

1995 CENSUS OF TRUMPETER SWANS ON ALASKAN NESTING HABITATS

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ABSTRACT

The sixth complete census of Trumpeter Swans (*Cygnus buccinator*) on their Alaska summering grounds was completed in 1995. Over 700 hours of flight time was expended by numerous survey crews to fly 90726 km of survey tracks, compared to 82645 km surveyed in 1990. Surveys were conducted over all the potential swan habitat depicted on 674 USGS 1:63360 scale maps, compared to 625 in 1990. The adult/subadult population was comprised of 7946 paired birds (+13% compared to 1990), 859 singles (+33%), and 3184 birds in flocks (+56%), making a total of 11989 white swans (+23%). There were 3834 cygnets (+7%), accounting for 24% (27% in 1990) of the total population of 15823 swans (+19%). 1218 broods were found (+8%), for an average brood size of 3.1 (3.2 in 1990). Although the population of 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 is of special concern. In Alaska, a combined program of complete censuses every 5 years and random sampling for interim years is recommended to provide the high quality data needed for the best management of this 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, and 1995 (Hansen et al. 1971, King 1976, King and Conant 1981, Conant et al. 1988, Conant et al. 1992). Because of the projected increase in the summer population, many survey crews and aircraft were needed at the outset to ensure completion of the 1995 census. A total of over 700 hours of flight time was expended to fly 90726 km of survey tracks over all the potential Trumpeter Swan habitat. The survey was initiated on 31 July and terminated on 29 August. The primary survey aircraft used were a specially modified turbine-powered deHavilland Beaver, Cessna 185s, Cessna 206s, and Piper Supercubs. The integrated computer system developed in 1985 to enter all attribute data and digitize the latitude and longitude of each observation was converted to IBM format in 1990 and was used again this year. Various map overlays and summaries of all Trumpeter survey data are available upon request from the Migratory Bird Management Office (MBMO) of the USFWS in Juneau, Alaska.

SURVEY AREAS

A total of 674 U. S. Geological Survey (USGS) quadrangle maps were censused in 11 separate Trumpeter Swan nesting areas in Alaska (Figure 1). Most of these 11 units were delineated on the basis of significant geographical features such as large drainages and mountain ranges.

METHODS

The aerial survey technique used small aircraft to put observers over all known or suspected Trumpeter Swan summer habitat (King 1973). Observations were recorded directly on 1:63360 scale USGS maps. Generally, a system of parallel tracks were flown within each quadrangle map at an altitude of 150-180m above ground. Pilot-biologists were responsible for navigation, for ensuring that all habitat was adequately searched, and for finding all swans. Consideration was given to factors such as sun glare and observer experience. The primary

observer was responsible for tracking the flight path on the maps, making swan observations, and recording them by type, number, and precise location. When non-wildlife pilots did the flying, all of these duties were performed by the primary observers. In some

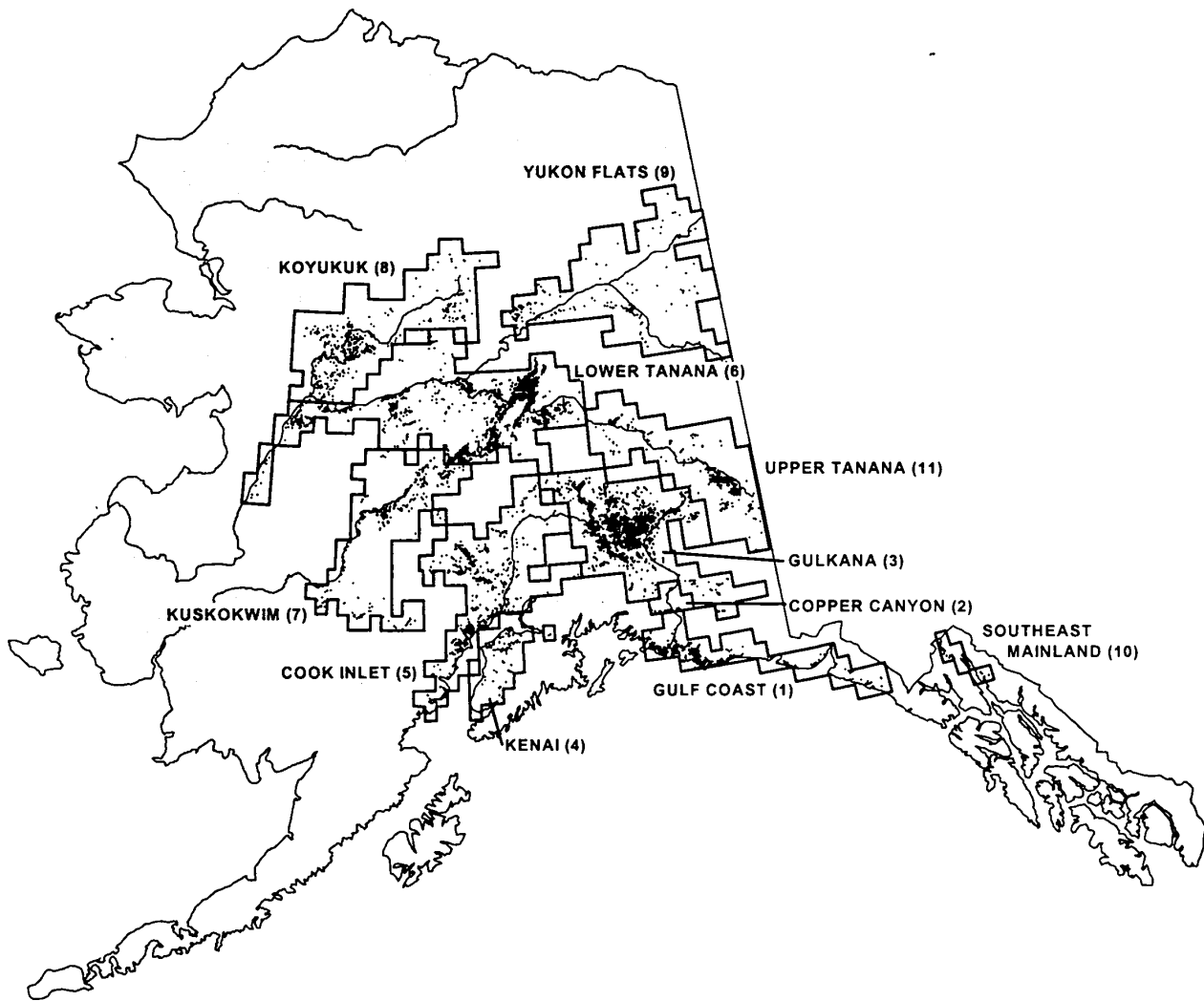


Figure 1. Eleven delineated units used to survey summering Trumpeter Swan in Alaska, covering 674 USGS maps of 1:63 360 scale. Each of the 5395 points represents a swan observation made during the 1995 census.

cases, secondary observers were used to increase detections made from the aircraft. Figure 2 defines the protocol followed by all contributors to the Alaska swan database.

Swan attribute data from completed maps were entered into an IBM-compatible PC computer. The exact latitude and longitude of each sighting was determined from the original survey maps with a IBM

compatible/Altek digitizing system in Juneau. These coordinates were then merged with the attribute data. The combined data are stored in a IBM-compatible PC in Juneau, which serves as the primary data storage bank for all Trumpeter census data for Alaska. Transparent map overlays, points on computer-generated maps of any scale.

Table 2. Protocol used for state wide Trumpeter Swan surveys in Alaska

**TRUMPETER AND TUNDRA SWAN SURVEY
PROTOCOL-1995**

The Alaska Region of the U.S. Fish and Wildlife Service (USFWS) has, over the years, developed field survey techniques and data archival procedures for Trumpeter and Tundra Swan surveys conducted in Alaska. An efficient, computer based data storage and retrieval system has evolved from which many useful products can be derived. The following protocol has been developed to enhance the standardization of data gathering and entry into the state-wide data base. This growing stockpile of Alaskan Swan data is increasing in value. We encourage all collectors of swan data to follow this protocol and contribute to the standard data base. All data and inquiries should be submitted directly to:

U.S. Fish and Wildlife Service
Migratory Bird Management
3000 Vintage Blvd., Suite 240
Juneau, AK 99801-7100

Keep in mind that, since the computer data entry system is specifically designed around the swan survey protocol, even slight deviations from the protocol can present major setbacks. Following these guidelines as closely as possible will help facilitate an efficient operation and reduce errors resulting from interpretation of non-standard data. Computer generated products can only reflect the quality of the data entered.

PROTOCOL:

Trumpeter Swans Survey completely all swan habitat within whole U.S. Geological Survey (USGS) 1:63,360 scale maps.

Tundra Swans Survey completely all swan habitat within whole or 1/4 quadrants of USGS 1:63,360 scale maps.

1. Sample units should consist of an entire 1:63,360 scale topographic map, or a one-quarter block of the map. Quarter blocks consist of NW, NE, SE, and SW quadrants of a map. Cover all known or suspected swan habitat within each sample unit (whole map or 1/4 map). The sample unit serves as a subsample of available habitat with known boundaries that can be surveyed on a regular basis. For areas where 1:63,360 scale maps are unavailable, 1:250,000 scale maps can be used,

but record data sequentially for each sample unit (1:63,360 map or 1/4 map).

2. Record flight line enroute to assure complete coverage of the map. Include a date (month/day/year) each time a flight line enters the sample unit. Display of flight lines with occasional directional arrows on the base maps also helps the person digitizing the observations (see example below).
3. Mark each observation on the map with a small dot to indicate the precise location. Do not circle observation numbers as this tends to obscure both numbers and observation points. Number all observations per sample unit (complete or 1/4 map) sequentially, and record the appropriate attributes along the map margin (do not use alpha characters, e.g., 1a, 1b, etc.). Recording data on separate sheets is not recommended. Where swans are dense it is important to concentrate your efforts on accurate counts and less precise positions.
4. Record the names of all pilot(s) and all observer(s) directly on each map.
5. Use this standard set of abbreviations for recording attributes on map margins (see example below).

Abbreviation	Meaning
Pr	Pair (do not use "P" or "2")
S	Single (do not use "1")
Flk	Flock (do not use "F" or "F1")
+	and
N	Nest
()	eggs

Examples	
Pr.	(pair)
Pr + 6	(pair + 6 young)
Flk 7	(flock of 7)
S	(single)
S + 5	(single + 5 young)
O + 4	(no adults, 4 young)
Pr. + N	(pair + nest)
S + N	(single + nest)
N(5)	(nest w/5 eggs)

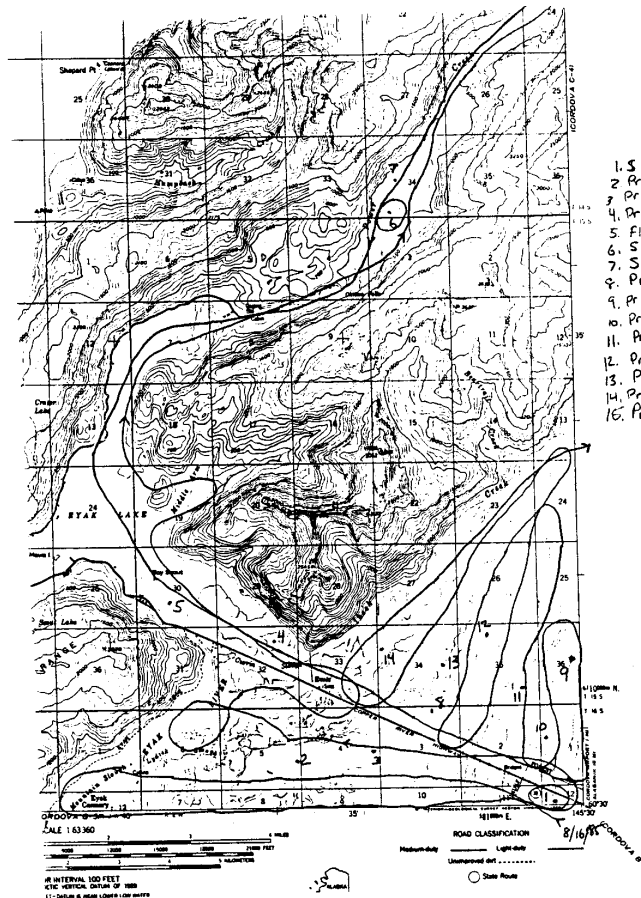
The following suggestions are offered to help avoid some typical problems we have encountered both during swan surveys and during the swan map digitizing.

1. Before submitting maps for digitizing, make absolutely sure all numbered attribute data have corresponding numbered observation points on the map and visa-versa. The "map review" is best done soon after the survey (preferably the same day) so that the observer can recall any omitted data.
2. Include only swan attribute data in the sequential list (i.e., do not include incidental species such as geese, moose, etc.).
3. Plot and number observations only within the map boundaries. Any observations made outside map boundaries should be transferred to the appropriate map.
4. Do not include observations from more than one sample unit in a sequential numbering system (i.e., each 1:63,360 quad or 1/4 quad must have its own, discreet attribute numbering system). When 1:250,000 scale maps are used, include a new numbering sequence for each 1:63,360 scale quad or 1/4 quad unit.

5. When submitting maps for digitizing, include only one original or copy of each map. If data were gathered on two maps, transcribe them onto one map with one sequential numbering system.
6. Try not to fold maps, and do not send maps folded (use tubes for mailing).
7. Try to get into the habit of recording all observations with the map oriented so that North is at the top (see example below).
8. Original survey maps are desirable to reduce possible transcription errors and reduce the field work. They must be legible and should be sent by certified mail or via an express mail service or at least copies kept at field stations to guard against loss during transit.

If you have any questions regarding the protocol described above, please call (907)586-7244 before submitting survey maps for digitizing.

Here is an example (reduced) of how a typical survey map should be submitted.



(e.g. Figure 1), tabular summaries, and computer-drawn graphs are examples of products that can be easily produced. Figure 3 shows examples of mapping products (reduced in size) that are available.

RESULTS

15823 Trumpeter Swans were observed during the 1995 surveys, up 19% from 1990. Results of the six statewide Trumpeter Swan censuses, conducted approximately every 5 years since 1968, show how the population has increased in size (Table 1, Figure 4). Numbers for single plus paired swans and the subtotal for all white swans (birds more than 1-year old) best show this population growth.

In 1995, there were 3184 swans in flocks, 7946 paired adults, and 859 single swans observed, making a total of 11989 white swans. Compared to 1990, the number of swans in flocks was up 56%, paired adults was up 13%, single swans was up 33%, and total white swans was up 23%.

The trend in numbers of white swans recorded for the six statewide counts varies by unit (Table 1, Figure 5). Increases in the density of swan numbers since 1975 is demonstrated by the increase in white swans recorded in units 1, 3, 5, and 6. Continued expansion of Trumpeters into the peripheral habitat in unit 3 and units 6-11 is shown in Table 1. This expansion is also evident by the increase in number of USGS maps surveyed within unit 3 and units 5-9.

Trumpeter Swan production, as measured in late summer, is summarized in Table 2 for the six census years. Average production is indicated by the values for average brood size, percent juvenile, and percent of pairs with broods. The number of cygnets and the number of broods both increased slightly, up 7-8% from 1990 to 1995. In 1995, there were 3834 cygnets, comprising 24% of the total population, compared to 27% of the population in 1990. 1218 broods were found, for an average brood size of 3.1 (3.2 in 1990).

Statewide distribution of all observation points for each of the six census years is shown in Figure 6. Figure 7 gives a comparison of the distribution patterns by unit for 1990 and 1995.

DISCUSSION

The 1995 census documented a slight decrease in the statewide annual rate of production from the 1990 census and from the overall average of the six censuses. Significant decreases were noted in the Gulf

Coast, Cook Inlet, Yukon Flats, and Upper Tanana (units 1, 5, 9, and 11) probably due primarily to the cool wet summer weather in those areas. Other areas, notably Gulkana, Lower Tanana, Kuskokwim, Koyukuk, and Southeast Mainland (units 3, 6, 7, 8, and 10) experienced average or slightly above average rates of production, mainly the result of an early spring breakup (Conant and Groves 1995).

The summering population of Trumpeter Swans continues to increase in Alaska but below the exponential rate of increase experienced in recent years. This continued growth is best reflected by the increase in the number of white swans recorded since 1968 (Figures 4, 8, and 9). Obviously, the population increase can not be sustained indefinitely, but it is still not apparent when the total summering population of Trumpeter Swans in Alaska will stabilize or even reverse.

A comparison of the population projections from 1990 and from 1995 shows that peak numbers projected now will be lower than previously predicted (Figure 10). The habitat appears to be saturated in the Gulf Coast (unit 1), Copper Canyon (unit 2), Kenai (unit 4), and Cook Inlet (unit 5) areas. For other units, various rates of increase have occurred (Figure 5). There appears to be a large amount of summer habitat (approximately 23000 km²) available on the Yukon Flats (unit 9) which is just beginning to fill with swans. The density of swan use in some of what is apparently the best habitat is still increasing (Gulkana, unit 3). Peripheral habitat is still being pioneered noticeably in the Gulkana (unit 3), Lower Tanana (unit 6), Kuskokwim (unit 7), Koyukuk (unit 8), and Upper Tanana (unit 11) areas.

If the earth is indeed warming as some suggest, more habitat may become available, and the 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. Planned additional analyses of these data for the adequacy of each census coverage 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, as well. There, swans are being displaced from good lake

SWANS - 1995

FAIRBANKS

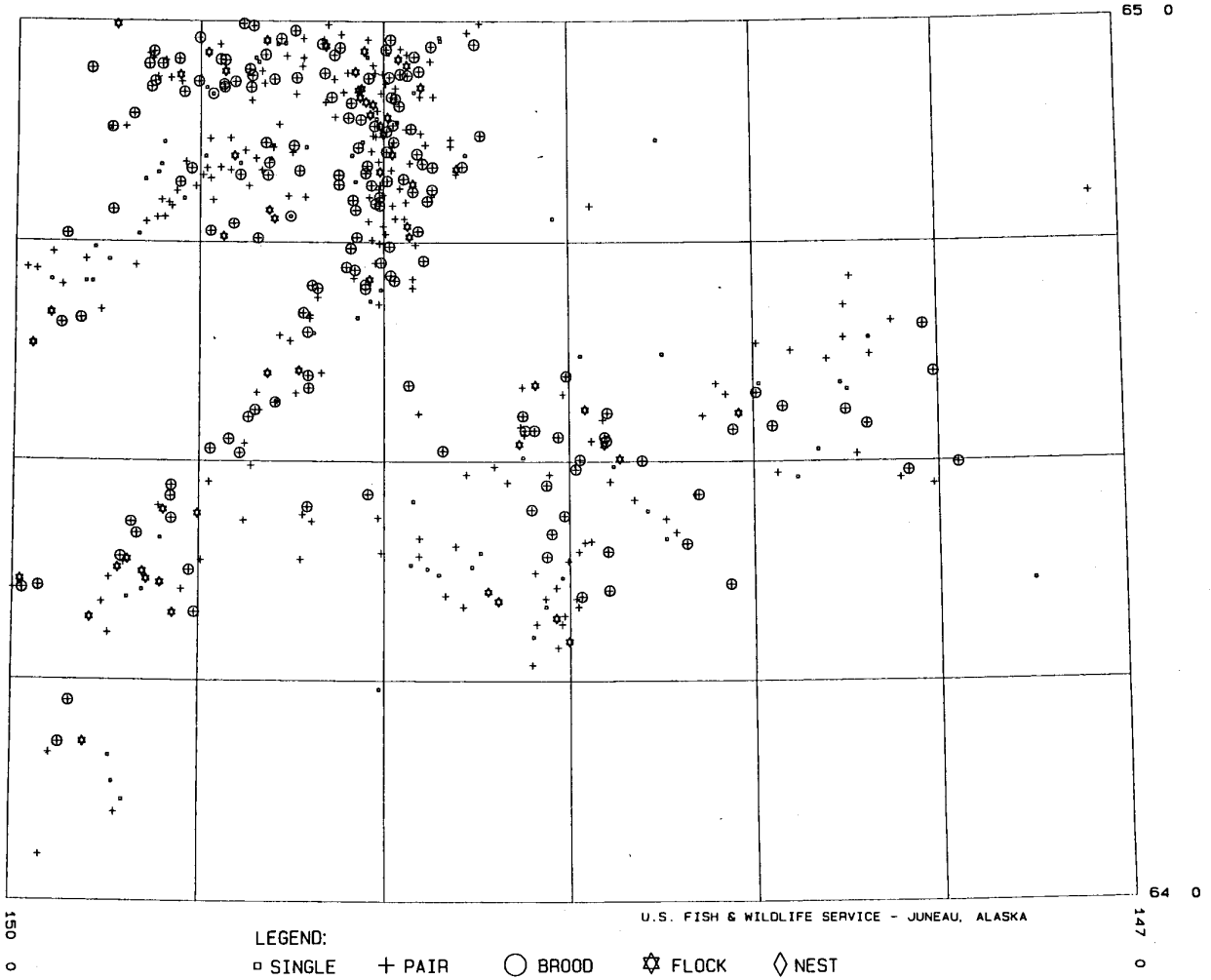


Figure 3a. Example of an overlay (reduced in size) for a U.S. Geological survey 1:250 000 scale map, one of several mapping products that are available from the Alaska swan database.

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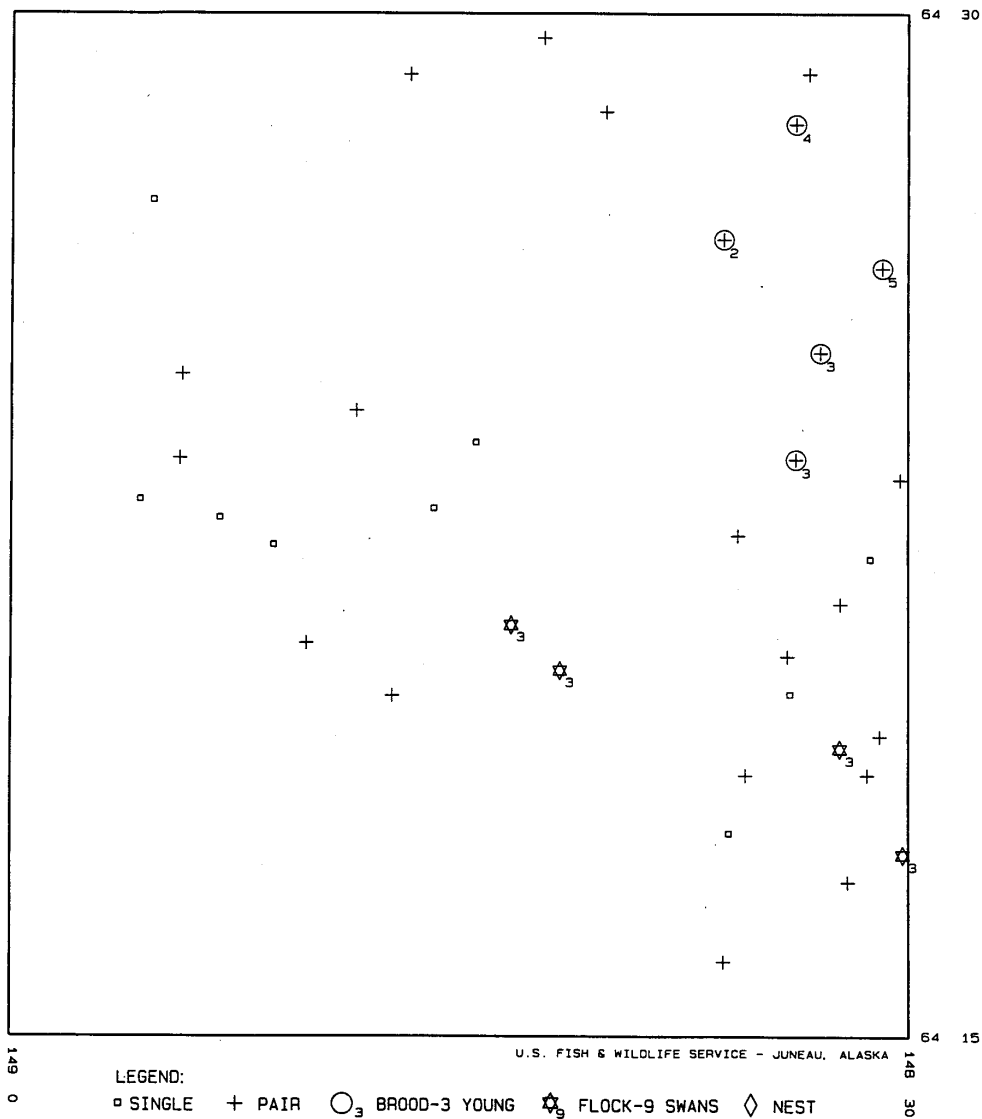


Figure 3b. Example of an overlay (reduced in size) for a U.S. Geological Survey 1:63 360 scale map, one of several mapping products that are available from the Alaska swan database.

and pond habitat because of recreational use (Timm and Wojcek 1978). Prior to 1985, the number of Trumpeter Swans in the Cook Inlet unit increased despite this displacement, due to the ability of Trumpeters to utilize beaver ponds and marshy areas not yet selected by people. However, since 1985, the numbers have failed to follow the population growth curve evident in most other similar units.

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 within their present distribution for their intrinsic value and the benefit of people

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

Unit	Year	White Swans				Total Cygnets	Total Swans
		in Pairs	as Singles	in Flocks	Total White		
1 Gulf Coast	68	442	29	191	662	363	1025
	75	442	32	190	664	193	857
	80	586	52	266	904	351	1255
	85	778	76	440	1294	164	1458
	90	666	59	205	930	434	1364
	95	628	72	295	995	150	1145
2 Copper River	68	56	5	53	114	44	158
	75	56	2	72	130	49	179
	80	70	4	33	107	33	140
	85	74	8	108	190	11	201
	90	88	7	0	95	21	116
	95	76	7	15	98	21	119
3 Gulkana	68	288	31	81	400	190	590
	75	556	43	155	754	284	1038
	80	1026	42	632	1700	660	2360
	85	1736	143	595	2474	533	3007
	90	2142	225	776	3143	778	3921
	95	2332	280	965	3577	1002	4579
4 Kenai	68	86	3	27	116	65	181
	75	72	5	29	106	39	145
	80	90	12	8	110	65	175
	85	92	5	40	137	51	188
	90	114	5	7	126	78	204
	95	130	11	29	170	79	249
5 Cook Inlet	68	224	19	50	293	124	417
	75	340	36	60	436	181	617
	80	608	38	186	832	369	1201
	85	800	66	454	1320	241	1561
	90	904	79	162	1145	516	1661
	95	838	91	269	1198	330	1528
6 Lower Tanana (Fairbanks)	68	224	21	94	339	137	476
	75	518	21	185	724	388	1112
	80	746	16	585	1347	773	2120
	85	1202	113	426	1741	503	2244
	90	2070	179	559	2808	1072	3880
	95	2268	219	987	3474	1315	4789
7 Kuskokwim (McGrath)	68						
	75	20	6	4	30	7	37
	80	60	0	22	82	63	145
	85	122	0	62	184	55	239
	90	386	21	141	548	233	781
	95	454	42	134	630	248	878
8 Koyukuk	68						
	75	94	6	45	145	35	180
	80	124	4	27	155	104	259
	85	206	23	29	258	45	303
	90	366	40	86	492	133	625
	95	524	56	158	738	228	966
9 Yukon Flats (Ft. Yukon)	68						
	75	2	0	0	2	1	3
	80	2	0	0	2	4	6
	85	10	0	0	10	3	13
	90	66	8	22	96	56	152
	95	200	26	107	333	90	423
10 S. E. Mainland (Chilkat Valley)	68						
	75	2	0	0	2	0	2
	80	6	0	3	9	11	20
	85	16	1	7	24	16	40
	90	34	1	23	58	50	108
	95	58	2	18	78	61	139
11 Upper Tanana (Fairbanks)	68						
	75						
	80	6	1	4	11	4	15
	85	84	14	43	141	64	205
	90	220	23	58	301	224	525
	95	438	53	207	698	310	1008
TOTAL	68	1320	108	496	1924	923	2847
	75	2102	151	740	2993	1177	4170
	80	3324	169	1766	5259	2437	7696
	85	5120	449	2204	7773	1686	9459
	90	7056	647	2039	9742	3595	13337
	95	7946	859	3184	11989	3834	15823

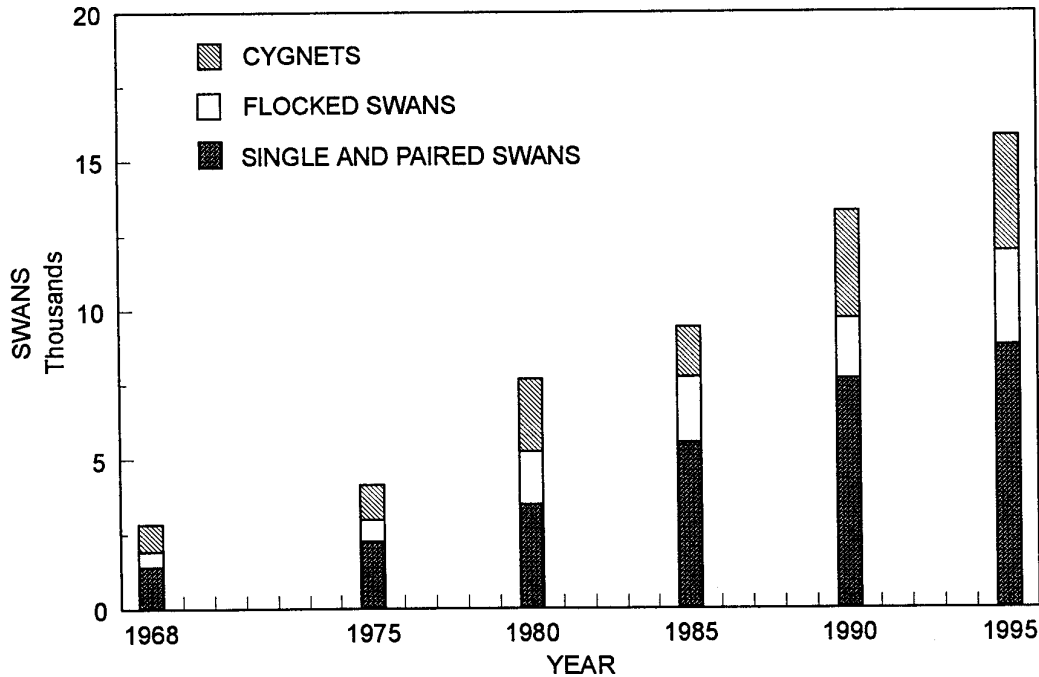


Figure 4. The number of Trumpeter Swans recorded in Alaska during six statewide summer censuses from 1968 to 1995 by age and adult group size.

The amount of area censused within the Trumpeter Swan summer range in Alaska continues to increase. The area surveyed was represented by 177 maps in 1968, 278 in 1975, 306 in 1980, 425 in 1985, 625 in 1990, and 674 in 1995. However, that factor is not the primary reason for the increase in the numbers of swans recorded. Personnel conducting statewide 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 increase were the increase in density on the previously censused 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 4, 8 and 9), the consequence of a number of recent years of good production.

Alaska hosts nesting populations of both Trumpeter Swans and Tundra Swans (*C. 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 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. With populations of both Trumpeter and Tundra Swans growing, 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 suggest 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.

Swans are quite visible from the air. The census is an exhaustive attempt to find and plot on maps all swans present, but an unknown proportion was missed. Poor light, pilot and observer fatigue, poor weather conditions, heavy cover, and other factors can cause swans to be missed. 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

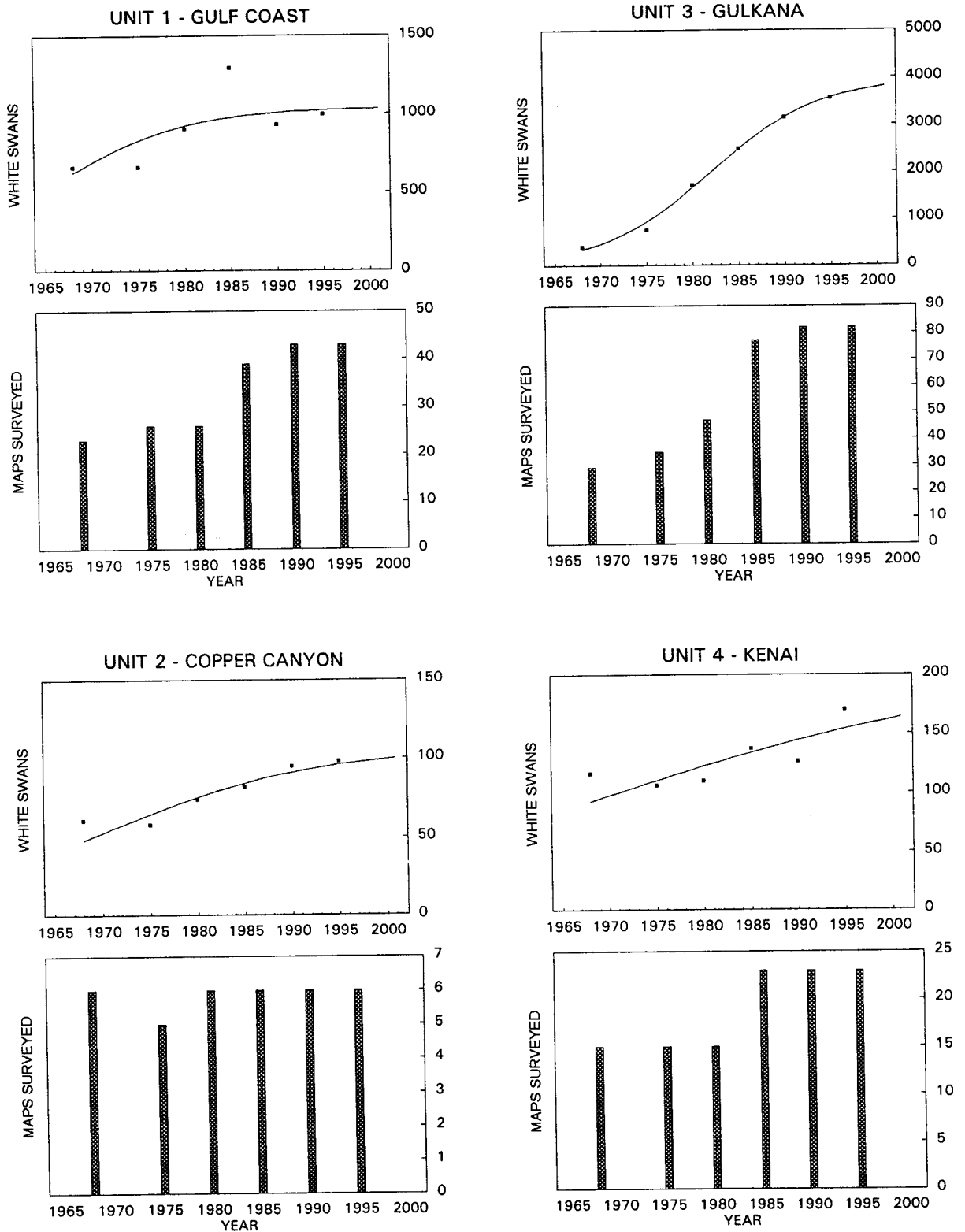


Figure 5a. Number of white phase Trumpeter Swans recorded within each unit, for units 1-4, during six censuses between 1968 and 1995, with fitted growth curves, and compared to the number of map areas covered by each census.

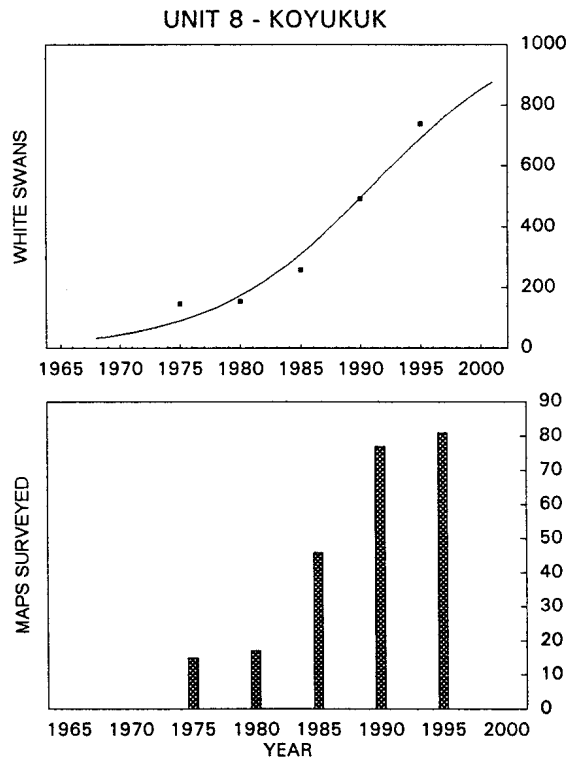
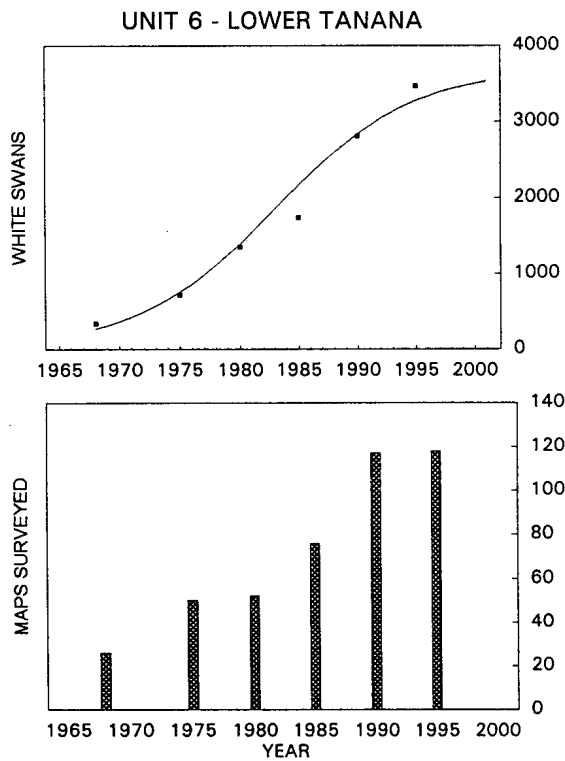
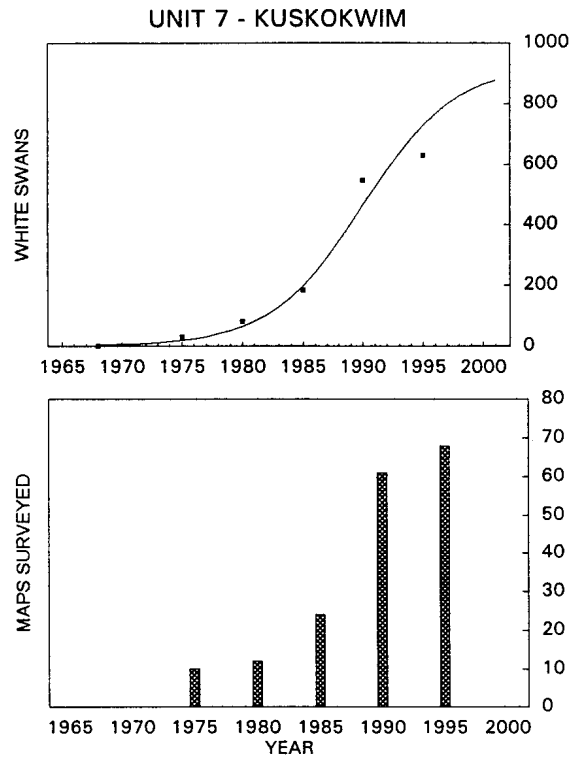
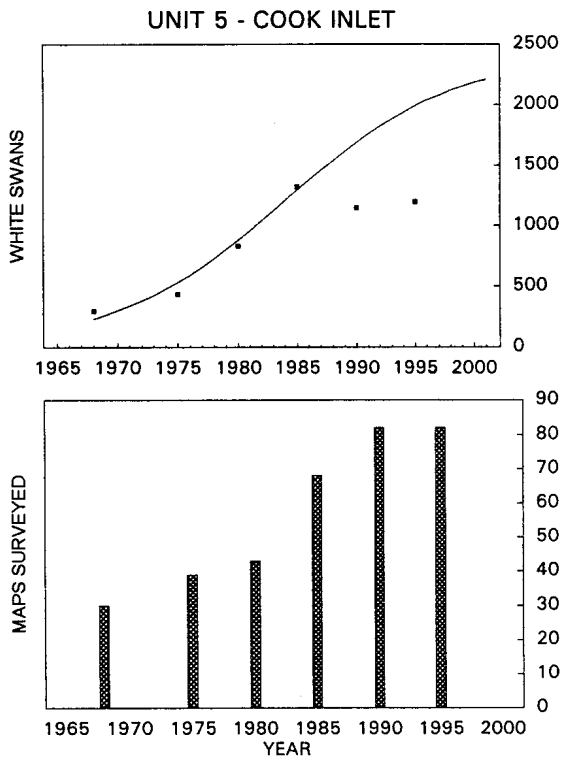


Figure 5b. Number of white phase Trumpeter Swans recorded within each unit, for units 5-8, during six censuses between 1968 and 1995, with fitted growth curves, and compared to the number of map areas covered by each census.

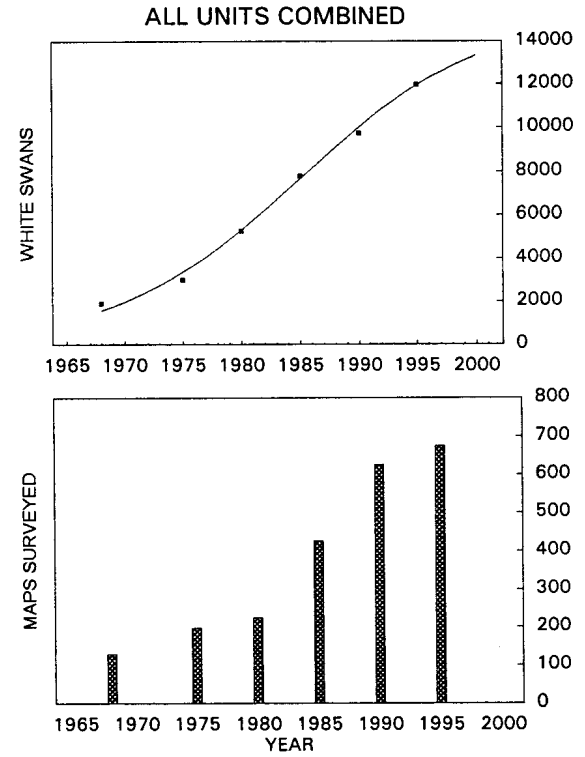
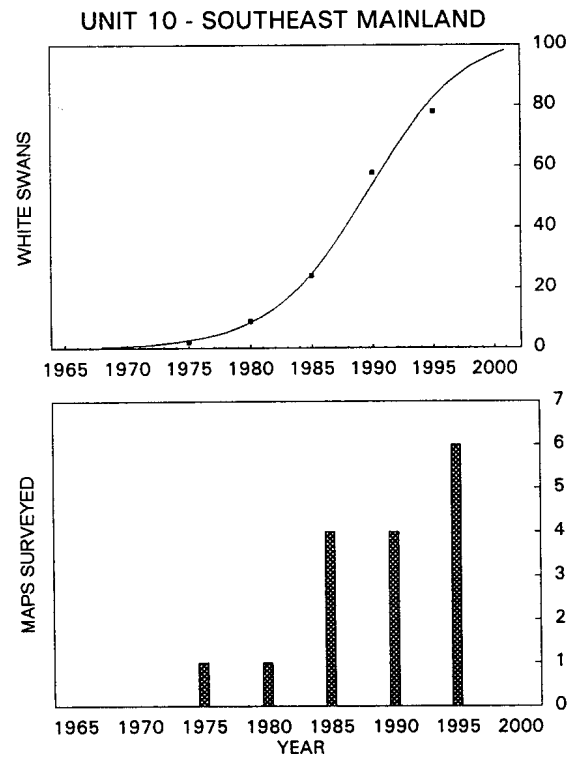
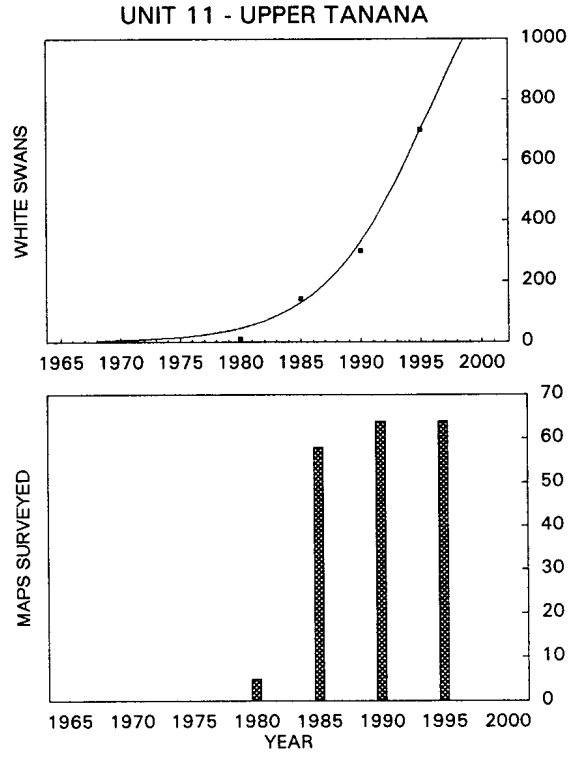
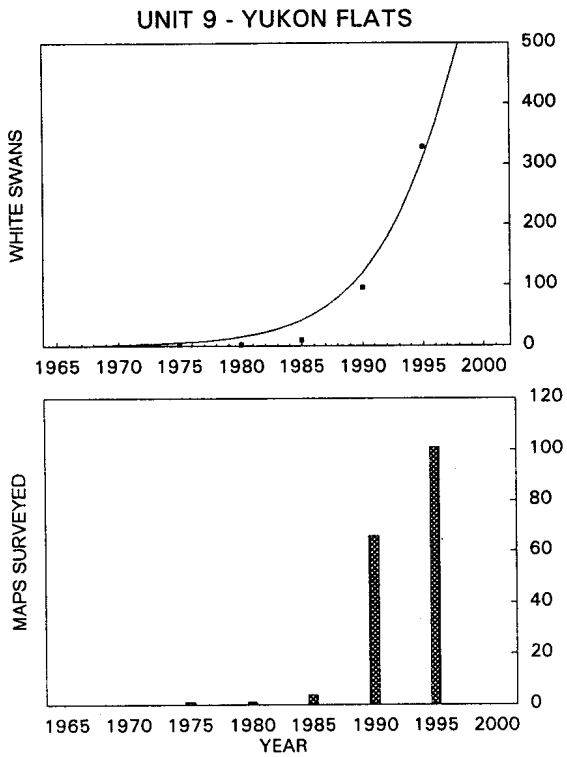


Figure 5c. Number of white phase Trumpeter Swans recorded within each unit, for units 9-11, and for all units combined during six censuses between 1968 and 1995, with fitted growth curves, and compared to the number of map areas covered by each census.

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

Unit	Year	Number of Cygnets	Number of Broods	Average Brood Size	Percent of Juvenile	Number of Pairs	Percent of Pairs with Broods
1 Gulf Coast	68	363	93	3.9	35	221	41
	75	193	61	3.2	23	221	27
	80	351	99	3.6	28	293	33
	85	164	57	2.9	11	389	14
	90	434	125	3.5	32	333	37
95	150	57	2.6	13	314	18	
2 Copper River	68	44	13	3.4	28	28	39
	75	49	16	3.1	27	28	57
	80	33	10	3.3	24	35	29
	85	11	3	3.7	5	37	8
	90	21	9	2.3	18	44	20
95	21	7	3.0	18	38	18	
3 Gulkana	68	190	52	3.7	32	144	36
	75	284	93	3.1	27	278	33
	80	660	194	3.4	28	513	36
	85	533	191	2.8	18	868	22
	90	778	276	2.8	20	1071	25
95	1002	310	3.2	22	1166	26	
4 Kenai	68	65	21	3.1	36	43	49
	75	39	15	2.6	27	36	42
	80	65	19	3.4	37	45	42
	85	51	16	3.2	27	46	35
	90	78	23	3.4	38	57	40
95	79	29	2.7	32	65	42	
5 Cook Inlet	68	124	36	3.4	30	112	29
	75	181	61	3.0	29	170	36
	80	369	103	3.6	31	304	34
	85	241	85	2.8	15	400	21
	90	516	157	3.3	31	452	34
95	330	107	3.1	22	419	25	
6 Lower Tanana (Fairbanks)	68	137	42	3.3	29	112	33
	75	388	112	3.5	35	259	42
	80	773	202	3.8	36	373	54
	85	503	179	2.8	22	601	29
	90	1072	336	3.2	28	1035	32
95	1315	426	3.1	27	1134	37	
7 Kuskokwim (McGrath)	68						
	75	7	3	2.3	19	10	30
	80	63	16	3.9	43	30	53
	85	55	18	3.1	23	61	30
	90	233	68	3.4	30	193	34
95	248	71	3.5	28	227	30	
8 Koyukuk	68						
	75	35	16	2.2	19	47	34
	80	104	36	2.9	40	62	55
	85	45	16	2.8	15	103	13
	90	133	50	2.7	21	183	26
95	228	85	2.7	24	262	31	
9 Yukon Flats (Ft. Yukon)	68						
	75	1	1	1.0	33	1	100
	80	4	1	4.0	67	1	100
	85	3	1	3.0	23	5	20
	90	56	18	3.1	37	33	55
95	90	25	3.6	21	100	25	
10 S. E. Mainland (Chilkat Valley)	68						
	75	0	0	---	--	1	--
	80	11	2	5.5	55	3	67
	85	16	3	5.3	40	8	38
	90	50	10	5.0	46	17	59
95	61	19	3.2	44	29	66	
11 Upper Tanana (Fairbanks)	68						
	75						
	80	4	1	4.0	27	3	33
	85	64	19	3.4	31	42	45
	90	224	53	4.2	43	110	48
95	310	82	3.8	31	219	37	
TOTAL	68	923	257	3.6	32	660	37
	75	1777	378	3.1	28	1051	35
	80	2437	683	3.6	32	1662	40
	85	1686	588	2.9	18	2560	23
	90	3595	1125	3.2	27	3528	31
	95	3834	1218	3.1	24	3973	30
6 Year Average				3.3	27		33

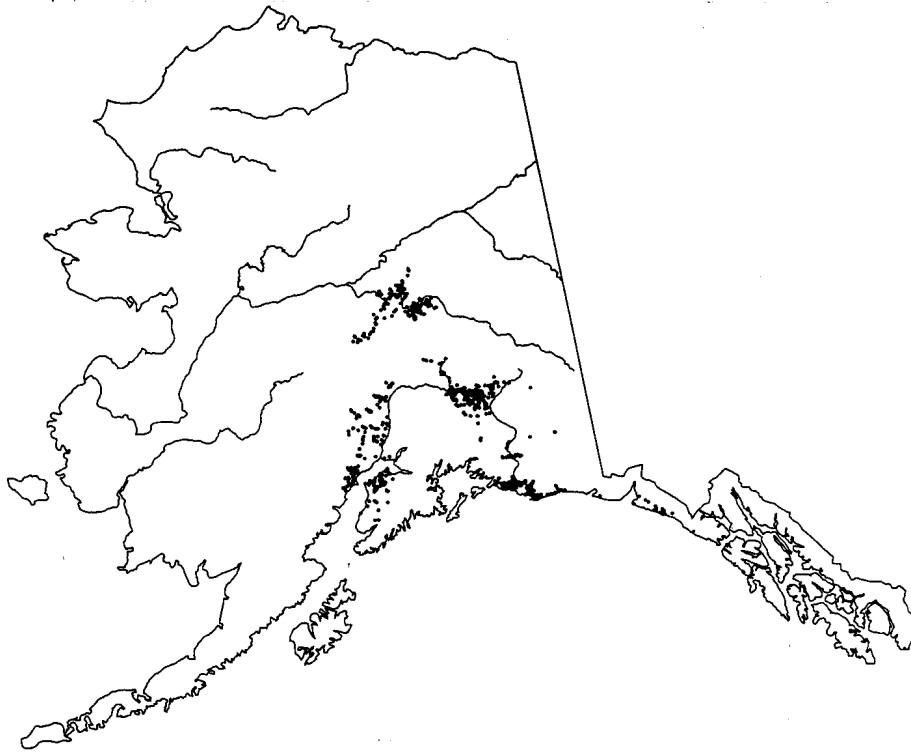


Figure 6a. 1968 Trumpeter Swan distribution in Alaska, based on 838 swan locations

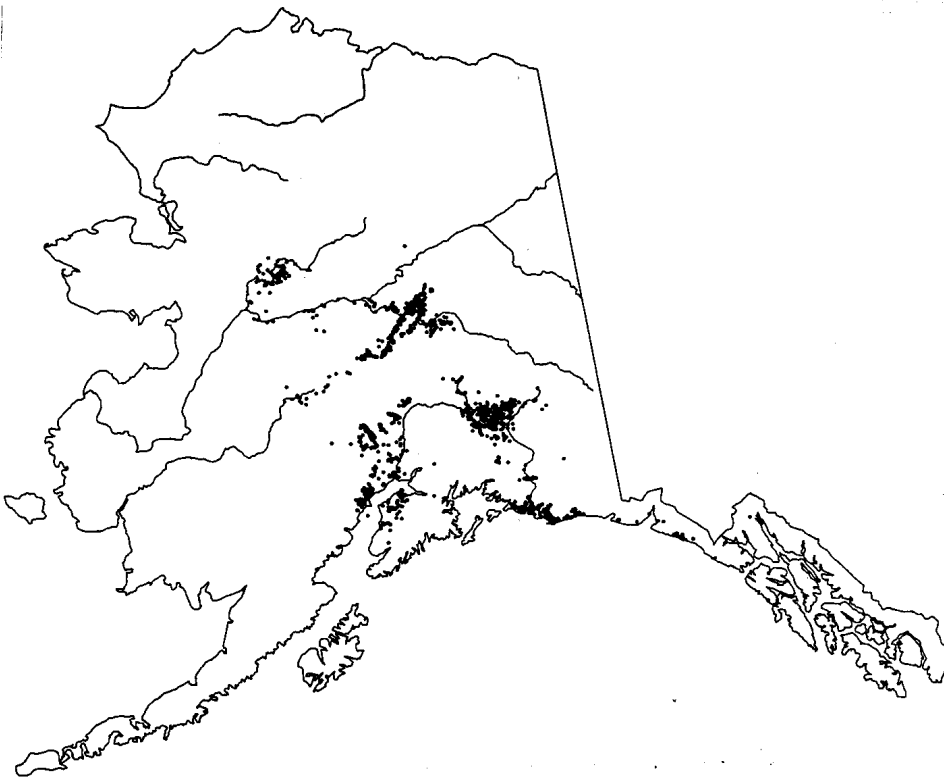


Figure 6b. 1975 Trumpeter Swan distribution in Alaska, based on 1329 swan locations

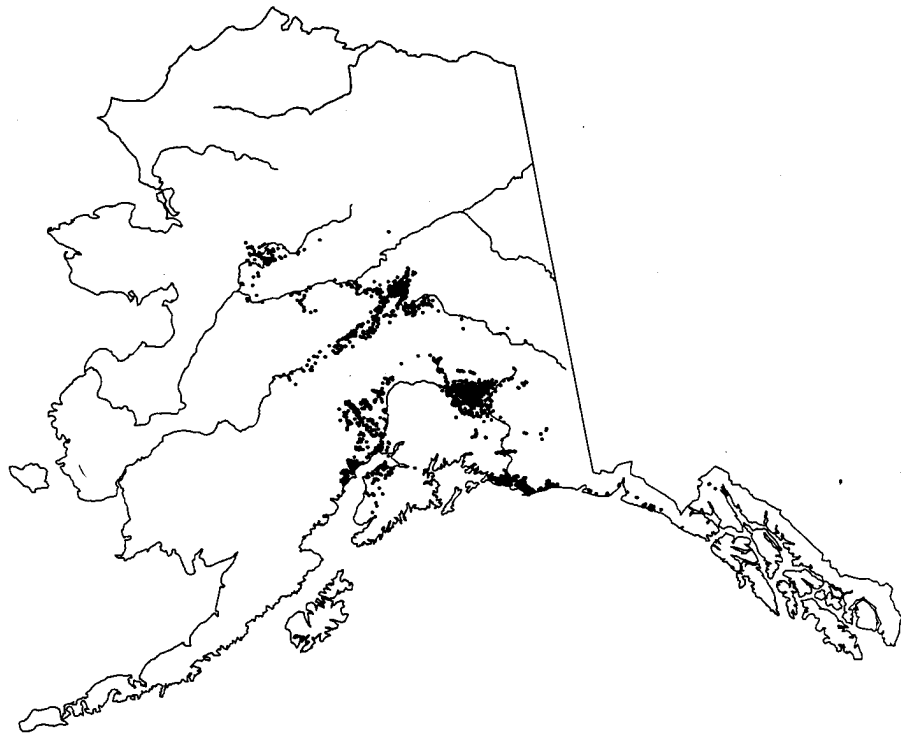


Figure 6c. 1980 Trumpeter Swan distribution in Alaska, based on 2043 swan locations

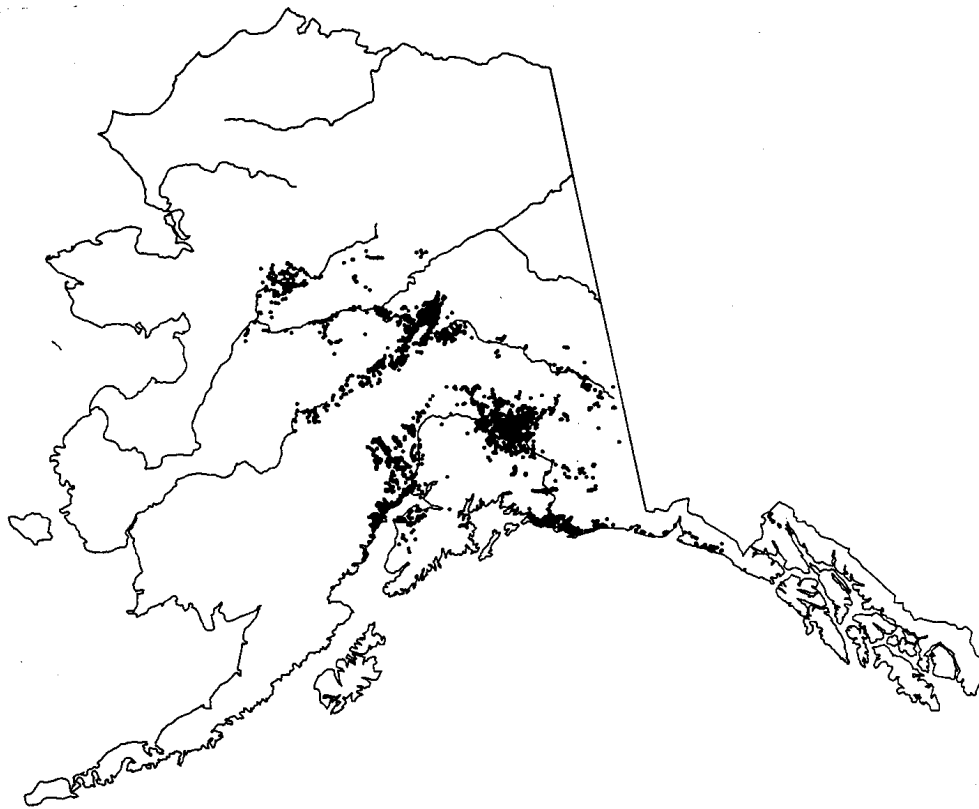


Figure 6d. 1985 Trumpeter Swan distribution in Alaska, based on 3327 swan locations

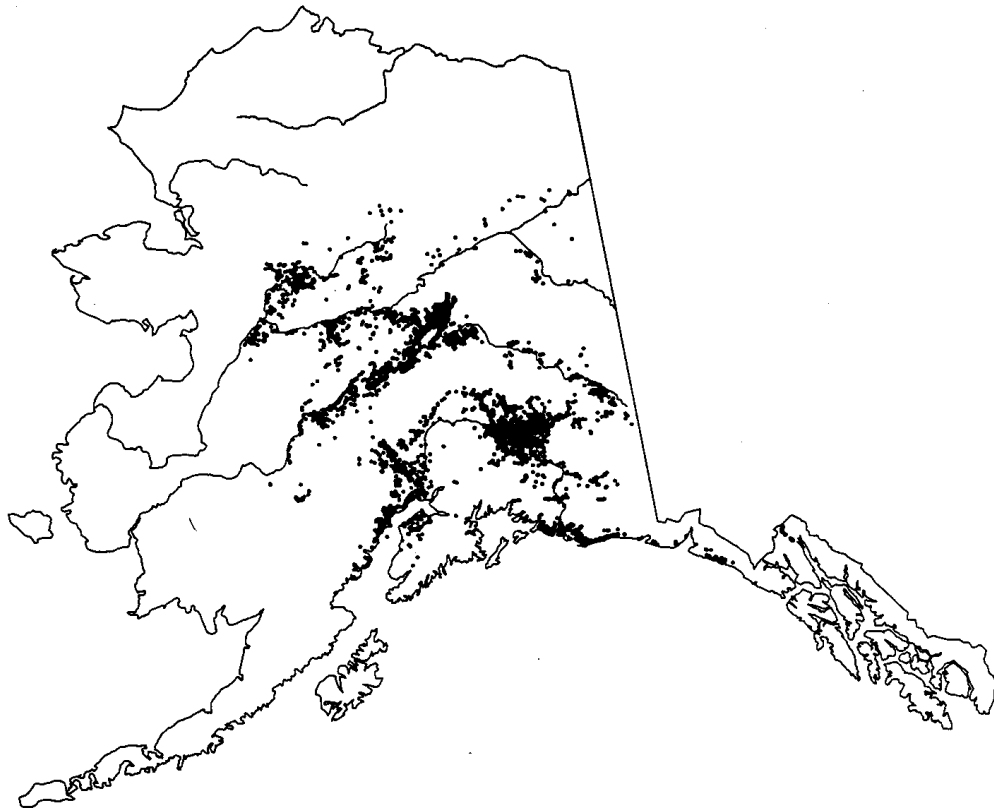


Figure 6e. 1990 Trumpeter Swan distribution in Alaska, based on 4503 swan locations

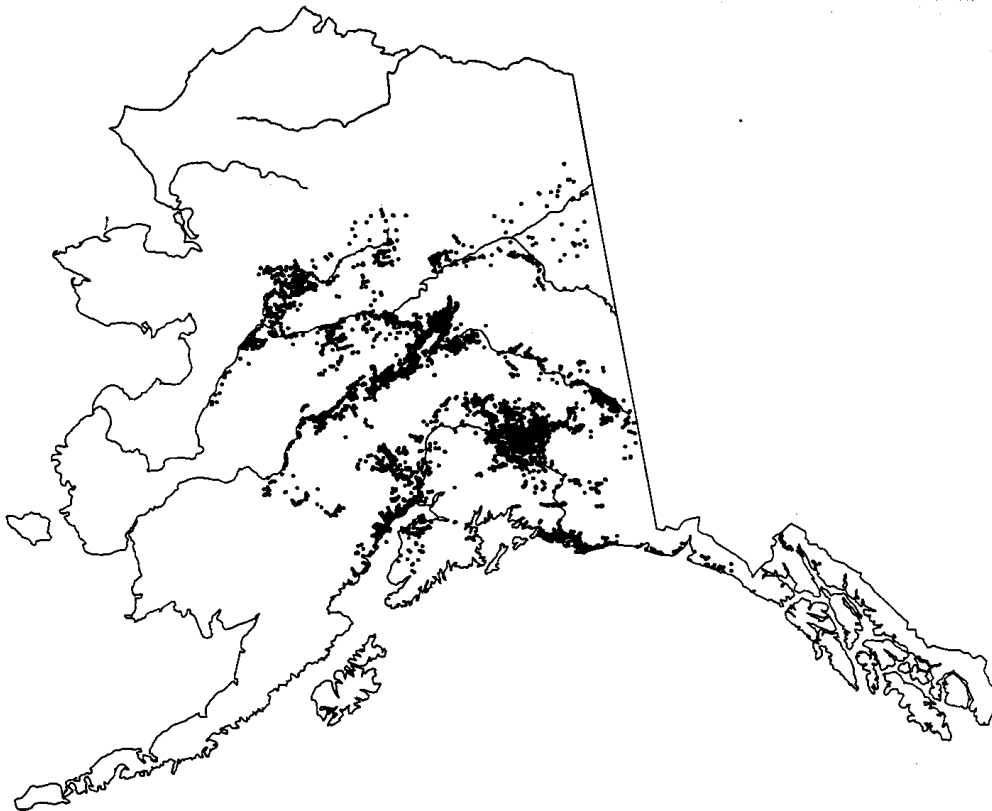


Figure 6f. 1995 Trumpeter Swan distribution in Alaska, based on 5395 swan locations

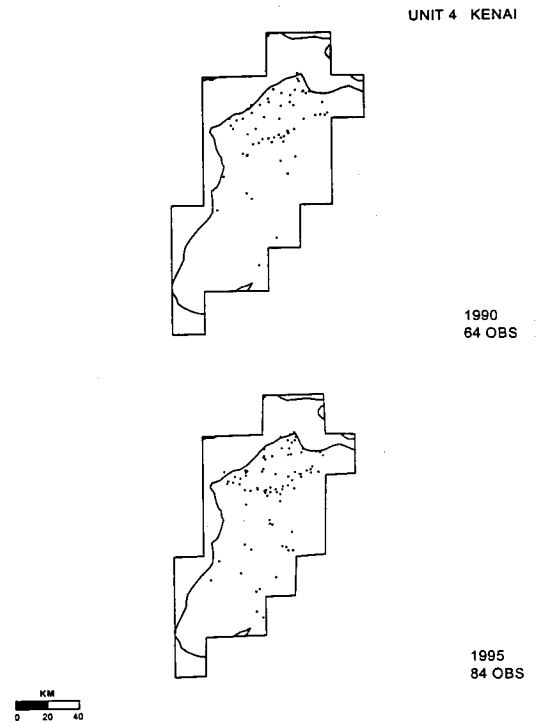
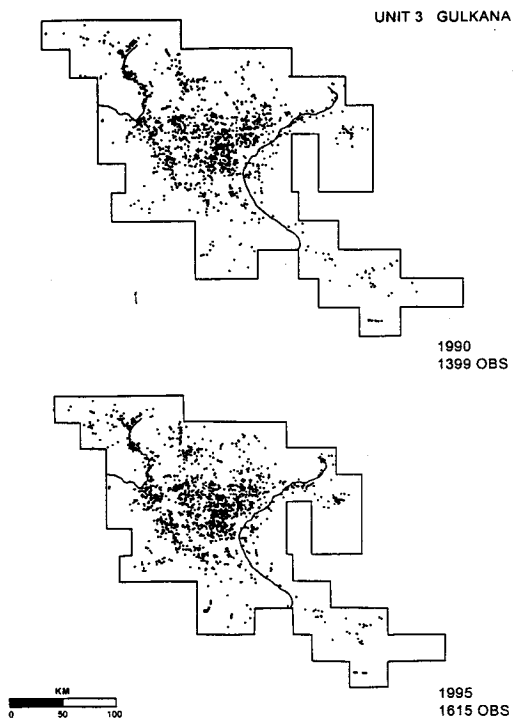
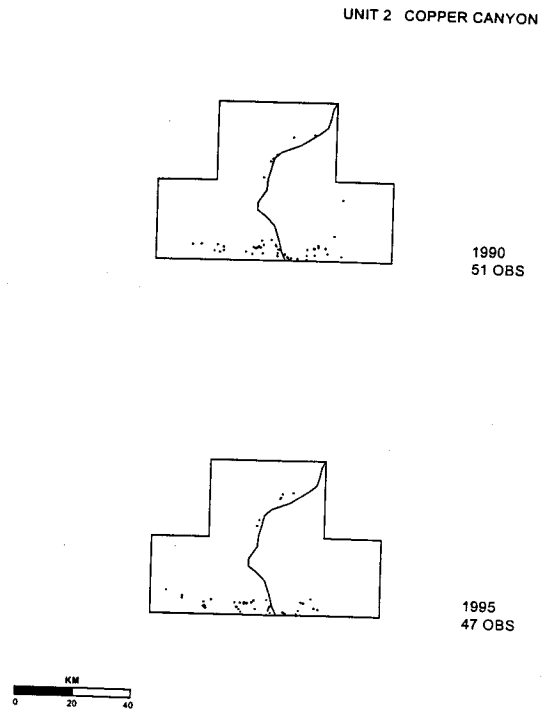
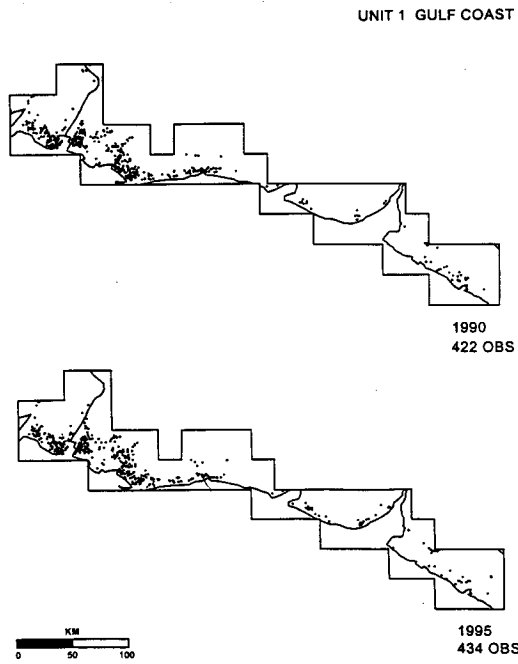


Figure 7a. Comparison of Trumpeter Swan distribution in 1990 and in 1995, by unit for units 1-4, as depicted by point locations from censuses in Alaska.

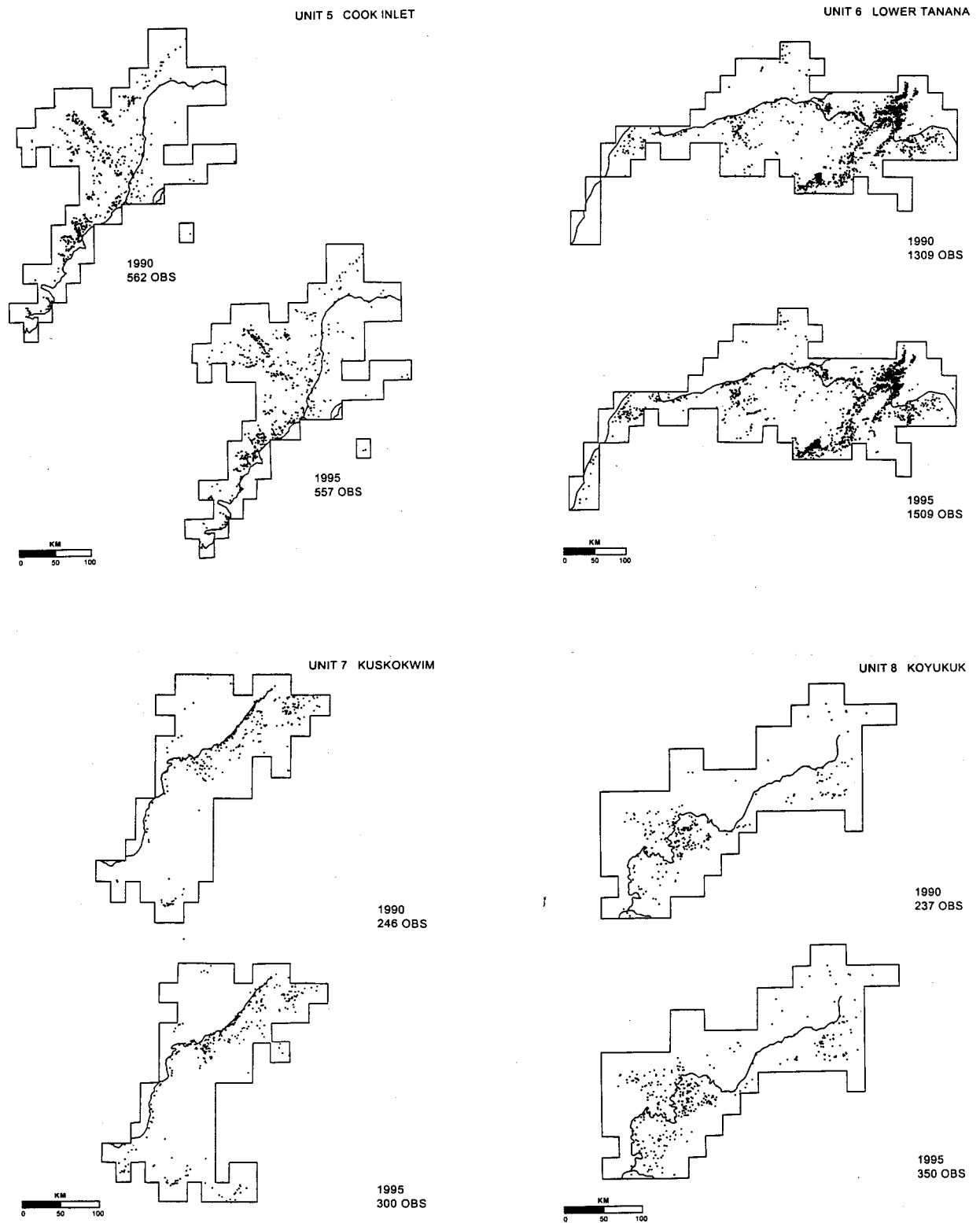


Figure 7b. Comparison of Trumpeter Swan distribution in 1990 and in 1995, by unit for units 5-8, as depicted by point locations from censuses in Alaska.

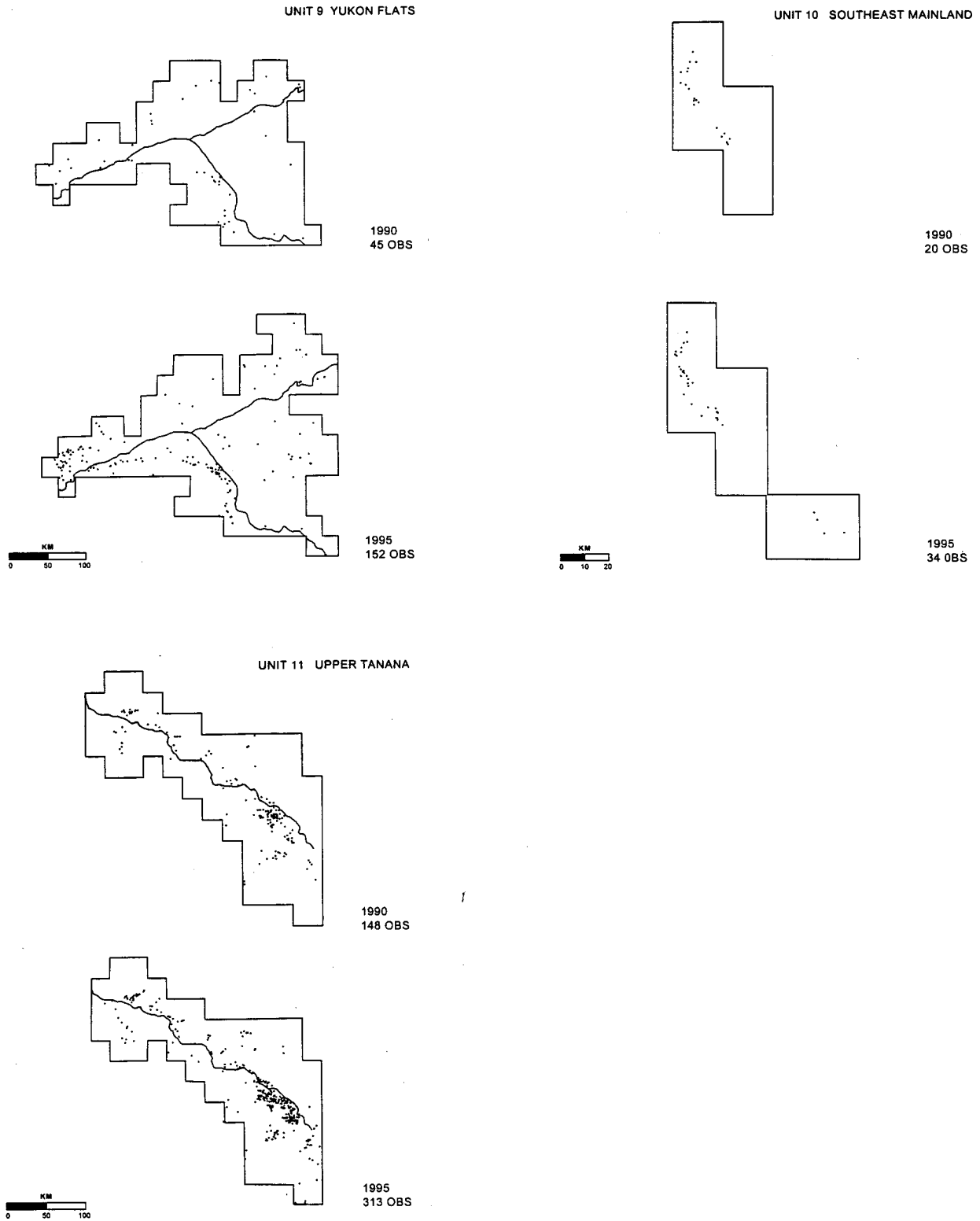


Figure 7c. Comparison of Trumpeter Swan distribution in 1990 and in 1995, by unit for units 9-11, as depicted by point locations from censuses in Alaska.

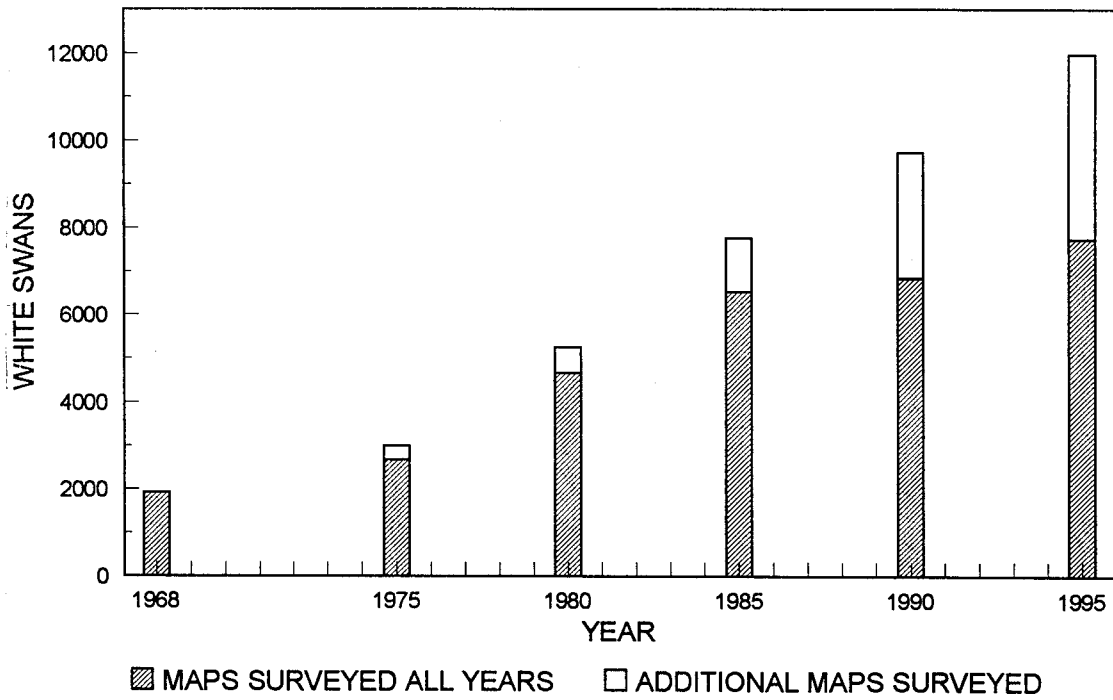


Figure 8. The number of white phase Trumpeter Swans in Alaska in high density habitats, as represented by map areas surveyed in all years of censusing, and in peripheral habitats, as represented by all other map areas surveyed.

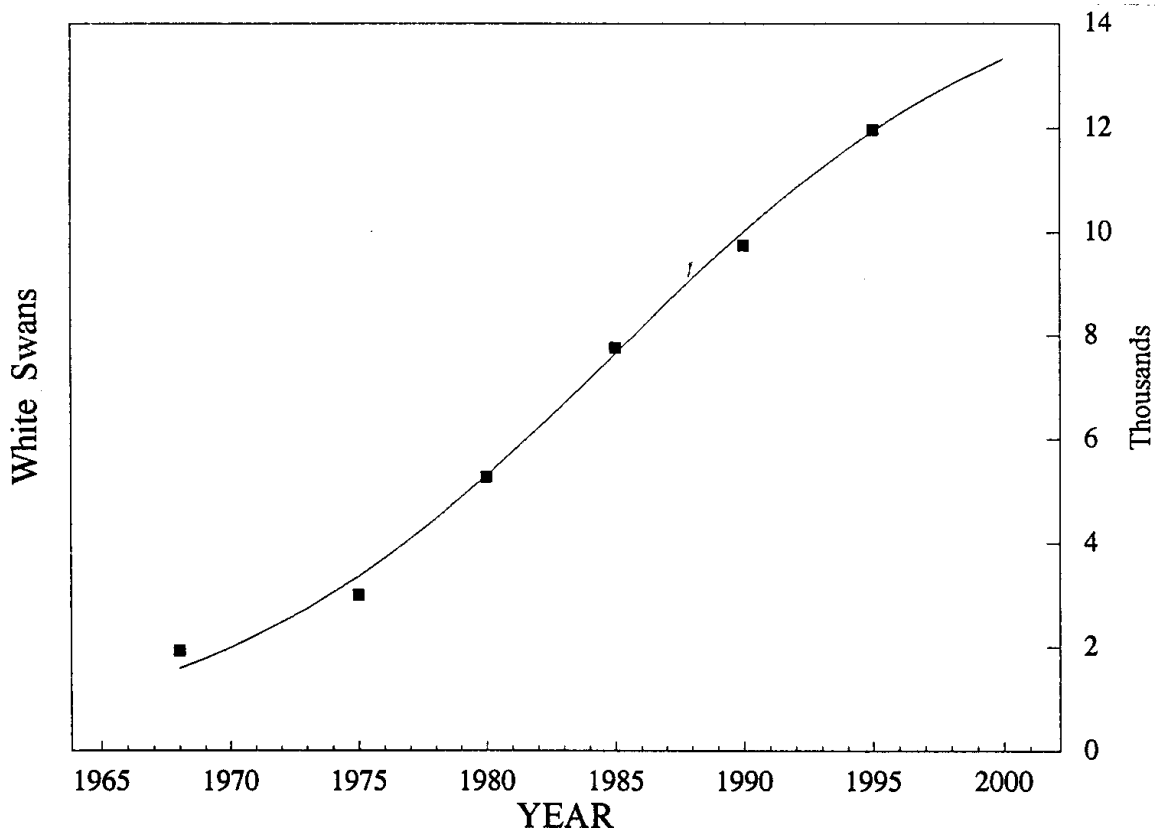


Figure 9. The number of white phase Trumpeter Swans recorded in Alaska during statewide summer censuses from 1968 to 1995, with a fitted growth curve.

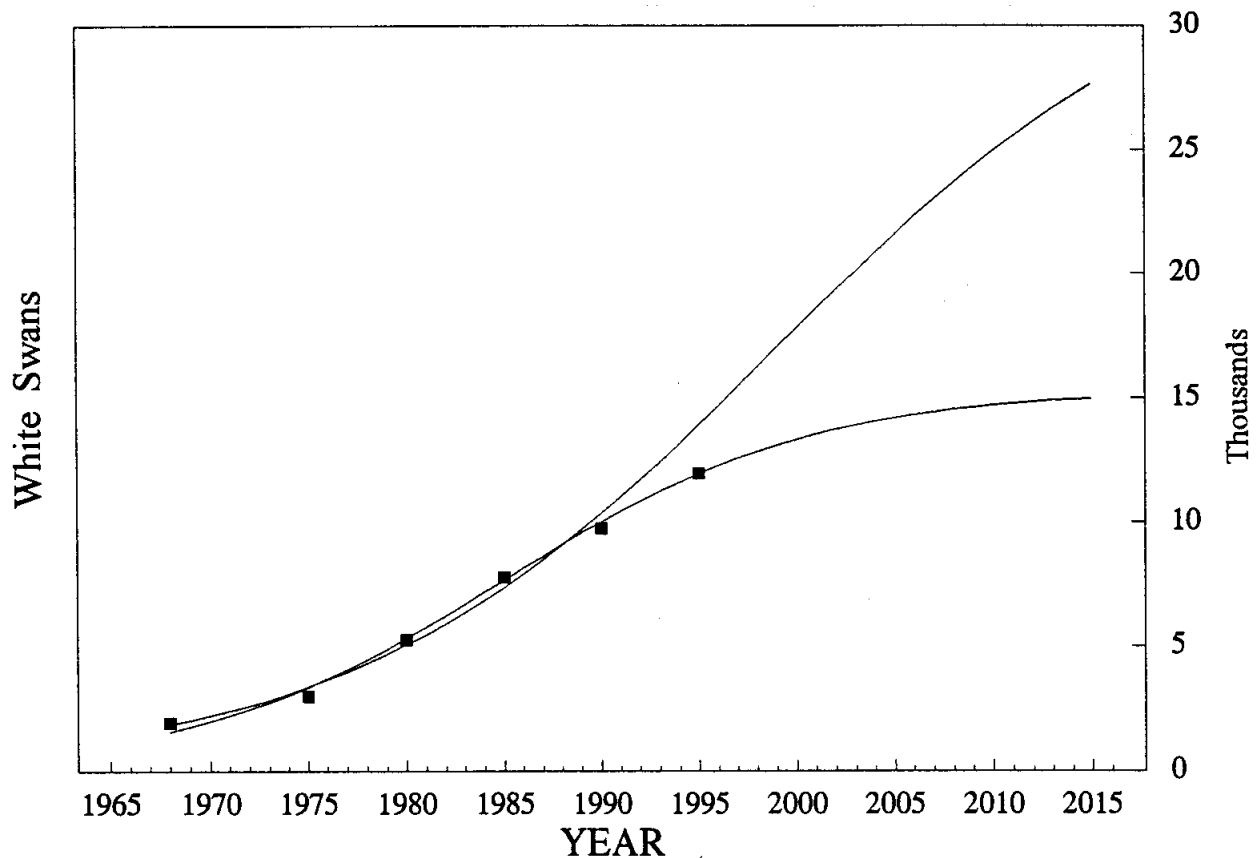


Figure 10. Comparison of the logistic growth curves fitted to the numbers of white phase Trumpeter Swans recorded on statewide summer censuses including the 1995 data (bottom curve) and excluding the 1995 data (top curve).

It is practical to monitor Trumpeter Swan populations in Alaska accurately with this census method. An integrated computer system for data entry, storage, and retrieval is in place. All swan data contributed on USGS maps in the prescribed format can be easily entered directly into this system. Computer generated map overlays can be quickly and accurately produced to meet planning and other swan data needs. Data manipulation and analysis are greatly facilitated with this system. Conversion to the ARC/INFO GIS format could further enhance the utility of the data by providing a format for the merging of the swan database with others, such as land ownership.

A stratified random sampling scheme was developed and used (Hodges *et al.* 1986) to better monitor the total Trumpeter population on Alaskan breeding grounds between the census years. Unfortunately, this survey was not repeated and only nonrandom sampling was used from 1987-89 and 1991-94 (Groves *et al.* 1994). A random sample could easily be re-employed to gather Trumpeter population data between census years.

We hope those wishing to continue or start collecting standardized Trumpeter population data will contribute to the computer-based storage system. A detailed data

collecting protocol has been developed and is available upon request. A continued complete census every 5 years is recommended to maintain the continuity of this impressive data set for better management of this magnificent international resource.

An Alaska Trumpeter Swan Atlas is available upon request (Conant *et al.* 1996). This two-volume set is a hard copy compendium of Trumpeter Swan information from the Alaska swan database. Volume I gives an overview of the Trumpeter Swan survey program in Alaska with tabular and graphic displays of all Trumpeter data through 1995. Volume II is a collection of reduced scale map overlays for all of the 1:250000 and 1:63360 scale USGS maps from the 1995 census in Alaska. A statewide conservation plan is envisioned as a Volume III addition to this set.

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