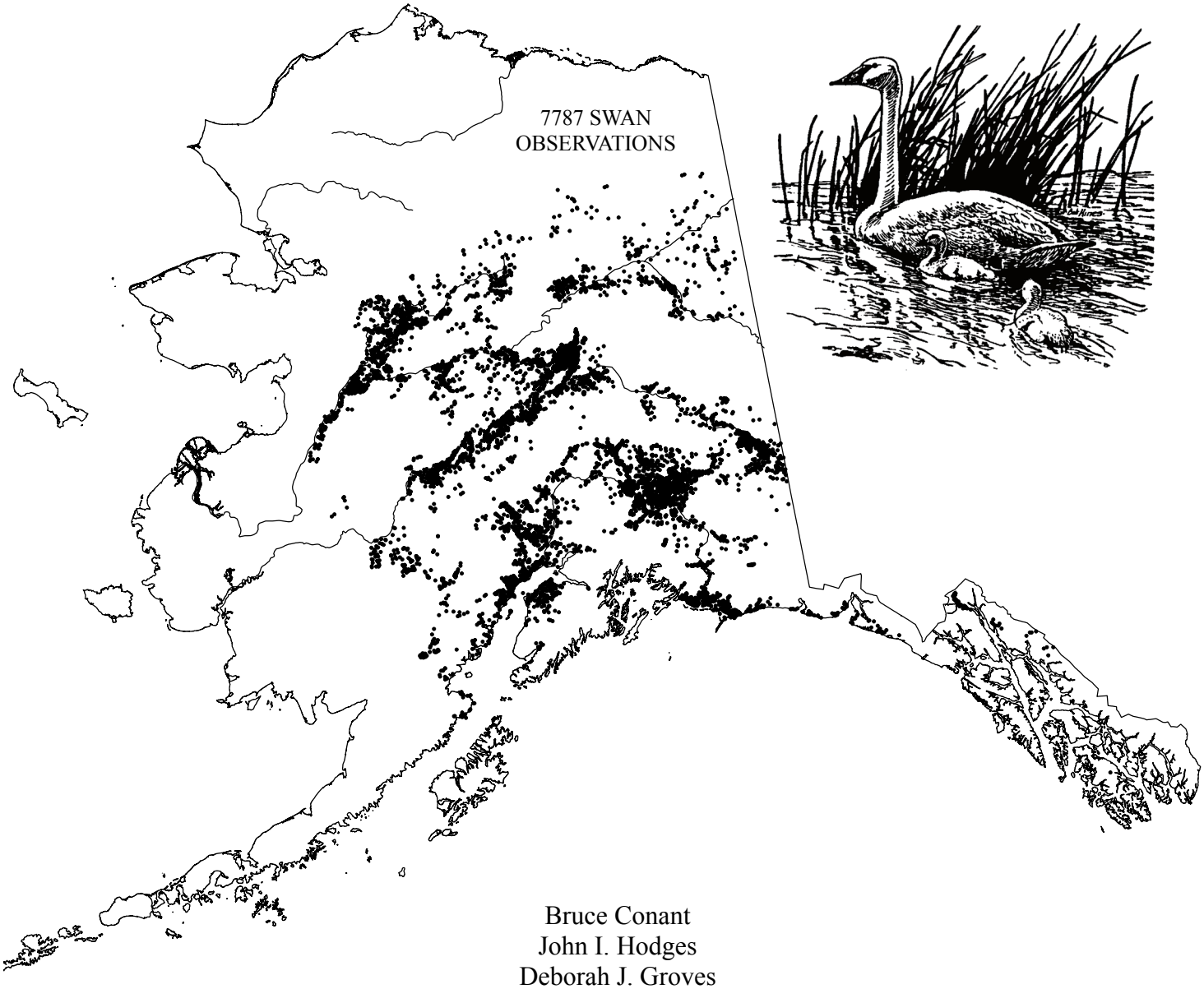
ALASKA
TRUMPETER SWAN STATUS REPORT
2005



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WATERFOWL MANAGEMENT
U.S. FISH AND WILDLIFE SERVICE
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THE 2005 CENSUS OF TRUMPETER SWANS ON ALASKAN NESTING HABITATS

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ABSTRACT

The eighth complete census of Trumpeter Swans (Cygnus buccinator) on their Alaska summering grounds was completed in late summer 2005. This year 1040 hours of flight time was expended by many survey crews to fly about 124,000 km of survey tracks (84,829 km in 2000) over all the potential Trumpeter swan habitat 128,332 km^2 in 2005 (123,864 km^2 in 2000) depicted on 780 (733 in 2000) USGS, 1:63,360 scale maps. Compared to 2000 the population was comprised of: paired birds 11940 (+20%); singles 1157 (+29%); flocked birds 4148(+36%); total white swans 17245 (+24%); cygnets 6447 (+100%); and total swans 23692 (+38%). Cygnets accounted for 27% of the population (19% in 2000) and 2084 broods (+81% from 1149 in 2000) were found with an average brood size of 3.1 (2.8 in 2000). Although the population of white phase Trumpeters summering in Alaska continues to follow a logistic growth curve, a comprehensive Alaska Trumpeter Swan Management Plan is still needed to ensure that they remain an integral part of each geographical unit of their present distribution. The continual loss of Pacific coast wintering habitat and the recent large losses of Pacific coast wintering swans to lead poisoning are of special concern. In Alaska a complete census every five years is recommended until the Alaska summering population stabilizes to provide the high quality data needed for the best management of this magnificent international resource.

INTRODUCTION

The U. S. Fish and Wildlife Service (USFWS) conducted complete censuses of Trumpeter Swan (Cygnus buccinator) summer populations in Alaska in 1968, 1975, 1980, 1985, 1990, 1995, 2000 and 2005 (Hansen et al. 1971, King 1976, King and Conant 1981, Conant et al. 1986, Conant et al. 1991, Conant et al. 1997, Conant et al. 2002). Because of the projected increase in the summer population, many survey crews and aircraft were needed at the outset to ensure completion of the 2005 census. A total of 1140 hours of flight time was expended to fly about 124,000 km of survey tracks over all the potential Trumpeter Swan summer habitat in Alaska (128,325 km^2).

SURVEY AREAS

A total of 780 U. S. Geological Survey (USGS) 1:63,360 scale quadrangle maps were censussed in 11 delineated Trumpeter Swan nesting areas in Alaska (Figure 1). Most of these 11 units were separated on the basis of significant geographical features such as large drainages and mountain ranges.

METHODS

The survey was initiated on 20 July and terminated on 8 September. The primary survey aircraft used were a specially-modified, turbine-powered de Havilland Beaver, Cessna 206's and 185's, Found Bushhawks and Piper Supercubs. The aerial survey technique used small aircraft to put observers over all known or suspected Trumpeter Swan summer habitat (King 1973). Generally, a system of parallel tracks was flown within each USGS 1:63,360 scale quadrangle at an altitude of 150-180 m above ground. Each survey crew consisted of a pilot-biologist and one primary observer. The pilot-biologist was responsible for navigation, searching for swans, and ensuring that all swan habitat was adequately surveyed, considering factors such as sun glare and observer experience. The primary observer recorded the flight path (when paper maps were used), searched for swans, and recorded the observations by type, number, and precise location. In a few cases where non-biologist pilots did the flying, all of these duties were performed by the primary observer. Most crews used a combination of an onboard computer, software, and a global positioning system (GPS) to record the swan data and the flight path. Several crews used a custom computer program, developed by John Hodges, that allowed the observer to record the location and attributes of each observation onto a moving digital 1:63,360 scale USGS topographic map, which was continuously displayed on the computer screen. The program also recorded the survey flight track automatically via a connection to the aircraft's GPS unit and displayed this on the screen as well. A few crews used their own combinations of hardware and software to record the data and flight track digitally, while the remaining crews recorded the data and track by hand onto USGS 1:63,360 paper maps.

After the survey, all digitally-recorded data were converted to a standard comma-delimited ASCII format, and location coordinates were projected to one common coordinate system (geographic coordinates, North American 1927 datum). Data and flight tracks that were recorded on paper maps were transcribed and digitized into digital format and combined with the remaining data set. The final data set was archived in the Alaska Swan Data Base in Juneau, from which summary tables, charts, graphs, and distribution maps of any scale can be easily produced.

RESULTS

The eight complete, state-wide Trumpeter censuses show how the population of white swans (birds more than one year old) has increased in size (Table 1, Figures 2 and 3). Singles plus paired birds and the subtotal for all white swans best show this sustained population growth (Figure 4).

Continued expansion of Trumpeters into the peripheral habitat (Units 5 and 7 through 11) is shown in Table 1 and Figures 3 and 5.

Trumpeter Swan production as measured in late summer is summarized in Table 2 for the eight census years. Above average production in 2005 is indicated by the values for the total number of cygnets and the total number of broods which both increased from 2000.

The trend in numbers of white swans recorded for the eight statewide counts varies by unit (Figure 5). Generally, the expansion of swans into peripheral habitat is best shown by the increase in the

amount of habitat surveyed for units 6-11. Increases in the density of swan numbers since 1975 is demonstrated by the increase in the numbers of white swans recorded in units 1, 3, and 4-11.

Appendix I contains statewide maps showing the increase, distribution and patterns of all swan observation points for all eight census years for easy comparison.

Appendix II gives a comparison of the distribution patterns by unit of all swan observation points for 2000 and 2005.

Appendix III gives examples of mapping products that are available from the Alaska Swan Data Base.

Appendix IV is a copy of the survey protocol.

Appendix V lists all participants of the 2005 Alaska Trumpeter Swan Census.

DISCUSSION

The summering population of Trumpeter Swans continues to increase in Alaska. This continued growth is best reflected by the increase in white swans recorded since 1968 (Figures 2-5). In the last census in 2000 we thought we were starting to see a leveling off of the white swan component. Thus we were surprised to see a large proportional increase in the numbers of white swans recorded in 2005. The large number of broods seen with an average rate of production added a record number of cygnets to the total population.

Obviously, the population increase can not be sustained indefinitely, but it is still not apparent when the total summering population in Alaska will stabilize or perhaps reverse. We thought that the habitat was saturated with swans in the Gulf Coast (unit 1), Kenai (unit 4) and Cook Inlet (unit 5) areas in 2000. Thus we were surprised by the increases noted in those units. For other areas various rates of increase have occurred (Figure 3). There appears to be a large (approximately 23,000 km^2) amount of summer habitat available on the Yukon Flats (unit 9) which is just starting to become occupied (numbers of white swans here nearly doubled again from 2000). The density of swan use in some of the apparent best habitat is still increasing (Kuskokwim-unit 7, Koyukuk-unit 8, southeast mainland-unit 10 and the upper Tanana-unit 11). Peripheral habitat is still being pioneered noticeably in the Lower Tanana (unit 6), Kuskokwim (unit 7), Koyukuk (unit 8), and Upper Tanana (unit 11) areas.

The scientific evidence that global warming is occurring (and particularly in Alaska) is increasing. More summering habitat yet may become available and the population increase may be sustained for some unknown period of time. Past or future limiting factors are not readily apparent although there is continual loss of wintering habitat. Of note is this measured increase in spite of large losses to lead poisoning on the wintering grounds of southwestern British Columbia and northwestern Washington. Additional analyses of these data currently underway and population modeling for survival rates may increase our understanding.

A factor which may be slowing and could ultimately reverse the present trend is the exclusion of swans from good habitat by human appropriation and disturbance, especially on the rapidly urbanizing wintering grounds in the Pacific Northwest. This obviously has happened to some of the swan habitat on the breeding grounds in the Cook Inlet (unit 5) area. There, swans are being displaced from good lake and pond habitat because of recreational use (Timm and Wojeck 1978). Despite this displacement, prior to 1985 (and perhaps in 2005) the population increased due to the ability of Trumpeters to utilize beaver ponds and marshy areas not yet selected by people. Since 1985, the population failed to follow the population growth curve evident in most other similar units until 2005. Perhaps we are seeing evidence of Trumpeters to better accommodate human disturbance. As the human population in Alaska also increases and becomes more mobile, the loss of swan habitat will accelerate. A rapidly expanding tourist industry presents an additional challenge for effective swan conservation in Alaska. A comprehensive Trumpeter Swan management plan is still needed for Alaska summering habitat as well as for the Pacific wintering grounds. Trumpeters should be allowed to flourish and remain an integral part of the avifauna of each geographical unit of their present distribution throughout their range for their intrinsic value and the benefit of people.

Although the amount of area censussed within the Trumpeter summer range in Alaska continues to increase (number of maps surveyed: 1968 - 177; 1975 - 278; 1980 - 306; 1985 - 425; 1990 - 625; 1995 - 674; 2000 – 733, 2005 - 780), that factor is not the primary reason for the increase in the numbers of swans recorded. Personnel conducting state-wide swan surveys have over the years been involved with other detailed waterfowl surveys and hence knew where any significant expansion of the summer swan population was occurring. The main factors responsible for the population increases were the increase in density on the previously censussed high quality habitat (Gulkana and Lower Tanana units) as well as the expansion of swan range into peripheral habitat (Upper Tanana, Kuskokwim and Yukon Flats units). Although the rate of increase was surprising, the pattern of expansion of habitat use was expected. It resulted from a rapidly increasing population (Figures 2, 3 and 4), the consequence of a number of recent years of good production.

Alaska hosts nesting populations of both Trumpeter and Tundra Swans (Cygnus columbianus) during the summer. The Trumpeter Swan census in Alaska is geographically based on general habitat type. All swans sighted during the census are plotted. Species are not differentiated from the air. In Alaska Trumpeters mostly summer in the south coastal and interior boreal forest and taiga habitat while Tundra Swans summer mainly on the western and northern coastal tundra. There is some overlap of these habitats and the range of both species. There are an unknown but probably small number of Trumpeters outside the Trumpeter census area and some Tundra Swans within it. Populations of both Trumpeter and Tundra Swans are growing and the amount of overlap is probably increasing. This census probably does not miss many Trumpeters but does include some Tundra Swans. Limited observations from the ground and helicopters have suggested that only the Koyukuk (unit 8) contains substantial numbers of Tundra Swans during the survey periods. More ground and/or helicopter studies are needed to determine the percent of Tundra Swans included and Trumpeters omitted in this and other units.

The census is an exhaustive attempt to find and plot on maps all swans present, but an unknown proportion was missed. Although swans are easily seen from the air, poor light, pilot and observer fatigue, poor weather conditions, dense vegetative cover, and other factors can cause swans to be

missed. The increased use of onboard computers increased the amount of time observers were able to look for swans and reduced survey fatigue. It is believed that the proportion missed is less than 10 percent of the total present. Repetitive air surveys, perhaps using a helicopter and/or ground study, could help evaluate the number of swans missed on a single fixed-wing air survey. An indication of potential under counting was obtained this year with the accidental double survey of one 1:63,360 scale map. Two surveys of this map occurred within one day of each other. One survey crew found 95 white and 30 cygnets while the other crew tallied 130 white and 42 cygnets. It is unknown, however, whether the difference was due to visibility bias or to movement of birds into or out of the area.

The custom computer program developed by John Hodges allowed more survey crews to enter observations directly into onboard computers. Simultaneously an accompanying global positioning system of navigation automatically recorded the aircraft flight track. These crews accomplished more than half of the flying in this year's census. It increased the efficiency, accuracy and ease of gathering vast amounts of geographically based swan observations.

Aircraft type and survey timing can affect the results of aerial surveys for swans (Spindler et al. 2000). They found that some detection rates varied with aircraft type and that during month long surveys swans exhibit increased flocking behavior. More studies are needed in other areas to better evaluate the complete census results. All eight censuses to date have been conducted in a similar sequence from year to year. Many different aircraft were used in the first attempt in 1968 and in the last four in 1990, 1995, 2000 and 2005. However, it is our belief that the population growth rate is not due to improved equipment or coverage.

Despite these concerns, it is practical to monitor Trumpeter Swan populations in Alaska with this census method. All swan data collected using the survey protocol is easily archived in the Alaska Swan Data Base and is directly comparable to data from previous surveys. The completeness of the georeferenced census data allows us to produce accurate swan distribution maps for any area within the Trumpeter's Alaska summer range. This has proven invaluable to wildlife managers and land-use planners evaluating potential impacts of human development and disturbance on waterfowl habitat in a large portion of Alaska.

We hope those wishing to continue or start collecting standardized Trumpeter population data will contribute to the digital storage system. A detailed data-collecting protocol has been developed (Appendix IV) and is also available upon request. A continued complete census every five years is recommended, at least until the Alaska summering population stabilizes, in order to maintain the continuity of this impressive data set for the better management of this magnificent international resource.

ACKNOWLEDGMENTS

Over half of the strenuous flying was provided by USFWS wildlife pilots Bruce Conant, John I. Hodges, William L. Larned, Ed Mallek and Paul Anderson of the Waterfowl Management (WM) Branch; and Rodney J. King and Karen S Bollinger of the Migratory Bird Management Office (MBMO). Most of the remainder was flown by wildlife pilots in the National Wildlife Refuge

(NWR) division of the USFWS and the U. S. National Park Service (USNPS). A private air charter service was utilized in one area where there were lower densities of swan numbers. Dedicated pilots and observers in the following organizations made completion of this census possible. These include: USFWS - WM/Anchorage, WM/Fairbanks, WM/Juneau, Koyukuk NWR, Kanuti NWR, Tetlin NWR, Yukon Flats NWR, Arctic NWR, MBMO/Mare Island, CA, MBMO/Laurel, MD, USNPS, U. S. Forest Service (USFS) Yakutat Ranger Districts. Logistic support was provided by the Koyukuk NWR of the USFWS, Gulkana Management Office of Bureau of Land Management (BLM) and USFS - Cordova Ranger District. Funding support was provided by Denali National Park and the Anchorage Field office of the BLM. Bruce Conant, Deborah Groves and Ed Mallek organized and coordinated the census. Deborah Groves served as a primary observer on one survey crew and post-processed all of the survey data. John I. Hodges developed the original transcribing and digitizing programs for paper map data as well as the new moving map/data entry program used in the aircraft. This census would not have been possible without the enthusiastic support of these individuals in the Alaska Regional Office of the USFWS: Rowan Gould-Regional Director, Doug Alcorn-Assistant Regional Director/Migratory Birds and State Programs, Russ Oates-Chief/WM, Robert Leedy-Chief Migratory Bird Management/Migratory Bird Coordinator and Todd Logan-Regional Chief National Wildlife Refuge System.

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Table 1. Summary of Trumpeter Swans from censuses during August-early September, by census unit in Alaska for 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

Unit	Year	White Swans in Pairs	White Swans as Singles	White Swans in Flocks	Total White	Cygnets	Total Swans
1 Gulf Coast	1968	442	29	191	662	363	1,025
	1975	442	32	190	664	193	857
	1980	586	52	266	904	351	1,255
	1985	778	76	440	1,294	164	1,458
	1990	666	59	205	930	434	1,364
	1995	628	72	295	995	150	1,145
	2000	754	58	230	1,042	314	1,356
	2005	800	85	474	1,359	459	1,818
2 Copper Canyon	1968	56	5	53	114	44	158
	1975	56	2	72	130	49	179
	1980	70	4	33	107	33	140
	1985	74	8	108	190	11	201
	1990	88	7	0	95	21	116
	1995	76	7	15	98	21	119
	2000	68	7	12	87	25	112
	2005	56	3	33	92	24	116
3 Gulkana	1968	288	31	81	400	190	590
	1975	556	43	155	754	284	1,038
	1980	1,026	42	632	1,700	660	2,360
	1985	1,736	143	595	2,474	533	3,007
	1990	2,142	225	776	3,143	778	3,921
	1995	2,332	280	965	3,577	1,002	4,579
	2000	2,520	280	683	3,483	503	3,986
	2005	2,440	252	510	3,202	1,228	4,430
4 Kenai	1968	86	3	27	116	65	181
	1975	72	5	29	106	39	145
	1980	90	12	8	110	65	175
	1985	92	5	40	137	51	188
	1990	114	5	7	126	78	204
	1995	130	11	29	170	79	249
	2000	200	15	34	249	105	354
	2005	282	20	91	393	172	565
5 Cook Inlet	1968	224	19	50	293	124	417
	1975	340	36	60	436	181	617
	1980	608	38	186	832	369	1,201
	1985	800	66	454	1,320	241	1,561
	1990	904	79	162	1,145	516	1,661
	1995	838	91	269	1,198	330	1,528
	2000	938	57	219	1,214	331	1,545
	2005	1,470	196	310	1,976	694	2,670
6 Lower Tanana	1968	224	21	94	339	137	476
	1975	518	21	185	724	388	1,112
	1980	746	16	585	1,347	773	2,120
	1985	1,202	113	426	1,741	503	2,244
	1990	2,070	179	559	2,808	1,072	3,880
	1995	2,268	219	987	3,474	1,315	4,789
	2000	2,788	227	1,026	4,041	901	4,942
	2005	3,054	305	1,040	4,399	1,786	6,185

Table 1 continued. Summary of Trumpeter Swans from censuses during August-early September, by census unit in Alaska for 1968, 1975, 1980, 1985, 1990, 1995, and 2005.

Unit	Year	White Swans in Pairs	White Swans as Singles	White Swans in Flocks	Total White	Cygnets	Total Swans
7 Kuskokwim	1968	--	--	--	--	--	--
	1975	20	6	4	30	7	37
	1980	60	0	22	82	63	145
	1985	122	0	62	184	55	239
	1990	386	21	141	548	233	781
	1995	454	42	134	630	248	878
	2000	662	40	177	879	226	1,105
	2005	1,016	69	338	1,423	535	1,958
8 Koyukuk	1968	--	--	--	--	--	--
	1975	94	6	45	145	35	180
	1980	124	4	27	155	104	259
	1985	206	23	29	258	45	303
	1990	366	40	86	492	133	625
	1995	524	56	158	738	228	966
	2000	772	80	162	1,014	248	1,262
	2005	950	104	467	1,521	460	1,981
9 Yukon Flats	1968	--	--	--	--	--	--
	1975	2	0	0	2	1	3
	1980	2	0	0	2	4	6
	1985	10	0	0	10	3	13
	1990	66	8	22	96	56	152
	1995	200	26	107	333	90	423
	2000	412	35	173	620	129	749
	2005	632	40	374	1,046	324	1,370
10 S.E. Mainland	1968	--	--	--	--	--	--
	1975	2	0	0	2	0	2
	1980	6	0	3	9	11	20
	1985	16	1	7	24	16	40
	1990	34	1	23	58	50	108
	1995	58	2	18	78	61	139
	2000	64	4	24	92	70	162
	2005	76	10	56	142	70	212
11 Upper Tanana	1968	--	--	--	--	--	--
	1975	--	--	--	--	--	--
	1980	6	1	4	11	4	15
	1985	84	14	43	141	64	205
	1990	220	23	58	301	224	525
	1995	438	53	207	698	310	1,008
	2000	808	96	309	1,213	369	1,582
	2005	1,164	73	455	1,692	695	2,387
Total	1968	1,320	108	496	1,924	923	2,847
	1975	2,102	151	740	2,993	1,177	4,170
	1980	3,324	169	1,766	5,259	2,437	7,696
	1985	5,120	449	2,204	7,773	1,686	9,459
	1990	7,056	647	2,039	9,742	3,595	13,337
	1995	7,946	859	3,184	11,989	3,834	15,823
	2000	9,986	899	3,049	13,934	3,221	17,155
	2005	11,940	1,157	4,148	17,245	6,447	23,692

Table 2. Summary of Trumpeter Swan production from censuses during August-early September, by census unit in Alaska for 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

Unit	Year	Number of Cygnets	Number of Broods	Average Brood Size	Percent Juvenile	Number of Pairs	Percent Pairs w/ Broods
1 Gulf Coast	1968	363	93	3.9	35	221	41
	1975	193	61	3.2	23	221	27
	1980	351	99	3.5	28	293	33
	1985	164	57	2.9	11	389	14
	1990	434	125	3.5	32	333	37
	1995	150	57	2.6	13	314	18
	2000	314	99	3.2	23	377	25
	2005	459	141	3.3	25	400	35
2 Copper Canyon	1968	44	13	3.4	28	28	39
	1975	49	16	3.1	27	28	57
	1980	33	10	3.3	24	35	29
	1985	11	3	3.7	5	37	8
	1990	21	9	2.3	18	44	20
	1995	21	7	3.0	18	38	18
	2000	25	7	3.6	22	34	21
	2005	24	7	3.4	21	28	21
3 Gulkana	1968	190	52	3.7	32	144	36
	1975	284	93	3.1	27	278	33
	1980	660	194	3.4	28	513	36
	1985	533	191	2.8	18	868	22
	1990	778	276	2.8	20	1,071	25
	1995	1,002	310	3.2	22	1,166	26
	2000	503	187	2.7	13	1,260	14
	2005	1,228	393	3.1	28	1,220	31
4 Kenai	1968	65	21	3.1	36	43	49
	1975	39	15	2.6	27	36	42
	1980	65	19	3.4	37	45	42
	1985	51	16	3.2	27	46	35
	1990	78	23	3.4	38	57	40
	1995	79	29	2.7	32	65	42
	2000	105	35	3.0	30	100	34
	2005	172	52	3.3	30	141	36
5 Cook Inlet	1968	124	36	3.4	30	112	29
	1975	181	61	3.0	29	170	36
	1980	369	103	3.6	31	304	34
	1985	241	85	2.8	15	400	21
	1990	516	157	3.3	31	452	34
	1995	330	107	3.1	22	419	25
	2000	331	105	3.2	21	469	22
	2005	694	216	3.2	26	735	28
6 Lower Tanana	1968	137	42	3.3	29	112	33
	1975	388	112	3.5	35	259	42
	1980	773	202	3.8	36	373	54
	1985	503	179	2.8	22	601	29
	1990	1,072	336	3.2	28	1,035	32
	1995	1,315	426	3.1	27	1,134	37
	2000	901	340	2.7	18	1,394	24
	2005	1,786	607	2.9	29	1,527	39

Table 2 continued. Summary of Trumpeter Swan production from censuses during August-early September, by census unit in Alaska for 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

Unit	Year	Number of Cygnets	Number of Broods	Average Brood Size	Percent Juvenile	Number of Pairs	Percent Pairs w/ Broods
7 Kuskokwim	1968	--	--	--	--	--	--
	1975	7	3	2.3	19	10	30
	1980	63	16	3.9	43	30	53
	1985	55	18	3.1	23	61	30
	1990	233	68	3.4	30	193	34
	1995	248	71	3.5	28	227	30
	2000	226	81	2.8	20	331	24
	2005	535	186	2.9	27	508	35
8 Koyukuk	1968	--	--	--	--	--	--
	1975	35	16	2.2	19	47	34
	1980	104	36	2.9	40	62	55
	1985	45	16	2.8	15	103	13
	1990	133	50	2.7	21	183	26
	1995	228	85	2.7	24	262	31
	2000	248	104	2.4	20	386	26
	2005	460	163	2.8	23	475	33
9 Yukon Flats	1968	--	--	--	--	--	--
	1975	1	1	1.0	33	1	100
	1980	4	1	4.0	67	1	100
	1985	3	1	3.0	23	5	20
	1990	56	18	3.1	37	33	55
	1995	90	25	3.6	21	100	25
	2000	129	51	2.5	17	206	25
	2005	324	103	3.1	24	316	32
10 S.E. Mainland	1968	--	--	--	--	--	--
	1975	0	0	--	--	1	--
	1980	11	2	5.5	55	3	67
	1985	16	3	5.3	40	8	38
	1990	50	10	5.0	46	17	59
	1995	61	19	3.2	44	29	66
	2000	70	22	3.2	43	32	69
	2005	70	22	3.2	33	38	50
11 Upper Tanana	1968	--	--	--	--	--	--
	1975	--	--	--	--	--	--
	1980	4	1	4.0	27	3	33
	1985	64	19	3.4	31	42	45
	1990	224	53	4.2	43	110	48
	1995	310	82	3.8	31	219	37
	2000	369	118	3.1	23	404	28
	2005	695	194	3.6	29	582	33
Total	1968	923	257	3.6	32	660	37
	1975	1,177	378	3.1	28	1,051	35
	1980	2,437	683	3.6	32	1,662	40
	1985	1,686	588	2.9	18	2,560	23
	1990	3,595	1,125	3.2	27	3,528	31
	1995	3,834	1,218	3.1	24	3,973	30
	2000	3,221	1,149	2.8	19	4,993	22
	2005	6,447	2,084	3.1	27	5,970	34
Average				3.2	26		32

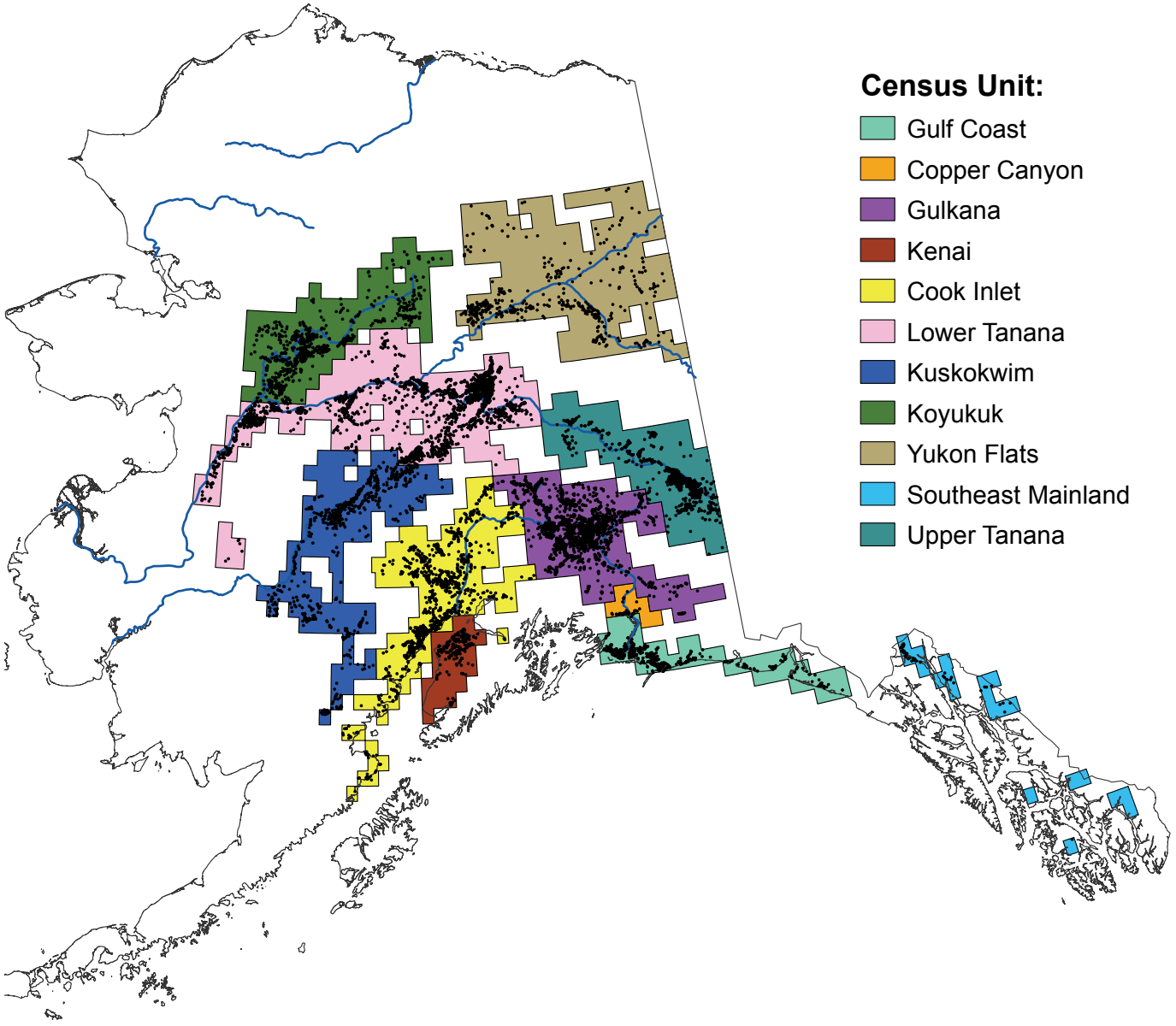


Figure 1. Trumpeter Swan summering areas in Alaska within 780 USGS 1:63,360 maps censused in 2005. Each of the 7787 points represents a swan observation.

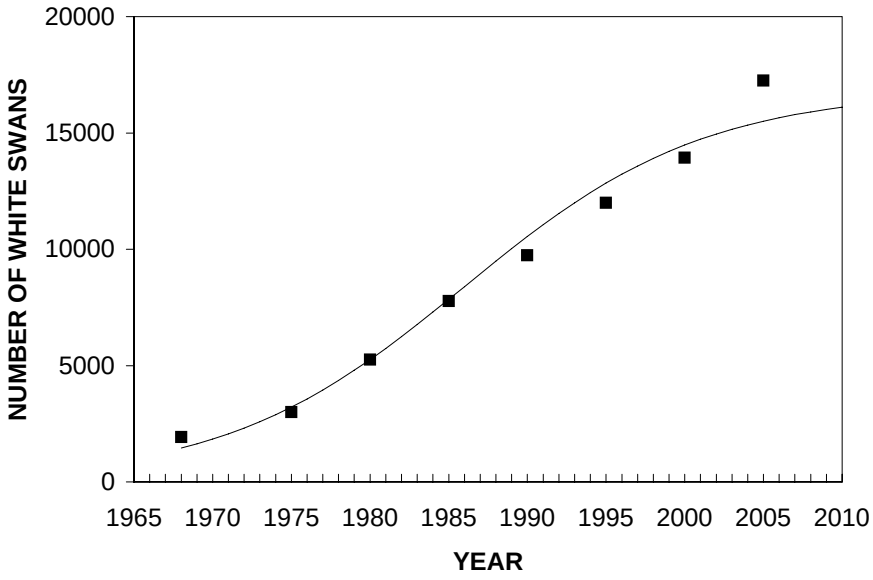


Figure 2. Numbers of white phase Trumpeter Swans with a fitted growth curve, from statewide summer censuses in 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

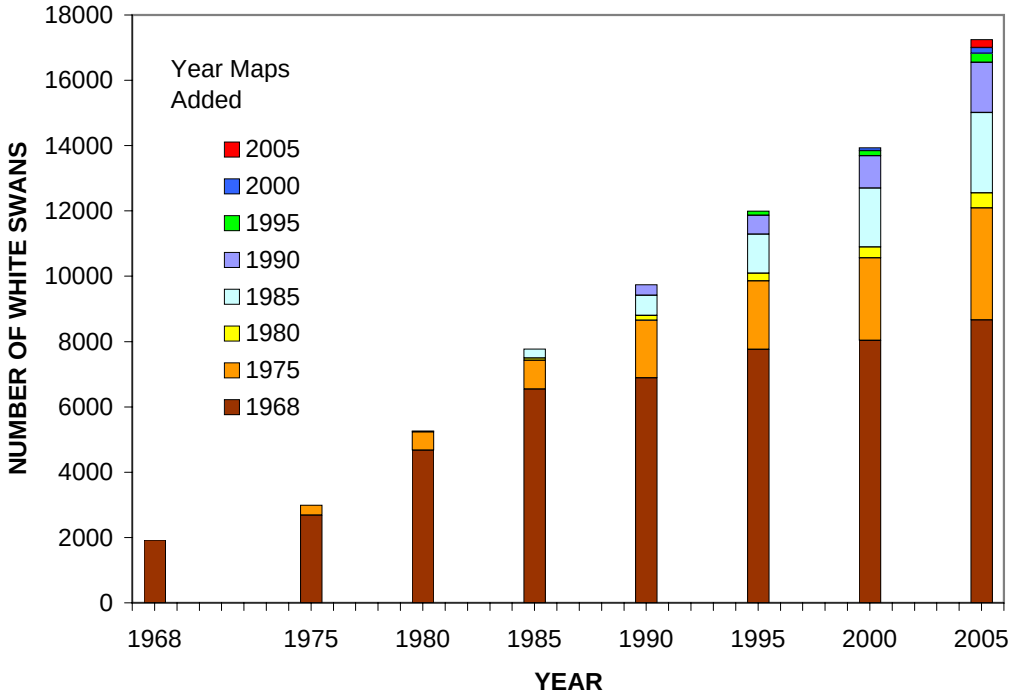


Figure 3. Growth in the number of white-phase Trumpeter Swans, 1968-2005. The survey area was expanded each census year with the addition of new maps. The number of swans recorded on these maps in succeeding years are represented by individual colors.

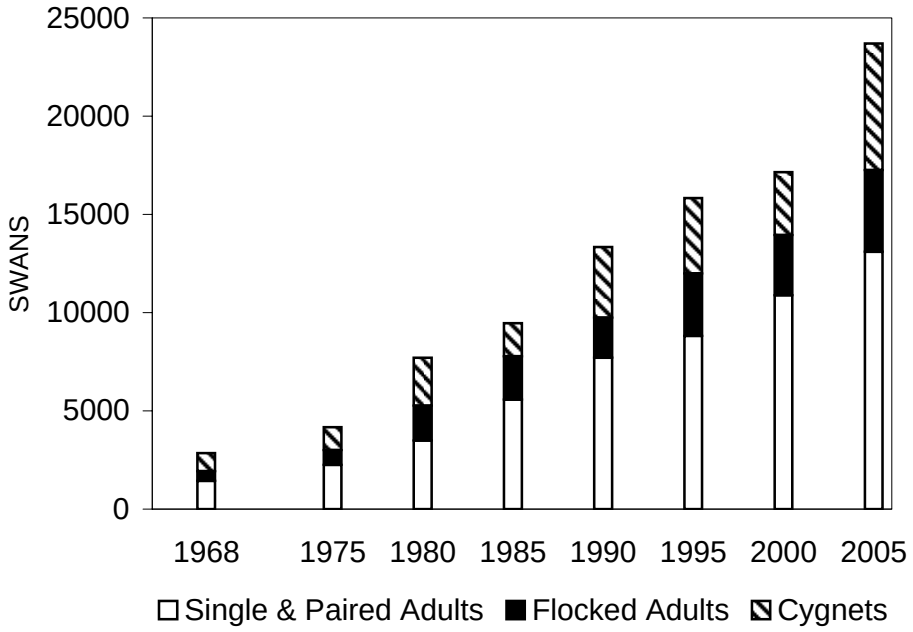


Figure 4. The numbers of Trumpeter Swans recorded in Alaska during state-wide summer censuses for 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

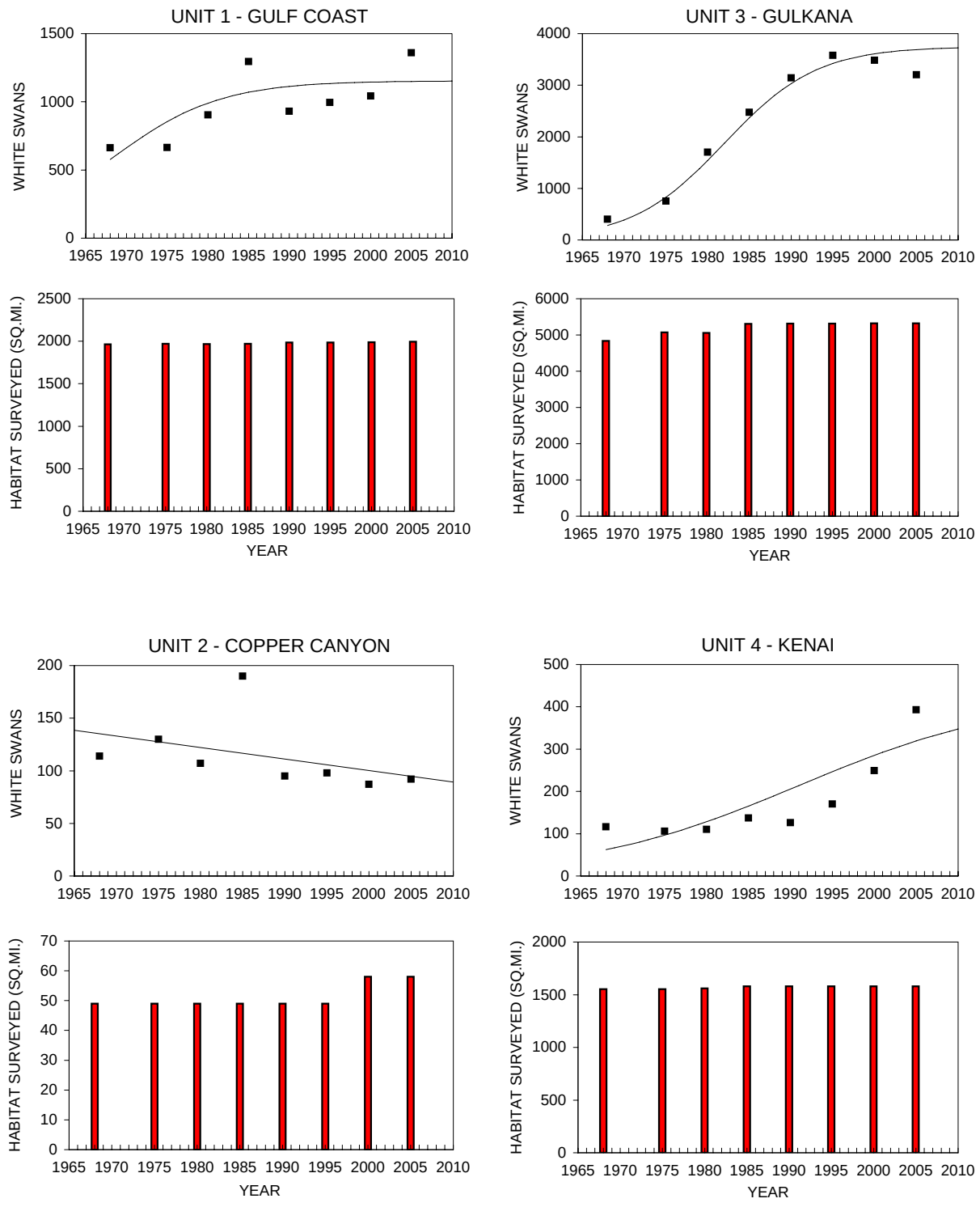


Figure 5. Numbers of white phase Trumpeter Swans recorded by unit with fitted growth curves and compared to the amount of habitat (sq. mi.) censused in 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

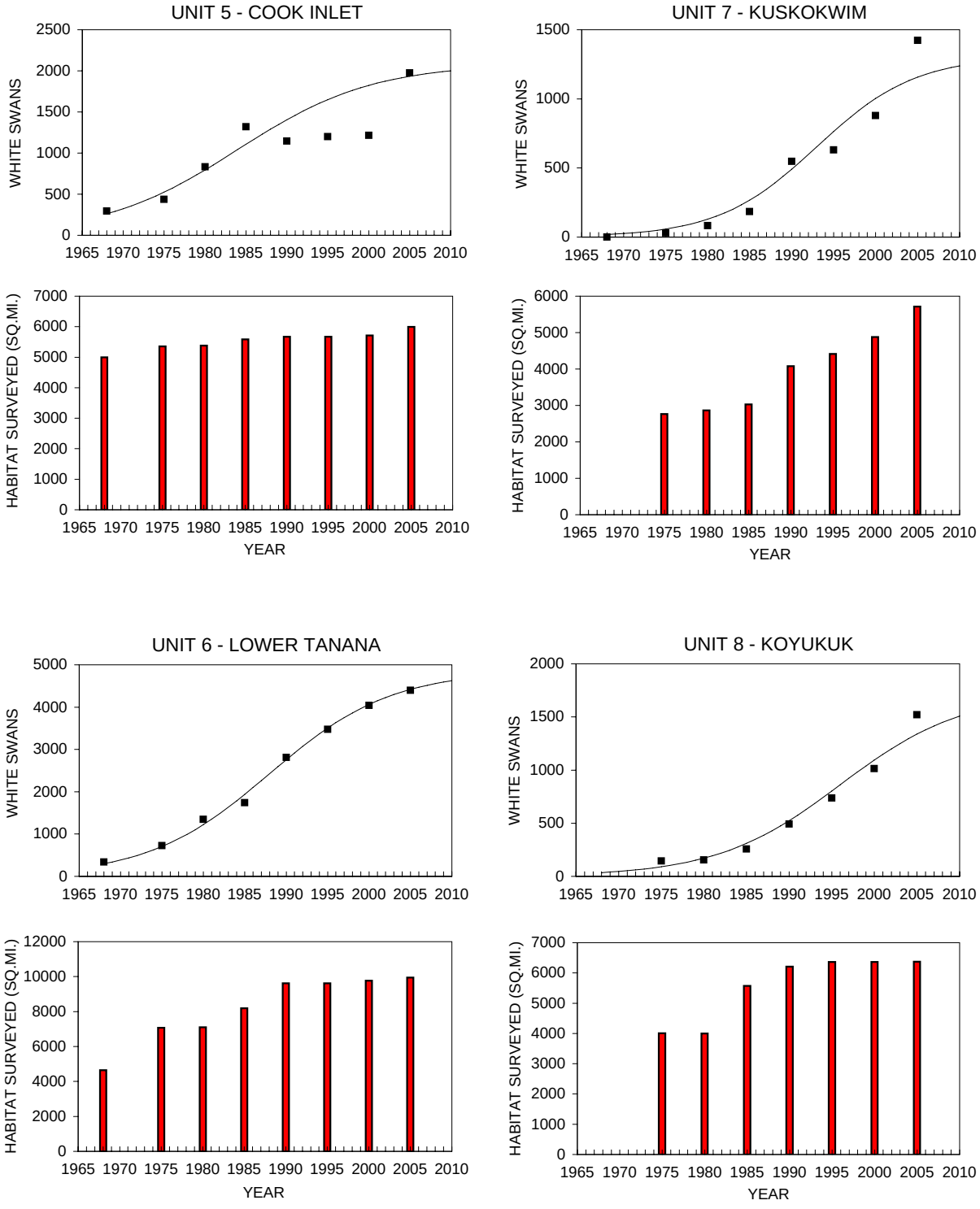


Figure 5 continued. Numbers of white phase Trumpeter Swans recorded by unit (5-8) with fitted growth curves and compared to the amount of habitat (sq. mi.) censused in 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

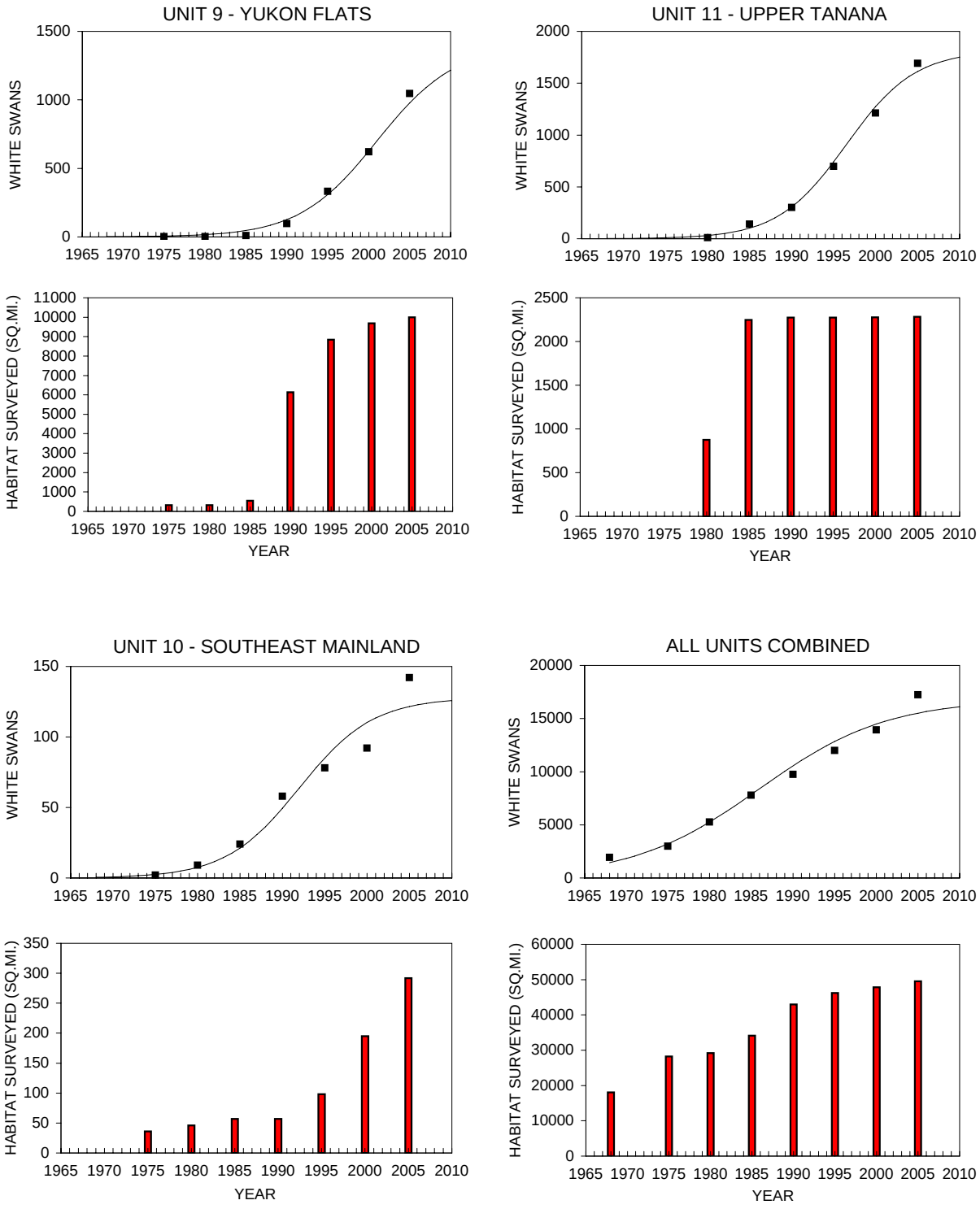
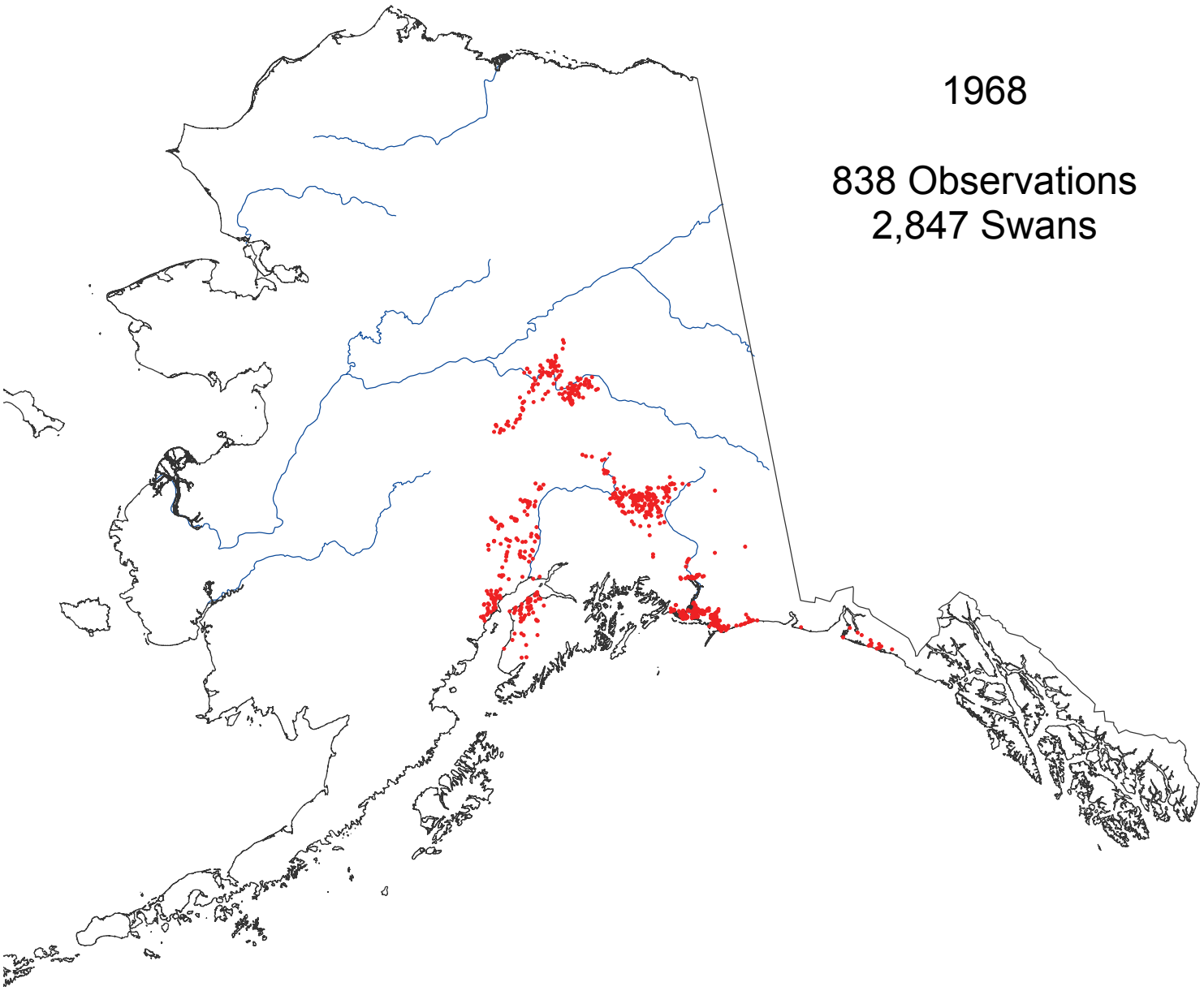
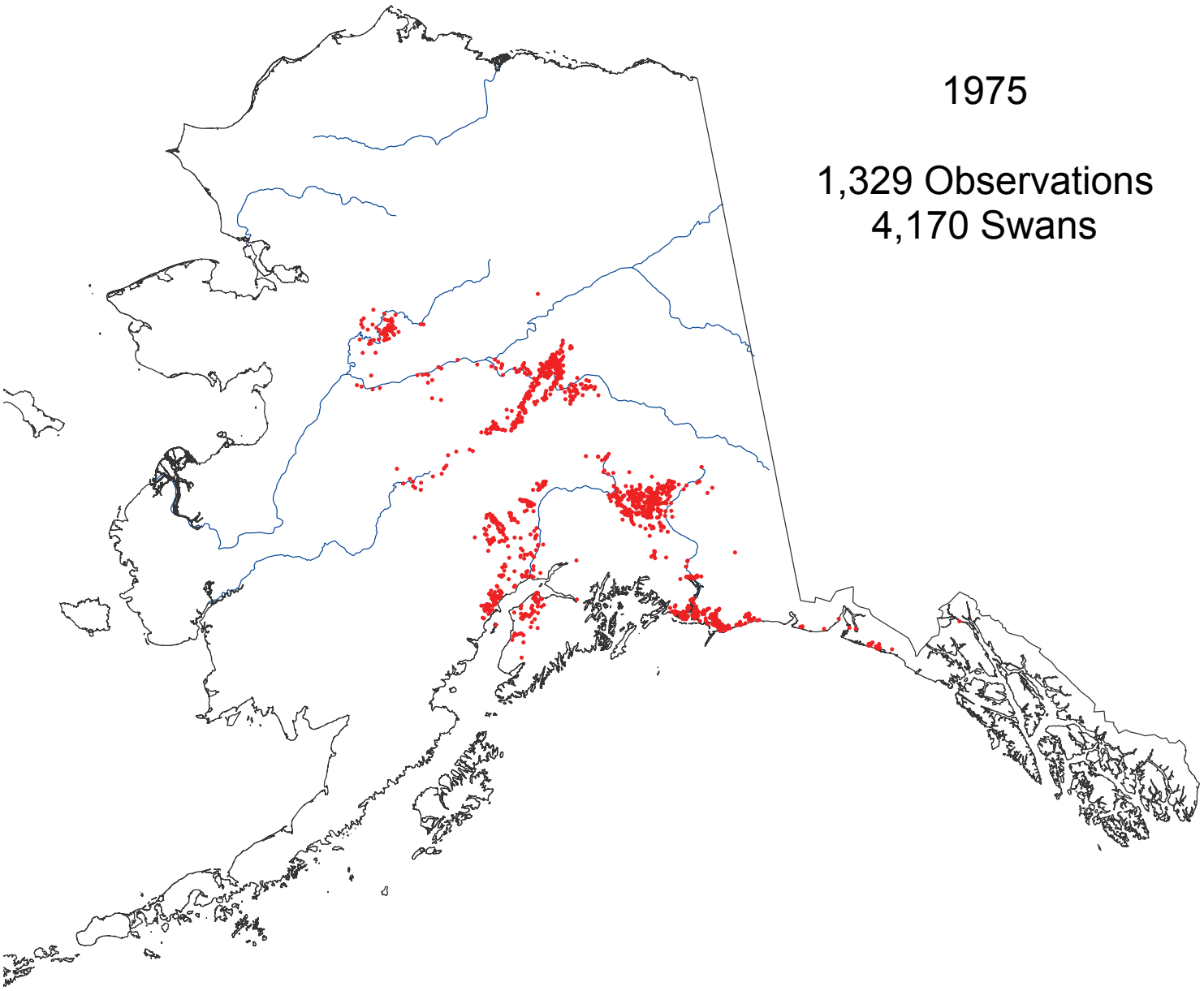
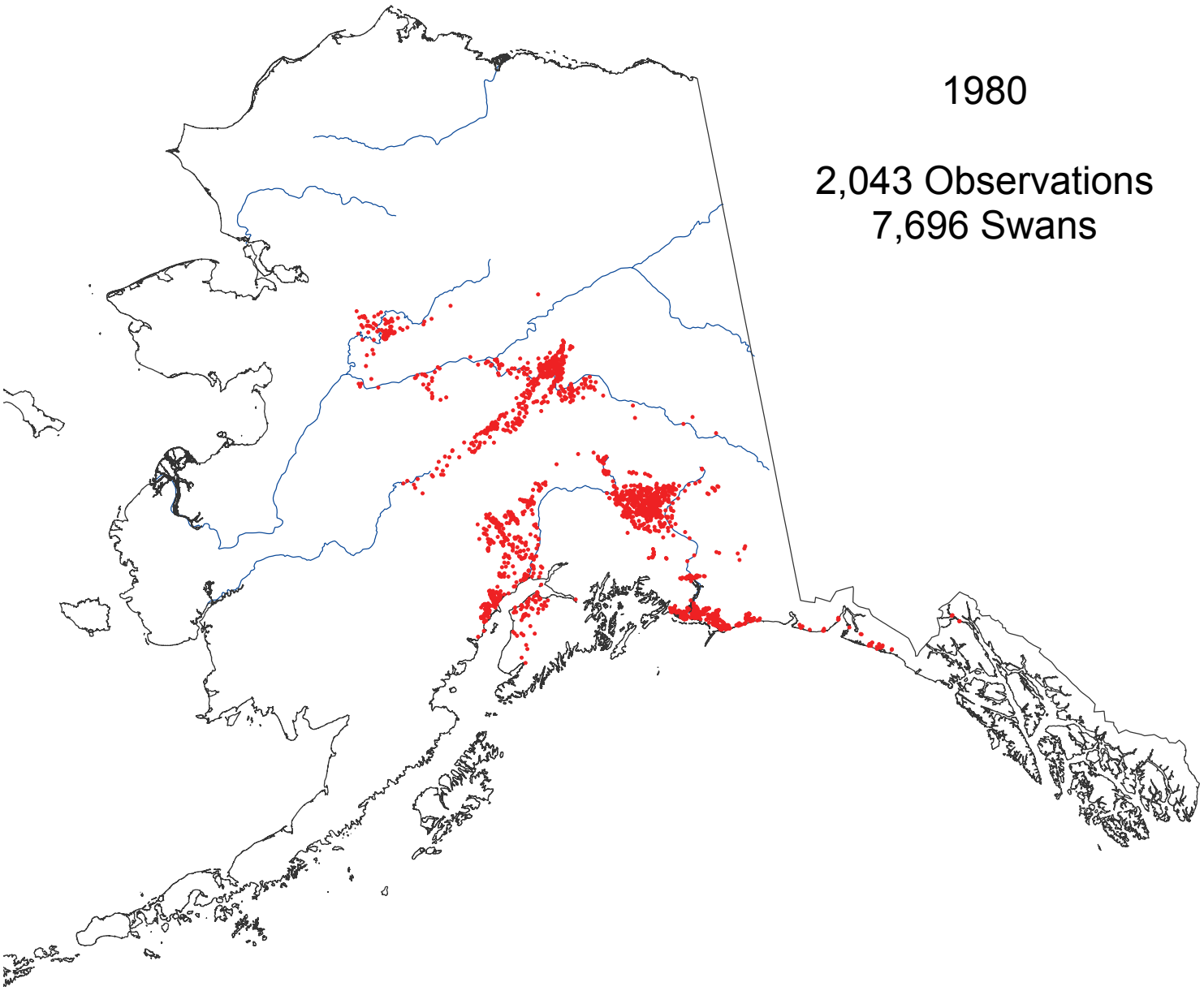


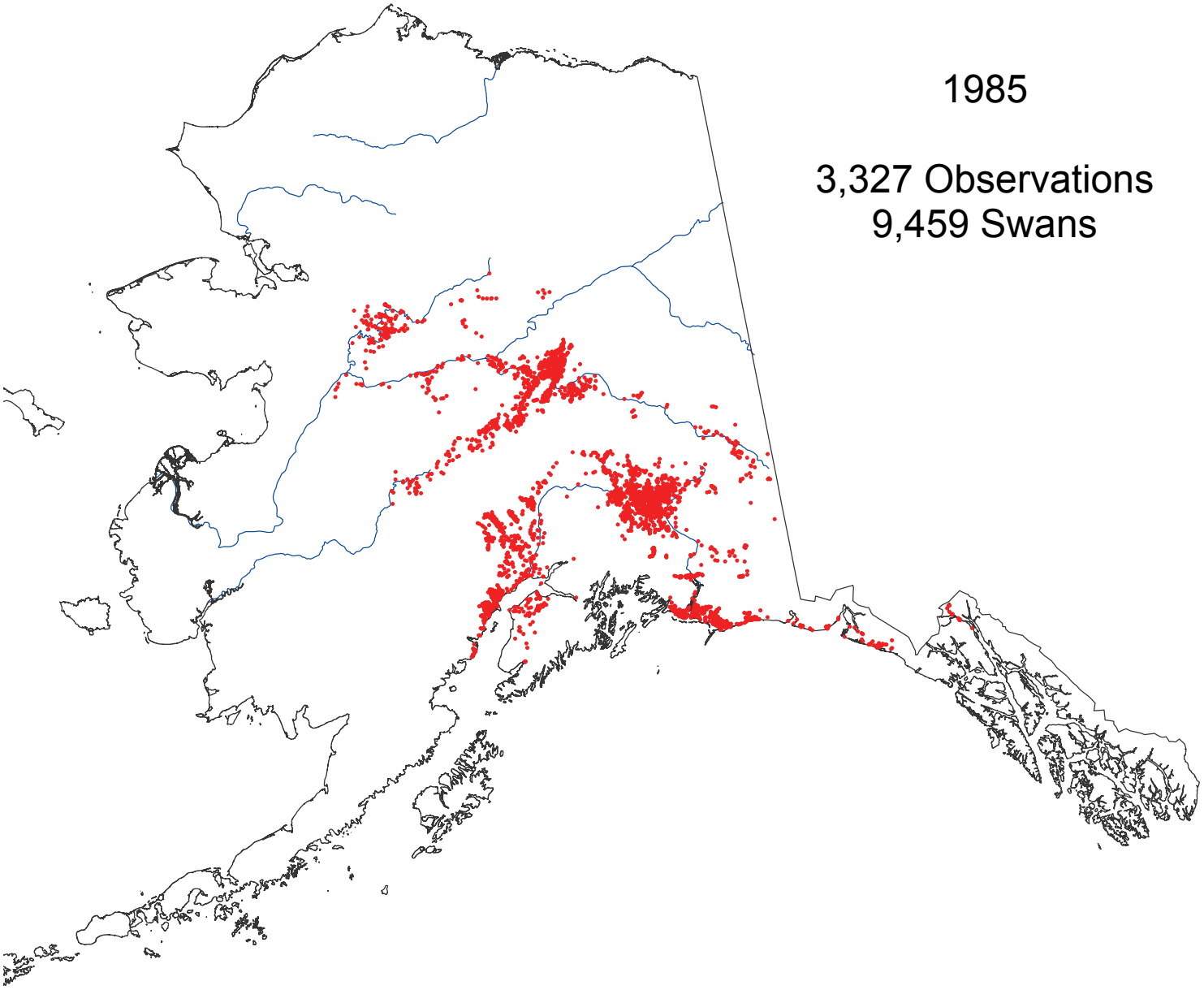
Figure 5 continued. Numbers of white phase Trumpeter Swans recorded by unit (9-11) and for all units combined with fitted growth curves and compared to the amount of habitat (sq. mi.) censused in 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

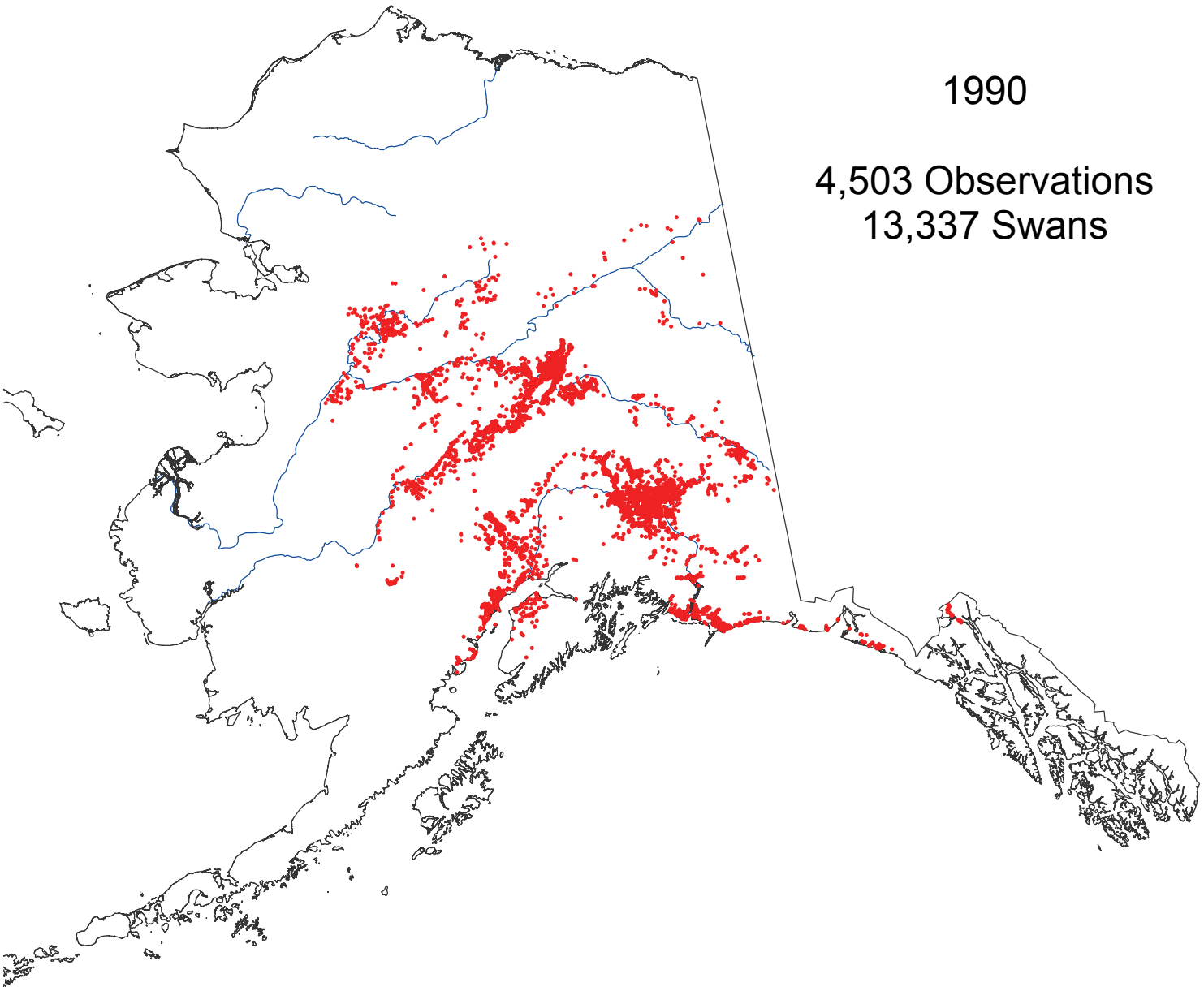
APPENDIX I. Comparison of statewide swan distribution as depicted by point locations of observations from Trumpeter Swan censuses in Alaska in 1968, 1975, 1980, 1985, 1990, 1995, 2000, and 2005.

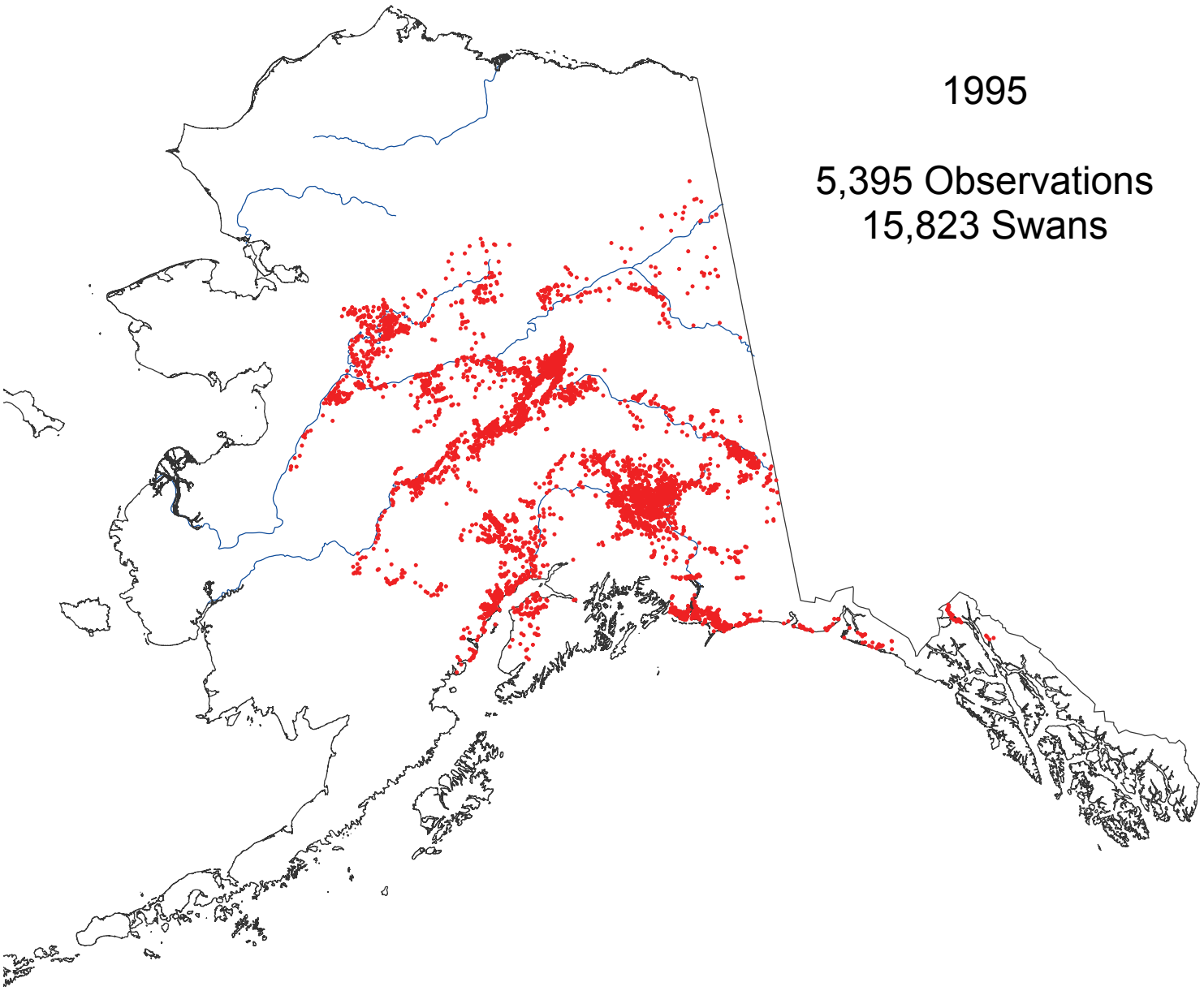

1968
838 Observations
2,847 Swans

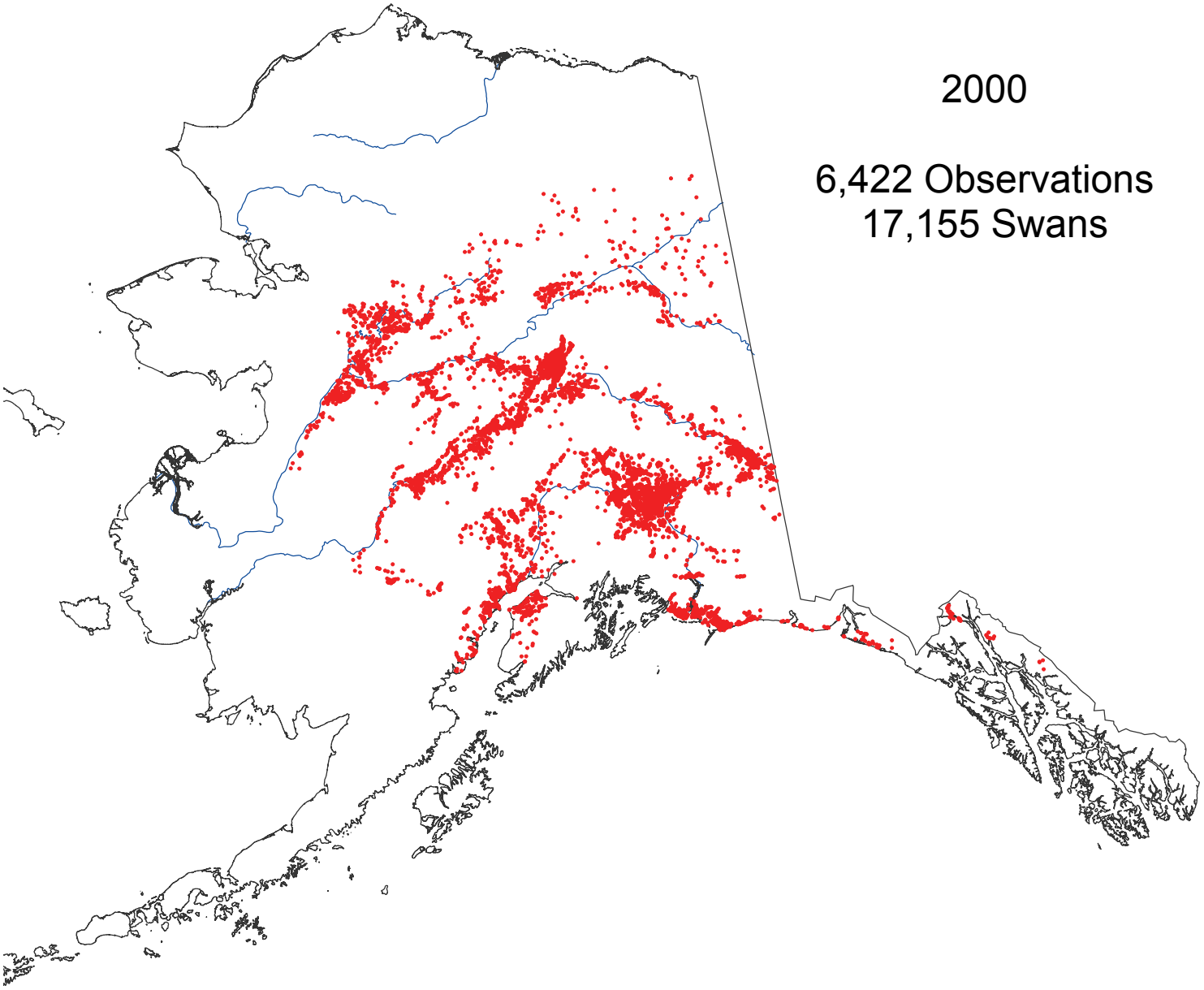

1975
1,329 Observations
4,170 Swans

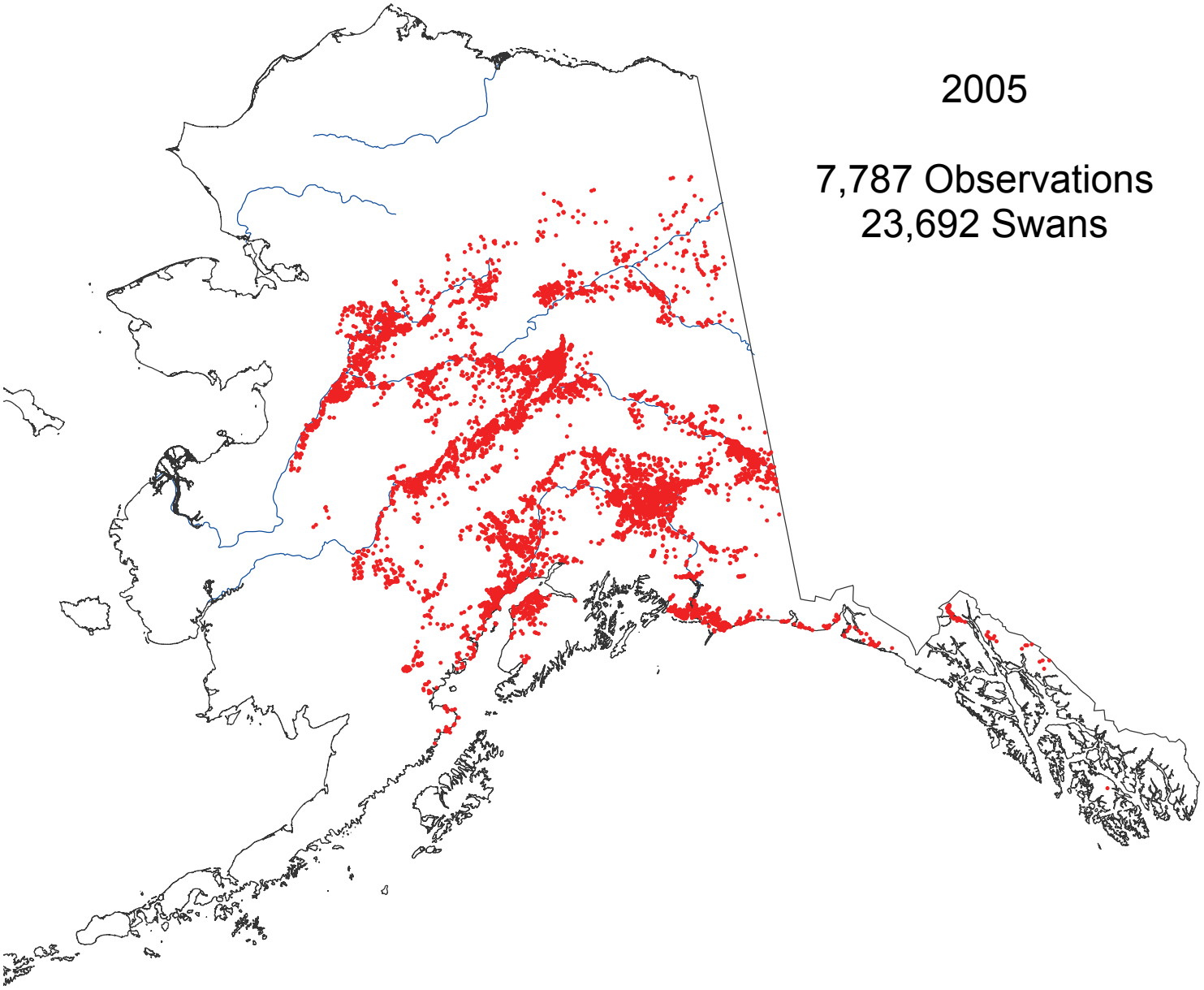

1980
2,043 Observations
7,696 Swans


1985
3,327 Observations
9,459 Swans


1990
4,503 Observations
13,337 Swans


1995
5,395 Observations
15,823 Swans

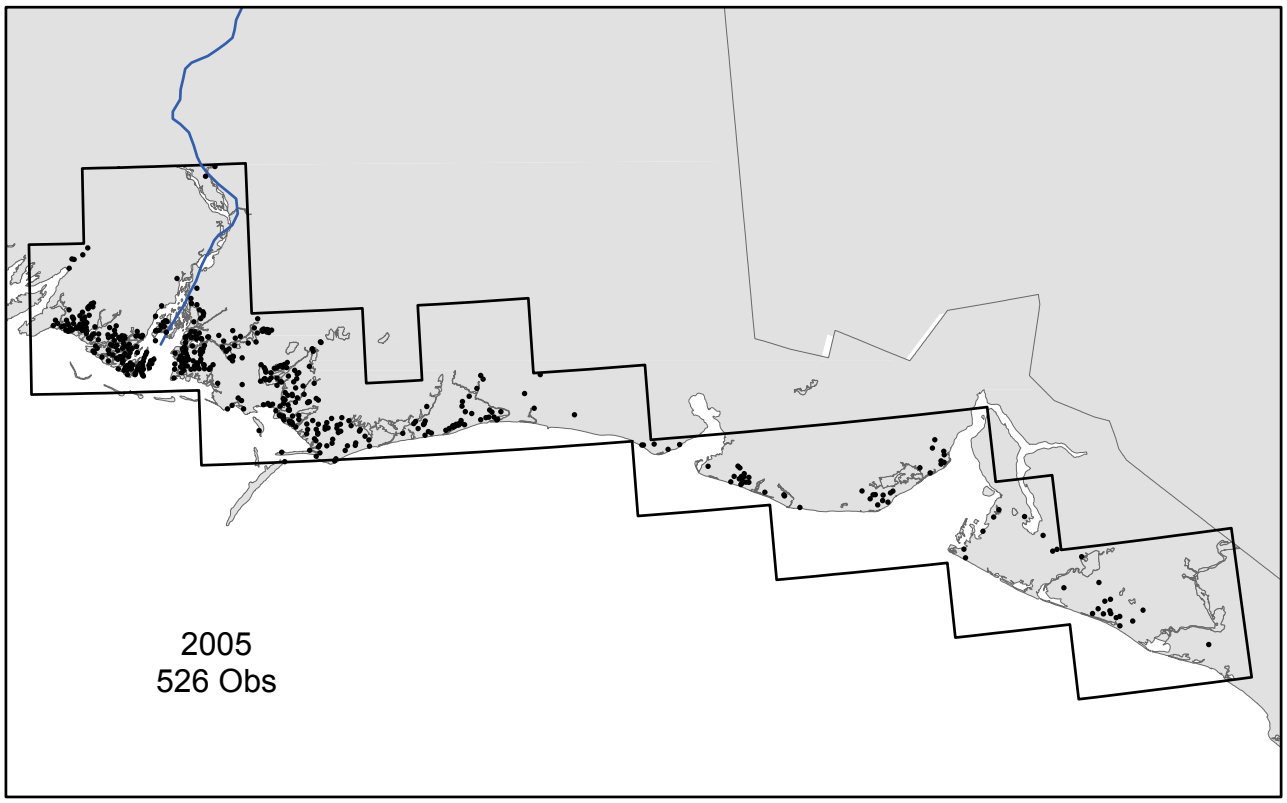

2000
6,422 Observations
17,155 Swans


2005
7,787 Observations
23,692 Swans

APPENDIX II. Comparison of swan distribution by unit as depicted by point locations of observations from Trumpeter Swan censuses in Alaska in 2000 and 2005.

UNIT 1 - GULF COAST

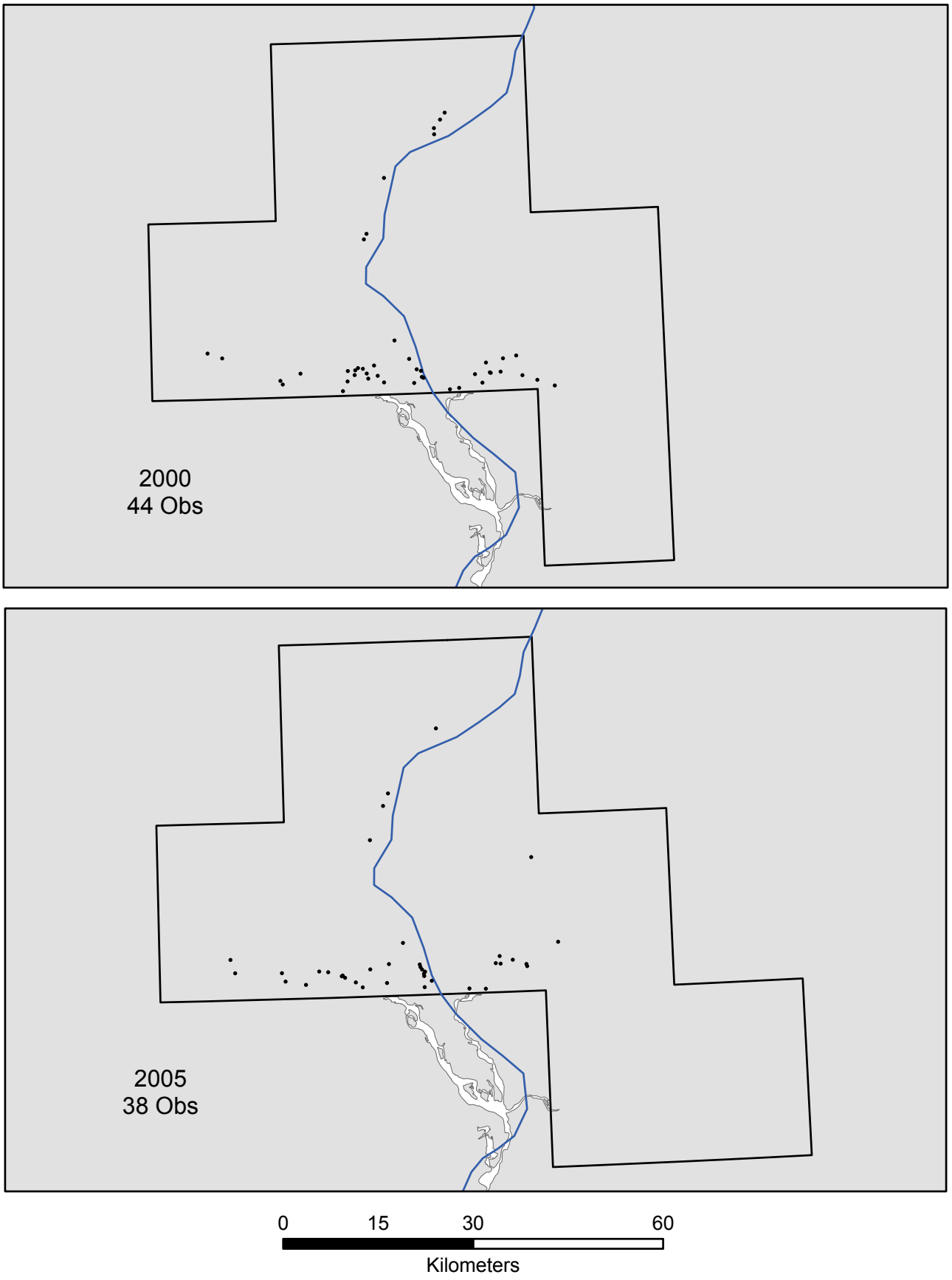




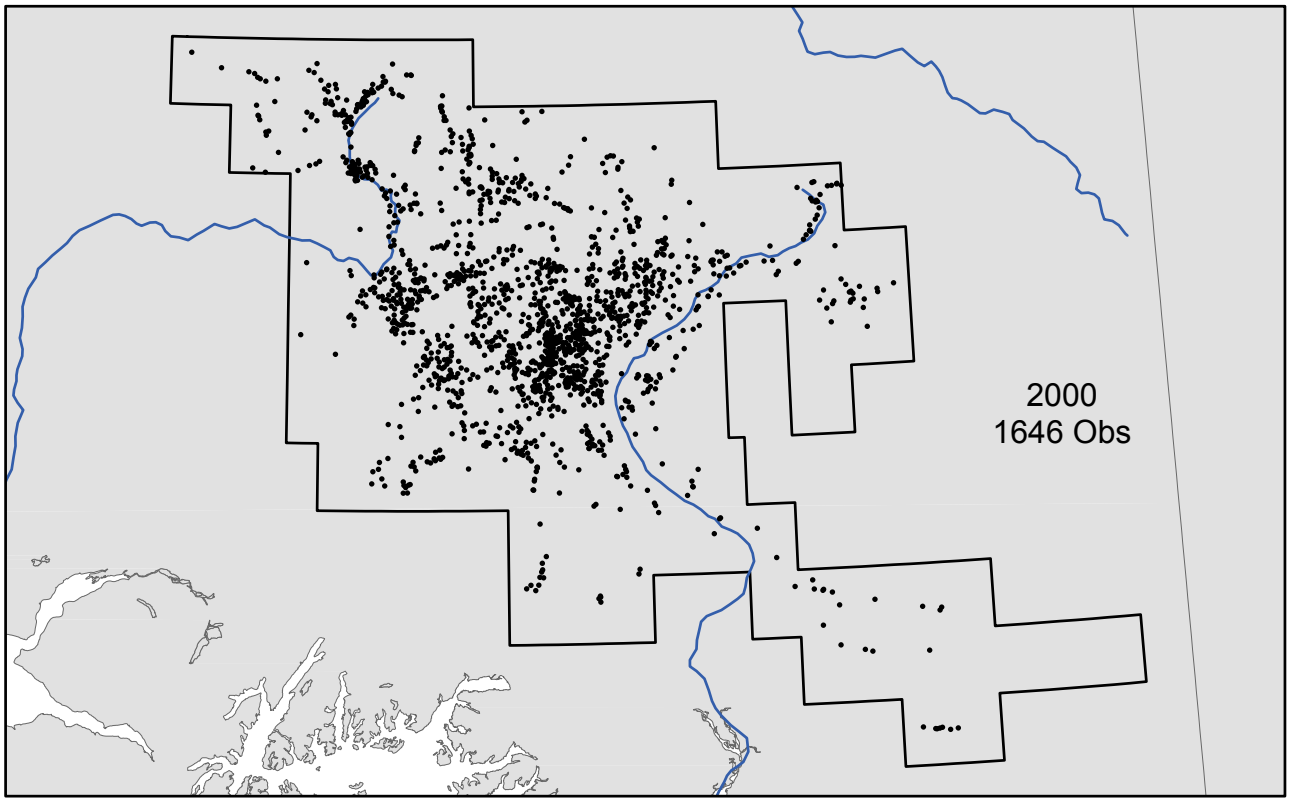
0 50 100 200

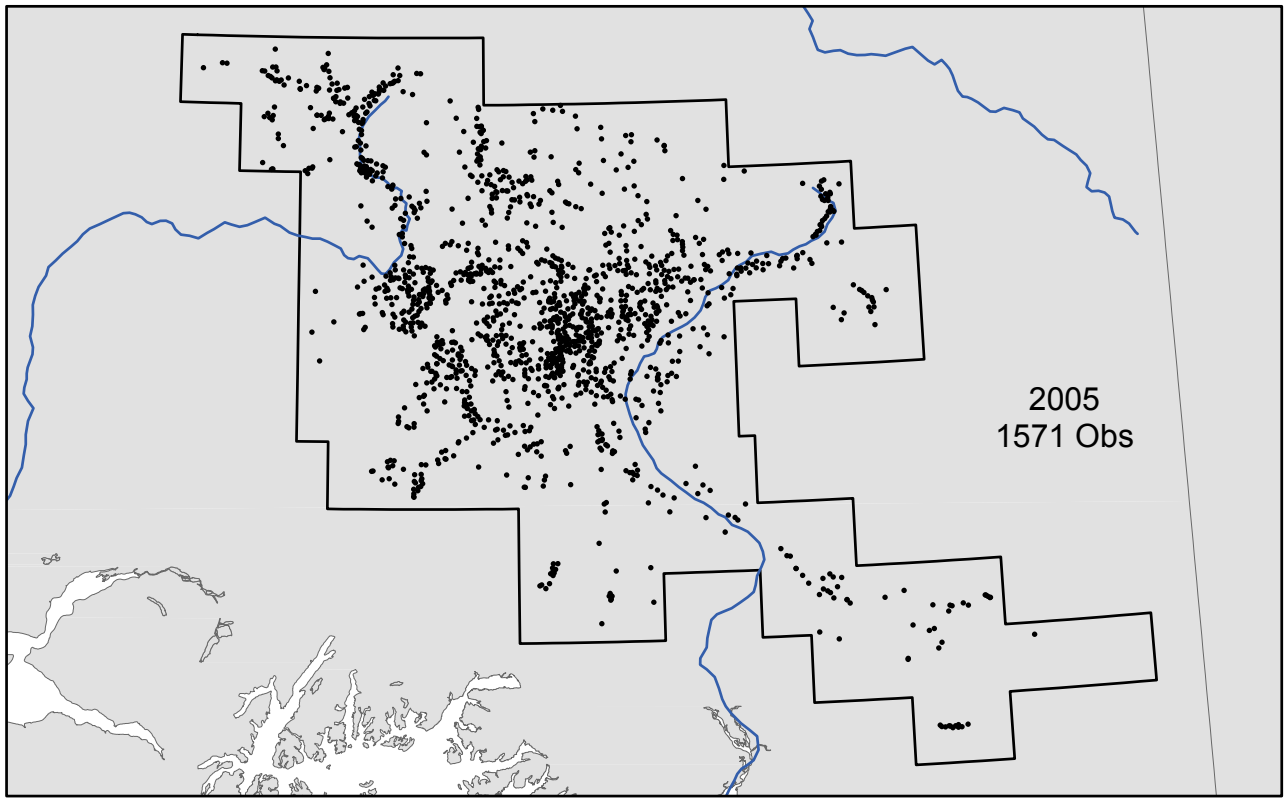
Kilometers

UNIT 2 - COPPER CANYON



UNIT 3 - GULKANA

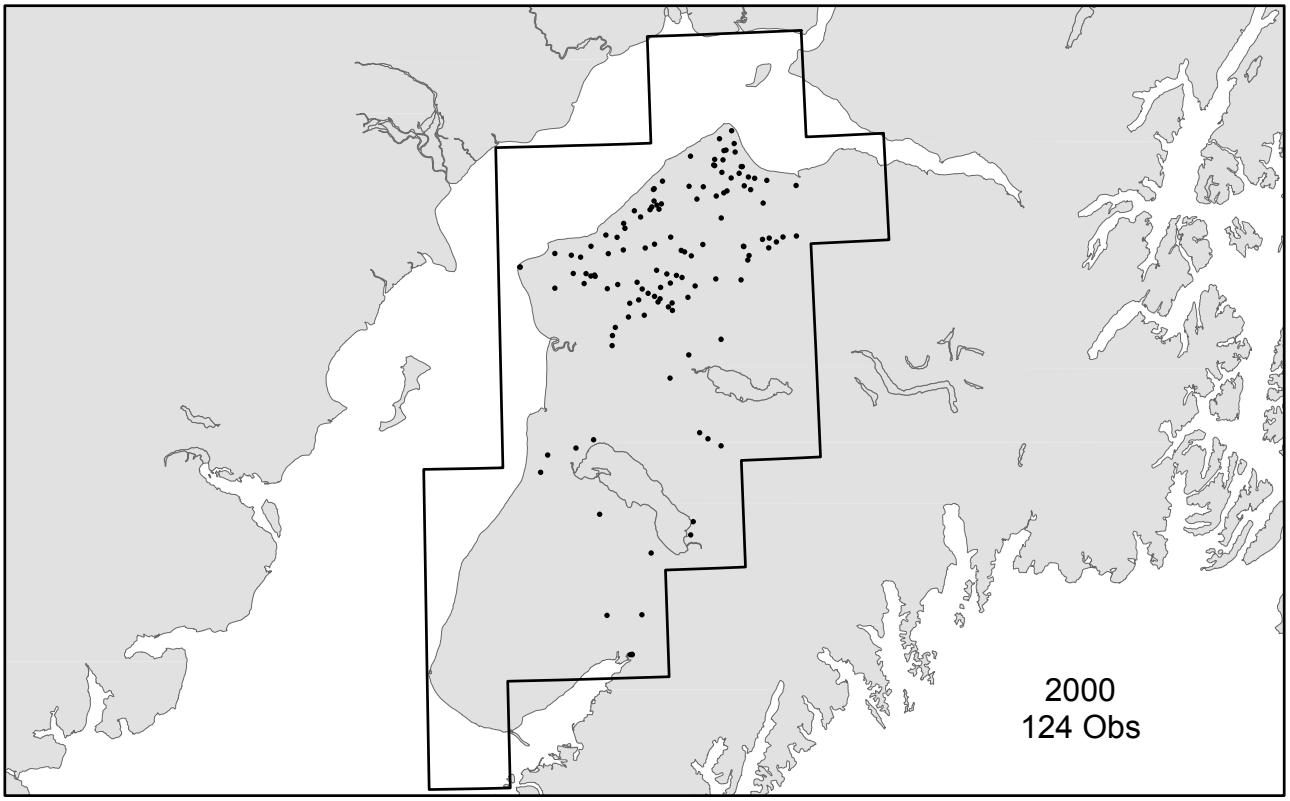


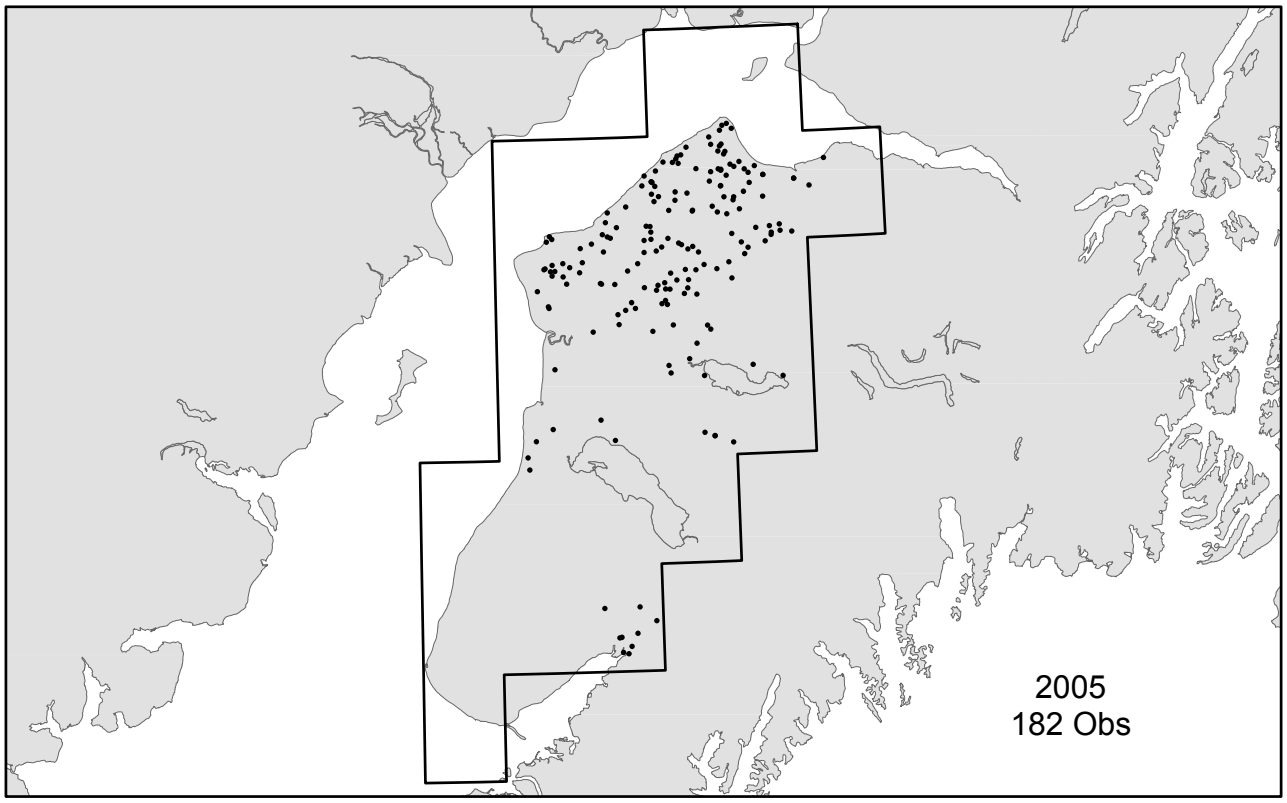


0 50 100 200

Kilometers

UNIT 4 - KENAI

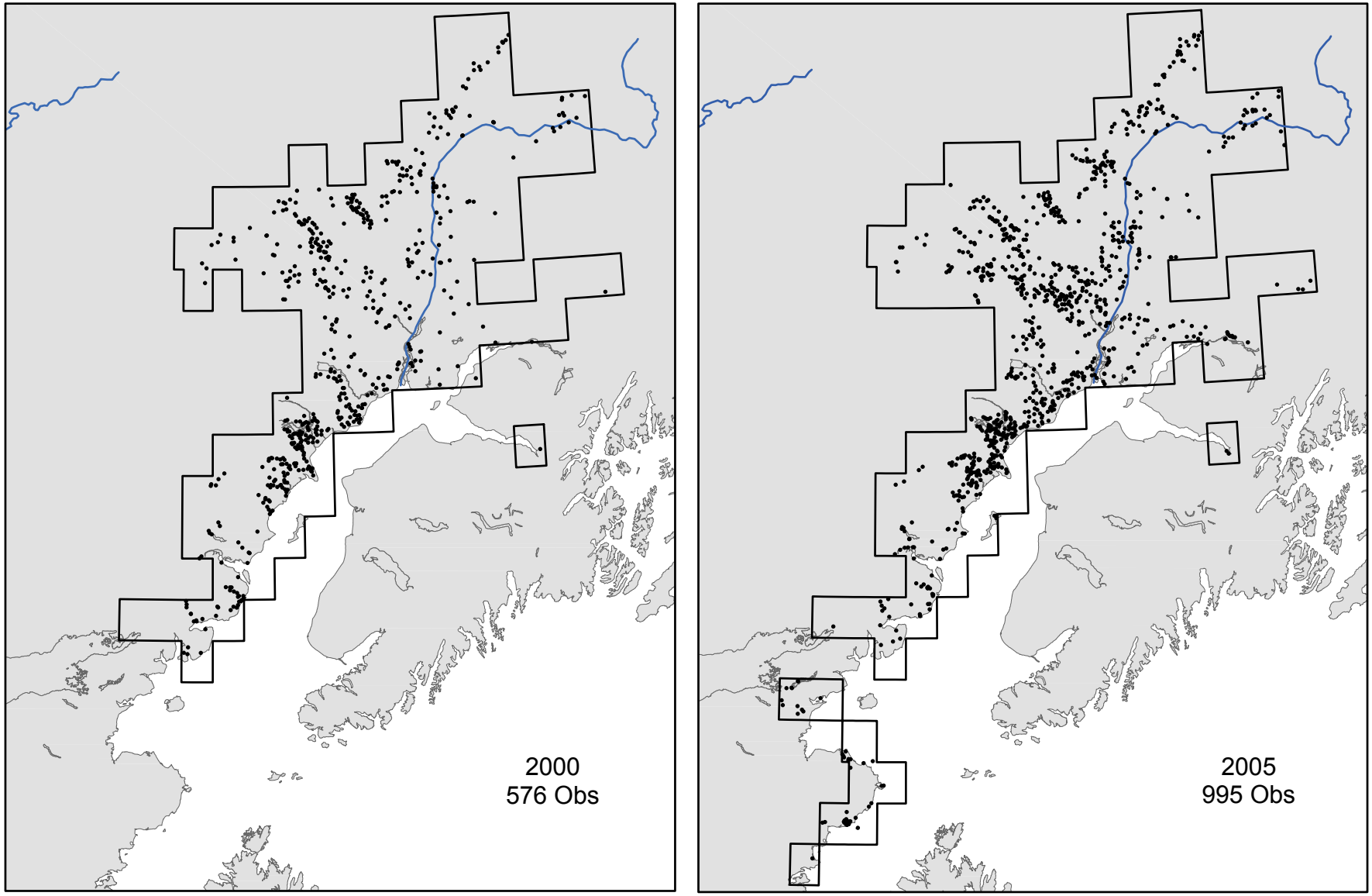




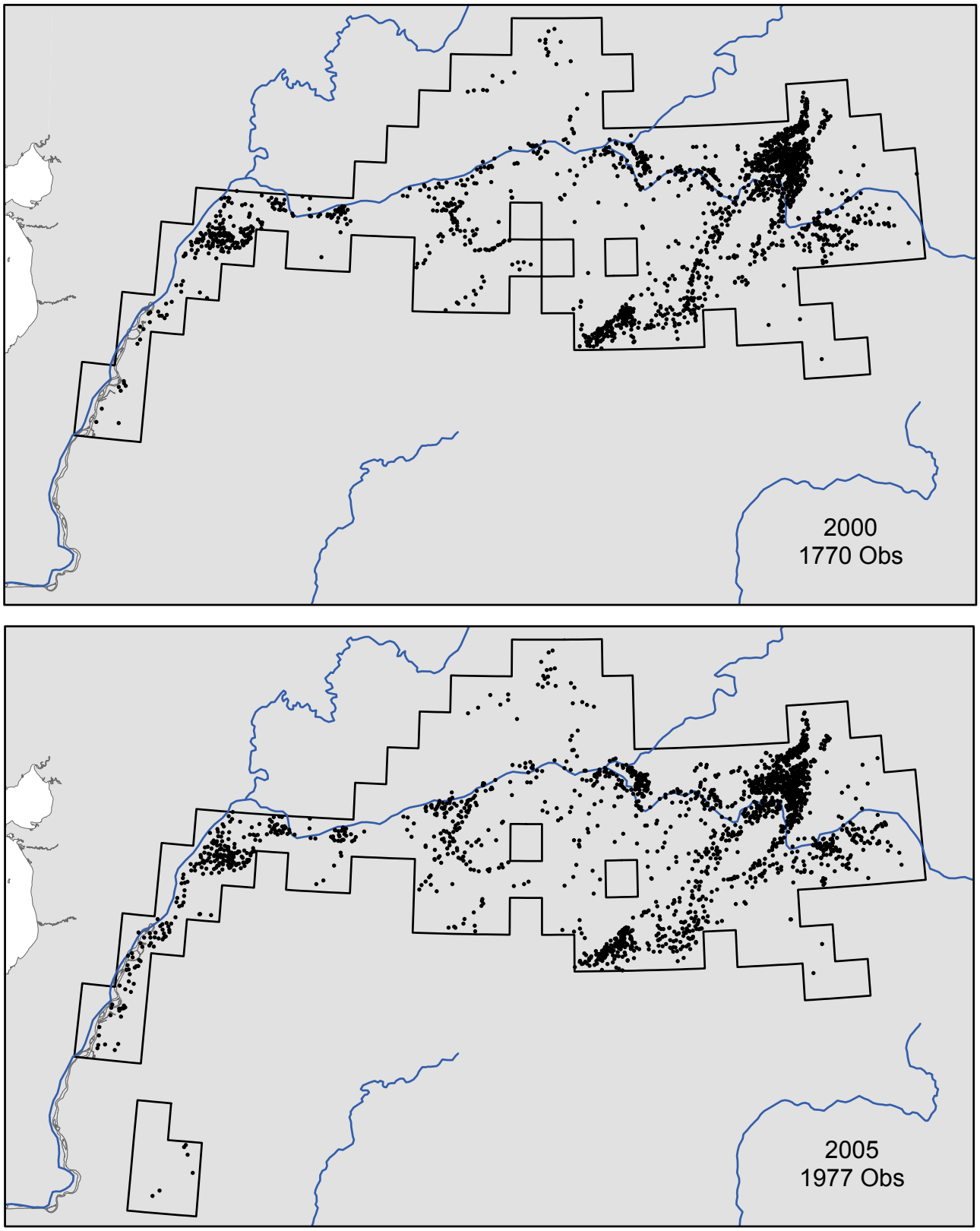
0 25 50 100

Kilometers

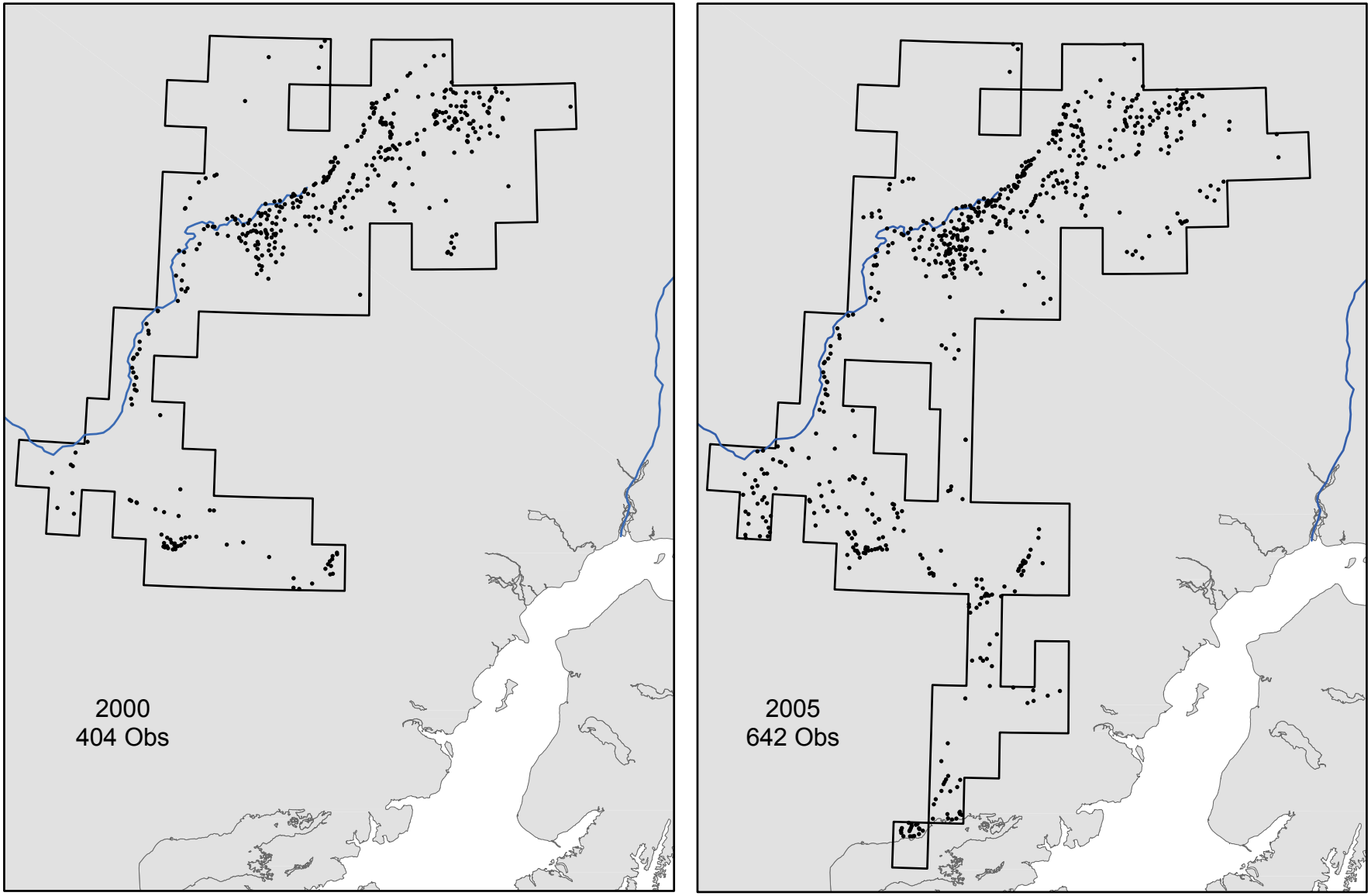
UNIT 5 - COOK INLET



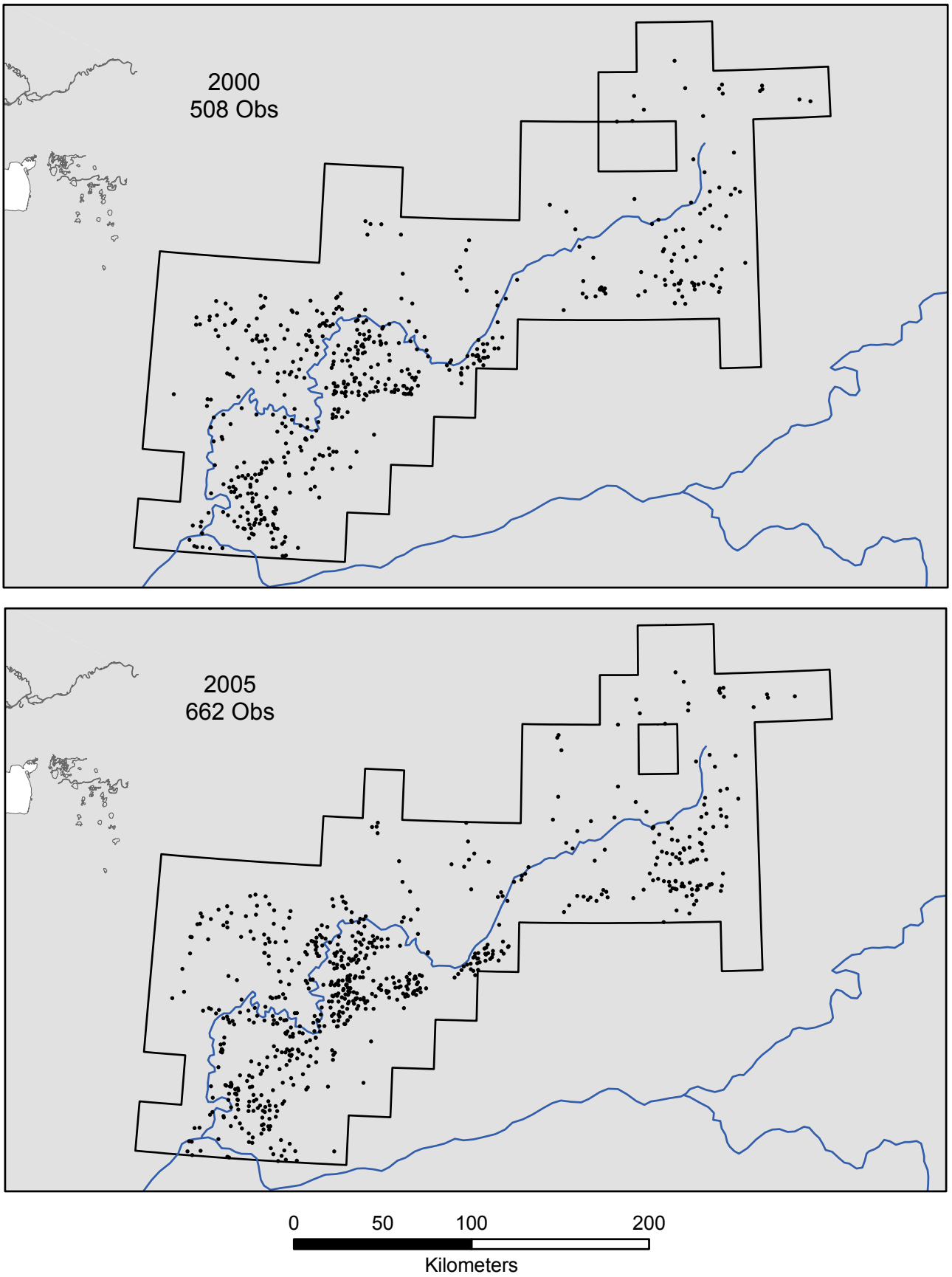
UNIT 6 - LOWER TANANA



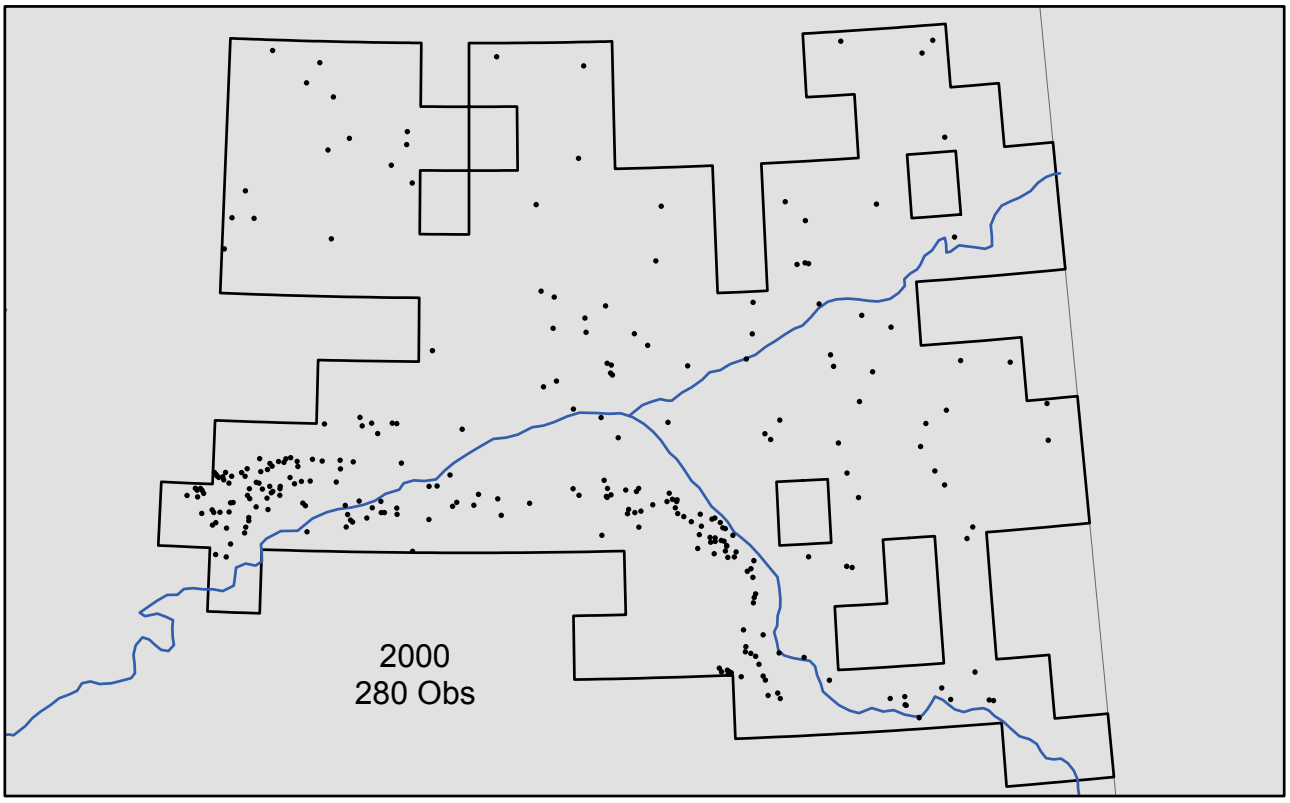
UNIT 7 - KUSKOKWIM

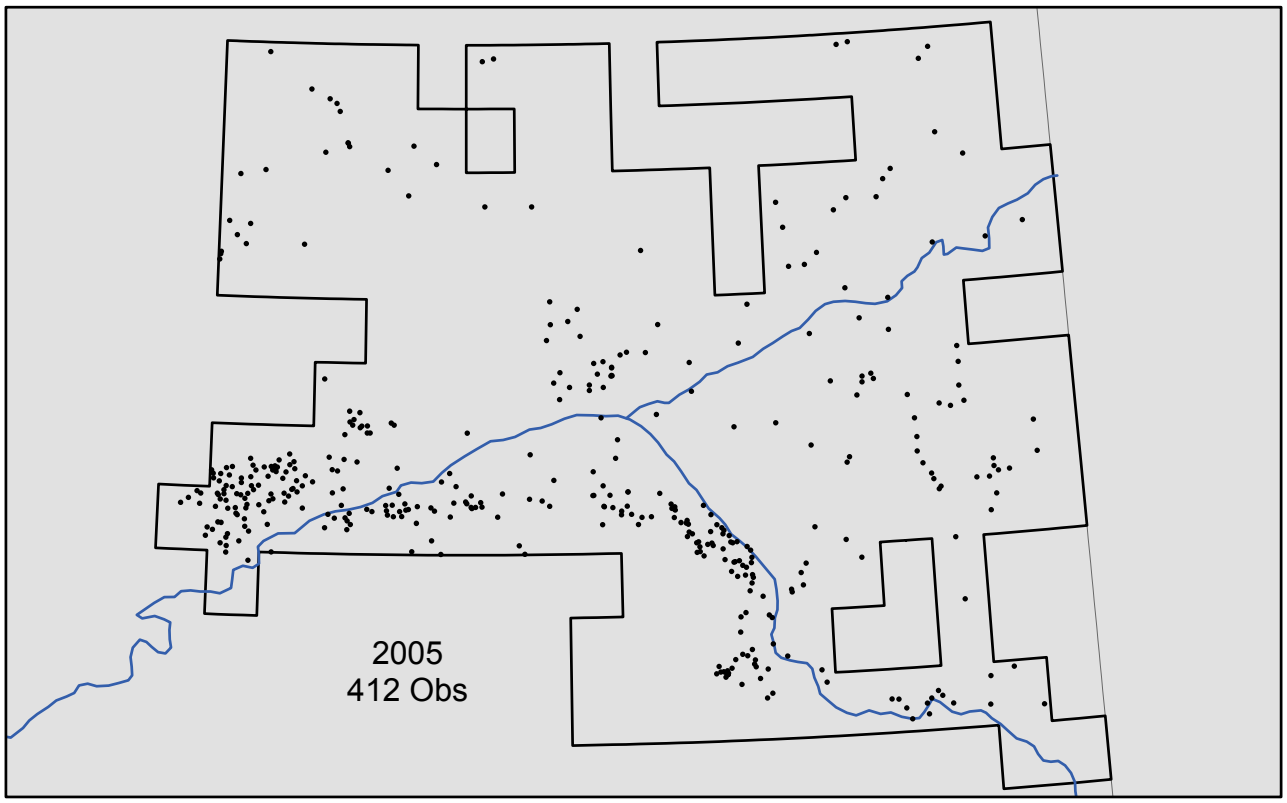


UNIT 8 - KOYUKUK



UNIT 9 - YUKON FLATS





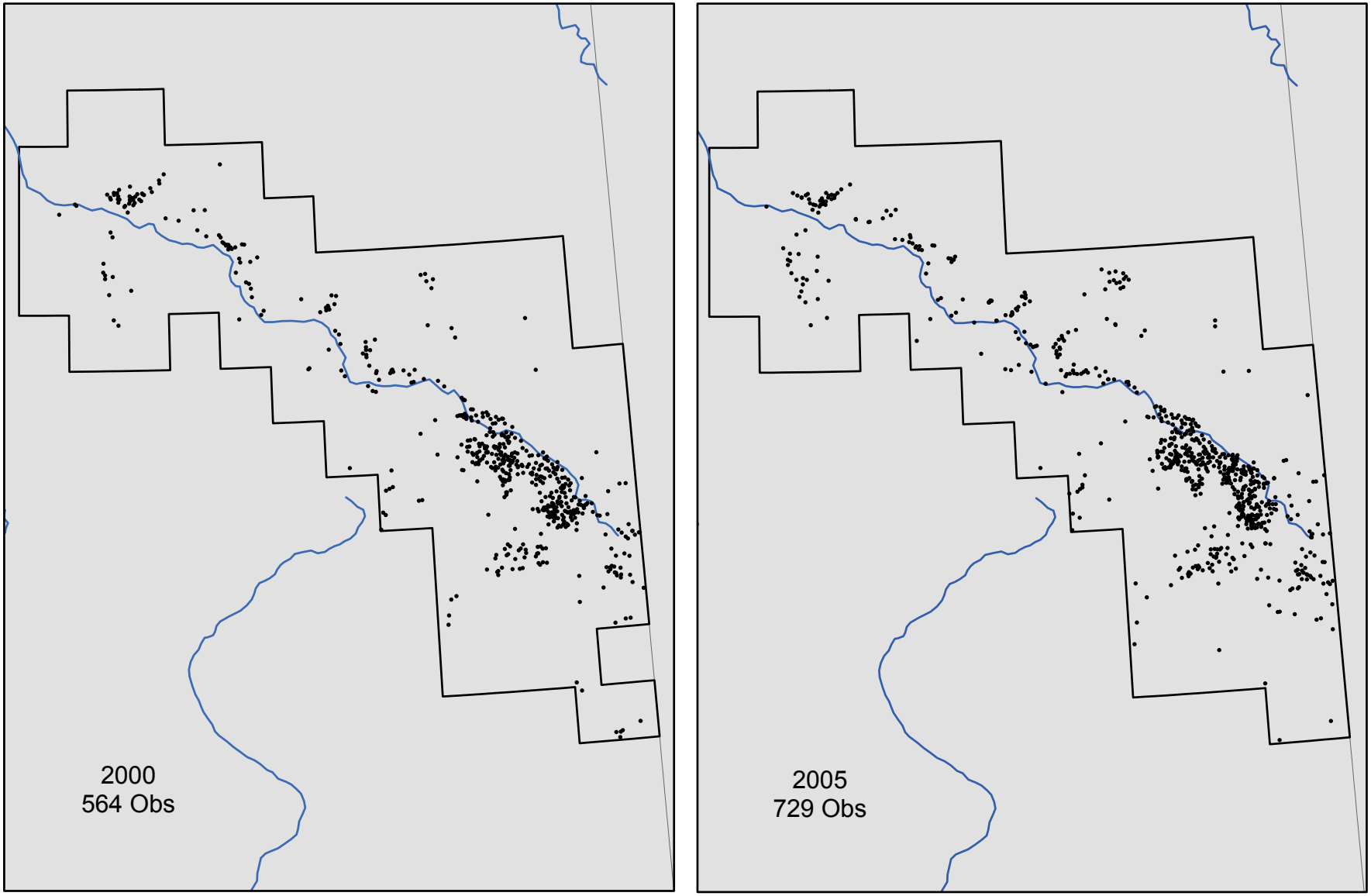
0 50 100 200

Kilometers

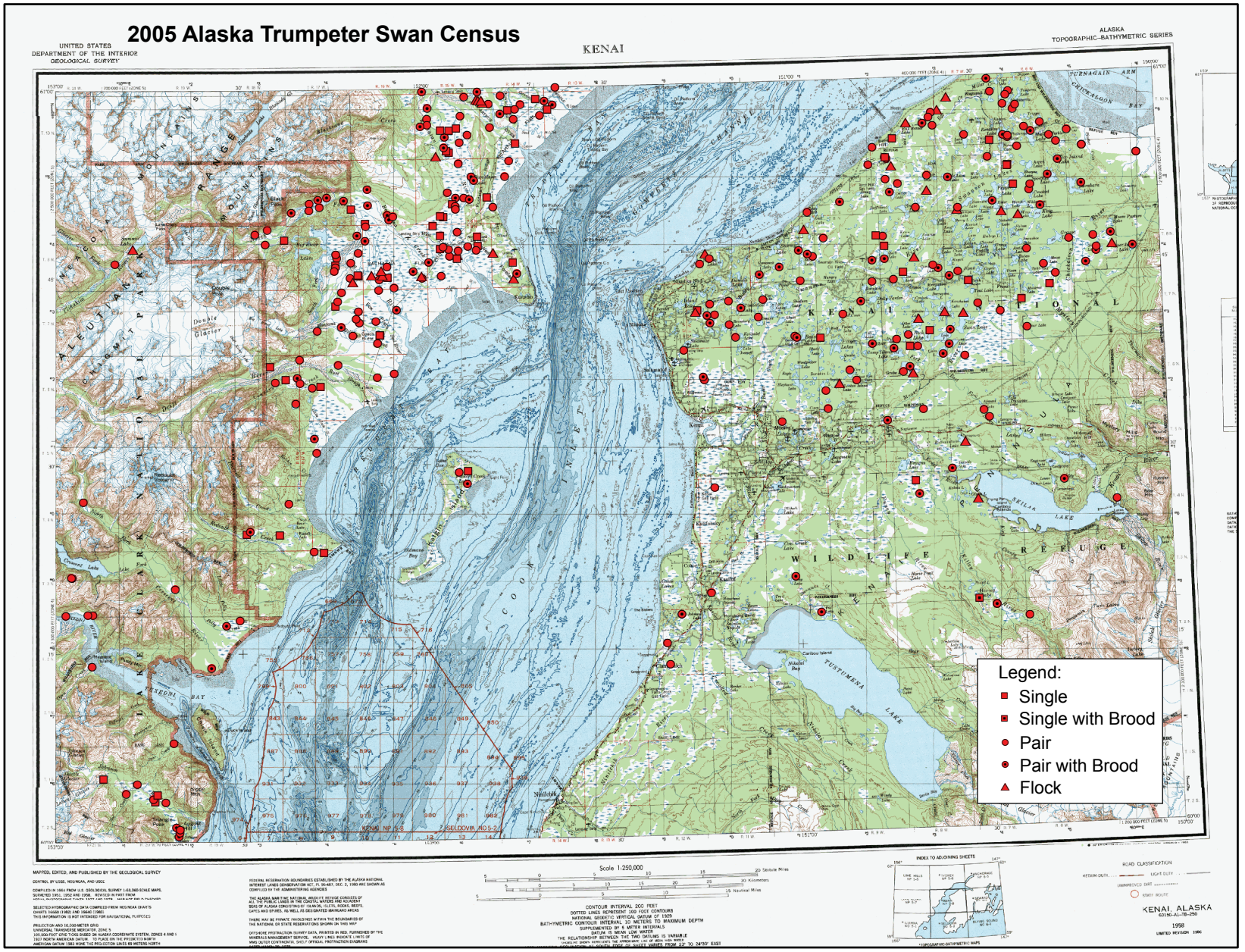
UNIT 10 - SOUTHEAST MAINLAND



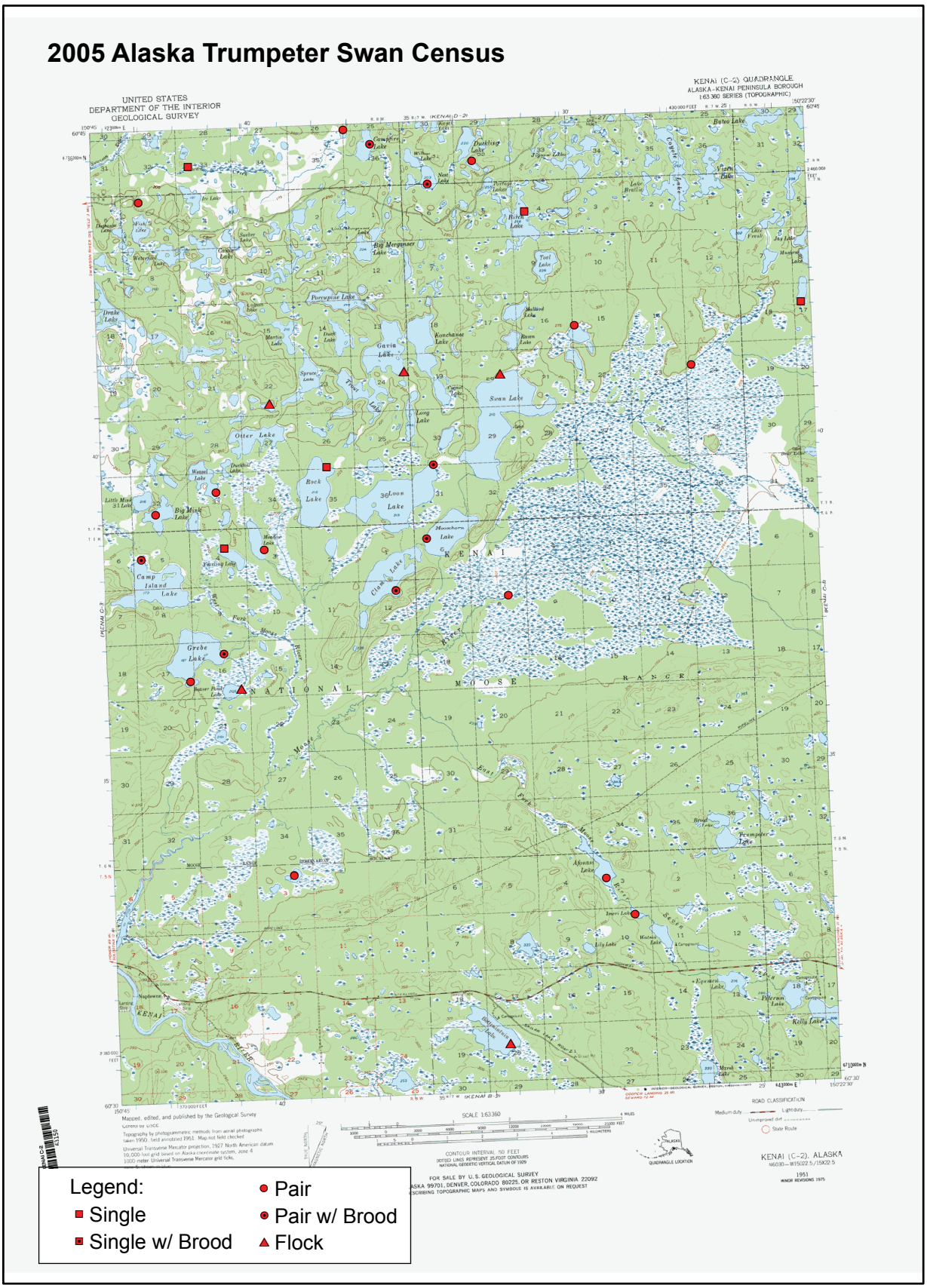
UNIT 11 - UPPER TANANA



APPENDIX III. Examples of mapping products that are available from the Alaska Swan Data Base.



U.S. Geological Survey 1:250,000 scale map showing swan distribution from the 2005 census.



U.S. Geological Survey 1:63,360 scale map showing swan distribution from the 2005 census.

APPENDIX IV. Trumpeter and Tundra Swan Survey Protocol – 2007.

TRUMPETER AND TUNDRA SWAN SURVEY PROTOCOL – 2007

Introduction

In the 1960's, the Alaska Region of the U.S. Fish and Wildlife Service (USFWS) developed a protocol for Trumpeter and Tundra Swan surveys in Alaska that has since been used by several government agencies and private entities to gather swan data. This standardized survey technique has allowed data collected by these diverse organizations to be stored together in a common digital archival system called the Alaska Swan Data Base, which is maintained by the USFWS Waterfowl Management office in Juneau, Alaska. The data base continues to increase in value as additional data are added each year. Several useful products can be derived from the data base, such as summary tables of demographic attributes and various types of distribution maps. The raw data can also be incorporated into a geographic information system, where more in-depth spatial analyses can be performed. Summary products, as well as the raw data, are available to agencies and the public upon request.

We encourage all collectors of swan data to follow this protocol and contribute to the Alaska Swan Data Base. Data and inquiries should be submitted to:

U.S. Fish and Wildlife Service
Waterfowl Management
3000 Vintage Blvd., Suite 240
Juneau, Alaska 99801-7100
debbie_groves@fws.gov
(907) 780-1174

From 1968-1999, the survey flight track, swan attribute data, and observation locations were recorded directly onto U.S. Geological Survey (USGS) paper maps by the survey observer and afterwards transcribed into a computer and digitized. Since 2000, however, an increasing number of surveys have been conducted using an onboard computer and a global positioning system unit (GPS) to collect and record the data and flight path. Digital data collection represents a signficant step forward in many respects, including lessening the burden on the survey pilot and observer and eliminating the need to transcribe and digitize the data. However, because different surveyors use different data-collection software, it has become necessary to allow for some deviation from the exact protocol, at least as it pertains to the recorded data format. Therefore, this revised version of the swan survey protocol includes both detailed instructions for the original paper data-collection method, as well as more general guidelines for collecting data digitally. Please note that the basic methodology must be adhered to without deviation if data are to be accepted. Following these guidelines as closely as possible will help facilitate an efficient operation and will reduce the potential for introducing errors into the data set.

Basic Methodology

1. Survey Timing

The bulk of swan surveys conducted in Alaska are of two types: Spring nesting surveys and late-summer productivity surveys. Spring nesting surveys should be timed to occur after the onset of incubation and before hatch. Generally, this is early to late May in the southern part of the state and late May to mid-June in the north. Productivity surveys should be conducted when cygnets are at least 4 to 6 weeks old, when they are large enough to be easily seen and counted and less likely to hide in dense vegetation. On the other hand, the survey should not be done so late that pre-migratory movements have begun. The best time period is generally mid- to late August but could be started in early August or extended into early September if necessary.

2. Sample Unit

A sample unit consists of one entire USGS 1:63,360 scale topographic map, or a complete one-quarter block of the map. Quarter blocks consist of NW, NE, SE, and SW quadrants of a map. Whole maps are strongly preferred, but in some cases logistical constraints or very densely-populated habitat (e.g. Tundra Swan habitat in parts of western Alaska) may require the use of ¼ maps. The sample unit serves as a subsample of available habitat with known and easily-delineated boundaries that can be replicated over time.

3. Survey Method

The pilot and/or observer is responsible for ensuring that all potential swan habitat within each sample unit is covered. The flight path can be determined either beforehand or enroute, but keep in mind that the distance required between flight lines will ultimately depend on the lighting conditions at the time of the survey as well as observer ability and experience. The optimal flight pattern will depend on the distribution and amount of potential swan habitat within the map unit. For example, if the entire unit area consists of wetlands, a set of parallel lines across the map, spaced to ensure complete coverage, would likely be the best option. However, if the only potential habitat is a few scattered lakes among otherwise upland terrain, then a route meandering from lake to lake would be adequate and more efficient. Because it is up to the surveyors to determine what constitutes "complete coverage," it is essential that the surveyors have some way of tracking their progress while enroute. This means having the ability to view the flight path while the survey is being conducted, either by having the observer record it on paper maps or by viewing it on a computer screen via some type of moving map software.

The optimal survey altitude is about 150 m (500 ft) above ground level. When a brood is encountered, it will often be necessary to descend to a lower altitude to count the number of cygnets, and it may require circling around the brood one or more times until an accurate brood count is obtained. This may also be necessary to obtain egg counts (optional) during spring nesting surveys.

4. Data Collection

For each survey, record the following:

- Names of the pilot(s) and observer(s)
- Date(s) survey was conducted (i.e., the specific date *each* map was surveyed)
- Projection and datum of observations/flight track if collected electronically

For each observation, record the following:

Observation number (if needed to tie the location coordinates to the attribute data)
The precise location
Number of adults (white swans)
Presence or absence of nest (spring survey)
Number of eggs in nest (spring survey)(optional, rarely recorded)
Number of cygnets (if present)

See below for more detailed explanations of observation attributes and examples.

5. Survey Flight Track

Record the flight track during the survey to ensure complete coverage of the map. Submit this along with your swan attribute data. See below for more information.

Recording Data on Paper Maps

Mark each observation on the map with a *small* dot to indicate the precise location. Remember that at 1:63,360 scale, the size of a sloppily-drawn pencil dot or a circle can represent a fairly large area on the earth. Therefore make the dot as small as possible to ensure accuracy when digitizing. Do not circle observation numbers as this tends to obscure both numbers and observation points. Number all observations in a sample unit sequentially, starting with the number 1 for each sample unit. Record the appropriate attributes neatly along the map margin. Recording data on separate sheets is not recommended.

Use the following set of abbreviations to record attributes on map margins (examples at right):

S = Single (do not use "1")
Pr = Pair (do not use "P" or "2")
Flk = Flock (do not use "F" or "Fl")
+ = and
N = Nest
( ) = Eggs

1. S (single)
2. S + 5 (single + 5 cygnets)
3. Pr (pair)
4. Pr + 6 (pair + 6 cygnets)
5. Flk 7 (flock of 7)
6. 0 + 4 (no adults, 4 cygnets)
7. Pr + N (pair + nest)
8. S + N (single + nest)
9. Pr + N(5) (pair + nest with 5 eggs)

Record the survey flight line during the survey on the map. Write the date (month/day/year) each time a flight line enters the sample unit. Draw occasional directional arrows on the flight lines to help the person digitizing determine the flight direction (see example below).

Recording Data Digitally

Biologists conducting swan surveys in Alaska have developed a variety of ways to take advantage of digital technology to collect the data. As a result, in recent years data have been

recorded in various formats that differ from the format described above for paper maps. The attribute abbreviations protocol for digital data can be somewhat less restrictive because digital data are easier to read and interpret than hastily-written handwriting on paper map margins. For example, the paper map protocol requires the observer to write "Flk" for flock, because handwriting could mistakenly turn a simple "F" for flock into a "P," or pair. This is not an issue with digital data entry, although errors are still possible with any data-entry system. Therefore, it is important that data be entered carefully and reviewed soon after the survey to correct any mistakes while observers retain some recall of events.

Several methods, using various combinations of hardware and software, have been used to capture the geographic coordinates of swan observations. One method is to use a touch-screen, portable computer with moving map software that displays the USGS 1:63,360 topo maps. Another method is to fly the airplane over each observation location and record the GPS waypoint when the airplane is directly overhead. Whatever method is used, it is essential that location coordinates are as accurate as possible. The geographic information stored in the Alaska Swan Data Base is an important component of the data base, and it is assumed to have sufficient accuracy for use in fairly detailed spatial analyses. Therefore, if you choose the latter recording method, make sure that you are *directly* over the bird(s) when you record an observation waypoint.

We can accept data stored as Excel spreadsheets or as text files (preferably comma-delimited). The exact format is not important, as long as the basic survey methodology described above has been followed and all the required information is present and accurate. The flight track, often originally an output file from the survey's GPS unit, can also be sent as an Excel or text file. Indicate what projection and datum your swan and flight track data were stored in, because we need to know whether or not it must be converted to the coordinate system of the Alaska Swan Database. (All data in the Alaska Swan Database are stored as geographic coordinates [latitude and longitude], North American 1927 datum.) An example of the final data format of the Alaska Swan Data Base, to which your data will be conformed, is provided below.

General Tips

The following suggestions are offered to help avoid some typical problems we have encountered both during swan surveys and during the paper map digitizing:

1. Only include observations that are located within the map boundaries. Any observations outside map boundaries should be transferred to the appropriate map (if included in the survey).

2. Include only swan attribute data in the sequential list of observations (i.e., do not include incidental species such as geese, moose, etc.).

3. Before submitting maps and data, review them for data-entry errors, ambiguous handwriting, missing attributes or point locations, etc. For paper maps, make sure all numbered attribute data in the margins have corresponding numbered observation points

on the map, and vice versa. This "map review" is best done soon after the survey (preferably the same day) so that the observer is more likely to recall any omitted data.

4. When submitting maps for digitizing, include only one original or copy of each map. If data for a given 1:63,360 map unit were recorded on two separate maps, transcribe them onto one map with one sequential numbering system.

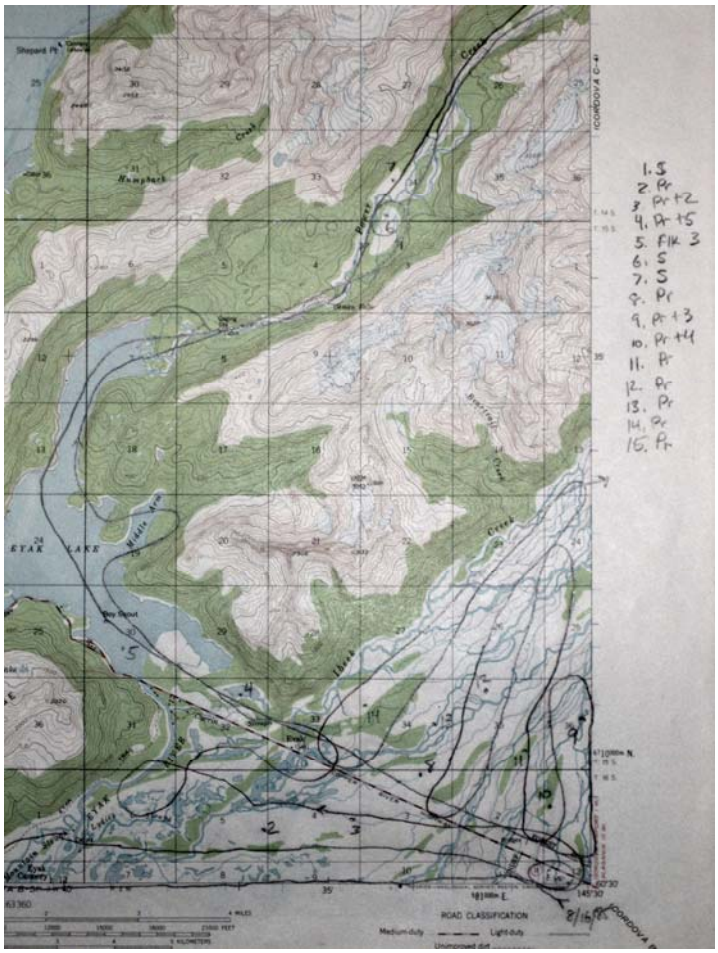
5. Try not to fold maps, because the creases can cause digitizing to be less accurate. Send rolled up maps in a map tube.

6. Send maps via certified mail or via an express mail service, or keep copies of the maps in case maps are lost during transit.

Reference

A useful reference for conducting swan surveys using this protocol is *King, J.G. 1973. The use of small airplanes to gather swan data in Alaska. Wildfowl 24:15-20.*

Paper Map Example



Alaska Swan Data Base Archival Format

Swan data are stored in a comma-delimited text format containing 16 fields as shown in the following example:

Unit	Map	Quad	QtrQuad	Month	Day	Year	Contrib	ObsNo	Lat	Lon	Adults	Young	Nest	Egg	Leg_Sym
1	96	A1	AL	5	24	1999	103	1	60.0333	-144.2067	2	0	0	NoData	P
1	96	A1	AL	5	24	1999	103	2	60.0717	-144.0022	2	0	1	NoData	PNest
1	96	A1	AL	5	24	1999	103	3	60.1022	-144.0378	3	0	0	NoData	F
1	96	A1	AL	5	24	1999	103	4	60.1117	-144.0931	2	0	0	NoData	P
1	96	A1	AL	5	24	1999	103	5	60.1417	-144.0989	2	0	0	NoData	P
1	96	A1	AL	5	24	1999	103	6	60.1394	-144.1689	2	0	0	NoData	P
1	96	A1	AL	5	24	1999	103	7	60.1536	-144.1939	2	0	1	NoData	PNest
1	96	A1	AL	5	24	1999	103	8	60.1558	-144.2125	1	0	1	NoData	SNest
1	96	A2	AL	5	24	1999	103	1	60.1631	-144.2069	2	0	0	NoData	P
1	96	A2	AL	5	24	1999	103	2	60.1639	-144.1803	2	0	0	NoData	P
1	96	A2	AL	5	24	1999	103	3	60.1831	-144.1522	2	0	1	NoData	PNest
1	96	A2	AL	5	24	1999	103	4	60.1794	-144.1972	1	0	0	NoData	S
1	96	A2	AL	5	24	1999	103	5	60.1894	-144.1897	2	0	0	NoData	P
1	96	A2	AL	5	24	1999	103	6	60.1747	-144.2031	2	0	0	NoData	P
1	96	A2	AL	5	24	1999	103	7	60.1625	-144.2389	2	0	1	5	PNest
1	96	A3	AL	5	25	1999	103	1	60.1803	-144.2103	3	0	0	NoData	F
1	96	A3	AL	5	25	1999	103	2	60.1942	-144.1936	2	0	0	NoData	P
1	96	A3	AL	5	25	1999	103	3	60.1981	-144.1819	2	0	0	NoData	P
1	96	A3	AL	5	25	1999	103	4	60.1944	-144.1822	1	0	0	NoData	S

Unit:

Trumpeter Swans:

1 = Gulf Coast
2 = Copper Canyon
3 = Gulkana
4 = Kenai
5 = Cook Inlet
6 = Lower Tanana
7 = Kuskokwim
8 = Koyukuk
9 = Yukon Flats
10 = Southeast Mainland
11 = Upper Tanana
12 = Canada

Tundra Swans:

1 = Kodiak
2 = Izembek
3 = Bristol Bay
4 = Yukon Delta
5 = Seward Peninsula
6 = Kotzebue Sound
7 = North Slope

Map: Map Number (USGS 1:250,000 scale quadrangle)

Quad: USGS 1:63,360 scale quad map letter and number

QtrQuad: Quarter Quad (1/4 of USGS 1:63,360 scale quad)

AL = All quarters surveyed
NE = Northeast 1/4 surveyed
NW = Northwest 1/4
SE = Southeast 1/4
SW = Southwest 1/4

Contrib: Contributor Code (Agency/office that collected and contributed data).
A separate file exists that lists the name and address for each code.

ObsNo: Observations recorded on paper maps are sequentially numbered; all observations recorded directly into computer have value of 0.

Lat/Lon: Swan location coordinates are stored in a geographic coordinate system (decimal degrees), North American 1927 datum.

Nest: 0 = Absent, 1 = Present

Egg: No. of eggs entered if eggs were counted; otherwise "NoData".

Leg_Sym: A field used by MBM-Juneau for displaying data in ArcGIS:

S = Single swan
P = Pair without nest or brood
SNest = Single with nest
PNest = Pair with nest
SBr = Single with brood
PBr = Pair with brood
0Br = Lone brood (no parent present)
F = Flock

APPENDIX V. List of participants in the 2005 Alaska Trumpeter Swan Census.

U.S. Fish and Wildlife Service:
Bruce Conant (pilot)
Jack Hodges (pilot)
Deb Groves
Jim King
Bill Larned (pilot)
Ed Mallek (pilot)
Paul Anderson (pilot)
Russ Oates
Chris Dau
Julian Fischer
Heather Wilson
Bill Eldridge
Rod King (pilot)
Karen Bollinger (pilot)
Liz Jozwiak
Tamara Mills
Robin Corcoran
Alan Brackney
Roger Kaye (pilot)
Jim Akaran
Colette Buchholtz
Gail Collins
Jim Ellis (pilot)
Susy Grimes
Hank Timm
Mike Spindler
Chris Harwood
Mark Bertram
Mike Vivion
Jenny Bryant
Brad Scotton (pilot)
Joee Huhndorf
Melanie Hans

National Park Service:
Nikki Guldager
Mason Reid
Tom Betts
Miranda Terwilliger

U.S. Forest Service:
Susan Oehlers
Nate Catterson

Others:
Josh Schmidt
James Wynbrandt
John Liston (pilot)
Eileen Henniger