrichment and low DO concentrations. DEP has made several recommendations to improve water quality in the basin. One recommended action is the elimination of an inactive CSO outfall at the head of the basin. A second recommendation was a pilot test (now underway) to determine if a reduction of stratification will eliminate odors in the basin. The basin is bulkheaded and lined with commercial and private pleasure boat dockage, and swimming is not permitted at beaches near its mouth. As a Jamaica Bay tributary, it is considered a State-designated "Significant Coastal Fish and Wildlife Habitat."

2.1.6 Bergen and Thurston Basins

Bergen Basin is over a mile long, with average widths and depths (MLW) of 400 feet and 12.5 feet, respectively. Thurston Basin is 5,000 feet long and 250 feet wide, and ranging in depth at MLW from 3 feet at its head to 20 feet at its mouth. Neither basin is compliant with DO or total coliform standards for Class I waterbodies. DEP is currently conducting CSO facility planning for these waterbodies. For Bergen Basin, the lowest DO concentrations were found in bottom waters near the head of the basin and are attributed to CSOs and sediment oxygen demand (SOD). The primary sources of pollutants to Bergen Basin are CSO and storm sewers, effluent from the Jamaica WWTP, storm sewers from JFK International Airport, and spills or leakage from fuel unloading facilities. The primary sources of pollutants to Thurston Basin are CSO and storm sewers, which are located at the head of the basin, and runoff from JFK International Airport. In Bergen Basin, fish and wildlife habitat is limited to a small area of intertidal flats and wetlands near the mouth on Grassy Bay, but such areas more-or-less surround Thurston Basin. Bergen Basin, as a Jamaica Bay tributary, is considered a



Figure 6. Restoration Concept 1-Spring Creek
U.S. Army Corps of Engineers, 1997

State-designated "Significant Coastal Fish and Wildlife Habitat." The USACE (1997) has suggested two possible restoration activities for Bergen Basin. One recommendation is the restoration of the shoreline and upland community to improve the terrestrial wildlife habitat (Figure 7). A second recommendation is the restoration of shoreline and creation of tidal marsh, which would serve to improve fish and wildlife habitat (Figure 8).

2.2 Status of Database

A UAA guidance (WERF, 1997) calls for "contemporaneous" and "comprehensive" field sampling and analysis of all components of an ecosystem, but falls short of explaining how all of those data would be used to establish use attainability. Therefore, in addition to formulating specific questions about Jamaica Bay's uses and standards attainability vis-à-vis this guidance and the DEP facility plans, the USA Project scope required a review of the available literature and data in order to better focus new studies. West-Valle et al. (1992) and Zhang (1992) summarized the literature through 1991, so this project focused on work performed since then. To supplement this review, key people most knowledgeable of the study area were contacted as to whether (1) they knew of other reports, or (2) they, or others they may be aware of, were planning to conduct additional research in 2000 and 2001. These contacts included university researchers who had done past work in the subject waterbodies as well as USA Project stakeholders. The intent of this search was to develop a program that would optimize USA Project resources by complementing rather than duplicating other's efforts.

There is a significant quantity of literature and data on Jamaica Bay (proper). But unlike Jamaica Bay, there is limited information on the tributaries. The Jamaica Bay CSO Facility Planning Project (O'Brien and Gere, 1993) and the Jamaica Bay Navigational Channels and Shoreline Environmental Surveys (USACE, 1997) were the two main studies that had reported sampling or field observations inside the tributaries of the bay.

2.2.1 Water and Sediment Sampling and Analyses

The DEP's Harbor Survey (HS), which includes sampling and analysis of DO, bacteria, nutrients and other water quality parameters throughout New York Harbor, has been in place since 1909. The HS regularly monitors stations in Jamaica Bay and has recently added tributary sampling. The current HS sampling stations are shown in Figure 9.

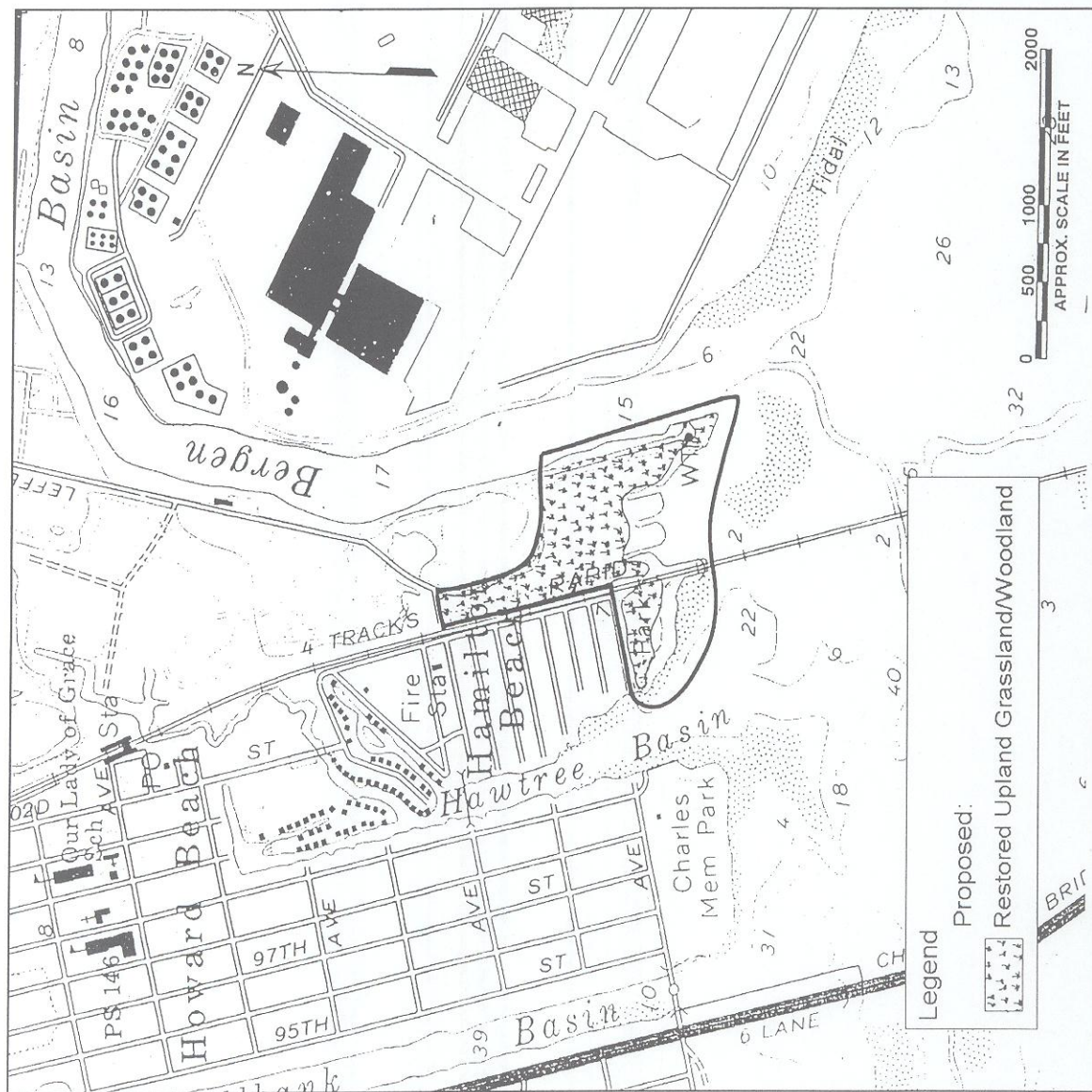


Figure 7. Restoration Concept 1-Bergen Basin
U.S. Army Corps of Engineers, 1997

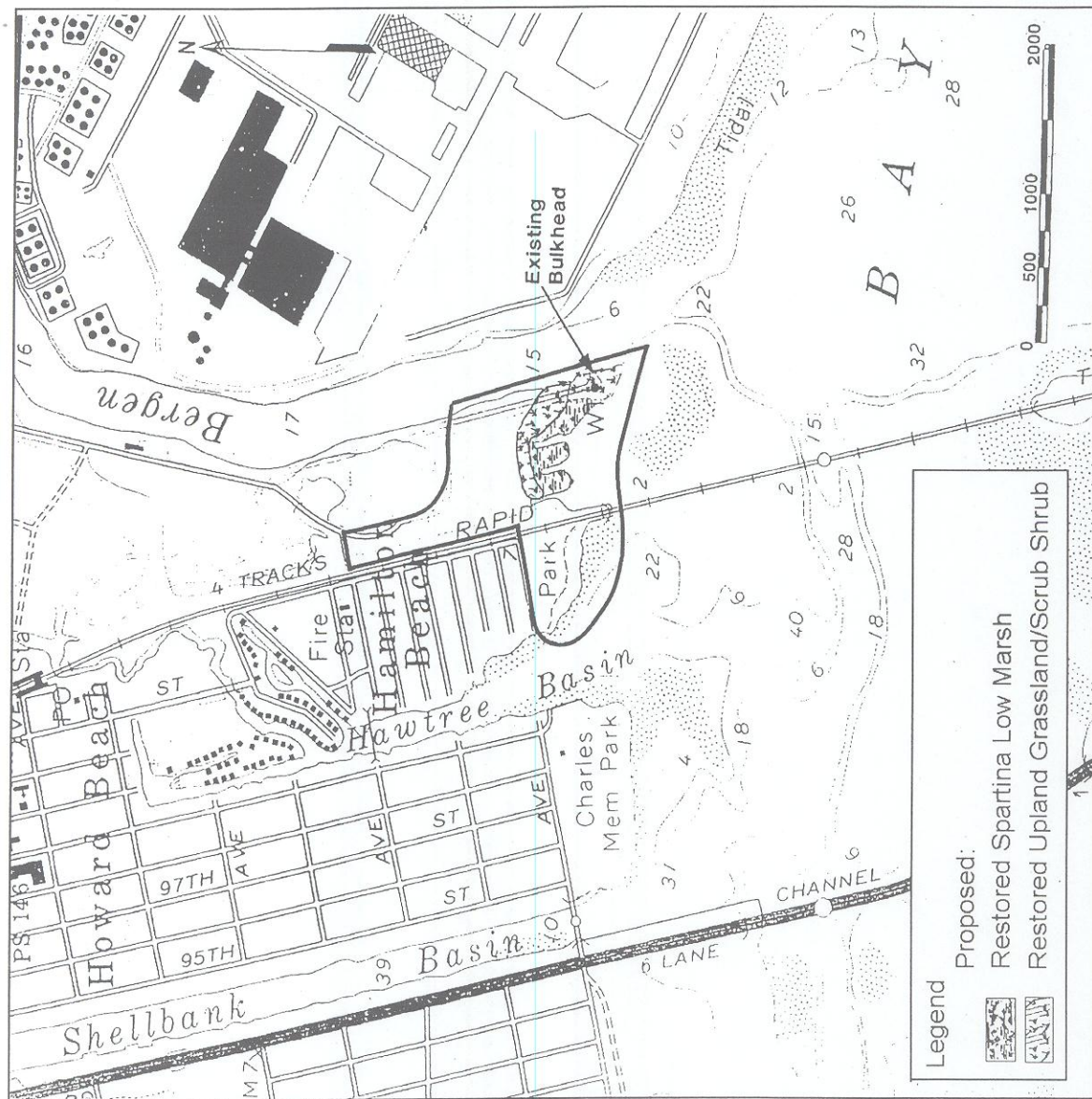


Figure 8. Restoration Concept 2-Bergen Basin
U.S. Army Corps of Engineers, 1997

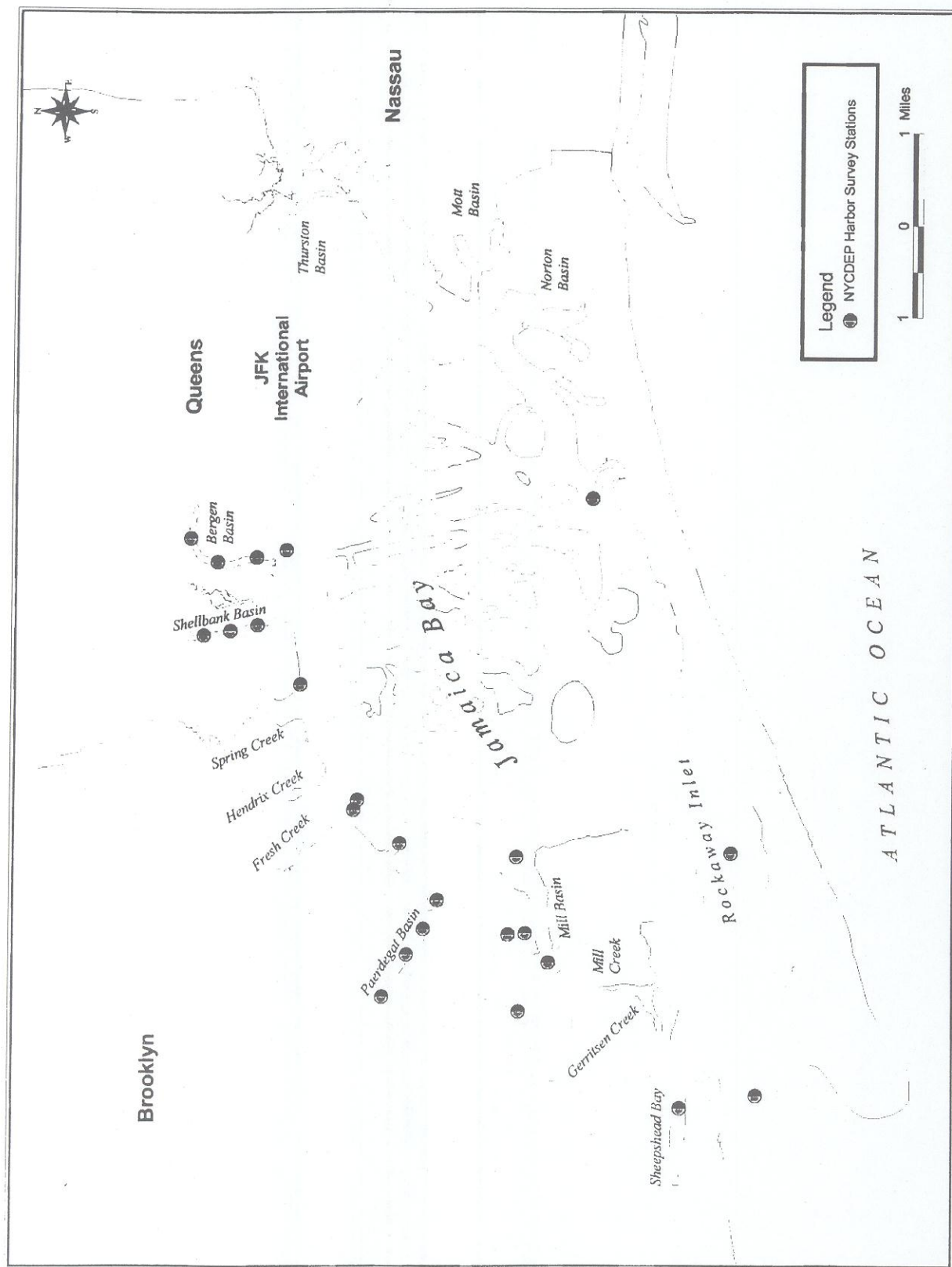


Figure 9. Locations of DEP Harbor Survey Monitoring Stations, 2000

For a one year period beginning in July 1995 and continuing through June 1996, New York City funded a special study of the Jamaica Bay system. This study, known as the Jamaica Bay Eutrophication Project, collected and analyzed water column samples for salinity temperature, DO, chlorophyll-a, and various forms of organic and inorganic nutrients.

As part of a salt marsh cordgrass biomass survey, the Jamaica Bay Eutrophication Project (EEA, 1997) collected and analyzed sediment for chlorophyll-a, total kjeldahl nitrogen (TKN), total oxygen carbon (TOC), and total phosphorus (TP). As part of its bivalve survey, the eutrophication project collected sediment samples at 91 stations for grain size analysis. Other Jamaica Bay sampling programs have included the NPS's long-term monitoring program and the Jamaica Bay CSO Facility Planning Project (O'Brien and Gere, 1993), which included sampling in all of the tributaries. (Figure 10) shows water and sediment sampling locations of DEP Projects in Jamaica Bay and tributaries. The EPA's Regional Environmental Monitoring and Assessment Program (R-EMAP) conducted sampling at 28 random stations in Jamaica Bay during 1993 and 1994 surveys, subsamples were collected for metals, organics, grain size, TOC and toxicity tests. The EPA's new National Coastal Assessment (also referred to as Coastal 2000) is a five-year monitoring program that focuses sampling efforts on water quality, sediment quality, and fish and benthos communities in the New York area, including the mouth of Jamaica Bay (Figure 11). Other sediment studies in the bay have focused on contaminants (Bopp et al., 1993) and metal pollution (Seidemann, 1991).

2.2.2 Biological Sampling and Analyses

The Jamaica Bay Eutrophication Project (O'Brien and Gere, 1997) included sampling of zooplankton and bivalve mollusks (clams, mussels) in 1996 (Figure 12). Studies have been performed measuring the abundance of plankton and primary productivity in the bay (Peterson and Dam, 1987; Cosper et al., 1989). Franz and Tanacredi (1992) studied secondary production of the amphipod, *Ampelisca abdita* (a dominant benthic invertebrate important in the diet of young fish, such as winter flounder), and in 1993 surveyed mussels at ten stations in Jamaica Bay (Figure 13). Franz and Harris (1985) performed a comprehensive study of benthic invertebrates and sediments in Jamaica Bay in 1984 (Figure 14). Borowsky et al. (1997) conducted a study to determine what effects Jamaica Bay sediments [Grassy Bay, Ruffle Bar, and East Hampton, Long Island (control sediment)] might have on the physiology and morphology of a local resident species of amphipod (*Melita nitida* Smith) (Figure 15). The results from Borowsky et al. showed that changes in reproductive parameters occurred in sediments of Grassy Bay; and changes in physiology and morphology were positively correlated with sediment contaminants. Franz and Harris (1988) studied seasonality and spatial

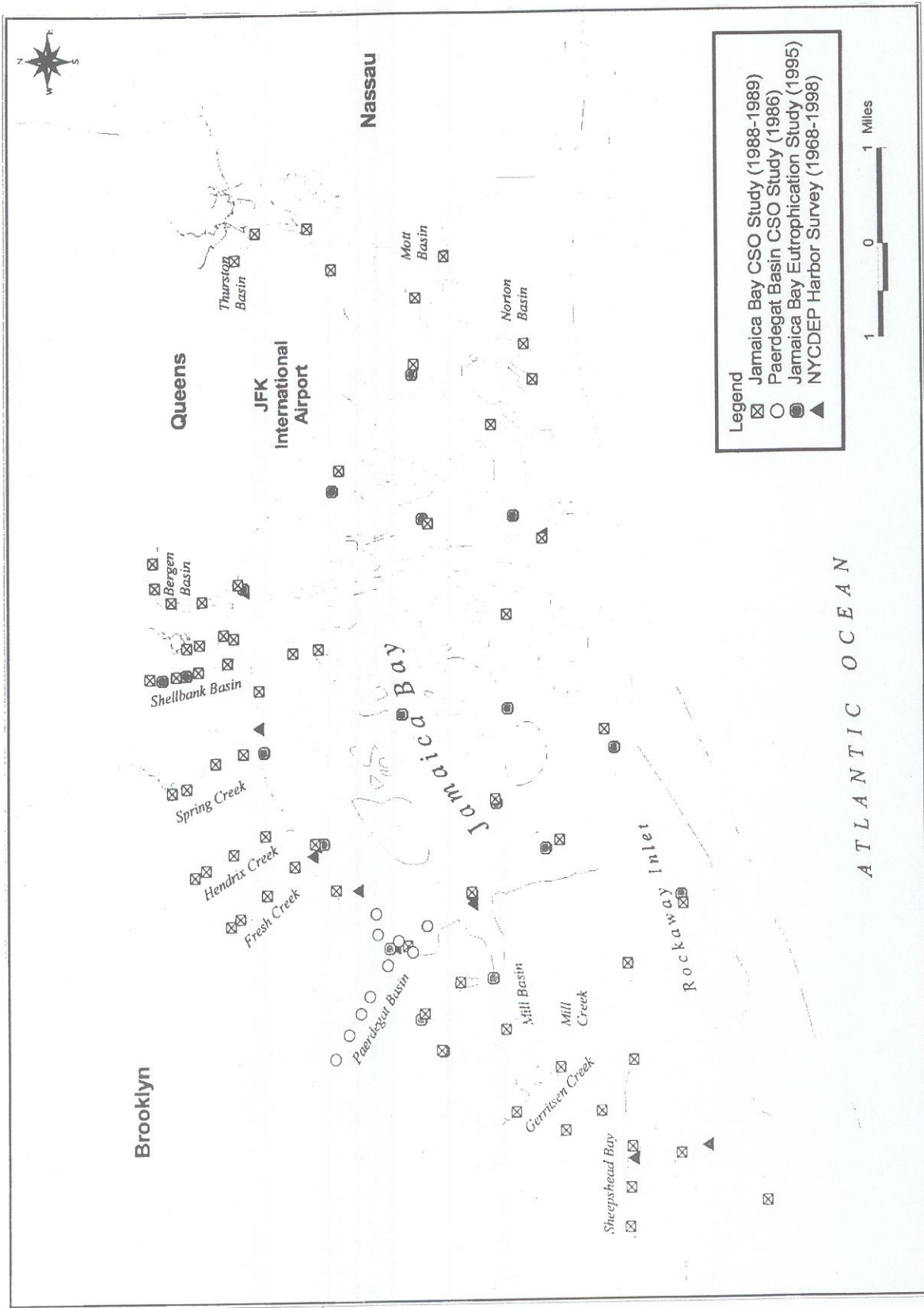


Figure 10. Distribution of DEP Water Quality and Sediment Sampling Stations in Jamaica Bay

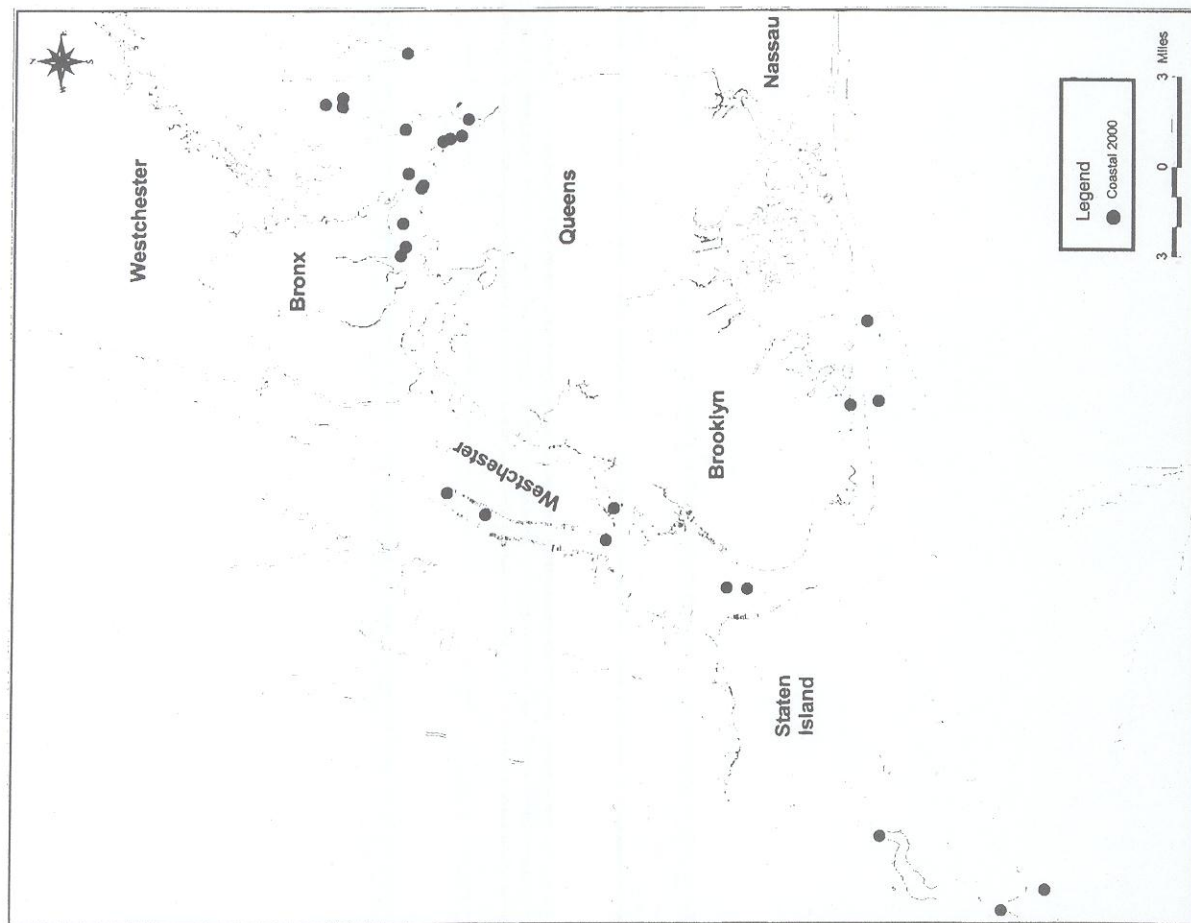


Figure 11. Proposed EPA Coastal 2000 Sampling Stations

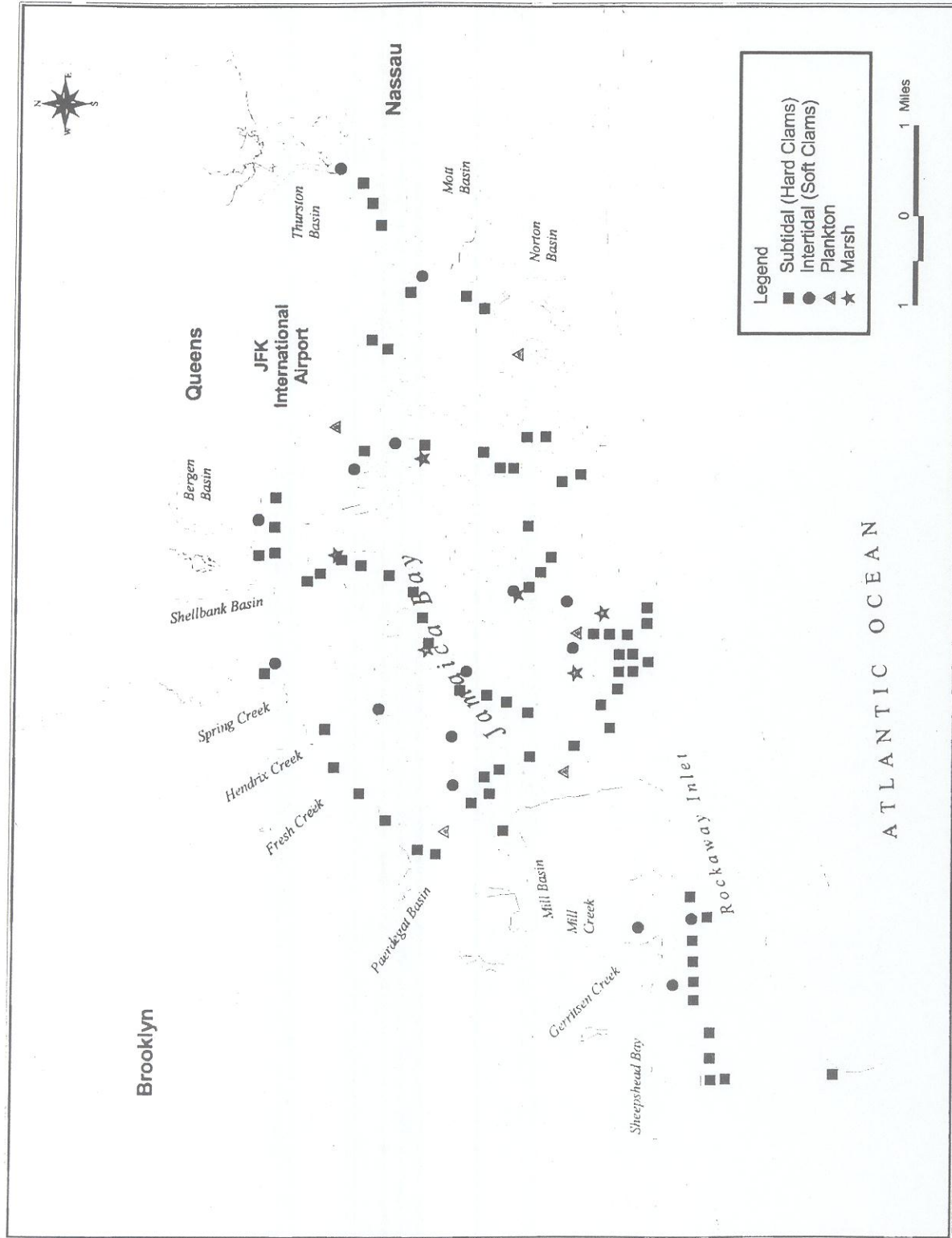


Figure 12. Bivalve and Zooplankton Survey Locations
Jamaica Bay Eutrophication Project, 1996

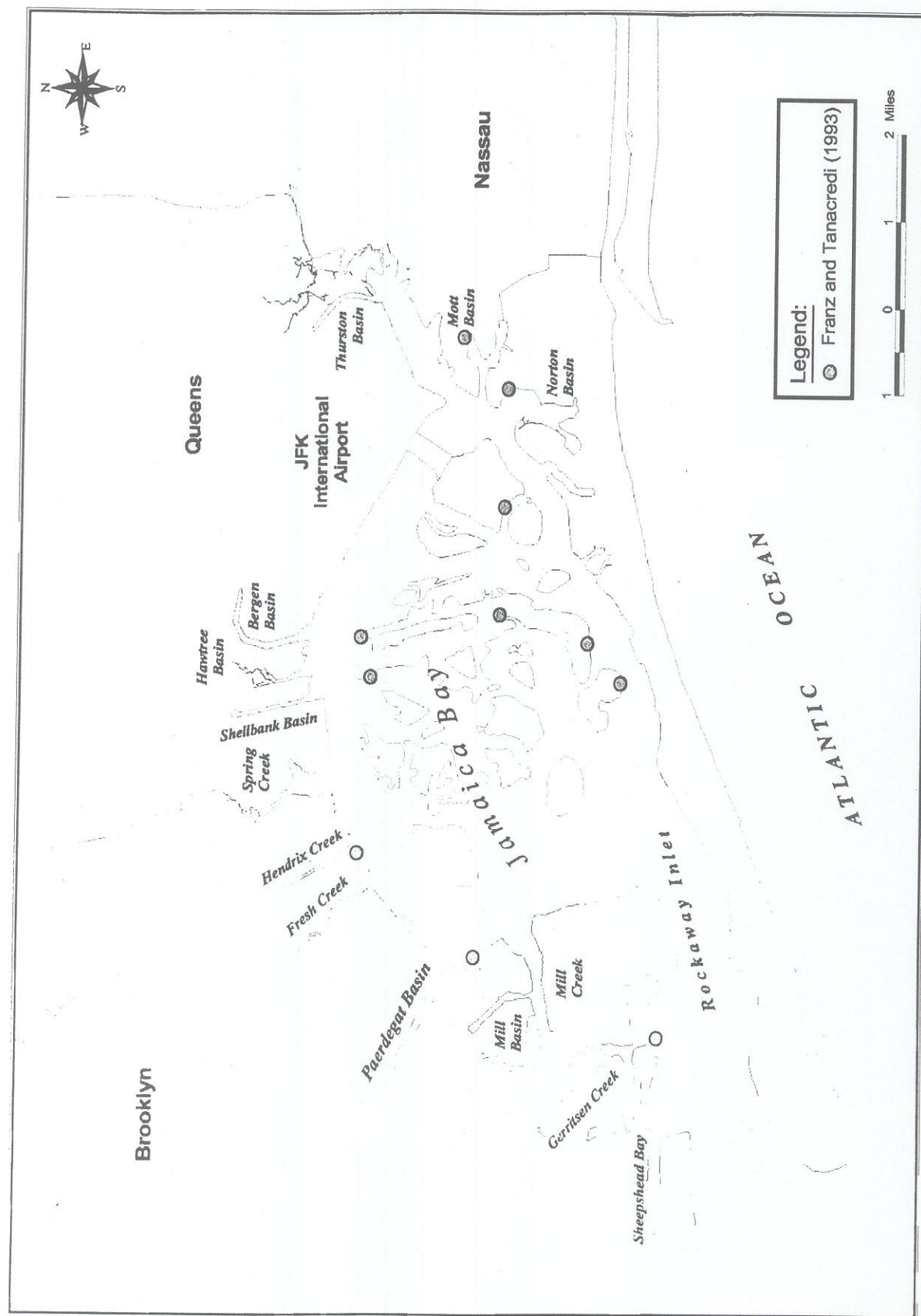


Figure 13. Sampling Sites from Franz and Tanacredi (1993)
Ribbed Mussel Survey in Jamaica Bay

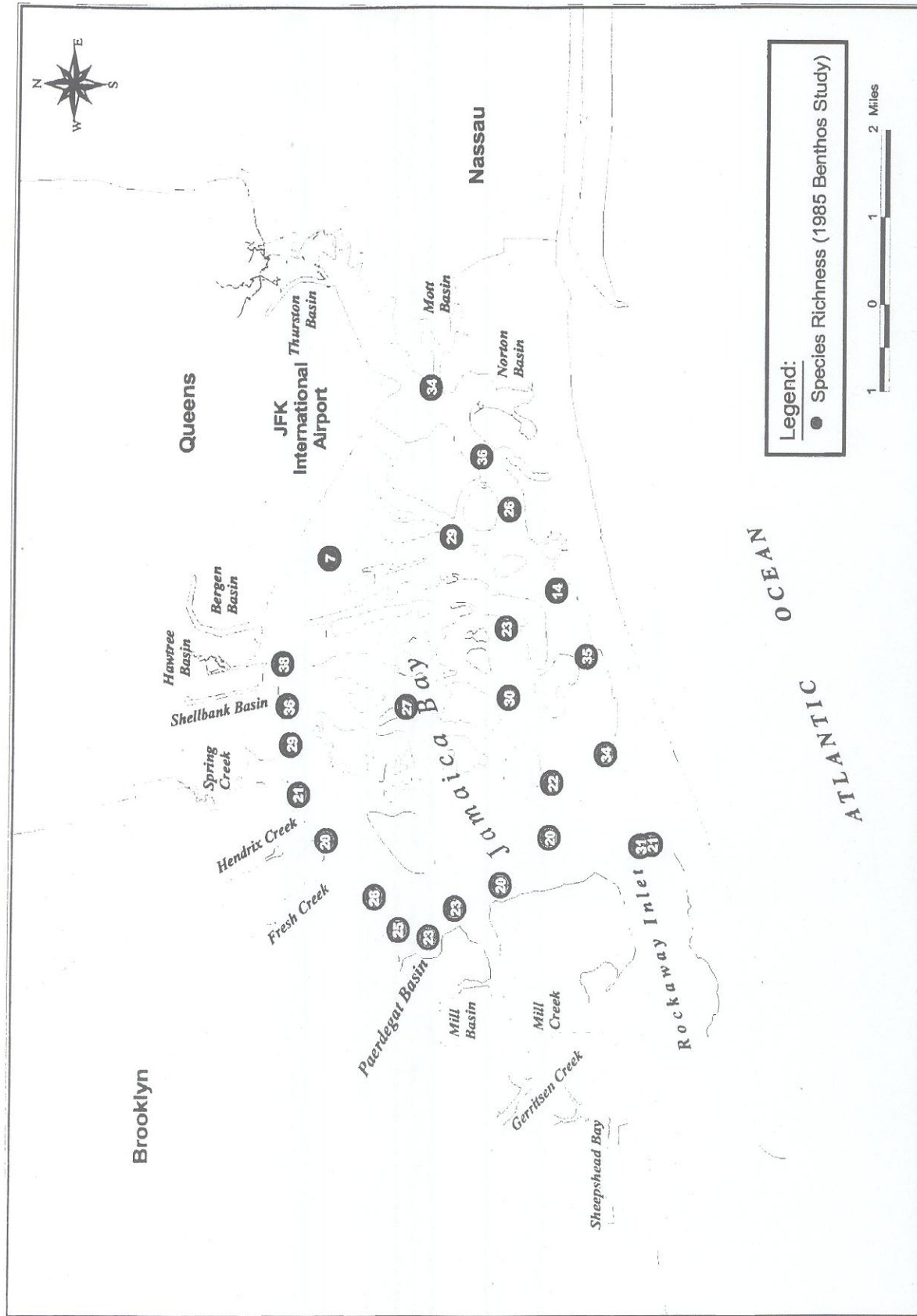
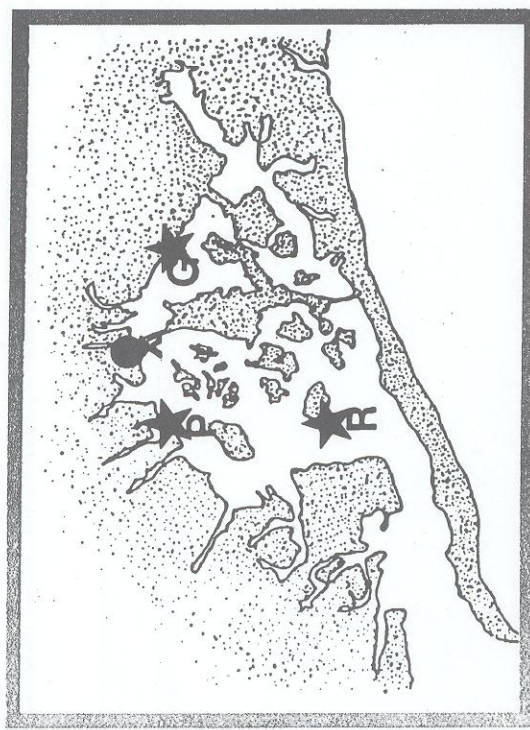


Figure 14. Sampling Sites from Franz and Harris (1985)
Benthos Study in Jamaica Bay



Legend

★ Sediment Sampling Locations

E = Easthampton, Long Island

G = Grassy Bay

P = Pennsylvania Avenue

R = Ruffle Bar

● Animal Collection

X = Cross-Bay Boulevard Bridge

Figure 15. Locations of Sediment Sample Sites
Borowsky et al. (1997)

variability in macrobenthos communities in the bay. Franz (1997) studied resource allocation in an intertidal salt-marsh mussel (*Geukensia demissa*) in relation to shore level. EPA's 1993 and 1994 R-EMAP, along with sediment sampling, included studies of survival rates of *Ampelisca abdita* at 14 stations in 1993 and 1994 (Figure 16). The Harbor Estuary Program (HEP) planned on performing sampling surveys for zooplankton, benthic invertebrates, fish and crustaceans as part of their Contaminant Assessment Reduction Project (CARP) in 1998. A benthic invertebrate study is being initiated in Jamaica Bay as part of a new comprehensive study led by the NPS and funded by DEP and the USACE (Figure 17). The study will include sampling of intertidal macroinvertebrates, interstitial copepods and subtidal benthos. Macroinvertebrates and copepods will be sampled by taking sediment core samples. Subtidal benthos will be sampled by taking grab samples, transect lines perpendicular and parallel to the shore will be surveyed, and slices of *Spartina* marsh habitat will be cut and collected. The issues of sea level rise and other factors involved in wetlands loss is the subject of ongoing investigations by the Metropolitan East Coast Assessment program. The USA Project is coordinating with Columbia University and NASA-Goddard Institute of Space Studies regarding their research efforts on Jamaica Bay.

Surveys of fish in the bay have been irregular. The NPS and U.S. Fish and Wildlife Service (USFWS) conducted a one-year finfish inventory of Jamaica Bay; and in conjunction with this inventory, fish were collected for analysis and a fishing survey was developed (Riepe and Tanacredi, 1988). The NPS performed surveys in Jamaica Bay during 1994 and 1995, and has recently initiated a new study of Jamaica Bay and its tributaries that includes monthly fish trawl surveys and gill netting (Tanacredi, pers. comm. 2000) (Figure 18). The DEC collects finfish data during their annual striped bass survey program, which includes bi-weekly (May-October) seining surveys at eight stations in the bay (Figure 19); and although absolute and relative abundance of fish changes over time, species composition is relatively well known. Surveys were conducted to assess the biological communities of the lower Hudson-Raritan estuary system, which included trawl surveys in Jamaica Bay (Woodhead, 1992). DEC conducted a synoptic survey of PCB, organochlorine pesticide and mercury concentrations in edible fish, bivalves and crustaceans from the New York-New Jersey Harbor, with Jamaica Bay being one of the study sites. The NPS and USFWS conducted histopathological evaluations of winter flounder to assess potential impacts from contaminant inputs to Jamaica Bay (USFWS, 1989). Augspurger et al. conducted this study in 1994 to reassess the 1989 findings of the NPS and USFWS (Figure 20)

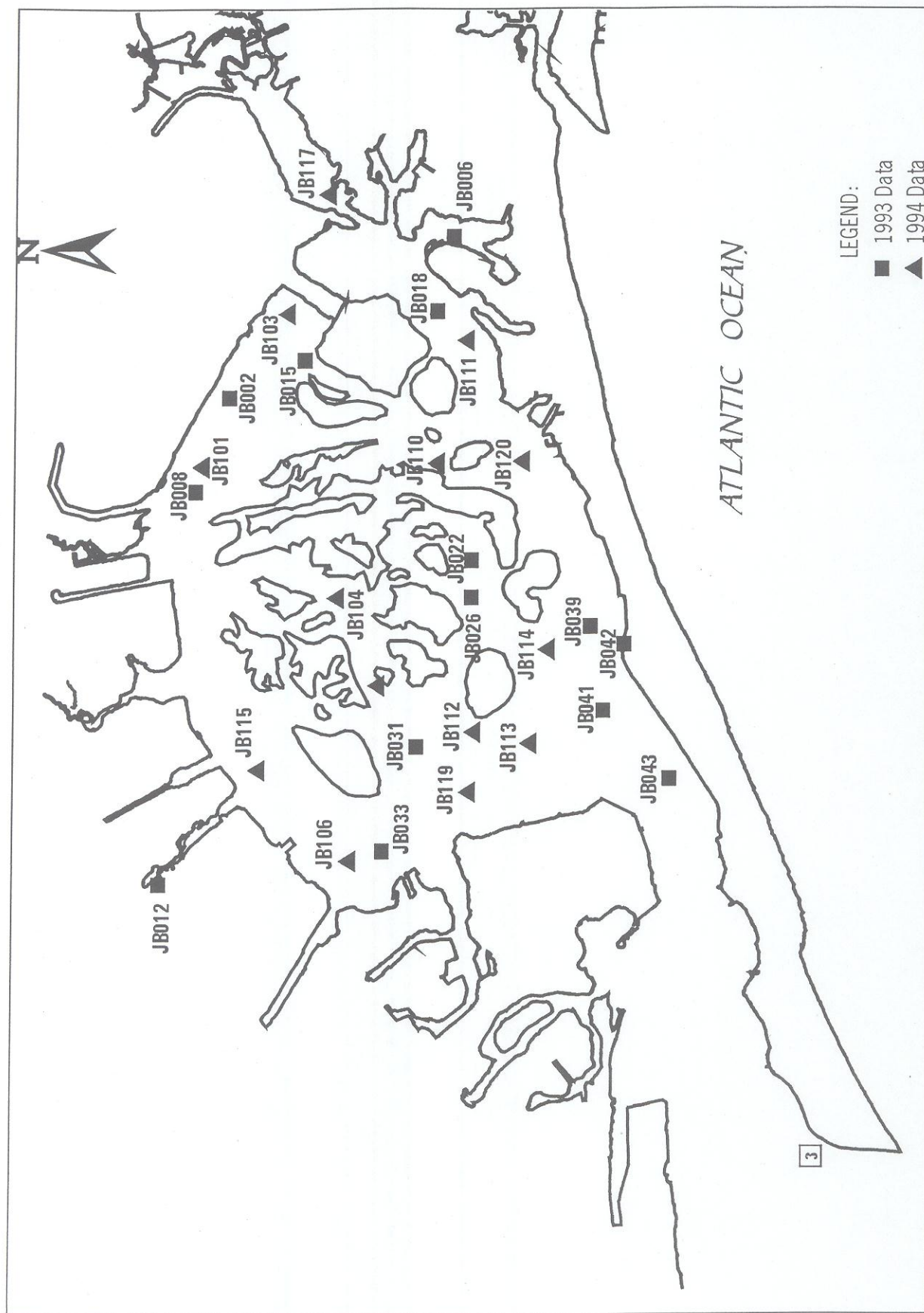


Figure 16. EPA REMAP Sampling Locations
1993 and 1994 Benthic Study in Jamaica Bay

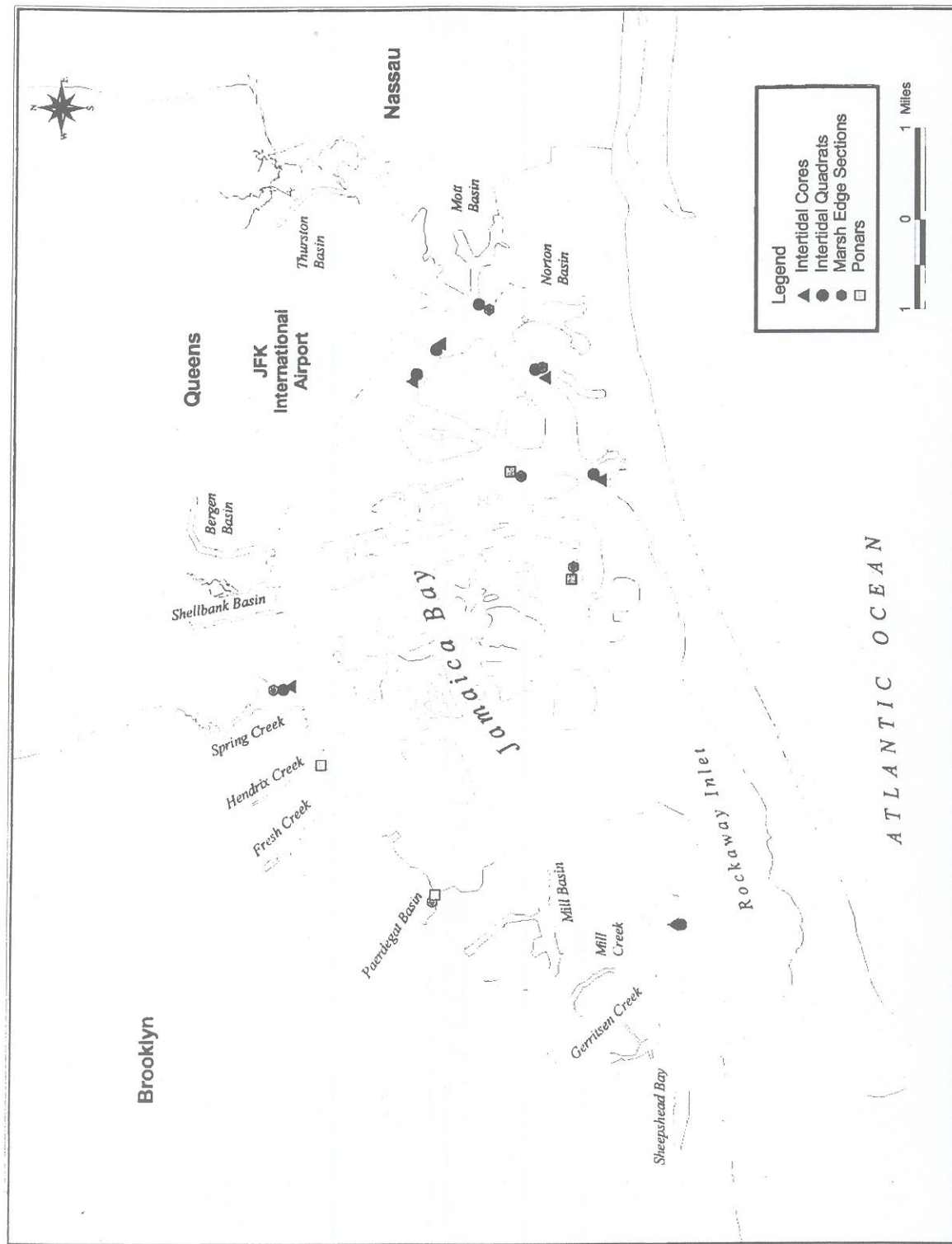


Figure 17. Year 2000 NPS Benthic Studies
 Borowsky and Franz (2000)

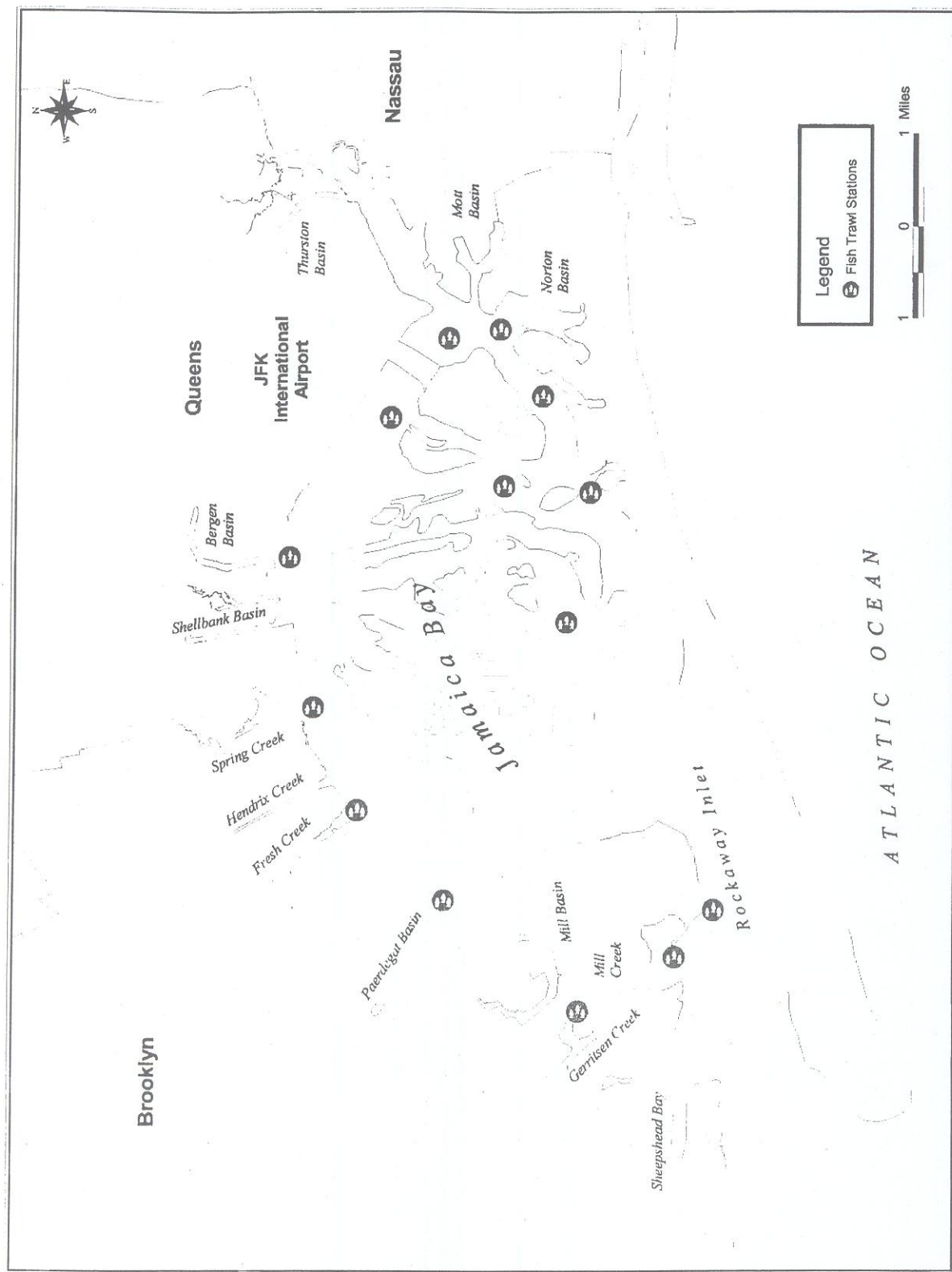


Figure 18. Year 2000
NPS Fish Trawling Sites

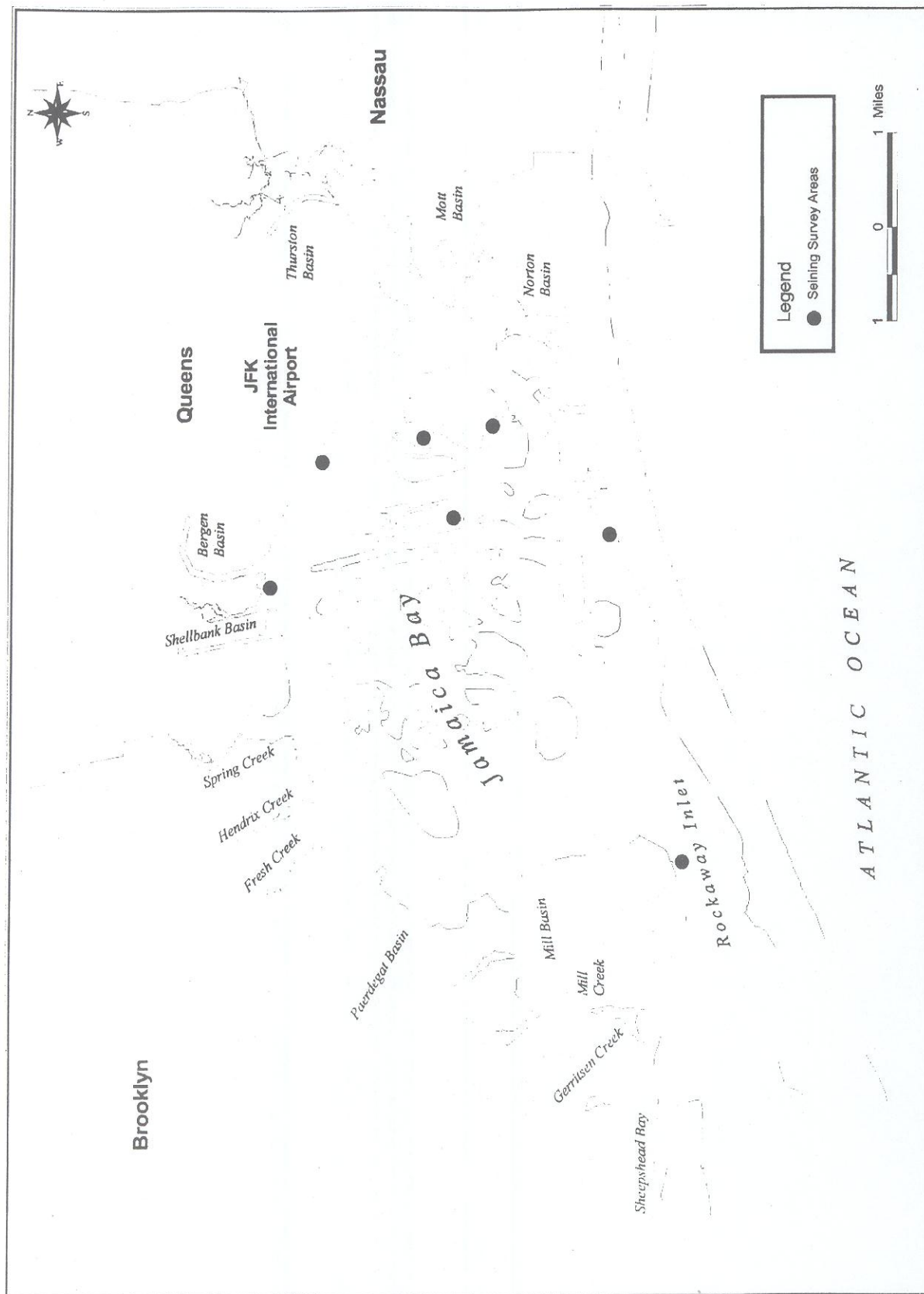


Figure 19. Location of DEC Seining Survey Areas

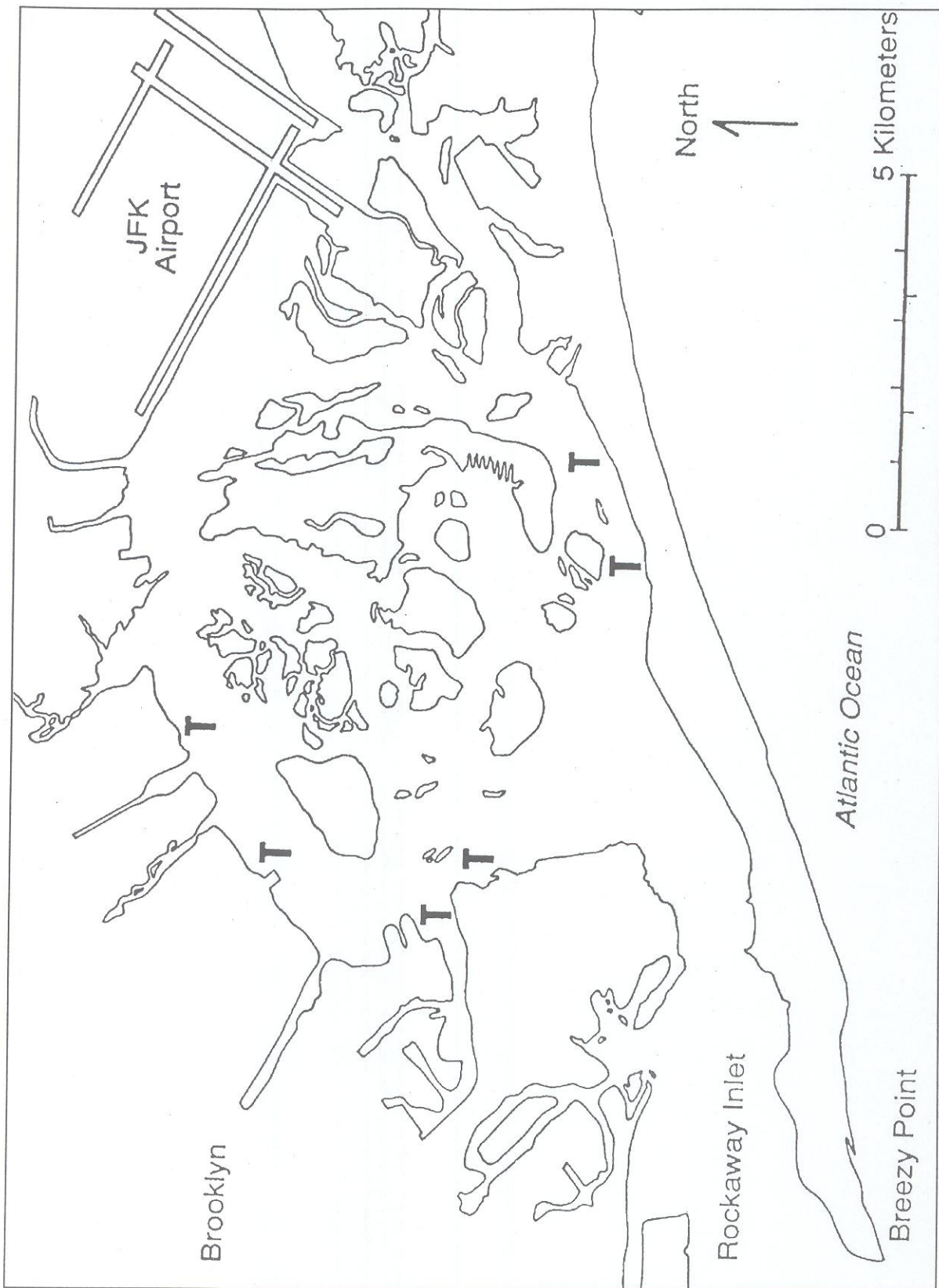


Figure 20. Trawling Locations of Augspurger et al. (1994)
Winter Flounder Survey, Jamaica Bay

2.3 Issues and Data Gaps of Relevance to the USA Project

In this FSAP, a number of issues have been addressed. Salient questions of concern to the USA Project are best dealt with by separating them according to tributaries, or Jamaica Bay proper.

The questions concerning the tributaries of Jamaica Bay, as introduced in the Paerdegat Basin FSAP, are as follows:

- a. Do any fish species (e.g. fluke, bluefish, anchovy) live in the tributaries during summer?
- b. Without accompanying improvement in physical habitat, would implementation of Jamaica Bay CSO facility planning alone be sufficient to create a better environment for fish to be attracted to?
- c. Would any fish species spawn there?
- d. Would physical habitat improvement alone be sufficient to better the tributary's fishing or propagation potential irrespective of present water quality (DO in particular)?
- e. With habitat improvement, are Class I water quality standards (4 mg/L DO) adequate for propagation and survival of representative fish species, or do they need 4.8 mg/L (proposed new EPA saltwater criterion or 5 mg/L (Class SC and SB standards) to succeed? Can winter or spring spawners (e.g. winter flounder) survive and grow even if late spring and early summer spawners (e.g. bay anchovy) may be limited by DO?
- f. Does the whole tributary need to meet larval growth and survival criteria, or would maintenance of standards downstream of some mixing zone suffice?
- g. What is the incremental improvement in the invertebrate food base and in fish propagation and survival resulting from incremental improvements in DO on the basis of the latest EPA research?
- h. Is the tributary a candidate for site-specific criteria?

The questions posed for Jamaica Bay proper are a little bit different, as follows:

- Would any more fish species, or more of the present species, spawn in the bay if it uniformly attained Class SB standards? Is their propagation success, as measured by the density of their eggs and larvae in the water column, any different than that of their tributaries, or same nearby reference waterbodies?
- How important is wetlands loss, or gain?
- Would fish abundance and community diversity increase if USACE site restoration plans (alone) were implemented throughout the bay and its tributaries? Would they increase with implementation of CSO facility plans alone? Would they increase if both site restoration and CSO improvement occurred?
- If Class SA or SB standards (e.g. 5 mg/l DO) were attained, without accompanying physical site restoration, would potentially viable populations of shellfish (hard clams) be enhanced in the bay?
- Is Grassy Bay or other sections of Jamaica Bay a candidate for site-specific DO standards?

To help answer these questions, a variety of physical, chemical and biological data over a range of conditions needs to be examined. In the case of Jamaica Bay proper, the combination of fairly recent DEP CSO facility planning projects and HS monitoring surveys, newly initiated NPS studies, and ongoing DEC seining surveys can be considered to be a fairly strong comprehensive and contemporaneous data base. However, other than the DEC juvenile fish seining studies, no others are directly linked to the subject of fish propagation, and the NPS trawl survey program is not expected to cover the winter/spring period in 2001. NPS benthic and wetland studies will provide valuable data about intertidal habitats at USACE restoration sites, but will not be providing new data about key subtidal areas. In the case of the tributaries, nothing but the HS monitoring survey is being done inside of them. The other studies (i.e. NPS) are focused on benthos and fishes just outside their mouths.

Based on the foregoing, the Jamaica Bay FSAP will be focusing on data gaps related to water quality standards and ecologically limiting factors, including DO and physical habitat, which are

important to fish propagation, growth and survival. Studies of habitat utilization, spawning and food distribution and abundance are included.

3.0 PROPOSED FSAP DESCRIPTION

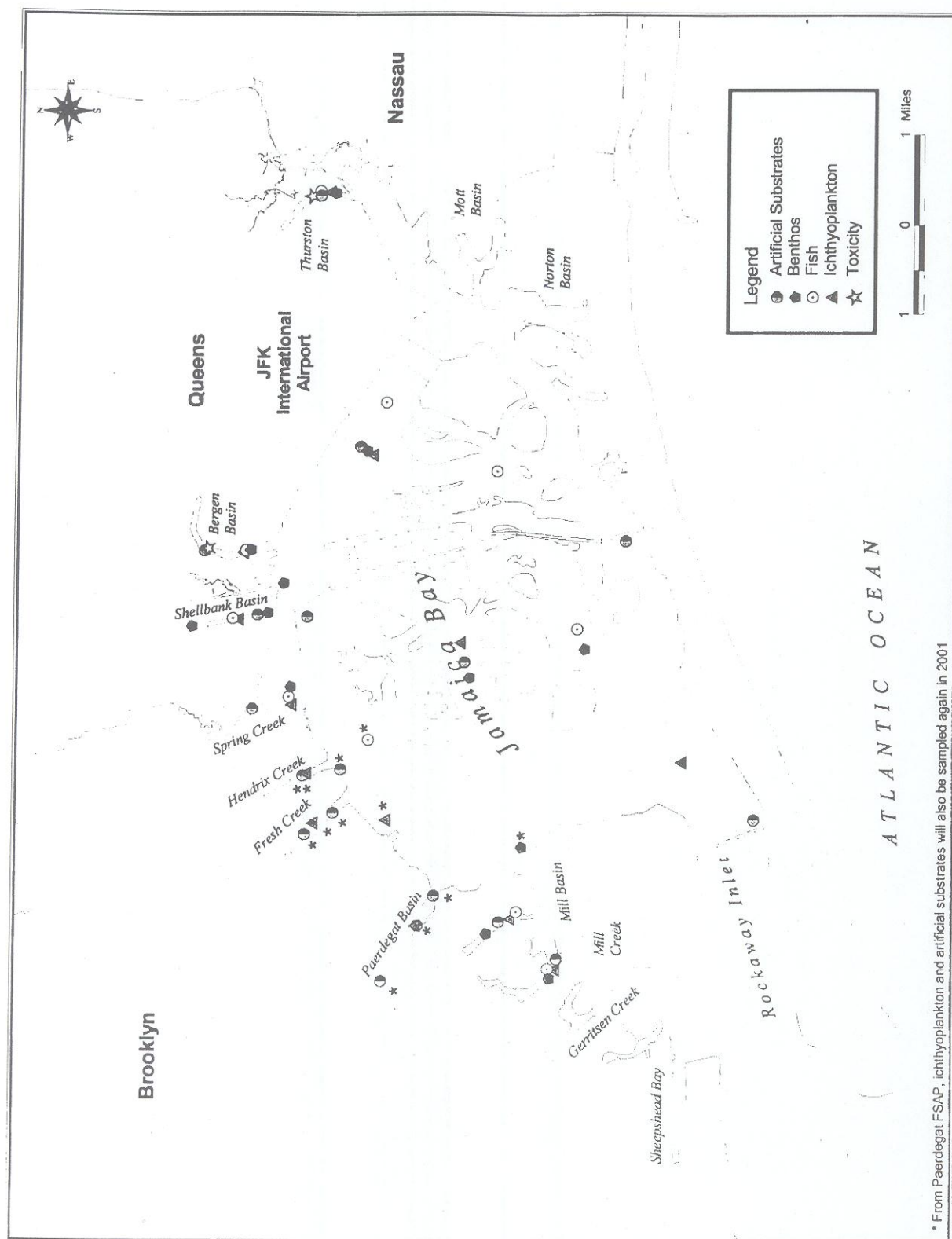
The intent of this FSAP is to define unambiguous objectives with either (1) testable hypotheses and alternative hypotheses (regarding evaluation of limiting factors and prognoses for improvement) or (2) qualitative end points not being addressed by others. Where logical, adoption of the former approach can ultimately provide stakeholders with a more convincing suite of conclusions and recommendations than simple inventories of all possible life forms would provide. This approach involves formulation of a series of objectives stating what is to be accomplished, and, for each objective, clearly defining its purpose relative to USA Project goals; the rationale for selecting a particular type of study; a null hypothesis (H_0) to be tested; and an alternative hypothesis (H_a). The latter delimits the conclusion(s) to be drawn if the former cannot be accepted with some degree of confidence, that is that results were not simply a function of sampling "error" (random noise).

Questions concerning most of these waterbodies, however, require both inventory and hypothesis testing studies. To accomplish the latter, that is to evaluate habitat vs. water quality limitations on aquatic life, comparisons need to be made among various stations. Both intra-basin (i.e. within each waterbody) and inter-basin (among different waterbodies) comparisons are needed. In the case of this FSAP, reference sites in other south shore bays will be established for some sampling programs, and all of the tributaries will serve as the other one's reference sites.

Six objectives have been defined to achieve, in tandem with the DEP's HS and the USACE's site restoration studies, the USA Project goals. Some details are subject to further review and field reconnaissance just prior to initiation of the studies in 2001. Figure 21 displays the general locations of stations to be sampled for each of the objectives discussed in Sections 3.1 through 3.6. Figure 22 provides the sampling schedule.

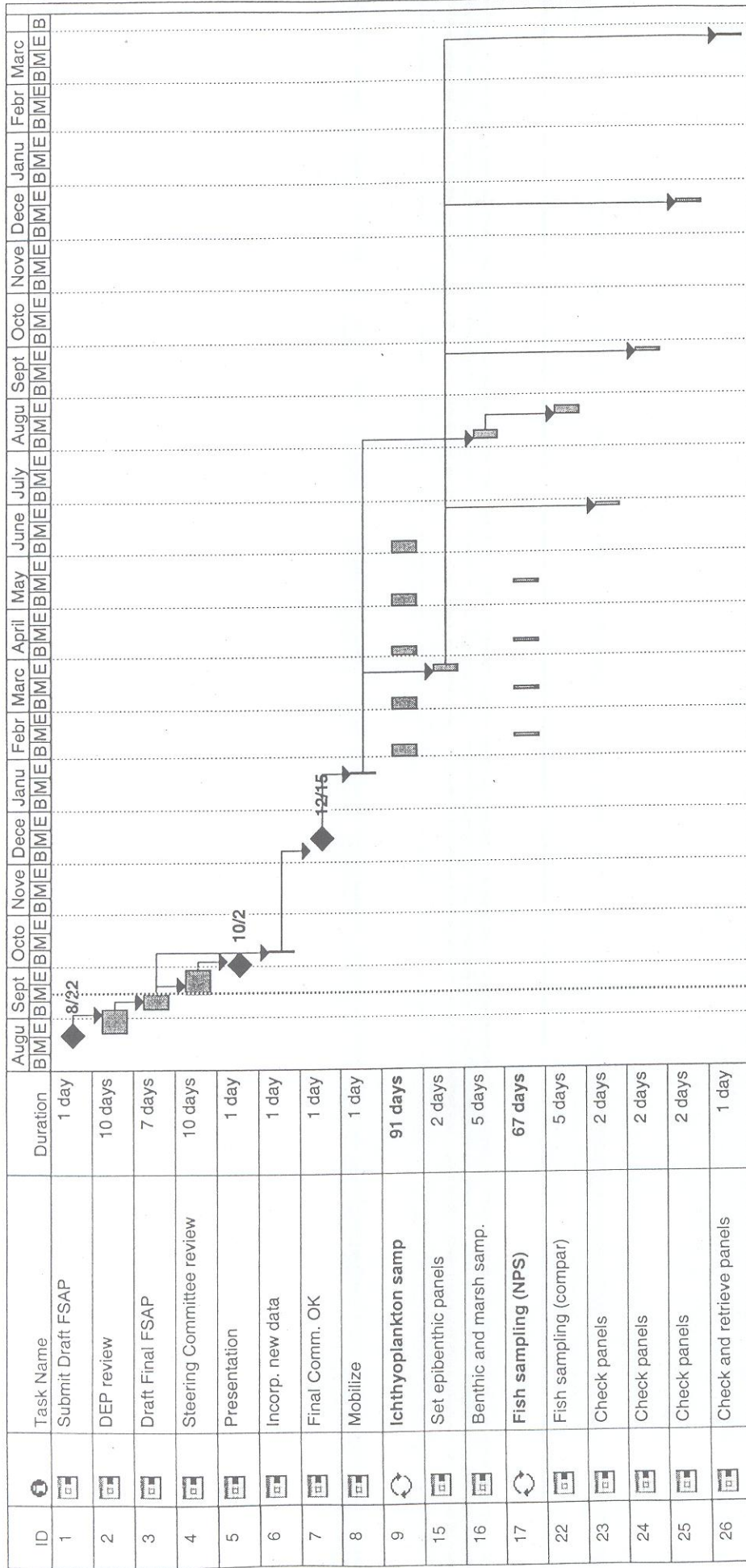
3.1 Objective #1 - Crab and Fish Species Inventory

To inventory crab and fish species presence or absence in Jamaica Bay and its tributaries.



* From Paerdegat FSAP, ichthyoplankton and artificial substrates will also be sampled again in 2001

Figure 21. Proposed Sampling Locations in Jamaica Bay and Tributaries



Task

Split

Progress

Milestone

Summary

Rolled Up Task

Rolled Up Split

Rolled Up Milestone

Rolled Up Progress

External Tasks

Project Summary

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... as to be a Schedule

3.1.1 Statement of Purpose

To determine if crabs and representative species of juvenile and adult fish currently utilize the tributaries and representative areas of Jamaica Bay during summer low DO conditions, and evaluate their relative abundance in comparison to habitat and varying degrees of water quality.

3.1.2 Rationale

Finfish and crabs, being motile organisms, choose which habitats they enter. Most species have distinct preference and avoidance responses to DO concentrations, temperature and turbidity, and their presence or absence can be used to evaluate differences among waterbodies.

3.1.3 Null Hypothesis

Crabs, and similar species of fish, utilize all of Jamaica Bay and its tributaries during summer.

3.1.4 Alternative Hypothesis

More fish and crab species are found in Jamaica Bay during summer.

3.1.5 Sampling Approach

To obtain representative samples of this community, a combination of gear types are used. Trawls, killie and crab pots are used to sample bottom-oriented organisms, whereas gill nets are used to collect fish species distributed throughout the water column. Gill nets, being types of stationary gear which are set overnight for one or more days, must be set and marked (buoys) outside the main navigation areas. This approach should provide a fairly definitive picture of the crab and fish stocks in the subject waterbodies.

- a. Methods and Materials. Killie pots (for forage fish such as killies, or mummichogs) and crab traps will be set and checked daily over a three-day period. A sinking gill net (100 feet x 6 feet) with various mesh sizes in 20-foot panels, would likewise be deployed and checked on each of two successive days. During each day, 400-yard long trawls will be made with a semi-balloon 20-foot mouth otter trawl. All organisms will be photographed, identified, counted, weighed, measured and inspected for

external diseases or parasites in the field, and live organisms will be returned to the water.

- b. Stations. Nine: one each inside of East Mill and Mill Basins, Spring Creek, Bergen Basin, Thurston Basin, and (if possible) Shellbank Basin; and three in Jamaica Bay.
- c. Depths. Gill nets will be suspended as close to the shore as possible to allow three feet of open water above the float (top) line. Pots and traps will be set in shallow waters below the intertidal mark, and otter trawling will be performed in channel areas away from active marinas or other docking facilities.
- d. Corollary Data. Water temperature, salinity, turbidity, and DO
- e. Schedule. August, 2001.

3.1.6 Lab Analysis

Not applicable.

3.1.7 Data Reduction and Analyses

Tabular and/or graphic representation of species presence, numbers, catch per unit effort, and relative abundance; length- and weight-frequency histograms; and Chi-square (C_2) tests of presence among sites.

3.2 Objective #2 - Winter and Spring Bay Fisheries

To describe the fish community of Jamaica Bay during winter and spring 2001.

3.2.1 Statement of Purpose

To determine what species of finfish utilize Jamaica Bay from February through June.

3.2.2 Rationale

The USA Project requires documentation of fish species utilization of Jamaica Bay. The NPS is doing this from July through December 2001, but their program ends in December. Since some species overwinter in the bay and/or use it for spawning (e.g. winter flounder), this objective is designed to continue that effort, at selected NPS stations.

3.2.3 Null Hypothesis

Not applicable.

3.2.4 Alternative Hypothesis

Not applicable.

3.2.5 Sampling Approach

NPS is using trawls to sample for finfish in Jamaica Bay. Though their trawls are not exactly the same as those used in the USA Project, representative and relatively comparable samples can be obtained to ascertain distribution and abundance of finfish in the bay.

- a. Methods and materials. 400-yard long trawls will be made with a semi-balloon 20-foot mouth otter trawl. All organisms will be photographed, identified, counted, weighed, measured and inspected for external diseases or parasites in the field and live organisms will be returned to the water. Type species will be preserved and made available to the NPS fisheries biologist.
- b. Stations. Four (see Figure 21)
- c. Corollary Data. Water temperature, salinity, turbidity and DO.
- d. Schedule. February through June 2001.

3.2.6 Lab Analysis

Not applicable.

3.2.7 Data Reduction and Analyses

Tabular and/or graphic representation of species presence, numbers, catch per unit effort, and relative abundance; length- and weight-frequency histograms; and Chi-square (C_2) tests of presence among sites.

3.3 Objective #3 - Spawning

To describe the ichthyoplankton communities throughout Jamaica Bay and its tributaries, as well as those of selected reference areas.

3.3.1 Statement of Purpose

To determine what, if any, species of fish expected to spawn in tidal waters of New York Harbor actually do so, and relatively how successful they are in each of the 23 USA Project waterbodies.

3.3.2 Rationale

Sampling of ichthyoplankton is one way to gauge existing fish propagation function in the different waterbodies. To best compare results, recognizing that (1) spawning activity and success may vary considerably between years, and (2) all 23 USA Project waterbodies will ultimately involve ichthyoplankton studies, this objective has been structured to sample representative areas of all of those waterbodies within the same year. Interpretation of results will naturally need to consider differences in spawning habitat preferences of the species, and tidal and current transport, but contemporaneous sampling in a single year will at least help reduce year class variability in fish egg and larvae density caused by differences in spawning stock abundance and/or environmental differences among years. This objective deals with Jamaica Bay and its tributaries, but, as defined in a separate "Ichthyoplankton Sampling FSAP" all methods and materials and results, will be coordinated in a single winter/spring sampling program (2001).

3.3.3 *Null Hypothesis*

Species composition and abundance of ichthyoplankton does not differ among New York Harbor waterbodies.

3.3.4 *Alternative Hypothesis*

Composition and diversities of fish eggs and larvae differ among waterbodies based on habitat and/or water quality (i.e. Jamaica Bay $\neq$ tributaries and reference sites; tributaries $\neq$ from each other).

3.3.5 *Sampling Approach*

To sample ichthyoplankton, fine mesh nets with flowmeters are towed through the water column. Organisms collect in a small container at the end of the net, and flowmeter readings are used to calculate the density of fish eggs and larvae in the water column sampled. Tow duration and number of replicates may be varied to obtain accurate and precise estimates of densities, and mesh size may be varied as a function of clogging and escapement.

- a. Methods and Materials. 0.75-meter diameter metered plankton net with 363 mm mesh.
- b. Stations. Two (2) replicates taken in: Grassy Bay (at JFK pier), Rockaway Inlet (at Marine Park), Big Fishkill Channel, DEP Pier (already included in Paerdegat Basin FSAP); Thurston, Shellbank, Bergen, and Mill (X2) Basins; Paerdegat Basin, Fresh and Hendrix Creeks (covered by Paerdegat Basin FSAP); and reference stations in Broad Channel (behind Long Beach), Middle Bay (behind Lido Beach) and Gould Inlet (behind Jones Beach).
- c. Depths. Oblique tows, mid-channel, open water stations; horizontal tows in tributaries.
- d. Corollary Data. Water temperature, salinity, DO and turbidity (Secchi depth).
- e. Schedule. Daytime; once per month; March, May and July (mid-reach stations in tributaries), and March through June (open waterbodies), 2001.

3.3.6 Lab Analysis

Samples will be preserved, labeled and sent to a qualified laboratory for identification and enumeration of taxa (lowest practicable taxa) present in the samples. All lab data will be recorded in terms of raw organism counts (number per sample or subsample) and number/m³ of water filtered.

3.3.7 Data Reduction and Analyses

Tabulations of taxa and number/m³, cluster analysis (Jaccard Coefficient) of presence/absence, correlation between abundance vs. DO over all sites, one-way ANOVA of densities among sites.

3.4 Objective #4 - Subtidal Sediment Communities

To determine benthic invertebrate community composition, species richness (S), and diversity (H) in subtidal sediments inside Jamaica Bay tributaries and compare them with (a) those of waterbodies that have substandard DO but better substrate, and (b) those of sites with similar substrate but higher DO concentrations.

3.4.1 Statement of Purpose

To evaluate whether the infaunal benthic invertebrate community is more limited by (a) physical habitat, or (b) DO concentrations in the water column.

3.4.2 Rationale

Infaunal benthic invertebrates, being relatively sessile and therefore incapable of moving from place-to-place when water quality conditions change, are good indicators of water quality impacts given that the required habitat (i.e. substrate) is available. The number of taxa and the numbers of individuals per taxa at one site can be related to habitat and/or water quality based on comparisons to other sites sharing some attributes but not others (e.g. good water quality/inferior substrate and vice versa).

3.4.3 *Null Hypothesis*

Species richness (S) and diversity (H) at sites with better (cleaner, more consolidated) substrates are higher, but S and H in similar substrates are not significantly different (i.e. not water quality-limited).

3.4.4 *Alternative Hypothesis*

S and H at sites with similar waterbody DO conditions are not significantly different; S and H at sites with similar substrates are higher at sites with higher DO concentration.

3.4.5 *Sampling Approach*

To sample the benthic infauna, a ponar sampler is typically used. With this sampler, the tool is lowered onto the substrate in an open position and then sprung so as to enclose a representative sample of the substrate and whatever organisms are colonizing it (typically worms, small clams, and amphipods). Clam tongs or epibenthic dredges (sleds) are commonly used to sample larger organisms, like hard clams and crabs, and evaluate their distribution and abundance. The choice of locations to sample, and the number of samples to collect, is a function of the habitat variety (heterogeneity) available for colonization. The greater the heterogeneity (e.g. in bottom types), the more the sampling approach needs to be stratified (i.e. segmented into areas of like substrate) so as to be able to sort out sources of variation in S and H. To be confident of getting accurate and precise estimates of these parameters, and to test the hypotheses, enough samples must be collected within each sampling stratum to account for organism patchiness and/or random variation in their distribution and abundance.

- a. Methods and Materials. The Young modification of the ponar sampler (0.025m² ponar with a frame around it for support on soft sediments) and clam tongs will be used to sample benthic infauna.
- b. Stations. A series of stations, from head to mouth, in each tributary (Mill Basin, E. Mill Basin, Spring Creek, Shellbank Basin, Bergen Basin and Thurston Basin) will be visually examined for texture, odor and animal life. If these are the same as sediments already sampled in Paerdegat Basin, Fresh Creek and Hendrix Creek, grain size and TOC will be measured but samples will not be sent to the labs for invertebrate

- a. Methods and Materials. 8-inch diameter artificial plate arrays suspended in the water column from available docks, or buoyed and anchored in open waters. Each array will include short- (3-month) and long- (6-, 9- and 12-month) plates. At each quarterly interval, the appropriate plate(s) will be retrieved, bagged with preservative, and returned to the lab for identification of organisms.
- b. Stations. Artificial substrate arrays will be placed in each of the remaining tributaries, thereby completing the universe of sampling stations in northern Jamaica Bay tributaries and providing direct comparisons of short-term colonization of winter and spring at stations already established in the Paerdegat Basin FSAP. In Jamaica Bay, new substrate arrays will also be deployed at the JFK pier; the Cross Bay bridge (north and south ends); Big Fishkill Creek; and the south end of Marine Parkway. Reference stations will be established at Austin Boulevard (to Long Beach); Meadowbrook Parkway (to Jones Beach); and Wantagh Parkway (near South Oyster Bay).
- c. Depths. Near surface and near bottom, depending on total depth available.
- d. Corollary Data. HS bi-monthly water quality tributary sampling; water quality field measurements during panel deployment and retrieval (temperature, salinity and DO).
- e. Schedule. Deploy arrays in March 2001, and retrieve appropriate panels in late June, September and December.

3.5.6 Lab Analysis

Surface area coverage of each plate covered by encrusting organisms will be calculated by use of a grid line system. Plates will be scraped of organisms and segregated by taxa. Utilizing a stereomicroscope, each taxonomic group will be further sorted, picked, and identified to species or lowest practical identification level (LPIL). Biomass of major taxonomic groups will be determined by recording wet weight after blotting. Data will be entered into spreadsheet format. A type collection will be maintained.

3.5.7 Data Reduction and Analyses

Similar to Objective #3.

3.6 Objective #6 - Bay Marshes

To assess present wetlands accretion or loss rates in Jamaica Bay.

3.6.1 Statement of Purpose

The purpose of this objective is to assess the impact of sea level rise on intertidal wetland loss within Jamaica Bay. Recent studies conducted by the Metropolitan East Coast Assessment program support the perception that, in addition to a long-term loss of wetlands over the last century, there has been recent and continuing loss of intertidal wetland area in Jamaica Bay. More work is needed to quantify the spatial extent of wetland surface area change and local rates of accretion or erosion.

3.6.2 Rationale

Wetland (intertidal marshes + freshwater wetlands) surface area within the Jamaica Bay region has declined 75% since the turn of the century, much of this due to dredging, filling and development. Modern estimates of surface area, over the past two decades, suggest continued loss of marsh habitat within the interior marsh islands of Jamaica Bay. Yet, such habitats play important roles as fisheries nursery grounds and sources of food, as well as influencing water quality (nutrient content, clarity). The interior marshes of the bay, without riverine inputs of suspended solids, must rely upon their own productivity and accumulation of peat in order to keep pace with erosional forces and inundation imposed by documented sea level rise of approximately 2.7 mm/yr now occurring within the region. Long-term accretion rates, measured with radiotracers (i.e. ^{210}Pb) over time scales of approximately 100 years, have suggested that some marsh locations within the bay can maintain themselves against this rate of sea level rise. Short-term accretion rates (over time scales of 1-10 years), using physical markers (aluminum foil, feldspar particles), will be needed to assess current conditions.

Besides local sea level rise, however, other factors may influence erosion of marsh faces on the interior marsh islands. Wave energy, ice formation and scour, boat wakes and dredging/channel deepening may lead to marsh loss on exposed shorelines.

3.6.3 Null Hypothesis

Erosion and loss of marsh area is locally determined by exposure to wave action, as induced by prevailing winds and by boat traffic.

3.6.4 Alternative Hypothesis

Erosion and loss of marsh area is regionally similar across Jamaica Bay marshes and is the result of local sea level rise rates exceeding marsh accretion rates.

3.6.5 Sampling Approach

Field activities will be executed at several island salt marsh locations within Jamaica Bay, and will encompass both near-shoreline marsh faces and marsh interiors. Locations will be stratified based on their degree of exposure to wave action (windward versus leeward marsh edges; proximity to boat traffic and channels).

Short-term accretion rates will be determined, using physical markers (aluminum foil, feldspar particles) to assess present conditions. Such measurements will be performed at several island salt marsh locations within Jamaica Bay, including near-shoreline and marsh interiors. Locations will be stratified based on their degree of exposure to wave action (windward versus leeward marsh edges; proximity to boat traffic and channels). Deployment of physical markers will occur in October 2000. Coring and recover of sediments for marker depth analysis will occur in 2002. Presence/absence and depths of physical markers (foil or feldspar particles) will be recorded. Cores of marsh sediments will be taken from the study sites. Short-term rate determinations may be supplemented by radiotracer analyses to compare short-term versus long-term measurement of accretion. Qualitative assessment of shoreline slopes at the leading edge of marshes and along interior channels will also be used to assess erosion.

Regional scale analysis of the change in spatial extent of wetland, such as with aerial photographic time series, is being performed by other studies (notably, the Metropolitan East Coast Assessment); results from those programs will be used to add a regional-scale context to this sampling work.

3.6.6 Lab Analysis

Lab analysis to be determined.

3.6.7 Data Reduction and Analyses

Results will be analyzed to infer accretion or erosion rates. If performed, profiles of ^{210}Pb activity will be determined from sediment cores by alpha spectrometry to infer long-term accretion rates.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

Detailed Quality Assurance/Quality Control (QA/QC) procedures have been developed in conjunction with design of field survey forms and instructions. Details are presented in a Standard Operating Procedure (SOP) manual (HydroQual, 2000), but QA/QC includes the following basic elements:

- project organization chart identifying responsible personnel,
- field and lab methods and materials, including standard operating procedures, equipment maintenance requirements, etc.,
- QA objectives and criteria, including data quality objectives,
- sample custody procedures,
- calibration procedure and preventative maintenance,
- documentation, data reduction and reporting,
- performance and system audits, and
- corrective action procedures.

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