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WATERFOWL POPULATION STATUS, 1999

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In North America the process of establishing hunting regulations for waterfowl is conducted annually. In the United States the process involves a number of scheduled meetings in which information regarding the status of waterfowl is presented to individuals within the agencies responsible for setting hunting regulations. The proposed regulations are published in the *Federal Register* to allow public comment. This report includes the most current breeding population and production information available for waterfowl in North America and is a result of cooperative efforts by the U.S. Fish and Wildlife Service (FWS), the Canadian Wildlife Service (CWS), various State and Provincial conservation agencies, and private conservation organizations. This report is intended to aid the development of waterfowl harvest regulations in the U.S. for the 1999-2000 hunting season.

Cover art: Greater Scaup, by Jim Hautman, winner of the 1999-2000 Federal Duck Stamp design competition.

ACKNOWLEDGEMENTS

Waterfowl Population and Habitat Information: The information contained in this report is the result of the efforts of numerous individuals and organizations. Principal contributors include the Canadian Wildlife Service, U.S. Fish and Wildlife Service, 49 state wildlife conservation agencies, provincial conservation agencies from Canada, and Direccion General de Conservacion Ecologica de los Recursos Naturales, Mexico. In addition, several conservation organizations, other state and federal agencies, universities, and private individuals provided information or cooperated in survey activities. Appendix A provides a list of individuals responsible for the collection and compilation of data for the Ducks section of this report. Appendix B provides a list of individuals who were primary contacts for information included in the Geese and Swans section. We apologize in advance for omission of individuals from these lists, and thank all participants for their contributions. Without this combined effort, a comprehensive assessment of waterfowl populations and habitat would not be possible.

Authors: This report was prepared by the U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Branch of Surveys and Assessment. The principal authors are Khristi A. Wilkins and Evan G. Cooch. The authors compiled information from the numerous sources to provide an assessment of status of waterfowl populations.

Report Preparation: The preparation of this report involved substantial efforts on the part of many individuals. Graphic support was provided by Paul D. Keywood and D. Alan Davenport. Support for the processing of data and publication was provided by Mark C. Otto, James A. Dubovsky, William L. Kendall, Judith P. Bladen, David F. Caithamer, and Larry Strong (USGS, Northern Prairie Research Center). James A. Dubovsky, Judith A. Bladen, Fred A. Johnson, and Graham W. Smith reviewed drafts of this report and provided helpful comments. John Bidwell, Elizabeth Buelna, Carl Ferguson, Jim Goldsberry, Rod King, Fred Roetker, John Solberg, Phil Thorpe, James Voelzer, and James Wortham provided habitat narratives, reviewed portions of the report that addressed major breeding areas, and provided helpful comments.

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Annual reports on waterfowl population status are available on the Internet at:
http://www.fws.gov/r9mbmo/reports/reports.html

STATUS OF DUCKS

Abstract: This report summarizes the most recent information on the status of North American duck populations to facilitate development of harvest regulations in the U.S. The results in this report differ from those published in the earlier ATrends in Duck Breeding Populations, 1955-99." Because of recent changes, tables from the Trend Report, not normally included in the Status Report, will be included this year. The 1999 estimate for total ducks in the traditional survey area was 43.4 million birds, the largest population size estimated since operational surveys began in 1955. This is an increase (P<0.01) of 11% over that of 1998, and 32% higher (P<0.01) than the 1955-98 average. Mallard (*Anas platyrhynchos*) abundance was 10.8 million, the second largest population size estimated. This is an increase of 12% (P=0.01) over last year and 47% (P<0.01) greater than the long-term average. Blue-winged teal (*Anas discors*) abundance was 7.1 million, an all time high, and 65% greater than the long-term average (P<0.01). Northern pintail (*Anas acuta*), scaup (*Aythya marila* and *Aythya affinis*), green-winged teal (*Anas crecca*), and northern shoveler (*Anas clypeata*) numbers increased from 1998 estimates, while gadwall (*Anas strepera*) decreased (P<0.04). Gadwall, green-winged teal, northern shoveler, redheads (*Aythya americana*), and canvasbacks (*Aythya valisineria*) were above their respective long-term averages (P<0.05), while pintails and scaup remained below their long-term averages (P<0.01). American wigeon (*Anas americana*) numbers were unchanged from last year or from long-term average. May habitat conditions in the traditional survey area were generally good to excellent, except for a few dry areas primarily in southern and central Alberta, Montana, and central Saskatchewan. The number of May ponds in the traditional survey area was 6.7 million, an increase of 46% over 1998 and 37% above the long-term average (P<0.01). In the eastern areas of Canada and the U.S. (strata 51-56 and 62), the total number of ducks (1.2 million) remained unchanged from last year and the 1995-98 average (P<0.10). Numbers of individual species in the east were similar to those of last year (P $ 0.10), except for goldeneye (*Bucephala clangula* and *B. islandica*), which were 196% greater than 1998 levels, and scaup, which were 93% below 1998 levels. Goldeneye were above their 1995-98 average, while blue-winged teal and scaup were below (P<0.03). Habitats in the east were somewhat drier than last year, and conditions were overall not as favorable for waterfowl production. The estimate of the total-duck fall-flight index is105 million birds, compared to 84 million last year. The fall flight is predicted to include 13.6 million mallards, 16% greater (P<0.01) than the estimate of 11.8 million in 1998.

METHODS

Breeding Population and Habitat Survey

Federal, provincial, and state agencies conduct surveys each spring to estimate the size of breeding populations and to evaluate the condition of habitats. These surveys are conducted using fixed-wing aircraft and encompass principal breeding areas of North America. The traditional survey area (strata 1-18, 20-50, and 75-77) is comprised of parts of Alaska, Canada, and the northcentral U.S. (Appendix C). The eastern survey area (strata 51-56 and 62) includes important breeding areas for waterfowl that winter in the eastern U.S. Surveys in strata 51-56 were initiated in 1990, and have continued to the present. In 1995, the survey was extended into Maine (stratum 62), and estimates have been incorporated into those for the eastern survey area. Beginning in 1996, additional areas in eastern Canada (New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, southern Quebec) were surveyed. Surveys in these areas remain experimental pending reviews of survey design, and estimates have not been included in this document. In Prairie Canada and the northcentral U.S., estimates of ducks and ponds seen from the air are corrected annually for visibility bias by conducting ground counts. In northern portions of the traditional survey area and in the eastern survey area, duck estimates are corrected using visibility rates derived from a comparison of airplane and helicopter counts. Helicopter counts are performed in select strata each year. Annual estimates of duck abundance are available since 1955 for the traditional survey area, and since 1990 for the eastern survey area. In the traditional survey area, estimates of pond abundance in Prairie Canada are available since 1961, whereas estimates for the northcentral U.S. are available since 1974. Several provinces and states also conduct breeding waterfowl surveys using various methods; some have survey designs that allow calculation of measures of precision for estimates of duck abundance. Habitat information is primarily supplied by biologists in the survey areas. However, much ancillary weather information was obtained from one serial publication and two internet sites, referenced at the end of this document.

Production and Habitat Survey

In July, aerial observers assess summer habitat conditions and duck production in a portion of the traditional survey area (strata 20-49 and 75-77) (Appendix C). This survey provides estimates of the number of duck broods (brood index) and the number of ponds. Because ground counts are not conducted concurrently with aerial surveys, estimates of the numbers of duck broods and ponds are not corrected for visibility bias. The coefficients of variation for the May pond estimates are used to estimate the precision of the July pond counts.

Fall-flight Indices

Total Ducks.--The fall-flight index of total ducks (excluding scoters [*Melanitta* spp.], eiders [*Somateria* and *Polysticta* spp.],

oldsquaws [*Clangula hyemalis*], mergansers [*Mergus* and *Lophodytes* spp.], and wood ducks [*Aix sponsa*]) is based on information from the breeding population and production surveys in the traditional survey area and breeding population estimates from six states (California, Colorado, Minnesota, Nebraska, Wisconsin, and Wyoming). This index is calculated using base production rates that represent the relative recruitment potential from each survey area. For regions encompassing Prairie Canada and the northcentral U.S. (strata 21-50), production rates are adjusted annually using production indices. Constant values are used for production rates in Alaska (strata 1-11), portions of northern Canada (strata 12-18, 20 and 75-77), and states conducting cooperative surveys because year-specific production information is not available. Recent analyses suggest that base production rates used historically are too high given our current knowledge of changes in duck abundance and survival rates, and should be reviewed. Because production surveys are not conducted annually throughout all areas and no corrections for visibility bias are calculated, the accuracy and precision of the fall-flight estimates are unknown. Therefore, the fall-flight index may be of marginal utility.

Mallards.--Mallard fall-flight indices predict the size of the fall population originating from the midcontinent region of North America. For management purposes, the midcontinent population is comprised of mallards originating from the traditional survey areas, as well as Michigan, Minnesota, and Wisconsin. The indices are based on the mallard models used for Adaptive Harvest Management, and consider breeding population size, habitat conditions, adult summer survival, and the projected fall age ratio (young/adult). The fall age ratio is predicted using the relationship between fall age ratios, breeding populations, and May pond numbers. Values for these fall-flight estimates are influenced by current understanding of the biology of mallards. As this understanding improves, values of the fall-flight indices will change.

RESULTS AND DISCUSSION

1998 in Review

The winter of 1997-98 was one of the warmest on record for Canada and the United States, due in part to El Niño induced weather currents. Only the northeastern area of Canada experienced below normal temperatures. The winter of 1997-8 was very dry across much of Canada, from the Yukon south through the Rockies to Saskatchewan, and in Quebec, Ontario, and Newfoundland in the east. Contrasting this, much of the U.S. was wetter than normal last winter, with record snowfalls along the East Coast and heavy rains in the Southeast and California.

The spring of 1998 was the warmest on record in Canada, and continued to be drier than normal in much of Canada. Temperatures in the northwestern corner of Northwest Territories and northern Yukon were as high as 8EC above average. Only parts of northeastern Canada to the Arctic Circle and small areas in southern British Columbia, Alberta, and Manitoba were wetter than normal in Canada last spring. The U.S. continued to be generally cool and wet, especially in the Great Plains and California. Wetland numbers in Prairie Canada and the northcentral U.S. in May 1998 (4.6 million) were 6% below the long-term average for this area as a whole (P=0.06); 27% below average in Prairie Canada and 43% above average in the northcentral U.S (P<0.01). The 1998 breeding population of ducks in the traditional survey area was 39.1 million birds, an 8% decrease from 1997 (P<0.01), but still 20% higher than the long-term average (P<0.01). Mallard, gadwall, green-winged teal, blue-winged teal, northern shovelers, redheads, and canvasbacks were above their long-term averages (P>0.04 for all); American wigeon was at its long-term average; and northern pintails and scaup were below their long-term averages (P<0.01 for both).

The summer of 1998 was the warmest on record in Canada, with all areas except the southern edges of Saskatchewan, Manitoba, Ontario, Quebec, and the Maritimes experiencing above normal temperatures. The U.S. was also generally warmer than normal. On average, Canada was wetter than normal last summer, although most of the prairies and eastern provinces were drier than normal. The western U.S., Midwest, and New England were excessively wet, while much of the south was in a severe drought. The estimate of ponds in July 1998 was 61% above the long-term average in the traditional survey area; +69% in prairie Canada and +56% in the northcentral U.S. (P<0.01). The number of broods in Prairie Canada 1998 decreased 52% from 1997 and was 54% below the long-term average. In the northcentral U.S., the number of broods counted was the second highest on record, and was 156% above the long-term average. The fall flight of total ducks in 1998 was estimated at 86.5 million birds.

Continuing 1998's record setting high temperatures, the fall of 1998 was the warmest fall on record in Canada, with only small areas of the Maritimes, southern Yukon Territory to northern British Columbia, and central Alberta experiencing normal to below normal temperatures. The U.S. was also warmer than normal across most of the country, including the north coast of Alaska. Much of the southern and eastern provinces experienced normal to below normal precipitation, with small patches of southern British Columbia, central Alberta, and Manitoba, and most of southern Saskatchewan receiving more rain than normal. In the U.S., abundant precipitation helped to end drought in much of the plains and Gulf states, although drought continued in the mid-Atlantic and Tennessee Valley regions.

During the winter of 1998-99, temperatures were above normal in almost all regions of Canada. Temperatures in the U.S. were well above average from the Northern Plains to the Northeast, and average in western and southwestern states. However, Alaska sustained a severe cold snap in late January/early February, the most widespread and longest lasting in 10 years. Canada experienced near normal precipitation on average, but variability among regions was high. The prairie provinces, Ontario, Quebec, and the

Maritimes were drier than normal, while British Columbia and the Northwest Territories were wetter than average. The winter of 1998/99 was warmer and dryer than usual across southern Ontario and southern Quebec. Although precipitation was average for the U.S. as a whole, the Pacific Northwest received record amounts of rain and snow, while much of the east returned to drought conditions. January weather was particularly severe in the U.S., with record numbers of tornadoes, crippling ice and snowstorms in the east and Midwest, and torrential rain and flooding in areas of the Ohio Valley to the Gulf Coast. In summary, Canada and the U.S. were both generally warmer than average during 1998-99, with Canada having its warmest year on record, while precipitation varied regionally.

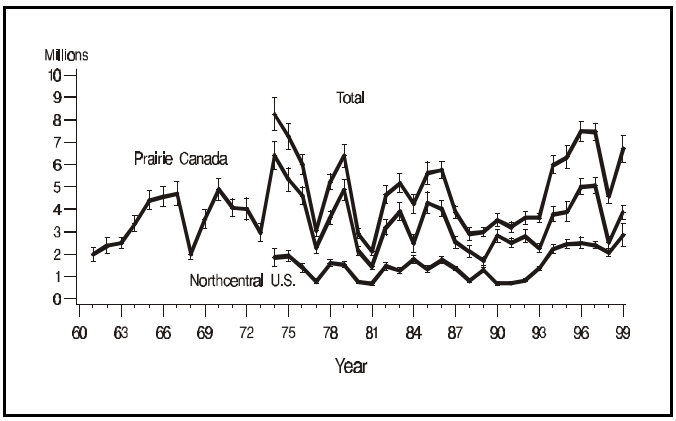


Fig. 1. Number of ponds in May and 95% confidence intervals for Prairie Canada and the northcentral U.S.

1999 Breeding Habitat Conditions, Populations, and Production

OVERALL STATUS

The spring of 1999 was very cool in the west, due to the cooling effects of the La Niña weather pattern. This delayed snowmelt, resulting in record snowpack late in the season, and delayed the arrival of spring by 1-2 weeks in Alaska, British Columbia, Washington, and Oregon. In the northern prairies of Canada and parts of Ontario, continued warm and dry conditions combined to cause an unusually high number of brush fires. Temperatures generally were below normal in the west and above normal in the east. While the eastern U.S. remained unusually dry, spring rain was greater than 150% of normal in the Plains, Midwest, and the Dakotas.

Breeding habitat conditions in the traditional survey area generally were good to excellent, and overall better than conditions in 1998. An early warm spring and copious precipitation resulted in abundant ponds and excellent nesting cover in most of the Dakotas, northern Saskatchewan, the Northwest Territories, and western Ontario. The exceptions to these good conditions were southern and central Alberta, central Saskatchewan, and western Montana, where a dry, early spring limited nesting habitat, and in Alaska, where spring was as much as 2 weeks late. The estimated number of ponds in May in Prairie Canada and the northcentral U.S. was 6.7 ("0.3) million in 1999 (Fig. 1, Appendix D). This estimate was 46% greater than that of 1998, and 37% above the long-term average (P<0.01) (Table 1). The pond estimate for Prairie Canada (3.9"0.2 million) was 53% above that of 1998 (P<0.01), and 12% above the long-term average (P=0.09). In the northcentral U.S., the pond estimate (2.8 "0.3 million), a record high, was 38% above last year, and 94% above the long-term average (P<0.01).

Unlike the traditional survey area, where habitat conditions improved over those of 1998, habitat conditions in the east were generally poorer this year. Much of the eastern survey area was relatively dry, especially Maine, the Maritimes, southern Quebec, and southern Ontario. These conditions resulted in few temporary ponds and low water levels in permanent wetlands. The northern portions of the east were in good to excellent condition, but lack of good quality brood rearing habitat is expected to limit production from this area.

In 1999, the estimated breeding population of all ducks (excluding scoters, eiders, oldsquaws, mergansers, and wood ducks) in the traditional survey area was 43.4 ("0.7) million birds (Tables 2, 5, Fig. 2). Estimates of duck populations differ from those published earlier, due to corrections in data analysis. This record high estimate was an 11% increase (P<0.01) from the 1998 estimate of 39.1 ("0.7) million, and was 32% above the long-term average (P<0.01). Approximately 60% of the ducks were found in the Prairie Pothole Region (strata 26-49), a percentage equal to that which occurred during the 1970's when wetland and upland conditions in this region were considered good. In the eastern survey area, the estimate of total ducks (1.2 "0.1 million) was similar (P=0.22) to that of last year (1.0 "0.1 million) and the 1995-98 average (P=0.11).

In other areas where surveys are conducted and measures of precision for estimates are provided (northeastern U.S., Wisconsin, Michigan, California, Washington, and British Columbia), total duck numbers were similar (P>0.10) to those of 1998, except for Washington, where total ducks were 8% greater than last year (P<0.01), and Michigan, where total ducks were 31% below 1998 (P=0.06). Total ducks were 24% above the long-term average in Washington, 14% above the long-term average in the Northeastern U.S., and 27% above the long-term average in California (P<0.10). Of the states that do not have measures of precision, Minnesota and Wyoming observed decreases in 1999, and Colorado, Oregon, Nevada, and Nebraska observed increases (Appendix E). However Nebraska implemented major changes in survey methodology, and it is likely that increases in duck numbers are due primarily to these changes.

Trends in abundance and annual breeding population estimates for 10 principal duck species from the traditional survey area during 1955-99 are provided in Fig. 2 and Appendix F, respectively. This year's estimate of 10.8 ("0.3) million mallards was 12% greater (P=0.01) than that of last year (9.6"0.3 million)

Table 1. Estimated number (in thousands) of May ponds in portions of Prairie Canada and the northcentral U.S.

			Change from 1998			Change from LTA	
Survey area	1998	1999	%	*P*	LTA[a]	%	*P*
Prairie Canada							
S. Alberta	559	716	+28	0.098	741	-3	0.816
S. Saskatchewan	1470	2535	+72	<0.001	2006	+26	0.010
S. Manitoba	492	611	+24	0.024	692	-12	0.278
Subtotal	2522	3862	+53	<0.001	3439	+12	0.085
Northcentral U.S.							
Montana and western Dakotas	680	672	-1	0.917	534	+26	0.083
Eastern Dakotas	1385	2170	+57	0.003	930	+133	<0.001
Subtotal	2065	2842	+38	0.004	1465	+94	<0.001
Grand total	4587	6704	+46	<0.001	4883	+37	<0.001

[a]Prairie Canada, 1961-98; northcentral U.S. and Grand total, 1974-98.

Table 2. Duck breeding population estimates (in thousands).

Region	1998	1999	Change from 1998 %	Change from 1998 *P*	LTA[a]	Change from LTA %	Change from LTA *P*
Traditional Survey Area[b]							
Alaska-Yukon Territory - Old Crow Flats	5728	5185	-9	0.106	3216	+61	<0.001
N. Alberta-N.E. British Columbia - Northwest Territories	6225	8316	+34	<0.001	7283	+14	0.003
N. Saskatchewan-N. Manitoba - W. Ontario	3411	3839	+13	0.101	3548	+8	0.141
S. Alberta	3204	3315	+3	0.691	4509	-26	<0.001
S. Saskatchewan	8376	9687	+16	0.005	7372	+31	<0.001
S. Manitoba	1394	1682	+21	0.052	1541	+9	0.102
Montana and western Dakotas	2999	2505	-16	0.043	1602	+56	<0.001
Eastern Dakotas	7744	8907	+15	0.011	3726	+139	<0.001
Total	39082	43436	+11	<0.001	32797	+32	<0.001
Eastern Survey Area[b]	1013	1247	+23	0.219	993	+26	0.114
Other Regions[c]							
British Columbia[d]	9	8	-10	0.597	7	+11	0.407
California	686	825	+20	0.282	649	+27	0.097
Michigan	946	650	-31	0.061	754	-14	0.330
Northeastern U.S.[e]	1444	1521	+5	0.582	1340	+14	0.062
Washington	185	200	+8	0.001	162	+24	0.04
Wisconsin	428	434	+2	0.920	360	+21	f

[a]Long-term average. Traditional survey area = 1955-98; eastern survey area = 1995-98; years for other regions vary (see Appendix E).
[b]Total ducks exclusive of scoters, eiders, oldsquaws, mergansers, and wood ducks.
[c]Species composition for the total duck estimate varies by region, and may include scoters, eiders, oldsquaws, mergansers, and wood ducks.
[d]Index to waterfowl use in prime waterfowl producing areas of the province.
[e]Includes all or portions of the states of Delaware, Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.
[f]Not estimable from current survey.

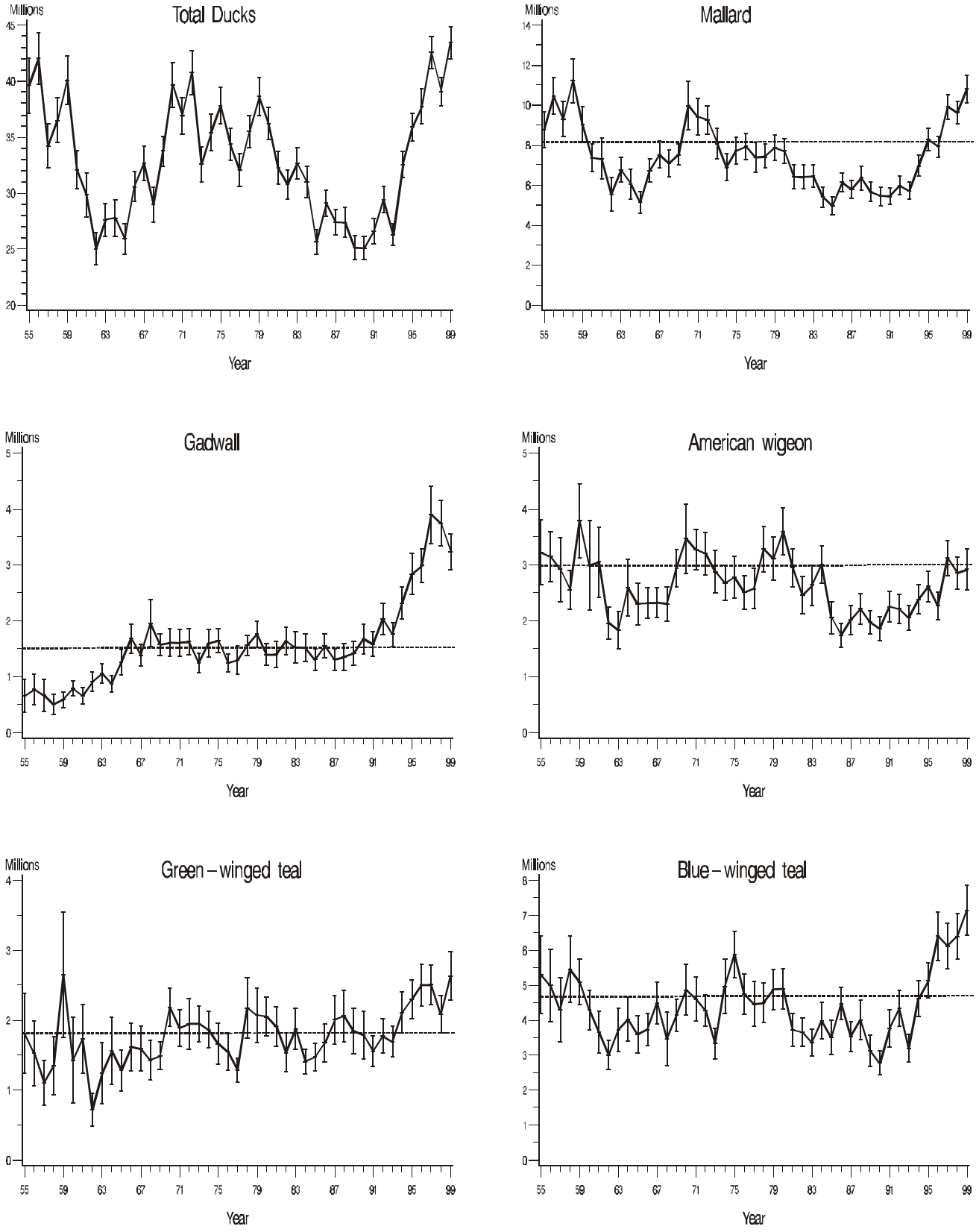
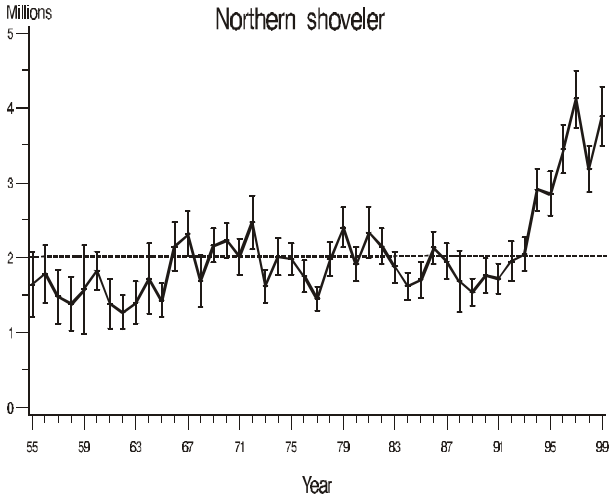
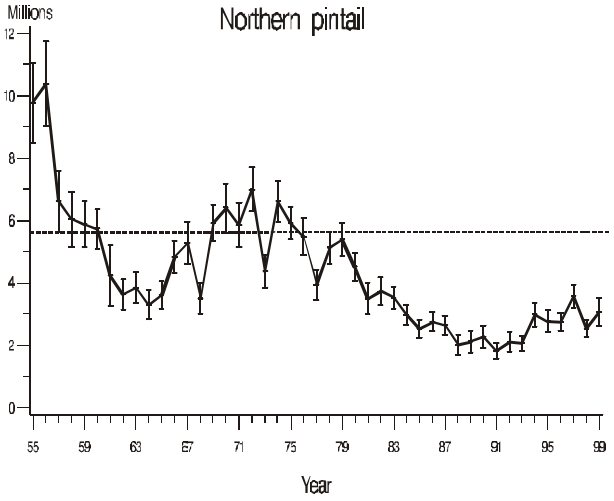
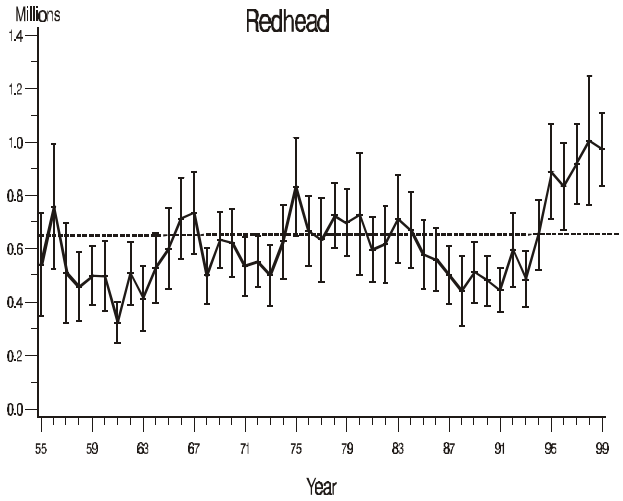
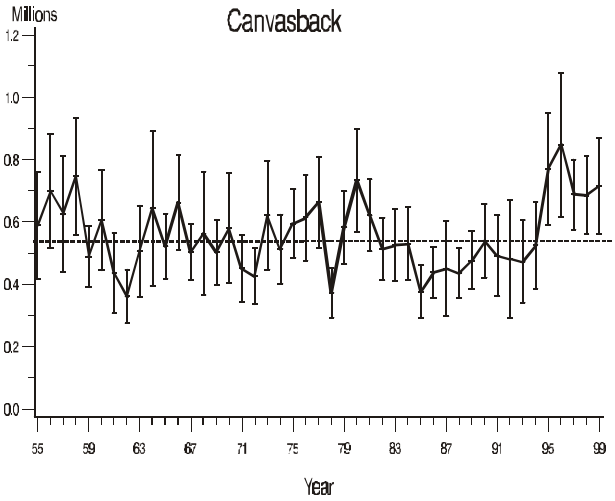


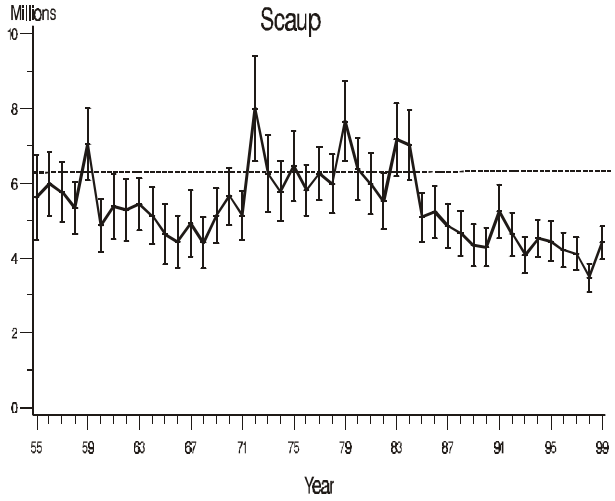
Fig. 2. Breeding population estimates, 95% confidence intervals, and North American Waterfowl management Plan population goal (dashed line) of selected species for the tradional survey area (strata 1-18, 20-50, 75-77)











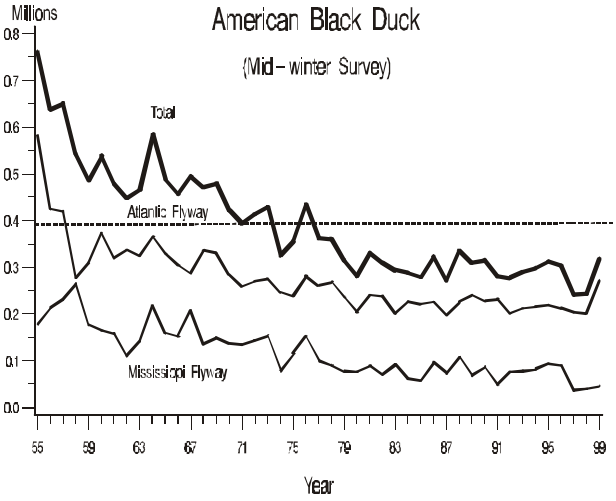


Fig. 2. (continued)

Table 3. Mallard breeding population estimates (in thousands).

			Change from 1998			Change from LTA	
Region	1998	1999	%	*P*	LTA[a]	%	*P*
Traditional Survey Area							
Alaska-Yukon Territory - Old Crow Flats	836	713	-15	0.203	295	+141	<0.001
N. Alberta-N.E. British Columbia - Northwest Territories	1055	2041	+94	<0.001	1084	+88	<0.001
N. Saskatchewan-N. Manitoba - W. Ontario	1058	1151	+9	0.557	1178	-2	0.804
S. Alberta	950	1032	+9	0.596	1153	-11	0.320
S. Saskatchewan	2449	2529	+3	0.711	2104	+20	0.007
S. Manitoba	439	514	+17	0.281	368	+40	0.004
Montana and western Dakotas	1068	689	-35	0.014	497	+39	0.010
Eastern Dakotas	1785	2137	+20	0.082	694	+208	<0.001
Total	9640	10806	+12	0.011	7374	+47	<0.001
Eastern Survey Area	309	245	-21	0.410	275	-11	0.518
Other Regions							
British Columbia[b]	1	1	-32	0.001	1	+11	0.100
California	361	534	+48	0.098	404	+32	0.175
Michigan	445	419	-6	0.795	413	+2	0.941
Minnesota	368	316	-14	0.516	202	+56	c
Northeastern U.S.[d]	775	880	+14	0.180	741	+19	0.029
Washington	79	86	+9	0.090	54	+60	0.120
Wisconsin	166	222	+34	0.160	138	+60	c

[a]Long-term average. Traditional survey area = 1955-98; eastern survey area = 1995-98; years for other regions vary (see Appendix E).
[b]Index to mallard use in prime waterfowl producing areas of the province.
[c]Value for the test statistic was not available.
[d]Includes all or portions of the states of Delaware, Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.

(Tables 3, 5), and was 47% above (P<0.01) the long-term average (7.4"0.1 million). This is the second highest estimate on record, only exceeded by the 11.2 million mallards estimated in 1958. Mallards increased from 1998 in the Northern Alberta-northeastern British Columbia-Northwest Territories and Eastern Dakotas regions and decreased in the Montana-western Dakotas region (P#0.09). Mallard abundance was above the long-term averages in six out of eight traditional survey areas (Alaska-Yukon Territory-Old Crow Flats, Northern Alberta-northeastern British Columbia-Northwest Territories, Southern Saskatchewan, Southern Manitoba, Montana-western Dakotas, and Eastern Dakotas [P#0.01]). The mallard estimate for the eastern survey region (0.2"0.04 million) was similar to that of last year (0.3"0.07 million) and the 1995-98 average (0.3"0.03 million) (P>0.41) (Tables 3, 6, Appendix G). Numbers of mallards counted in British Columbia were lower than in 1998 but above the 1988-98 average (P<0.10). Mallard numbers in California and Washington increased relative to 1998 levels, and were also greater than the long-term average in the northeastern U.S. (P#0.10). Abundances for other areas with measures of precision of mallard estimates were similar to those of last year (P>0.10) and their respective long-term averages (P>0.12). Of the states that do not have measures of precision, Minnesota, Oregon, and Wyoming observed decreases in 1999 relative to 1998, and Colorado, Nevada, and Nebraska observed increases (Appendix E). Again, changes in survey methodology in Nebraska make comparisons to previous years of limited value.

In the traditional survey area, estimates for 4 of the other 9 principal species were above their respective estimates from 1998 and 1 was below (Table 5). Numbers of green-winged teal (2.6"0.2 million; +26%), northern shovelers (3.9"0.2 million; +22%), northern pintails (3.1"0.2 million; +21%), and scaup (4.4"0.2 million; +27%) increased from counts in 1998. Although gadwall decreased for the third year in a row (3.2"0.2 million; -14%), the estimate is still the third largest gadwall population recorded. Numbers of American wigeon (2.9"0.2 million), blue-winged teal (7.1"0.4 million), redheads (1.0 "0.1 million), and canvasbacks (0.7"0.1 million) were similar (P>0.13) to those of last year. Estimates for gadwall (+110%), green-winged teal (+50%), blue-winged teal (+65%), northern shoveler (+95%), redheads (+60%), and canvasbacks (+29%) were above their long-term averages (P<0.05), the estimate for American wigeon was similar (P=0.14) to its long-term average, and the count for northern pintails (-30%) and scaup (-18%) were below averages (P<0.01). The estimate for blue-winged teal was a record high, and green-winged teal, redheads, northern shovelers, and bufflehead (*Bucephala albeola*) were at their second-highest levels in the traditional survey area. In the eastern areas of Canada and the U.S., abundances of individual species generally were similar to those of last year, except for increases in goldeneye (+196%) and decreases in scaup (-93%) (P<0.07) (Table 6). Goldeneye were above their 1995-98 average (+287); while blue-winged teal (-95%) and scaup (-90%) were below average (P<0.03).

The status of the American black duck (*Anas rubripes*) has been monitored primarily by mid-winter surveys conducted each January in states of the Atlantic and Mississippi flyways. The trends in wintering populations for each Flyway and for the total population are depicted in Fig. 2. The dashed line represents the total black duck wintering population goal of the North American Waterfowl Management Plan. Mid-winter counts suggested that the number of black ducks (318,000) was 31% above last year (243,400) and 11% above the most recent 10-year average (287,500). In the Atlantic Flyway, the size of the wintering black duck population (271,300) was 34% above the 1998 count (202,500) and 25% above the most recent 10-year average (217,000). The 1998 estimate for wintering black ducks in the Mississippi Flyway (46,700) was also above last year (40,900) by 14%, but the count was still 34% below the most recent 10-year average (70,500). For the third consecutive year, over 80% of the black ducks that winter in the U.S. were counted in the Atlantic Flyway. Recently, the eastern survey area of the Breeding Population and Habitat Survey has provided additional information regarding the status of this species. The spring population in the eastern survey area was 126,000 birds, which was similar (P=0.22) to that of 1998 (176,000), and also similar (P=0.23) to the 1995-98 average (167,000) (Table 6, Appendix G).

Trends in wood duck populations are monitored by the North American Breeding Bird Survey (BBS), a series of roadside routes surveyed during May and June of each year. Wood ducks are encountered at low abundances along the roadside BBS routes, limiting the amount and quality of available information for analysis (Sauer and Droege 1990). However, within these limitations, the BBS provides the only long-term index of regional populations of the species. Trends suggest that numbers of wood ducks have increased in the Atlantic and Mississippi Flyways over the long term (1966-98) and short term (1980-98) by 5-6%. Specifically, in the Atlantic Flyway, BBS trends in wood ducks indicate a 5.6% annual increase over the long term (P<0.01) and a 5.0% annual increase over the short term (P<0.01). In the Mississippi flyway, trends in wood ducks have increased 4.8% over the long-term (P<0.01) and 4.5% over the short term (P=0.01) (J. Sauer, pers. commun.).

Weather and habitat conditions during the summer months influence waterfowl production. During June and early July, above-normal temperatures generally prevailed

Table 4. Estimated number (in thousands) of July ponds in portions of prairie Canada and the northcentral U.S.

			Change from 1998			Change from LTA	
Survey area	1998	1999	%	*P*	LTA[a]	%	*P*
Prairie Canada							
S. Alberta	553	793	+43	0.006	471	+68	<0.001
S. Saskatchewan	1665	1697	+2	0.861	927	+83	<0.001
S. Manitoba	633	286	-55	<0.001	318	-10	0.250
Subtotal	2851	2776	-3	0.720	1715	+62	<0.001
Northcentral U.S.							
Montana and western Dakotas	477	609	+28	0.041	391	+56	0.001
Eastern Dakotas	876	1823	+108	<0.001	497	+266	<0.001
Subtotal	1353	2432	+80	<0.001	889	+174	<0.001
Grand total	4203	5208	+24	0.001	2682	+94	<0.001

[a]Long-term average. Prairie Canada = 1961-98; northcentral U.S. and Grand total = 1974-98.

Table 5. Duck breeding population estimates (in thousands) for the traditional survey area.

			Change from 1998			Change from LTA	
Species	1998	1999	%	*P*	LTA[a]	%	*P*
Mallard	9640	10806	+12	0.011	7374	+47	<0.001
Gadwall	3742	3235	-14	0.054	1538	+110	<0.001
American Wigeon	2858	2920	+2	0.791	2641	+11	0.137
Green-winged teal	2087	2631	+26	0.015	1756	+50	<0.001
Blue-winged teal	6399	7149	+12	0.128	4337	+65	<0.001
Northern shoveler	3183	3890	+22	0.006	1999	+95	<0.001
Northern pintail	2521	3058	+21	0.045	4348	-30	<0.001
Redhead	1005	973	-3	0.822	610	+60	<0.001
Canvasback	686	716	+4	0.767	556	+29	0.046
Scaup (greater and lesser combined)	3472	4412	+27	0.002	5405	-18	<0.001
Total [b]	39082	43436	+11	<0.001	32797	+32	<0.001

[a] Long term average (1955-98)

[b] Includes black duck, ring-necked duck, goldeneye, bufflehead, and ruddy duck; excludes scoter, eider, oldsquaw, merganser, and wood duck.

Table 6. Duck breeding population estimates (in thousands, for the 10 most abundant species) for the eastern survey area.

			Change from 1998			Change from LTA	
Species	1998	1999	%	*P*	LTA[a]	%	*P*
Mallard	309	245	-21	0.410	275	-11	0.518
American black duck	176	126	-28	0.223	167	-25	0.232
Gadwall	4	14	+241	0.328	11	+25	0.821
American Wigeon	21	77	+268	0.201	22	+258	0.199
Green-winged teal	142	185	+30	0.627	123	+50	0.267
Blue-winged teal	15	2	-89	0.151	29	-95	<0.001
Scaup (greater and lesser combined)	21	1	-93	0.073	15	-90	0.018
Ring-necked duck	177	213	+20	0.662	228	-7	0.842
Goldeneye (common and Barrow's combined)	104	308	+196	0.053	80	+287	0.028
Bufflehead	40	64	+58	0.305	34	+88	0.159
Total[b]	1013	1247	+23	0.219	993	+26	0.114

[a]Long-term (1995-98) average.

[b]Includes northern shovelers, northern pintails, redheads, canvasback, and ruddy ducks; excludes scoters, eiders, oldsquaws, mergansers, and wood ducks.

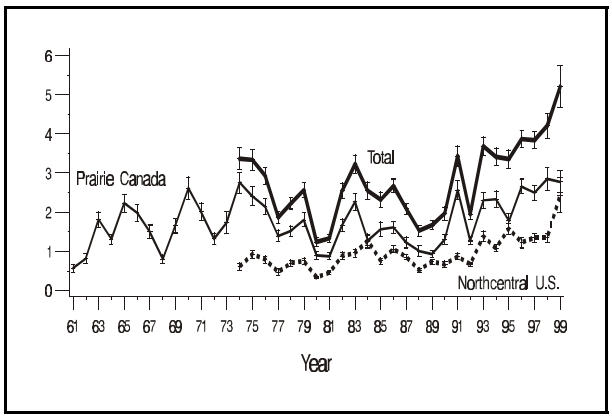


Fig. 3. Number of ponds in July and 95% confidence intervals for Prairie Canada and the northcentral U.S.

in the northcentral U.S. and Prairie Canada. Frequent shower activity in western portions of much of the traditional survey area maintained wetland conditions. Results of the July Production and Habitat Survey indicate that the total number of ponds in the traditional survey area during July 1999 was 5.2 ("0.3) million, the largest number on record, which was 24% greater (P<0.01) than last year (4.2"0.2 million) and 95% above the long-term average (P<0.01) (Table 4, Fig. 3, Appendix H). The estimate for Prairie Canada (2.7"0.1 million) was not different from the 1998 estimate, but was 62% above (P<0.01) the long-term average. The number of July ponds in the northcentral U.S. (2.4"0.2 million) was 80% greater than (P<0.01) last year (1.4"0.1 million), and was 174% above average (P<0.01). This is the greatest number of ponds reported in the northcentral U.S., and second greatest number in Prairie Canada. The number of broods in 1999 was 30% above the long term average in Prairie Canada and northcentral U.S., combined.

REGIONAL STATUS

A description of habitat conditions, populations, and production for each major breeding area follows. In all cases, populations are considered to have changed significantly if $P \# 0.10$.

Southern Alberta.--In southern Alberta (strata 26-29), spring precipitation was below normal except for the western portion of the Aspen Parklands, which experienced above-average precipitation. Temperatures and precipitation in May generally were below average in most areas of the province. Soil moisture levels were in the low-to-medium range in 80% of the survey area. Phenology of spring conditions was average, with waterfowl on nesting territories and well-developed vegetation by mid-May. In general, habitat in this area was considered in fair-to-poor condition for breeding waterfowl, with the exception of some good habitat in the center of Alberta. The number of ponds in May 1999 was 28% above last year (the tenth driest year on record for the area)(P=0.10), but unchanged from the long-term average (P=0.82). The number of total ducks was unchanged from last year (P=0.69), but was 26% below the long-term average (P<0.01). Of the 10 principal species, only green-winged teal and redheads changed significantly from 1998 levels, increasing by 107% and 168% respectively (P<0.03). American wigeon (-44%), blue-winged teal (-39%), northern pintails (-86%), and scaup (-40%), were below their long-term averages (P<0.01) while redheads (+53%) were above their long-term average in this area (P=0.04). Temperatures remained below average in June, and precipitation remained below average in most areas of the province, except the southern regions, which had average to above-average precipitation. Habitat conditions improved from May through July, including increased water and upland cover. The number of July ponds was 43% above last year and 68% above the long term average (P#0.01).

Southern Saskatchewan.-- Spring precipitation continued to remain above to well above average (115-200% of normal) across southern Saskatchewan (strata 30-35), with areas in the southeast being extremely wet. Rain and snow events were numerous throughout May, especially in the southern parts of the survey area. May temperatures were average to below average. Spring runoff in Saskatchewan was early this year because of the above-average temperatures over the winter and was complete by mid-April. Because of the early run-off, few ephemeral or temporary wetlands were present in early May and many seasonal wetlands were in poor condition; however, by mid-May wetland conditions had improved dramatically throughout May and June. Residual cover was in good-to-excellent condition across most of the survey area. The number of May ponds was above both 1998 levels (+72%) and the long-term average (+26%) (P#0.01). The total duck population estimate was also greater than 1998 levels (+16%) and the long-term average (31%) (P#0.05). Numbers of blue-winged teal (+33%), northern pintails (+59%), and northern shovelers (+62%) increased over 1998 (P#0.06), while only gadwall (-23%) decreased from 1998 levels (P=0.10). Six of the 10 principal species were above their long-term averages -- mallards (+20%), gadwall (+96%, the third highest number recorded), green-winged teal (+51%), blue-winged teal (+79%, the third highest number recorded), northern shoveler (+114%, the second highest number recorded), redheads (+56%), and canvasbacks (+39%) (P#0.04). Abundances of scaup (-35%), pintail (-33%), and American wigeon (-24%) were below their long-term averages (P#0.08). By July, most wetlands were in good-to-excellent condition for brood rearing. However, broods were not plentiful, as indicated both by aerial and ground reports. Cool, wet conditions may have adversely affected duckling survival. Nesting was still active in mid-July and warmer, drier conditions during July may improve

duckling survival and result in average recruitment. The number of July ponds was unchanged from last year and 83% above the long-term average (*P*#0.01).

Southern Manitoba.--Warm, extremely wet conditions prevailed over much of southern Manitoba (strata 36-40) during the May survey. Almost every wetland basin and depression contained some water and wetland vegetation was in excellent condition. However, flooding in wetland fringes may have submerged nesting habitat. The number of May ponds (+24%) and total ducks (+21%) increased over estimates from last year (*P*#0.05), although neither was different from the long-term average. American wigeon (+129%), blue-winged teal (+70%), and northern shoveler (+75%) were all above 1998 levels (*P*#0.07). Mallards (+40%), gadwall (+96%, the second highest number ever recorded), and northern shoveler (+62%) were above their long-term average (*P*<0.01), while American wigeon (-71%), green-winged teal (-24%), northern pintail (-49%), and scaup (**B**51%) were all below their respective long-term averages (*P*#0.09). Significant rainfall continued throughout June and July, flooding out many agricultural fields. Moisture caused a significant proportion of cropland to remain unseeded, leaving residual cover from last fall as excellent nesting habitat for late nesting ducks. The number of July ponds was 55% below last year and not different from the long-term average (*P*#0.01).

Montana and Western Dakotas.-- Spring was early in eastern Montana (strata 41-42), although temperatures were cooler in May than in April. Breeding habitat conditions across eastern Montana ranged from excellent to poor. Where available, water provided for good-to-excellent breeding conditions. Eventually, sufficient precipitation arrived in all areas of Montana during May, but most of it soaked into the ground in dry areas, leaving conditions only poor-to-fair in these areas. Habitat conditions in the western Dakotas (strata 43-44) were considered excellent for nesting and production, except for the extreme western portion of North Dakota, which was in only fair condition. A warm April and abundant moisture allowed grasses to germinate earlier than usual, and by early May all species of ducks were present and established on territories. The number of May ponds was 26% above the long-term average for this region (*P*#0.08). The total number of ducks was 16% lower than last year, although it was 56% above the long-term average (*P*#0.04). While the number of mallards decreased from 1998 (-35%), the estimate was still above the long-term average (+39%) (*P*#0.01). The abundance of American wigeon decreased (-43%) compared to last year (*P* # 0.01), while northern shovelers increased 122% (*P*#0.01). Gadwall (+107%), green-winged teal (+102%), blue-winged teal (+120%), and northern shovelers (+204%) were above their long-term averages, (*P*#0.04) while northern pintails (-29%) and scaup (-31%) were below their long-term averages (*P*#0.08). The 1999 estimate for northern shoveler was a record high and that for blue-winged teal was the third largest recorded. Habitat conditions in the western Dakotas deteriorated somewhat after May. Overall water and cover quality ranged from above-average to poor in July, and total production is expected to be from average to slightly above average. The number of July ponds was 28% above last year and 56% above the long-term average (*P*#0.04), and was the largest ever recorded.

Eastern Dakotas.-- Continued mild weather from winter promoted early and rapid development of new vegetation in the eastern Dakotas (strata 45-49). The entire area had excellent residual nesting cover for early-arriving birds. While April precipitation was variable (25-200% of normal), heavy precipitation the first week of May and a warm spring resulted in excellent nesting cover and mostly excellent conditions for breeding waterfowl in this region. Excellent habitat conditions translated into record numbers of May ponds, total ducks, mallards, and blue-winged teal in the area. The second largest number of gadwall recorded (after last year=s record high) and the third largest number of redheads were seen in the Eastern Dakotas this year. The number of May ponds was greater than 1998 levels (+57%) and above the long-term average (+133%) (*P*<0.01). The estimate of total ducks was also greater than 1998 levels (+15%) and above the long-term average (139%) (*P*#0.01). Mallards (+20%) and northern shovelers (+45%) were above 1998 levels (*P*<0.01), while numbers of scaup (-32%) decreased from last year (*P*=0.06). Mallards (+208%), gadwall (+210%), American wigeon (+81%), blue-winged teal (+146%), northern shovelers (+100%), redheads (+92%), and scaup (+79%) were above long-term averages (*P*#0.02). June and July weather patterns in the eastern Dakotas maintained and improved wetland and cover conditions throughout the area. While some nests may have been negatively impacted by heavy rains, hail, and flooding in localized areas, overall conditions were excellent for brood rearing and late nesting in most areas. Excellent production is expected from the Eastern Dakotas this year. The number of July ponds were at record high levels, and were 108% above last year and 266% above the long-term average (*P*<0.01).

Northern Saskatchewan, Northern Manitoba, and Western Ontario.-- Sufficient moisture and moderate temperatures resulted in good breeding-habitat conditions in northern Saskatchewan and Manitoba (strata 21-25). Conditions also were good in western Ontario (stratum 50). Only scaup increased over last year (+115%), while northern shovelers decreased (*P*<0.01). Gadwall (-66%), blue-winged teal (-38%), northern shovelers (-41%), and northern pintail (-81%) all were below their long-term averages (*P*#0.03), while green-winged teal was above its long-term average (+48%) (*P*<0.01).

Northern Alberta, Northeastern British Columbia, and Northwest Territories.-- Sufficient moisture and moderate temperatures resulted in good breeding habitat conditions in northern Alberta, northeastern British Columbia, and the Northwest Territories (strata 13-18, 20, 75-77). Water conditions in northern Alberta were better than last year. The number of total ducks was higher than last year (+34%) and the long-term average (+14%) (P#0.01). Mallards also were higher than last year (+94%) and were above the long-term average (+88%) (P#0.01). American wigeon (+40%), green-winged teal (+50%), and scaup (+49%) increased over 1998 levels (P # 0.07), while northern shovelers decreased from 1998 levels (-44%) (P<0.01). Gadwall (+282%), green-winged teal (+34%), and redheads (+159%) were above long-term averages (P # 0.09), while scaup (-23%) and northern pintail (-55%) were below their long-term averages (P<0.01). This year=s estimates for gadwall and canvasbacks were the second highest, those for mallards and redheads were the third highest recorded.

Alaska - Old Crow Flats, Yukon Territory.-- Alaska and Old Crow Flats (strata 1-12) experienced a later spring than in recent years. Amounts of snowfall were about one-third of normal. Spring arrived as much as two weeks late on the western tundra and North Slope of Alaska and up to one week late in interior regions. Interior habitat conditions were improved somewhat by little to no flooding in the river valleys. In general, breeding habitat conditions were fair in the coastal regions and good in interior regions. The total number of ducks (+61%) and mallards (+141%) were above their respective long-term averages in the Alaska/Old Crow Flats region (P<0.01). Only numbers of American wigeon were different from last year, decreasing by 22% (P=0.07). However, numbers of American wigeon were above their long-term average (+115%; P<0.01). Green-winged teal (+141%) and northern shovelers (+227%) also were above their long-term averages (P<0.01). This year, estimates of mallards, green-winged teal, and northern shovelers were the second highest recorded, and estimates of American wigeon were the third highest recorded. The delayed spring on the western tundra and North Slope will negatively affect production this year. The somewhat normal spring breakup in the interior, coupled with very little flooding, should result in near average production in the interior.

Eastern Survey Area.-- Unlike the traditional survey area, which was mostly wet, the eastern survey area (strata 51-56, 62) was mostly dry. The drought that began in the winter continued through May, especially in Maine, the Maritimes, and southern Ontario and Quebec. Maine had the driest April since the 1880's. Even so, breeding habitat conditions in western Ontario improved from the even drier conditions of 1998. Seasonal water areas were lacking, bogs were dry, water levels in beaver ponds and lakes were low. The numbers of total ducks and mallards did not change significantly from either 1998 or the 1995-98 average. Numbers of scaup declined both from 1998 (-93%) and was below the 1995-98 average (-90%) (P#0.07), while goldeneye increased over last year (+196%) and was above average (287%) (P#0.05). The abundance of blue-winged teal was 95% below the 1995-98 average (P<0.01). Nesting habitat was plentiful, but brood habitat was limited to beaver ponds and larger lakes, where broods are vulnerable to predators. Only fair production is expected from the eastern areas this year.

Other Areas.-- Winter precipitation was above normal in California, but spring was generally cool and dry, and nesting was delayed. Most observers judged nesting habitat to be average to good. In British Columbia, breeding habitat conditions on surveyed wetlands were generally average this year, and not as good as the previous two years. In Colorado, spring breeding conditions for waterfowl generally were favorable; however, cool, wet, conditions early in the spring may have negatively impacted early nesting ducks. Spring wetland conditions in Nebraska were excellent and most wetland basins contained water. Numbers of water areas increased, but most of this increase was probably due to major changes in survey methodology. Early spring was dry in Minnesota, but water conditions improved dramatically in May, and pond numbers increased 24% over 1998 and were 22% above the long-term average. Statewide precipitation was 52% above normal for the April-through-May period in Wisconsin, and overall the number of wetlands was grater than last year. The number of wetlands was above the long-term mean in the two northern strata but below average in the two southern strata. Pond counts decreased in Washington compared to last year, but still above the long-term average. Most wetlands were at or above average water levels in Nevada this year as a result of above average precipitation. Cool and wet weather late in the spring probably negatively impacted early nesting birds in Wyoming, but there appears to have been a good later-nesting effort by mallards.

In California, most areas that measure duck production are reporting lower production. The production outlook is average throughout most of Colorado, with possibly above average production in the San Luis Valley. In Nebraska, duck production is expected to be good to excellent. Production is expected to be slightly above average in Wisconsin. Brood surveys in Washington indicate good production for most of the state. Water levels dropped slightly in July in Nevada, but wetlands still are in fair condition. Limited reports suggest production is down from last year in Wyoming, in part due to the cool early spring conditions.

Fall-flight Indices

Total Ducks.-- The 1999 total duck fall flight index is predicted to be 105 million birds, the largest ever. The fall flights from all regions are expected to be similar to or larger than last year, with the exception of Alaska where conditions for duck production were only fair.

Mallard.--The size of the midcontinent mallard population during spring 1999 was 11.8 million birds, which is 11% higher (P=0.02) than that of 1998 (10.6 million). Additionally, the number of wetlands in May increased from that of 1998. Our current understanding of mallard population dynamics suggests that as the density of mallards (i.e., number of birds/number of wetlands) decreases, the recruitment rate (i.e., the number of young produced/adult female) increases. Because the density of birds decreased this year, the predicted recruitment rate increased 18% over that of last year. As a result, this year=s mallard fall flight is predicted to be 13.6 million, which is 16% higher than the value for 1998 of 11.8 million (P<0.01) (Fig. 4).

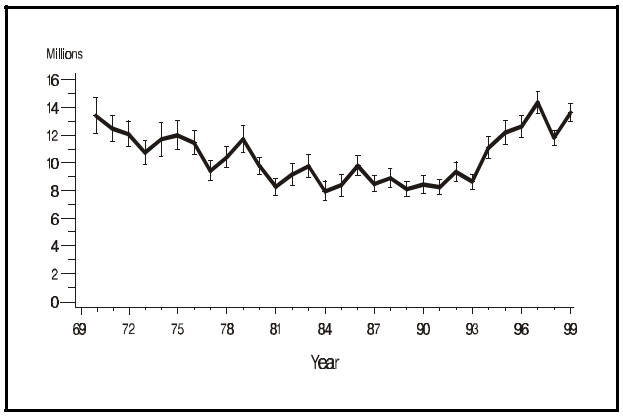


Fig. 4. Estimates and 95% confidence intervals for the size of the mallard population in autumn.

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STATUS OF GEESE AND SWANS

Abstract: Most goose and swan populations in North America remain numerically sound and the size of most fall flights will be similar to or increased from last year. Twelve of the 29 populations of geese and swans we report on appear to have increased (≥+10%) since last year, 4 appear to have decreased (≤-10%), 9 appear to have changed little, and no comparisons were possible for the remaining 4. Some of the annual variation reflects differences in the timing of surveys; spring estimates of several Canada goose populations that nest near Hudson Bay were probably biased low last year. Of the 25 populations for which data spanning the last 10 years were available, 14 have exhibited a significant increasing trend (5 of 7 of *Anser* populations, 1 of 2 swan populations, and 8 of 15 *Branta* populations), 1 showed evidence of significant decline (1 of 7 *Anser* populations), while 10 appeared stable (7 of 15 *Branta* populations, 1 of 7 *Anser* populations, 1 swan population). As in previous years, forecasts for production of young in 1999 varied regionally based largely on spring weather and habitat conditions. Generally, spring phenology was earlier than normal in northern Quebec, the Hudson Bay Lowlands, and the mid-central Arctic, and this should lead to greater-than-average production for geese nesting there. In the north-central and western Arctic, the high Arctic, and along the west coast of Alaska, seasons were moderately to severely delayed, and average to below-average production is expected for geese and swans nesting in those areas. For temperate-zone breeding geese, spring weather in British Columbia and the Pacific Northwest was cold and wet, with delayed snow melt, which will negatively impact production from those areas. Conditions in the eastern tier of the Pacific flyway are reported as average to below average, with generally average to good conditions for most of the Central Flyway. Habitat conditions for nesting geese were good to very good in south-central and eastern Canada and much of the contiguous U.S east of the Mississippi River.

This report summarizes information regarding the status and expected fall flights of goose and swan populations in North America. Information was compiled from a broad geographic area and is intended to assist managers in regulating sport harvests. We have relied on the most widely-accepted designations for various goose populations, but they may differ from other published information. Each of the 27 goose populations described herein is solely or predominantly comprised of a single species, but several populations contain more than one subspecies. This report also contains information concerning the status of 2 populations of tundra swans (*Cygnus columbianus*).

Most populations of geese and swans in North America nest in the Arctic or subarctic regions of Alaska and Canada (Fig. 1), but several Canada goose (*Branta canadensis*) populations nest in southern Canada and the northern U.S. Few breeding population surveys exist for geese, and sizes of most populations are estimated from surveys conducted on migration and wintering areas. The production of most goose populations can only be predicted qualitatively, based on habitat conditions and nesting phenology. In the Arctic, production is heavily dependent on the extent and duration of snow-cover, which can limit availability of nest sites and food resources. In general, goose production will be better than average if nesting begins by late May in western and central portions of the Arctic and the southern Hudson Bay lowlands, and by early June in the eastern Arctic. Production throughout the Arctic usually is poor if nesting is delayed much beyond 15 June. However, severe weather after hatching, and significant predation in some areas (both during nesting and post-hatching), can significantly influence production in many Arctic breeding colonies. For populations that nest farther south, recruitment rates are less variable and annual production is more dependent on the size and age-structure of the breeding population, which is a function of many factors, including breeding performance and recruitment from the preceding year, and body condition at the start of nesting.

METHODS

Unlike ducks, population estimates for geese generally are not derived from coordinated annual surveys, and are obtained primarily from surveys conducted during fall and winter by federal, state, and provincial biologists, with additional spring survey data provided by universities and various government agencies. Where appropriate (i.e., when the estimates are based on a formal sampling scheme), the 95% confidence interval is presented with population estimates. Such estimates are available for only a few populations. Average population growth rates for the last 10 years were determined by regressing the natural logarithm of survey counts on year; the slope coefficient was tested for equality to zero (*t*-test). One-year change in population size was estimated by differencing 1998 and 1999 population estimates (Appendix J and K); where possible, the significance of the change was assessed with a *z*-test, using the sum of sampling variances for the 2 estimates.

Habitat conditions during the 1999 breeding season were assessed using satellite imagery, weather data, and reports from field biologists. The portion of North America covered by snow or ice in early June was determined from weekly on-line reports (Northern Hemisphere Snow and Ice Boundary summaries) prepared by the National Oceanic and Atmospheric Administration. This analysis provides useful information of a general nature, but does not always provide reliable assessments of local conditions.

Forecasts for production were based on information from various waterfowl surveys and from interviews with field biologists. For some populations, recruitment rates were predicted from satellite imagery data gathered this spring, and from the historic relationship between satellite data and indices of recruitment. Satellite (Advanced Very High Resolution Radiometer [AVHRR]) imagery was interpreted to estimate the proportion of snow and ice coverage, snow-free land, open water, and an index to the amount of actively-growing green vegetation, for 8 regions of the Canadian Arctic and subarctic. Satellite images of these

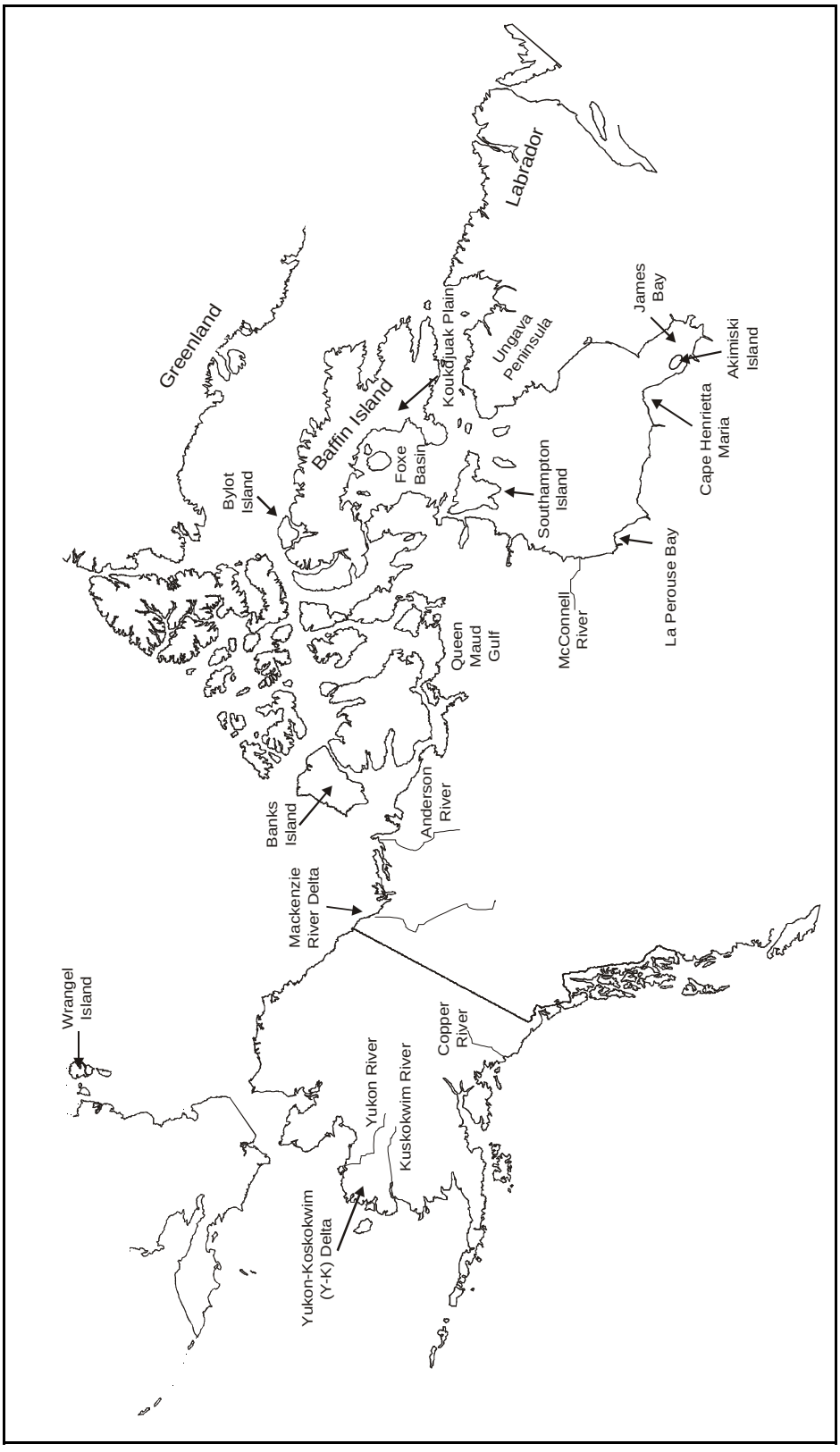

Fig. 1. Important goose nesting areas in Arctic and sub-Arctic areas of North America

regions were obtained for 3 periods (early May, early June, and late June). These methods still are being refined and the predictions should be interpreted cautiously. In some cases, expected production represents a compromise between various forecast methods, including observations from biologists in the field.

RESULTS AND DISCUSSION

Conditions in the Arctic and Subarctic

Onset of spring weather conditions was average or earlier than average in the south-central, and southeastern Arctic, and later than average in the western and high Arctic and Alaska. Based on information from the National Oceanic and Atmospheric Administration (NOAA), snow and ice coverage in early-June 1999 was similar to last year in northern Quebec, northern Labrador, the western Canadian Arctic, and on the North Slope of Alaska (Fig. 2). Indices derived from AVHRR satellite images, indicated unusually sparse snow coverage by early June in northern Quebec, south-central areas of the Arctic, much of West Hudson Bay, near the Anderson River, and on Banks Island (Fig. 3). In these areas, the amount of open land was greater than in most years, and similar to last year (Appendix I; Fig. 3).

Field biologists in Alaska reported that spring weather was about 2 weeks later than normal for the North Slope, 1-2 weeks later than average on the Yukon-Kuskokwim (Y-K) Delta, and approximately 1 week later than average in most interior regions. Ice breakup off the Y-K Delta was the latest since 1977. In the interior of Alaska, flooding was localized and generally less than average. The Copper River Delta experienced a prolonged and cold spring, with late pond opening. Field biologists in the western Canadian Arctic reported that spring weather was somewhat later than average for nesting geese, with a rapid warming and melt in June; average production is expected. Near Queen Maud Gulf in the Central Canadian Arctic, biologists reported mild temperatures during May, but cooler and more seasonal weather in June. On Bylot Island, cold and snowy weather in late May and early June delayed nesting. Conditions were delayed on the Koukdjuak Plains on Baffin Island. In a broad area including the lowlands west, south, and east of Hudson Bay, and in northern Quebec, snow coverage at the end of winter was generally heavy, but temperatures in May were mild, and snow melt generally was rapid.

Conditions in Southern Canada and the United States

Conditions conducive to a successful breeding season vary less from year to year in mid-latitude areas of North America than in the Arctic. Wetlands numbers increased relative to last year over much of south-central Canada this spring, while conditions in much of the upper Midwest and southern Prairies were considered to be good to extremely good for staging Arctic-breeding geese and nesting Canada geese. Breeding conditions south of the Great Lakes and in the eastern and mid-Atlantic states was reported to be average or above average. However, flooding in some parts of Utah and Nevada inundated potential nesting sites and destroyed some nests.

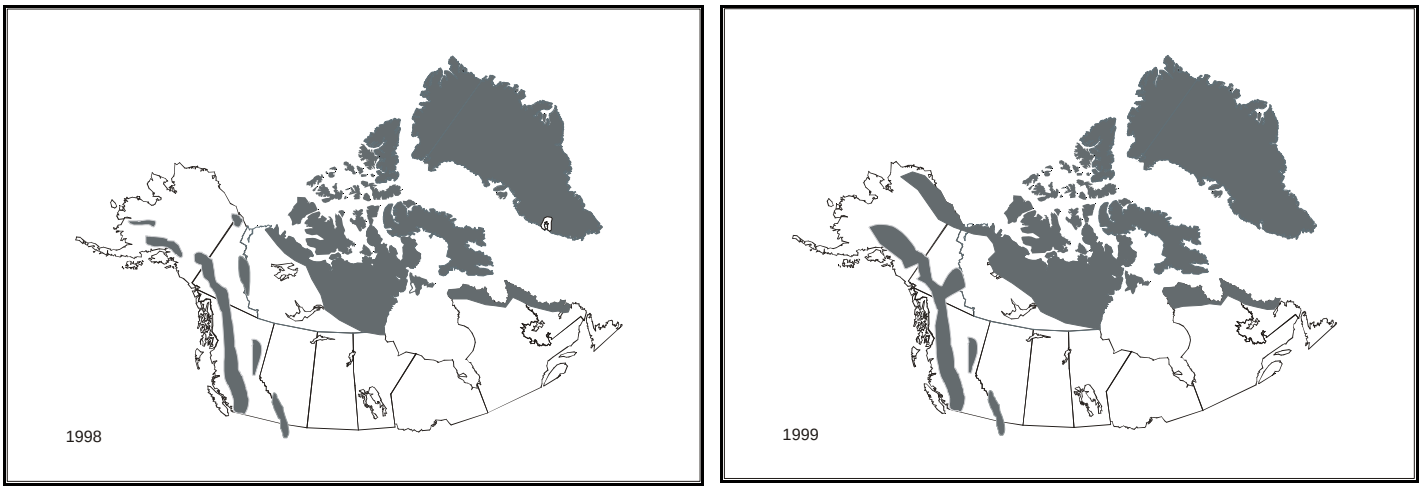

Fig. 2. The extent of snow and ice cover in North American for 1-7 June, 1998 and 2-4 June, 1999. These figures were reproduced from a report prepared by the National Oceanic and Atmospheric Administration.

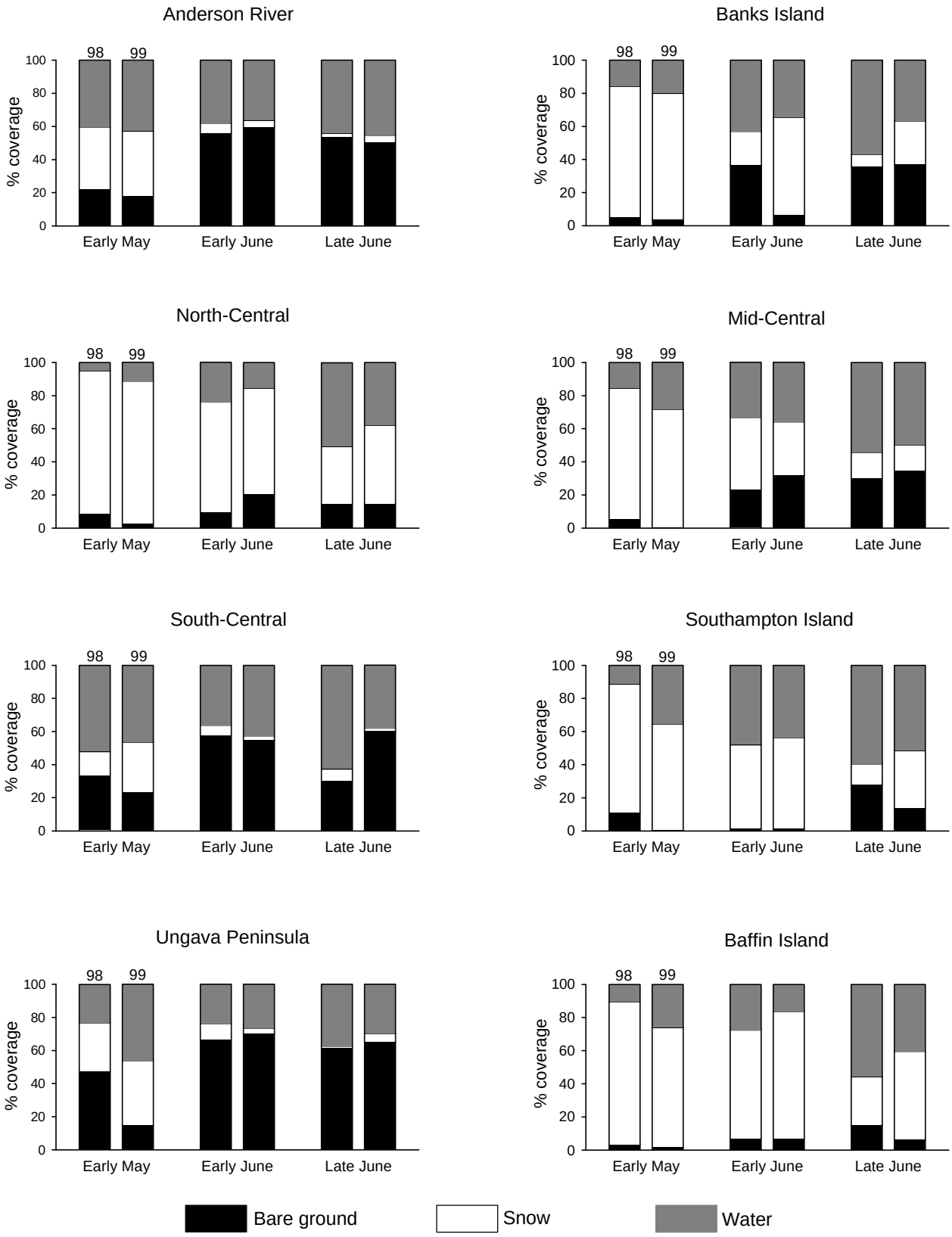

Fig. 3. Percent of the area in vicinity of major nesting areas that was snow-covered, water-covered, and open land in regions of the Canadian Arctic; as determined from satellite imagery during spring 1998 and 1999.

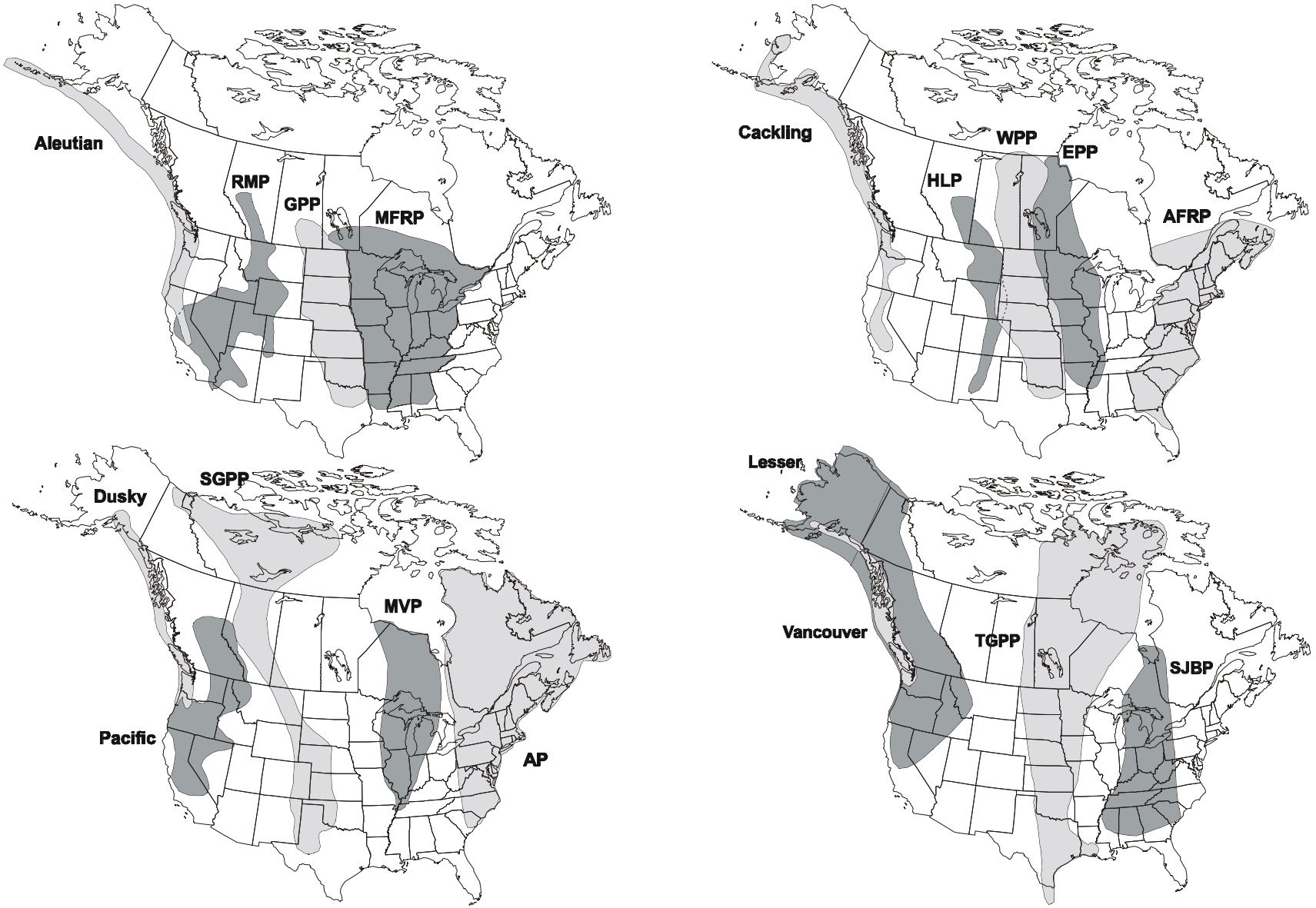

Fig. 4. Approximate ranges of Canada goose populations in North America. Population names are abbvreviated as in text.

Status of Canada Geese

Atlantic Population (AP).--AP Canada geese nest throughout much of Quebec, especially along Ungava Bay, the eastern shore of Hudson Bay, and on the Ungava Peninsula. The AP winters from New England to South Carolina, but the largest concentration occurs on the Delmarva Peninsula (Fig. 4). On the Ungava Peninsula, there were 77,451 (32,348-51,984) breeding pairs in 1999; this represents a 84% increase ($P < 0.01$) since last year (Fig. 5). However, the relative timing of the survey in 1998 was later than in previous years (due to early nesting), and this may have caused the 1998 estimate of the breeding population to be biased low. The rate of change in the number of breeding pairs since 1989 is not statistically different from a stable population ($P>0.5$). The total population estimate of 428,166 (285,570-570,507) in June 1999 is similar ($P>0.5$) to the 1998 estimate. Despite significant snow during winter, exceptionally mild weather in late April-early May led to rapid melt with generally early nesting. Mean laying date was intermediate between 1997 and 1998. The number of nests in study plots south of Povungnituk increased by 22% relative to last year. However, nest predation by foxes was high in 1999, reducing nest success by 25% relative to the past two years. Biologists note that the higher -than-average predation may have inflated the number of nests due to renesting by geese whose nests were predated early in the season. Clutch size was marginally lower than the past 2 years. Data from other study locations suggest similar breeding performance, although there are indications that fox predation may not have been universally high. Surveys in northern Quebec indicated that the number of Canada geese in total (including non-breeders) was approximately equal to the 1997 total (the last comparable survey), although the number of geese observed as pairs or single birds increased by 15%. In the boreal forest, where Canada geese are counted as part of the annual Breeding Waterfowl and Habitat survey, the number of breeding pairs was the highest recorded since the start of the survey in 1999. Predictions based on satellite imagery indicate only fair production. Considering that the breeding population may have increased, and the likelihood of good production, the fall flight should be similar to or slightly larger than that of 1998.

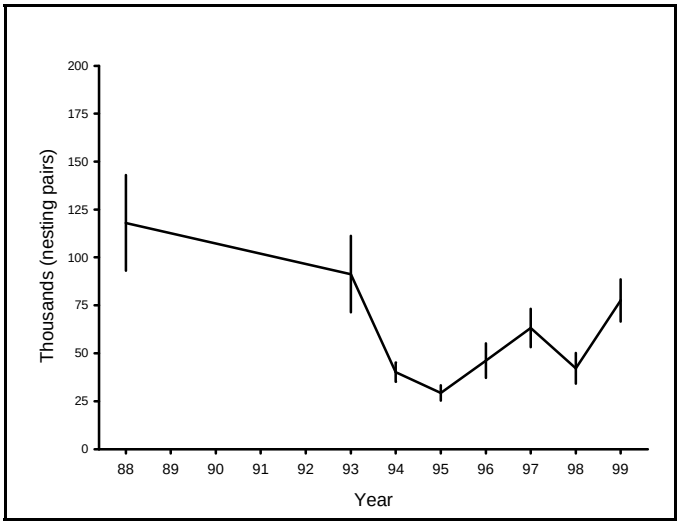

Fig. 5. Estimated number of breeding pairs (and 95% confidence intervals) in the Atlantic Population of Canada Geese in northern Quebec.

North Atlantic Canada Geese (NACG).-- Geese in this population nest in Newfoundland and Labrador, and generally mix during winter with AP Canada Geese (although the distribution is more coastal than AP Canada geese). Surveys of geese breeding in Labrador showed significantly increased nest densities. Fall flight forecasts for this population are not possible without further information.

Atlantic Flyway Resident Population (AFRP).-- This population occurs in southern Quebec, the southern Maritime provinces, and all states of the Atlantic Flyway (Fig. 4). In the spring of 1999, there were 999,496 (762,706-1,236,285) Canada geese in the northeastern U.S. (Fig. 6), which is similar ($P>0.5$) to the previous year's estimate. These estimates have increased ($P<0.01$) an average of 14% per year since 1989. In most areas, field biologists expect production to be average or better than average. Showers and flooding during May probably reduced production in Massachusetts and West Virginia. Overall, the fall flight should be similar to last year's, considering the size of the spring population and anticipated recruitment.

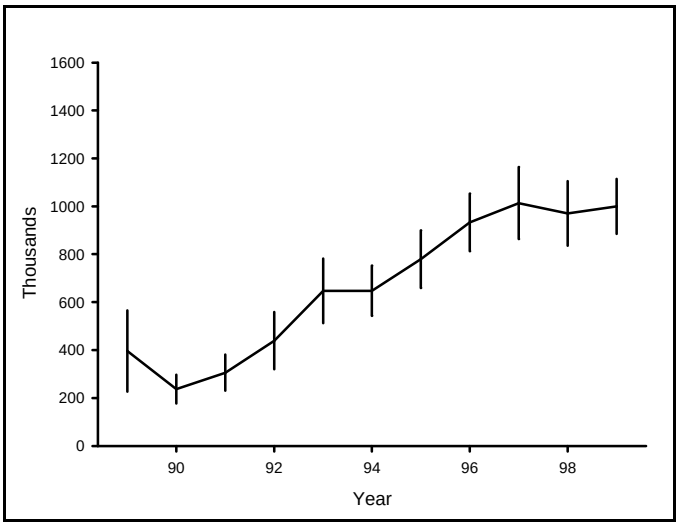

Fig. 6. Estimated size (and 95% confidence intervals) of the Atlantic Flyway Resident Population of Canada geese during spring.

Southern James Bay Population (SJBP).--This population nests on Akimiski Island in James Bay and in the adjacent lowlands to the south and west. The SJBP winters from southern Michigan to Mississippi, Alabama, Georgia, and South Carolina (Fig. 4). There were 136,623 (121,335-151,911) Canada geese counted on the breeding range during surveys on May 20-22, which similar to the 1998 estimate ($P>0.5$) to last year's estimate (Fig. 7). There has been a significant increase in the size of the total population during the last 10 years ($P<0.02$). In 1999 there

were 54,032 (42,276-65,788) breeding pairs, which is 42% higher (P<0.10) than the 1998 estimate. Estimates of non-breeders decreased by approximately 31% from 1998 estimates. Survey timing was optimal on both Akimiski Island and the mainland; no broods were observed during the survey (Canada geese become more secretive when they have a young brood, the estimated number of breeding pairs on the mainland may be biased low if the survey is conducted during hatching). Conditions on Akimiski Island were generally wet, with good nesting success. Late season snow on the mainland may impact brood success in those areas. Predictions using satellite imagery suggest average to above-average recruitment. With the significant increases in the breeding population, and forecasts for good recruitment, the fall flight probably will be above that of last year.

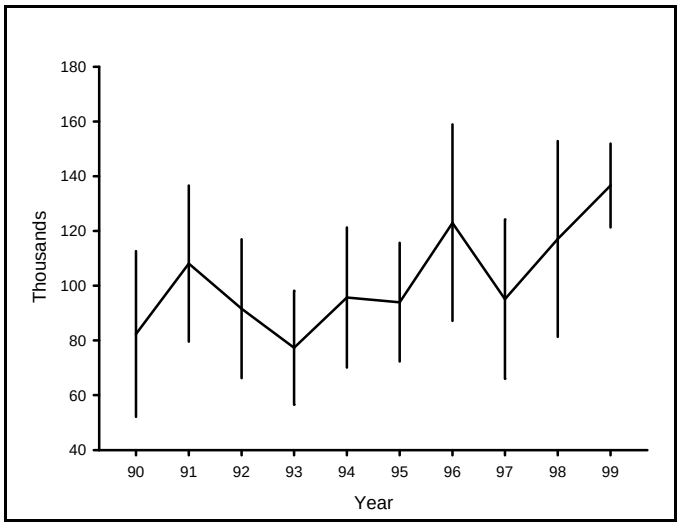

Fig. 7. Estimated size (and 95% confidence intervals) of the Southern James Bay Population of Canada geese during spring.

Mississippi Valley Population (MVP).--The principal nesting range of this population is in northern Ontario, especially in the coastal lowlands west of James Bay and south of Hudson Bay. MVP Canada geese concentrate in the fall in southeastern Wisconsin and winter primarily Illinois and southern Wisconsin in warmer years (Fig. 4). Snow melt was early this year over much of the breeding range. Surveys conducted on the breeding range during 23-25 May indicated 969,499 (773,385-1,165,613) geese, which is 118% higher (P<<0.01) than the 1998 estimate (Fig. 8). The proportion of non-breeders was judged to be similar to the long-term average. In 1999, there were 242,618 (208,933-276,303) nests, which is 51% higher (P<<0.01) than the estimate in 1998. The marked differences between 1998 and 1999 estimates probably reflect relative differences in the timing of the surveys; in 1998, survey timing may have been late in the interior stratum, and this may have caused estimates of breeding adults to be biased low. Fall-flight forecasts for 1999 do not appear to be significantly larger than during the previous 10 years, excluding 1998. There has been no trend (P>0.5) in the size of the spring population since 1989, and no trend (P>0.5) was detected in numbers of nests over the last 10 years. Models using data from satellite images predict average to above-average production. Based on the spring population, the number of active nests, and model forecasts for average to above-average production, the fall flight should be good to very good for this year. Flyway biologists have estimated the fall flight at 1,283,536 birds, which is almost twice as many as forecast for 1998.

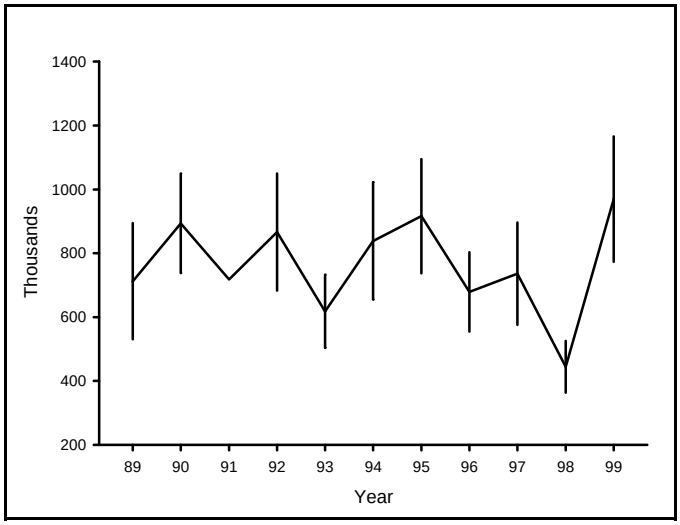

Fig. 8. Estimated size (and 95% confidence intervals) of the Mississippi Valley Population of Canada geese during spring.

Mississippi Flyway Giant Population (MFGP).--These birds have been reestablished in many states of the Mississippi Flyway, and represent a significant portion of Canada geese occurring there (Fig. 4). This population has been monitored with a spring survey for the past 2 years. The preliminary 1999 population estimate was 1,390,200, which is only 1.5% greater than the 1998 estimate. Biologists reported that conditions were favorable to extremely favorable for nesting geese throughout their breeding range. Another large fall flight is expected.

Eastern Prairie Population (EPP).--These geese nest in the Hudson Bay Lowlands of Manitoba and primarily winter throughout Missouri (Fig. 4). The breeding population estimate of 270,540 (241,416-299,664) in 1999 is 68% larger (P<0.01) than the estimate from 1998 (Fig. 9). There has been no trend (P>0.2) in the spring estimate over the last 10 years. The 1999 index to the number of pairs increased 71% (P<0.02), while the number of productive (nesting) geese was 29% higher than last year's value (P<0.05). Mild temperatures, minimal snow cover, and little flooding made conditions favorable for nesting during May. Biologists at Cape Churchill reported very low nesting density, with slightly lower than average clutch size. However, this low nesting effort in the Cape Churchill area may reflect continued deterioration of local breeding conditions, generally thought to be due to excessive grubbing and grazing by lesser snow geese nesting in the area. Post-laying weather conditions were characterized by drought conditions throughout the breeding

range, with generally poor post-hatch availability of primary food plants. This may negatively impact brood survival in many areas. Predictions from satellite data (which considers primarily timing of snow melt) indicate that production for the EPP will be about average. The expected fall flight for 1999 is hard to predict; significant increases in population size from 1998 and a strong, early nesting effort should result in an increased fall flight over that of 1998, likely similar to the 1988-97 average. However, the impact of rangewide drought conditions on brood survival is unknown.

Western Prairie Population/Great Plains Population

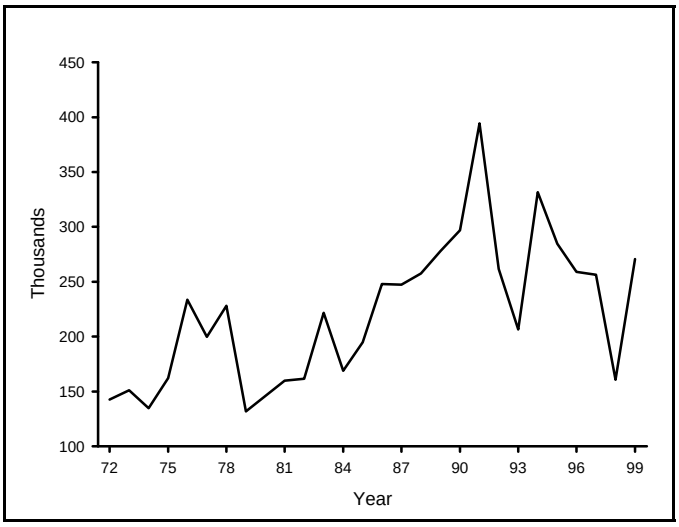

Fig. 9. Size of the Eastern Prairie Population of Canada geese estimated from breeding ground surveys.

(WPP/GPP).--The WPP is composed of large Canada geese that nest in eastern Saskatchewan and western Manitoba. The GPP is the result of restoration efforts in Saskatchewan, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. In winter, geese from these 2 breeding populations are found with other Canada geese along the Missouri River in South Dakota, and on reservoirs from southwestern Kansas to Texas. The fall and winter ranges of the WPP and GPP overlap (Fig. 4) and separate counts of the 2 populations are not available from existing surveys. During the January 1999 survey, 467,162 WPP/GPP geese were counted, which is similar to the previous year's index (Fig. 10). This population index has increased 4% per year over the last 10 years ($P<0.05$). Spring surveys conducted principally for ducks in the Dakotas, Saskatchewan, and Manitoba in 1999 indicated 785,650 Canada geese in this area, which is marginally larger (+5.2%; $P>0.15$) to last year's estimate. These estimates have increased ($P<0.01$) 6.4% per year since 1989. Habitat conditions during the nesting period generally were favorable to good throughout the breeding range. Flooding in portions of the range of GPP probably destroyed some nests. However, the population of WPP/GPP remains well above objective levels. Production of WPP/GPP Canada geese should be at least average and their fall flight should be similar to or larger than that of last year.

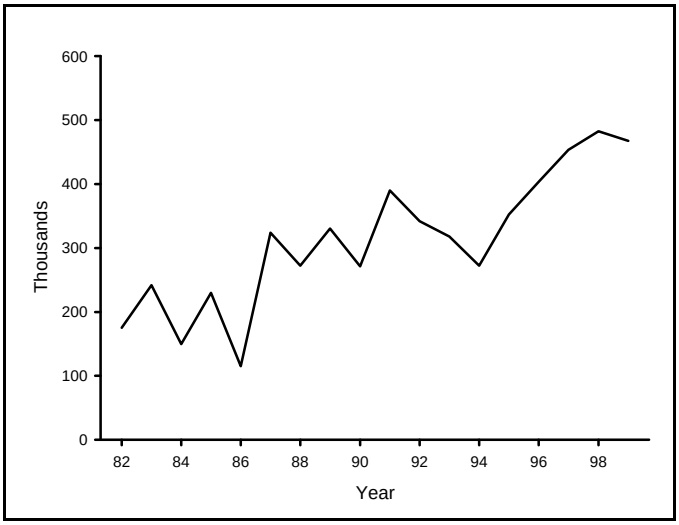

Fig. 10. Size of the WPP/GPP population of Canada geese estimated from winter surveys.

Tall Grass Prairie Population (TGPP).--This population nests on Baffin (particularly on the Great Plain of the Koukdjuak), Southampton, and King William islands, and on the mainland along the McConnell and Maguse rivers. The range on the mainland extends west and north to the Queen Maud Gulf. TGPP Canada geese winter mainly in Oklahoma, Texas, and northeastern Mexico. These geese mix with other Canada geese on wintering areas, making it difficult to estimate the size of the population (Fig. 4). Based on the Central Flyway survey in January 1999, this population contained 548,206 geese, which is about 63% larger than the December 1997 estimate (Fig. 11; note that

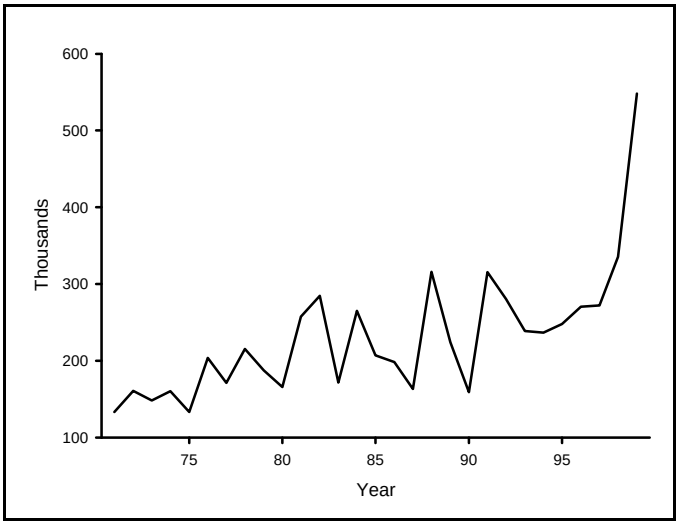

Fig. 11. Size of the TGPP population of Canada geese estimated from winter surveys.

prior to 1998, estimates include both Central and Mississippi Flyways). During the most recent 10-year period (including the 1999 estimate), a significant trend ($P<0.05$) was detected in numbers of TGPP geese in the winter survey. Spring weather on Baffin and Southampton Island was quite poor, and nesting was delayed. Based on satellite imagery, the production of young should be below average. With poor breeding success, but a large January population index, forecasting fall flight for this population is difficult; conservatively, a fall flight marginally larger than last year's is expected, biased towards adults.

Short Grass Prairie Population (SGPP).--This population nests on Victoria and Jenny Lind islands and on the mainland from Queen Maud Gulf to the Mackenzie River and south into northern Alberta. These geese winter in southeastern Colorado, northeastern New Mexico, and the Oklahoma and Texas panhandles (Fig. 4). In January 1999, 403,197 SGPP geese were counted, which is similar to the previous year's count (Fig. 12). No trend was detected in these counts over the last 10 years ($P>0.3$). Breeding surveys conducted principally for ducks in the western part of the Northwest Territories and northern Alberta (strata 13-20, and 75-77) provide no evidence ($P>0.5$) of a trend in numbers of Canada geese in this area since 1989. This spring's estimate (257,627) was 68% higher than that of last year ($P<0.03$). Snow melt was early and water levels were generally lower than average in northern Alberta and the Northwest Territories this spring. Near Queen Maud Gulf and Walker Bay, weather during mid-May was warm and snow coverage was not extensive. Nest-initiation dates were average near Queen Maud Gulf and Walker Bay. Biologists in these areas predict that production will be average to slightly better than average. Production of young is predicted to be better than average based on satellite images. Considering the similar size of the January population estimate, the increased numbers of breeding birds estimated in May surveys, and the possibility of above average production, the fall flight probably will be larger than that of last year.

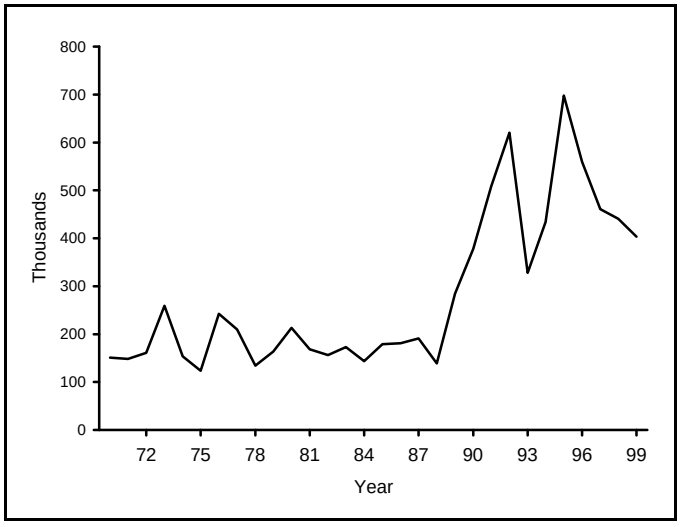

Fig. 12. Size of the SGPP population of Canada geese estimated from winter surveys.

Hi-Line Population (HLP).--These large Canada geese nest in southeastern Alberta, southwestern Saskatchewan, eastern Montana and Wyoming, and in north-central Colorado. They winter in north-central Colorado and in central New Mexico (Fig. 4). The January 1999 survey of this population resulted in an estimate of 119,500 geese, which is 37% lower than last year's estimate (Fig. 13). Based on results from January surveys, the number of HLP geese has increased ($P<0.01$) an average of 7% per year during the last 10 years. An estimate of the spring population was obtained for areas in Saskatchewan, Alberta, and Montana that were surveyed principally for ducks. In contrast to the results of the January survey, the 1999 spring estimate of 305,232 (251,159-359,304) is 60% larger ($P<<0.01$) than the 1998 estimate. The spring population estimate has increased ($P<0.01$) approximately 6% per year since 1989. Overall, habitat conditions were good over most of the breeding range of the HLP and production should be near or above average. The fall flight of HLP geese should be somewhat larger than that of last year.

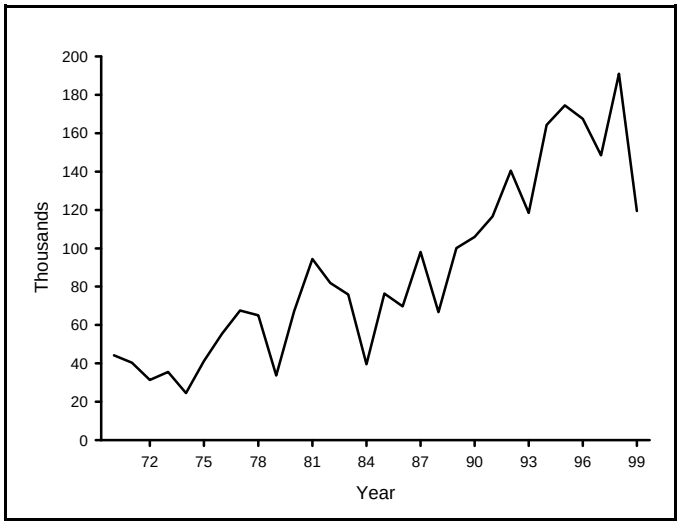

Fig. 13. Size of the Hi-Line population of Canada geese estimated from winter surveys.

Rocky Mountain Population (RMP).--These Canada geese nest in southern Alberta, the inter-mountain regions of Utah, Idaho, Nevada, Colorado, and Wyoming, and in western Montana. They winter mainly in central and southern California, Arizona, Nevada, Colorado, Utah, Idaho, and Montana (Fig. 4). In January 1999, 114,416 geese were counted, which is marginally higher than the 1998 estimate (Fig. 14). Results of January surveys provided no evidence ($P>0.1$) of a significant short-term trend in the size of the RMP during 1989-1999, although overall numbers have clearly increased over time ($P<<0.01$; Fig. 14). Spring surveys, conducted principally for ducks in southern Alberta, southwestern Saskatchewan, and Montana, produced an estimate of 175,469 (113,564-237,373), which was not significantly different ($P>0.2$) from the estimate for 1998 (Note: the value of 75,652 reported for 1998 in the 1998 status report was in error - the

correct estimate for 1998 was 130,874). Spring estimates have increased by approximately 8% per year since 1989 ($P<0.01$). Biologists report that nesting conditions in Utah and Nevada were generally poor, and production from these areas is expected to be below average. Wetland conditions in Alberta and Montana were generally perceived to be better than last year, and biologists expect good production. Based on little change in the population, and the variable outlook for production, a fall flight similar to last year is expected.

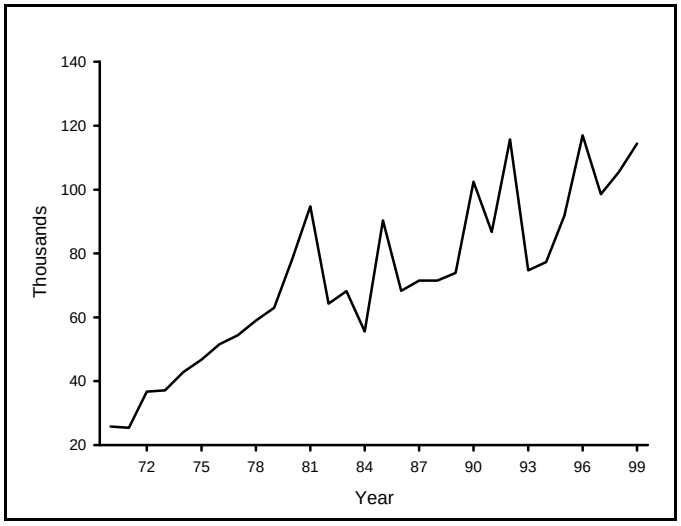

Fig. 14. Size of the Rocky Mountain Population of Canada geese estimated from winter surveys.

Pacific Population (PP).--This population nests and winters west of the Rocky Mountains (Fig. 4). Biologists report that the number of nesting pairs and overall production were down slightly in California this year relative to the 10-year average for both indices. California experienced above-average precipitation last winter. However, the spring was cool and dry. Biologists anticipate average numbers of geese from California this year. Numbers of geese in Idaho, Nevada, and Oregon this spring were similar to those of last year, while in Washington the index to nesting geese declined slightly. Flooding in parts of Oregon, Idaho, and Nevada probably destroyed some nests, while cold and rainy weather may have diminished survival of goslings in British Columbia and Washington. Production was expected to be below average in British Columbia and Washington, and average in Idaho, Nevada, and Oregon. The size of the fall flight can not be reliably predicted without more complete information.

Dusky Canada Geese.--The Copper River Delta in southeastern Alaska is the only known nesting area of this relatively small population. These geese winter principally in the Willamette Valley of western Oregon (Fig. 4). The size of the population is estimated through observations of marked geese during December and January. In January 1999, the population estimate was 13,447 (14,142-28,418), which is 36% lower ($P<0.05$) than the estimate from the previous winter (Fig. 15). Preliminary results

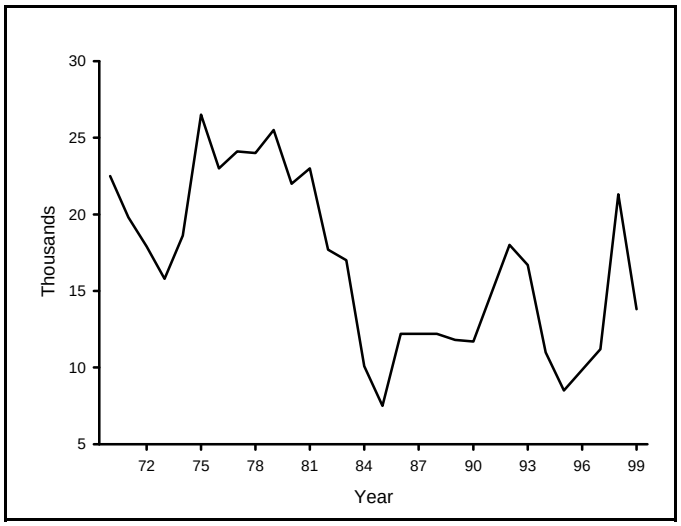

Fig. 15. Size of the Dusky Canada goose population estimated from winter surveys.

from a spring survey of Dusky geese on the Copper River Delta indicated that the number of singles and pairs and total birds are down 11% and 36%, respectively, from last year. Field biologists reported cold and prolonged spring weather at Copper River, with ice remaining on ponds several weeks longer than average. Laying was delayed by as much as 10 days in some areas. Nesting predation and renesting effort appeared to be lower than in 1998, with total nests remaining approximately unchanged. The fall population of Dusky geese will be small, and is predicted to be lower than that of last year.

Cackling Canada Geese.--Cackling Canada geese nest along the Bering Sea coast of the Yukon-Kuskokwim Delta. They winter in Oregon and northern California (Fig. 4). The calculated 1998 fall count (based on the spring Yukon Delta breeding pairs survey) was 195,516 geese. This is marginally larger (<2%) than the index from autumn 1997. The number of cackling geese esti-

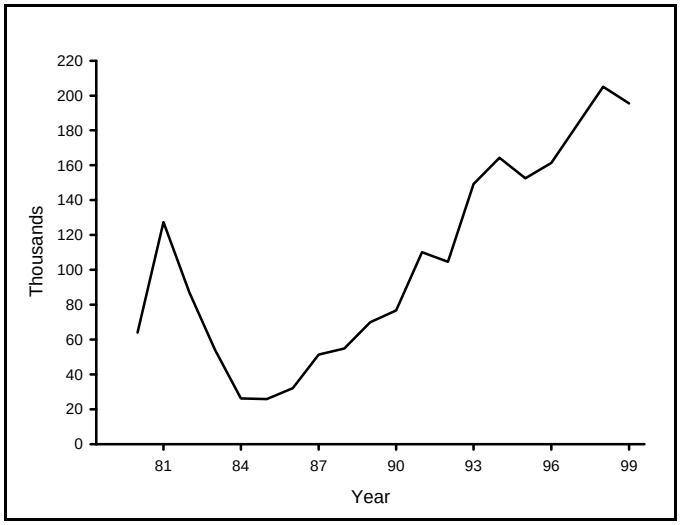

Fig. 16. Size of the Cackling Canada goose population estimated from winter surveys.

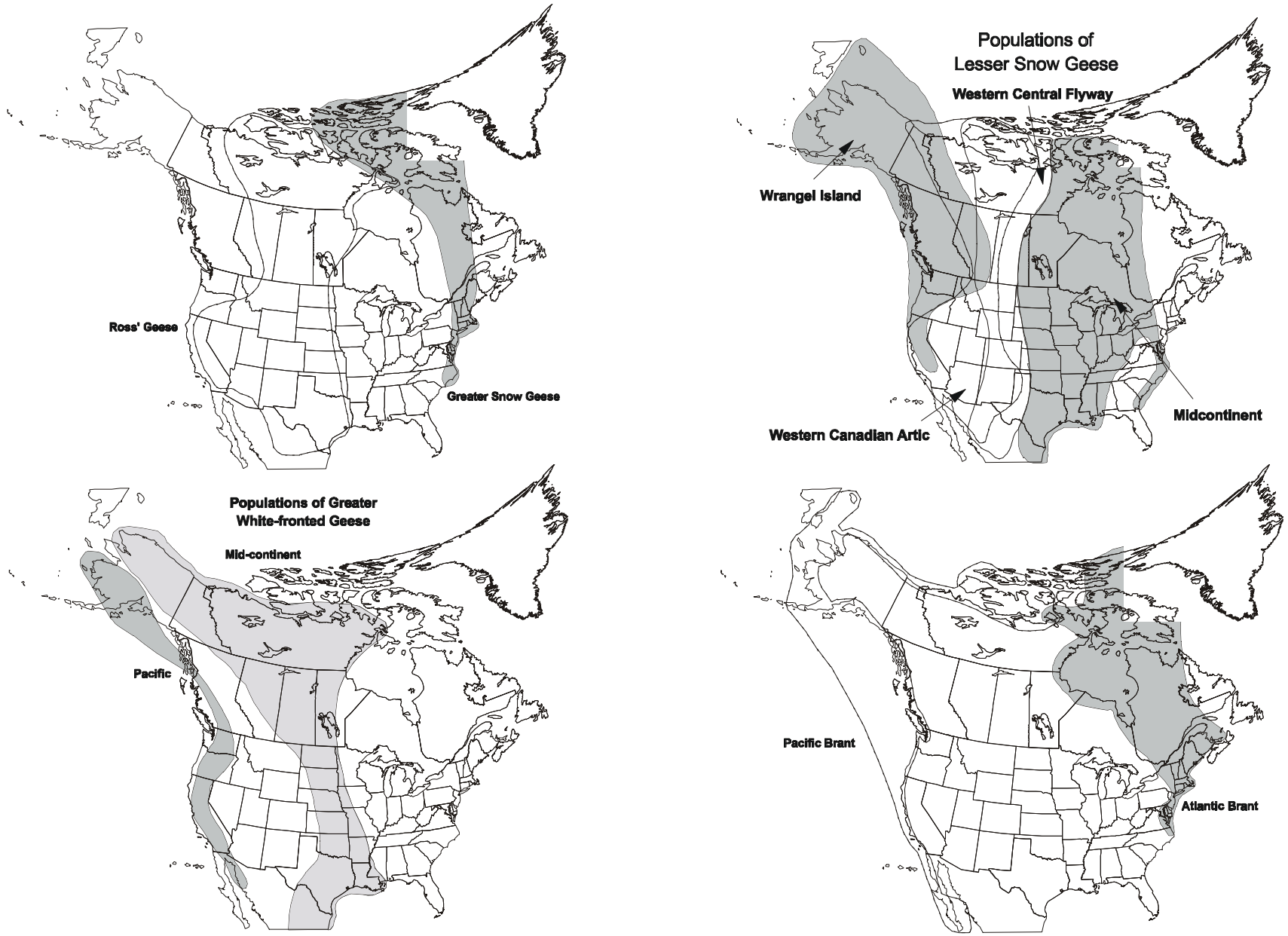

Fig. 17. Approximate ranges of selected goose populations in North America

mated using this index has been increasing ($P < 0.01$) an average of 12% per year during 1988-1998 (Fig. 16). Results of the spring survey on the Yukon-Kuskokwim Delta indicated that the number of breeding pairs and total birds increased by 10% and 17%, respectively. Preliminary data from a nest plot survey suggest no significant change in nesting effort in the survey area relative to last year. Slight delays in spring melt combined with slight increases in the number of breeding birds suggest that fall flight for this population should be about the same as last years.

Lesser Canada Geese.--These geese nest throughout much of Alaska and winter in Washington, Oregon, and California (Fig. 4). During the winter, lesser Canada geese mix with other Canada geese and no reliable estimates of population size are available. Across much of the interior of Alaska and on the North Slope, conditions appeared to be approximately 1 week later than usual. However, there seemed to be little flooding. These conditions should be favorable for nesting geese, and a fall flight similar to that of last year is expected. .

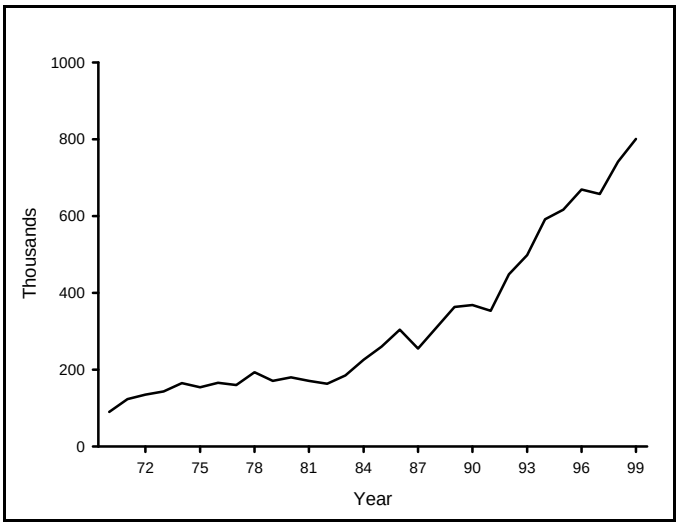

Fig. 18. Size of the Greater Snow goose population estimated from spring surveys.

Status of Greater Snow Geese (GRTR)

These geese (*Anser caerulescens)* nest principally around northern Foxe Basin, northern Baffin, Bylot, Axel Heiberg, and Ellesmere islands, and Greenland. They winter along the mid-Atlantic coast from New Jersey to North Carolina (Fig. 17). Preliminary results from the 1999 photographic survey conducted during spring staging in the St. Lawrence Valley indicated that there were 800,387 geese, which is a new record high. Final results from this survey typically yield estimates that are larger than the preliminary estimates. This year's preliminary estimate is 15% larger than last year's final estimate of 741,200 (Fig. 18). The number of greater snow geese counted in the spring has increased ($P<0.01$) an average of 14% per year since 1989. On Bylot Island, where the largest known colony nests, initial reports were that breeding was likely to be very late, with significantly reduced nesting effort, primarily influenced by late snow melt and cold conditions. This was reflected in estimates from satellite data, where poor recruitment is predicted; models based on satellite data rely heavily on measures of snow cover. However, biologists report that the first two weeks in June were warmer than usual, and snow melt was only marginally later than normal. Nonetheless, biologists confirm that nesting was notably late, despite the rapid melt during early June (median nesting date of June 18, close to the latest on record), with significantly reduced breeding propensity. Average clutch size was very low (3.2 eggs/clutch compared to average of 3.9 eggs/clutch), and there was significant predation (~50%) of those few nests which were initiated. Significantly lower-than-average production of young from Bylot Island is anticipated. Biologists speculate that the delay in timing and reduction in intensity of nesting, despite only marginally late timing of snow melt, may reflect poor physiological condition of the birds upon arrival at the breeding colony. The fall flight of greater snow geese will be lower than that of last year, considering the very poor breeding success.

Status of Lesser Snow Geese

Mid-Continent Population (MCP).--This population nests primarily in colonies along the southern and western shores of Hudson Bay and on Southampton and Baffin Islands (Fig. 17). During the January 1999 survey, 2,575,700 'light' geese (primarily lesser snow geese, with some Ross geese) were counted, which is slightly lower than last year's count (Fig. 19). The winter index has increased ($P<0.01$) an average of 5% per year during the last 10 years. On the western shore of Hudson Bay, field biologists reported that temperatures were warmer than normal during May, and nest initiation was quite early, with generally average clutch size. A high frequency of infertile eggs was detected in some areas of the colony, which may indicate increased nutritional stress among nesting females. The number of nesting pairs was similar to that of last year near La Pérouse

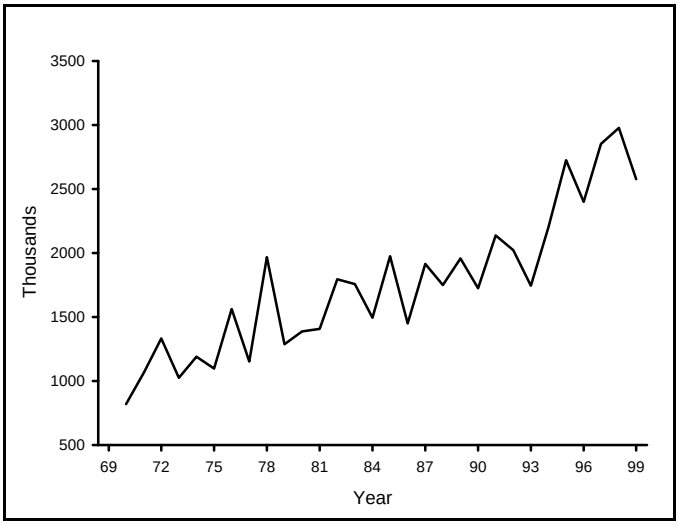

Fig. 19. Size of the Mid-Continent Population of 'light' geese (Lesser Snow Geese + Ross Geese) estimated from winter surveys.

Bay. Seasonal weather dominated during late-incubation and at the time of hatch. Goslings in traditional areas of the nesting colony had lower mortality than last year, due to very early emergence of primary food plants (earliest on record). Typically, areas farther inland and south of the traditional colony have increased gosling production and survival. However, conditions were exceptionally dry during the post-hatch period at La Pérouse Bay and in the Cape Churchill area this year, and broods were forced to use inland fresh-water forage plants, rather than their preferred salt-marsh food plants. Whether or not this will negatively impact overall gosling growth and survival is unknown. Assuming such impacts are minimal, biologists expect that production will be average to above-average average for the Churchill area. The small Akimiski Island colony was similar in size to 1998, but had about 50% fewer breeding pairs in the main study areas than observed in recent years. Biologist suggest this may reflect increased nesting inland in freshwater marshes compared to recent years. Nesting was marginally later than last year, but still earlier than average. Higher rates of nest parasitism and and increased asynchrony in laying may be consistent with suggestions of variable physical condition among these birds. The Cape Henrietta Maria colony showed fewer nesting pairs overall than previous years, with about average clutch size. Satellite monitoring showed below-average snow cover in early June on Southampton and Baffin islands, which are important nesting areas. However, biologists report poor weather during nesting and hatching in various locations on Baffin Island, which may negatively impact production from the large colonies on Baffin Island. This contrasts with predictions based on satellite data indicating that the production rate for the MCP will be higher than average. Given the uncertainty concerning breeding success of the large colonies on Baffin Island, but the likely good to very good production from colonies on West Hudson Bay and James Bay, the fall flight of MCP snow geese again will be large.

Western Central Flyway Population (WCFP).--This population, consisting primarily of snow geese, but with significant proportions of Ross geese, breeds in the western Canadian Arctic, with large nesting colonies at Queen Maude Gulf and on Banks Island. These geese stage in the fall in eastern Alberta and western Saskatchewan and spend the winter in southeastern Colorado, New Mexico, the Texas Panhandle, and the northern highlands of Mexico (Fig. 17). WCFP geese wintering in the U.S. portion of their range are surveyed annually, but the entire range, including Mexico, is surveyed only once every 3 years. In the U.S. portion of the survey, 236,400 geese were counted in January 1999; this is >100% larger than the previous year's index (Fig. 20), and is unlikely to represent internal growth of this population. However, in general the U.S. counts for the WCFP of snow (and Ross) geese have increased an average of 9% per year since 1988. The entire range (U.S. and Mexico) was surveyed in December 1996. This survey resulted in an estimate of 216,082 geese, which is 17% lower than the last comparable survey that was conducted in 1993. Biologists on the nesting range near Queen Maud Gulf reported that weather was generally favorable for nesting, with a near-absence of snow on arrival. As a result, nesting was slightly earlier than normal, with about average production predicted. The situation on Banks Island was notably different; protracted snow cover delayed nesting significantly, and biologists report lower-than-average brood sizes. Evidence of mortality due to avian cholera was again observed at the large Egg River colony. Relatively few foxes and lemmings were observed, suggesting the risk of nest predation may be lower than last year. Overall, above-average recruitment is predicted from satellite imagery of temporal changes in habitat conditions for this population,The overall fall flight will probably be larger than that of last year due to the increased number of adult geese reported in the winter survey, and the good production from the Queen Maud Gulf Colony. The expectations for a very large fall flight are attenuated by reduced success among birds breeding on Banks Island.

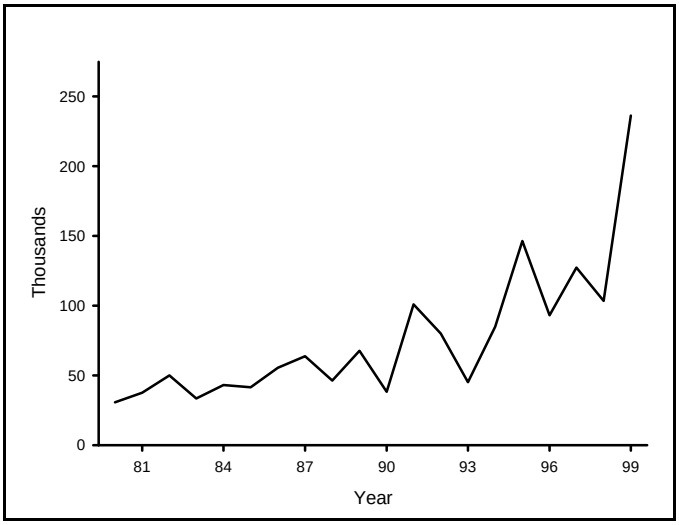

Fig. 20. Size of the Western Central Flyway Population of 'light' geese (Lesser Snow Geese and Ross Geese) estimated from winter surveys.

Western Arctic - Wrangel Island Population (WAWI).--Most of the snow geese in the Pacific Flyway originate from nesting colonies in the Western Arctic (WA; Banks Island, in the Anderson and Mackenzie River deltas, on Jenny Lind Island, and in the western Queen Maud Gulf region) and Wrangel Island (WI) off the north coast of Russia. The WA segment of the population winters in central and southern California, New Mexico, and Mexico, while the WI segment winters in the Puget Sound area of Washington and in northern and central California (Fig. 17). Possible interchange of individuals between the two breeding sites may occur in overlapping wintering ranges in California. The number of snow geese wintering in the Pacific Flyway was estimated at 354,300 individuals, which is 15% smaller than the count for 1998 (Fig. 21). The Pacific Flyway population of snow geese is notable for being the only population of light geese which has declined significantly over the past 10 years, at approximately -6% per year. This population has been characterized by large apparent shifts in abundance (for example, from 204K to 760K between 1980 and 1981). However, the protracted decline over

the past decade is notable. Segregating total counts between the WA and WI segments is not possible because WA and WI snow geese mix with other "white geese" in the Pacific Flyway during winter. Biologists monitoring a large nesting colony on Banks Island reported protracted snow cover, and average to below average production (see narrative for WCFP snow geese). At smaller colonies near the Anderson River and on Kendall Island, production likely will be low due to the relative lateness of spring melt, nest predation and low nesting efforts, respectively. The number of geese nesting at Anderson River was well below historic values. Biologists attribute much of this decline to increased incidence of nest production by Grizzly bears. The estimated number of nesting geese at Kendall Island was was near the long-term average for this colony. Average recruitment for the WA (North American) breeding segment is expected based on satellite imagery. No current information from Russian biologists working on Wrangel Island was received in time for the preparation of this report. Fall flight for the overall population cannot be reliably predicted without information from Wrangel Island. However, production from the segment of the population breeding in the western Canadian Arctic is expected to be below average.

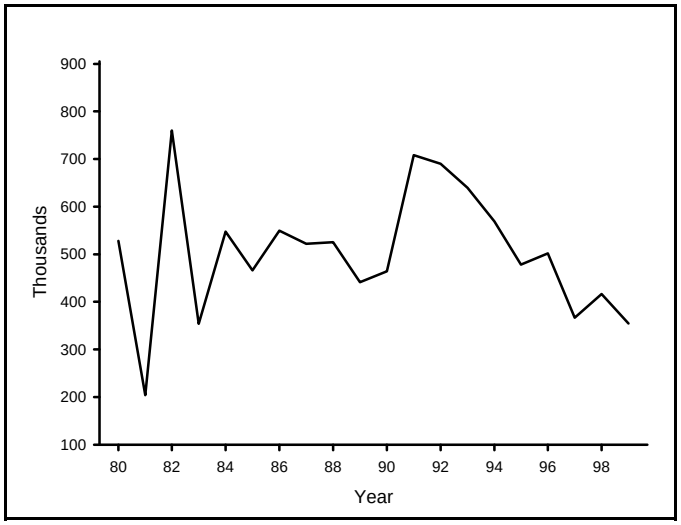

Fig. 21. Size of Western Arctic-Wrangel Island (Pacific Flyway) Population of 'light' geese (Lesser Snow geese and Ross Geese) estimated

Status of Ross' Geese

Most Ross' geese (*Chen rossii)* nest in the Queen Maud Gulf area, but some nest on Banks Island and along the western coast of Hudson Bay. Ross geese are represented in 3 different populations of 'light' geese (MC, WCFP, and WAWI), and winter in northern and central California, New Mexico, Mexico, and along the Gulf Coast of Texas (Fig. 17). No annual estimate of wintering-population size is available. However, both the MCP and WCFP populations of 'light' geese in which Ross geese are found have increased significantly over the last 10 years. In addition, periodic surveys in breeding and wintering areas suggest steady increases in the number of Ross' geese since the mid-1960's. Preliminary estimates from Canadian biologists suggest approximately 1 million Ross' geese in North America. Field biologists expect about average to slightly below average production from the Queen Maud Gulf area; nesting of Ross Geese was delayed by as much as a week relative to nesting of lesser snow geese at the colony (normally Ross' geese nest 1-2 days later than snow geese at Queen Maud Gulf). Predictions from satellite imagery also indicate average to below average recruitment. The relative size of the fall flight can not be predicted without an annual index to the size of the breeding population.

Status of Greater White-fronted Geese

Pacific Population (PP).--These geese (*Anser albifrons)* nest in western Alaska, primarily in the Yukon-Kuskokwim Delta, and most winter in the Central Valley of California (Fig. 17). An index to this population is derived from a fall survey conducted on staging and wintering areas in the Pacific Flyway. The 1998 fall index was 413,100, which is 29% larger than last year (Fig. 22). Numbers of PP white-fronted geese in the fall survey have steadily increased ($P<0.01$) an average of 7% per year during the last 10 years. On the Yukon-Kuskokwim Delta this spring, spring thaw was about 1-2 weeks later than normal, but biologists report nesting was only slightly later than normal. Spring surveys conducted here revealed increases in total geese, breeding pairs, with a slight but significant decline in the numbers of nest from 1998. Like the fall population count, indices from the Delta have generally increased over the last 10 years. Predictions from satellite imagery suggest an average to below average production year. Based on the size of the spring population, and the slight delay to nesting and decrease in the number of nests, an average production year is predicted.

Mid-Continent Population (MCP).--Birds from this population nest across a broad region of the western and central Arctic

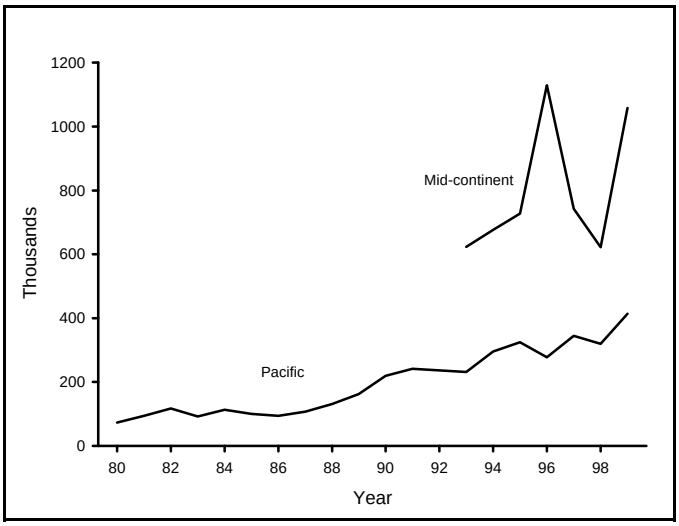

Fig. 22. Sizes of the Mid-continent and Pacific populations of greater white-fronted geese estimated from winter surveys.

that extends from northwestern Alaska to the Foxe Basin. They concentrate in southern Saskatchewan during the fall, and most spend the winter in Texas or Louisiana (Fig. 17). This population was formerly divided into eastern and western segments. In 1998, 1,058,300 were counted during the autumn, which is 70% higher than the 1998 estimate (Fig. 22). There was no evidence of a trend in this population over the last 7 years. Biologists on the North Slope of Alaska believe that spring phenology was later than normal this year and anticipate average to slightly below-average production. In the western Canadian Arctic, field biologists expect that production will also be below average. Near Walker Bay in the central Arctic, biologists predicted only poor to fair production due to avian predation on eggs. Production is expected to be average based on satellite imagery. Overall the fall flight is expected to be average to below average; the size of the spring population increased relative to last year, but breeding success is likely to be poor.

Status of Brant

Atlantic Brant (ATLB).--Most of this population of brant (*Branta bernicla)* nests in the eastern Arctic and winters along the Atlantic Coast from Massachusetts to North Carolina (Fig. 17). The January 1999 estimate of brant in the Atlantic Flyway was 171,628, which is 24% greater than the 1998 estimate (Fig. 23), and 25% higher than the 10-year average. No trend has been detected (P>0.5) in the size of this population over the most recent 10-year period. Above-average production is predicted using satellite images of the eastern Arctic. The fall flight should be larger than that of last year.

Pacific Brant (PACB).--These geese nest from Melville and Banks Islands to the Queen Maud Gulf, and west along the coastal mainland to western Alaska and Wrangel Island. They migrate as far south as Baja California and the west coast of Mexico (Fig. 17). The survey in January 1999 in the Pacific

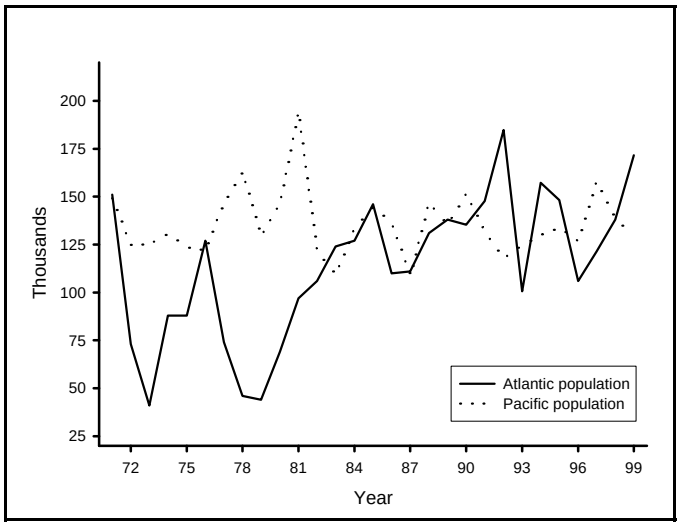

Fig. 23. Sizes of the Atlantic and Pacific populations of brant estimated from winter surveys.

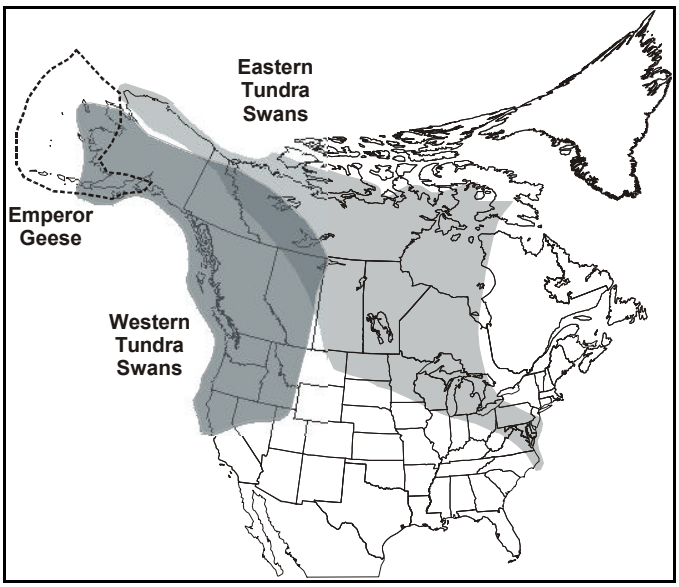

Fig. 24. Approximate range of Emperor goose, eastern and western Tundra Swan populations in North America.

Flyway and Mexico resulted in a count of 129,208 brant, which is 7% lower than the index of the previous year (Fig. 23). No trend was evident in the number of brant counted over the last 10 years (P>0.6). Weather and habitat conditions on the Yukon-Kuskokwim Delta were later than average. Spring phenology on the North Slope of Alaska was 1-2 weeks later this year and this may negatively impact nesting brant. Biologists report that brant in the large colonies on the Yukon-Kuskokwim Delta showed reduced nesting effort, but clutch size and nesting success were reported as average to good. Near the Anderson and Mackenzie deltas, biologists expect low to moderate production. The fall flight likely will be smaller than that of last year, considering the decreased breeding population and the outlook for low or moderate recruitment.

Status of Emperor Geese

The breeding range of the emperor goose (*Chen canagica)* is restricted to coastal areas of the Bering Sea, with the largest concentration on the Yukon-Kuskokwim Delta in Alaska. Emperor geese migrate relatively short distances and winter primarily in the Aleutian Islands (Fig. 24). Since 1981, emperor geese have been surveyed annually on spring staging areas in southwestern Alaska. This year's count was 54,600 geese, which is 38% higher than the previous year's index (Fig. 25). The 3-year moving average is now 50,500 geese. No trend was detected (P>0.5) in the number of geese counted during this survey over the last 10 years. However, spring breeding pairs and total bird indices for the Yukon-Kuskokwim Delta breeding pairs surveys were only marginally higher than last years values (+6% and +1%, respectively). Preliminary data from nest plot surveys on the Yukon-Kuskokwim Delta suggest no change in emperor goose nesting effort in the survey area from last year, despite a slightly later (2-3

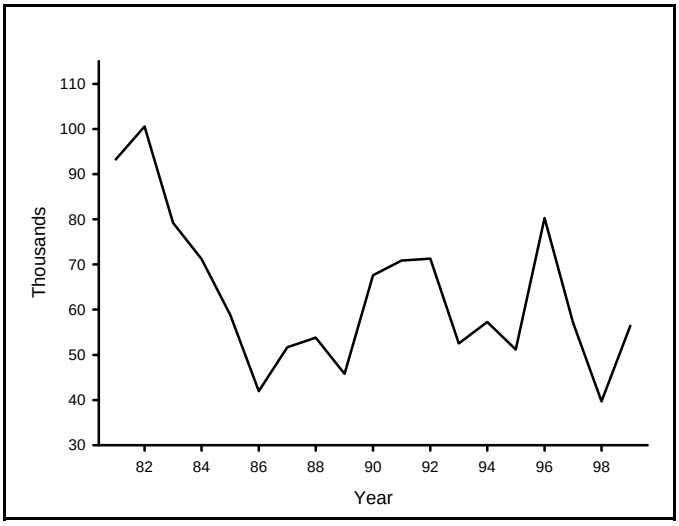

Fig. 25. Size of the Emperor Goose population estimated from May surveys.

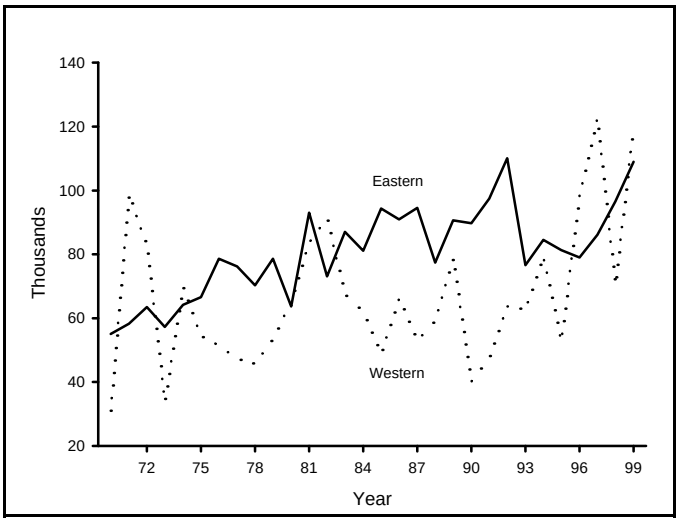

Fig. 26. Sizes of the Eastern and Western populations of tundra swans estimated from winter surveys.

days) average hatch date than 1998. Mean clutch size was slightly lower than the long-term average. The fall flight of emperor geese probably will be somewhat above that of last year due to the larger population this spring.

Status of Tundra Swans

Western Population.--The Western Population of tundra swans (*Cygnus columbianus)* nests along the coastal lowlands of western Alaska, particularly between the Yukon and Kuskokwim Rivers. They winter primarily in California, Utah, and the Pacific Northwest (Fig. 24). The January 1999 estimate of 119,800 swans is 70% larger than the estimate from 1998 (Fig. 26). This population has been increasing at an average rate of 7% per year since 1989 (P<0.1). An assessment of western tundra swans also was available from aerial surveys conducted in spring on the Yukon-Kuskokwim Delta. Numbers of breeding pairs on the Delta were 11% higher relative to last year's estimates. Total birds declined by 23%. Preliminary data from the nest-plot surveys on the Yukon-Kuskokwim Delta indicated a lower nesting effort for western swans. Habitat and weather conditions on the Delta this spring were later than average and should lead to average to below average production.

Eastern Population.--The Eastern Population of tundra swans nests from the Seward Peninsula of Alaska to the northeast shore of Hudson Bay and Baffin Island. These birds spend winters in coastal areas from Maryland to North Carolina (Fig. 24). The January 1999 estimate was 109,000 swans, which is 13% greater than last year's estimate (Fig. 26). There is no evidence (P >0.5) of a trend in the size of this population over the last 10 years. Spring temperatures were about average across much of the central and western Canadian Arctic. On the North Slope of Alaska, snow melt was slightly later than normal. Overall, about average production is expected, and the fall flight will be similar to that of last year.

Appendix A. Individuals who supplied information on the status of ducks.

Alaska & Yukon Territory (Old Crow Flats): B. Conant, J. Hodges, and D. Groves

Northern Alberta-Northeastern British Columbia-Northwest Territories: C. Ferguson and D. Melvin

Northern Saskatchewan & Northern Manitoba: F. Roetker and B. Mense

Southern & Central Alberta

Air	E. Buelna and D.A. Davenport
Ground	D. Duncan[a], P. Pryor[a], K. Froggatt[b], B. Ilnicki[c], E. Hoffman[b], S. Barry[a], R. Russell[b], K. Kaczanowski[c], G. Kindrat, I. McFarlane[c], M. Barr[c], B. Peers[c], R. Hunka[c], J. Rasmussen[a], J. Gonek[a], B. Meagher[a], J. Heese[a]

Southern Saskatchewan

Air	P. Thorpe, H. Bell, R. King, and R. Bentley
Ground	D. Nieman[a], J. Smith[a], K. Warner[a], D. Tide[c], D. Caswell[a], R. Bazin[a], P. Rakowski[a], M. Schuster[a], G. Ball[b], J. Caswell[a], A. Didiuk[a], M. Hosegood[a], D. Kerbes[a], D. McKinnon, L. Myndio[a], P. Nieman[a], C. Park[a], J. Peterson, C. Swoboda[a], A. Williams[a], M. Van Osch[c], J. Galbraith[a], T. Smith[a], M. Blanchard[a], D. Pisiak[a], D. Knudson[a]

Southern Manitoba

Air	R. King and R. Bentley
Ground	D. Caswell[a], R. Bazin[a], P. Rakowski[a], M. Schuster[a] ,G. Ball[b], J. Caswell[a], M. Van Osch[c], J. Galbraith[a], T. Smith[a], M. Blanchard[a], D. Pisiak[a], D. Knudson[a]

Montana & Western Dakotas

Air	J. Voelzer and K. Bollinger
Ground	A. Arnold[b] and M. Ennis

Central & Eastern Dakotas

Air	J. Solberg and M. Defley
Ground	D. Caithamer, G. Allen, N. Fahler, and M. Meade

Quebec: J. Wortham and L. Breton[a]

New York/Eastern Ontario: J. Wortham and M. Koneff

Western Ontario: B. Butler, B. Fisher, M. Koneff, and R. Lamont[a]

Maine and Maritimes: J. Goldsberry and J. Bidwell

British Columbia: A. Breault[a], P. Watts[d], J. Beaubier[b], A. Candy[d], C. Dyck[b], A. Dibb[b], M. Dennington[d], D. Ghikas[b], W. Haras[b], E. Hennan[d], C. Holschuh[b], C. Jones[b], E. Leupin[d], R. MacDonald[b], E. MacDonald[b], E. McAlary[b], D. Pehl[d], J. Picther[b], M. Porter[d], J. Robinson[b], R. Ritcey[b], C. Strong[b], B. Swan[d], K. Taylor[b], L. Taylor[b], S. Waggoner[b], M. Weninger[b], S. Wrazej[d], and M. Yasue[b]

California

Air	D. Yparraguirre[b], M. Adolf[b], J. Hainline, and D. Mauser
Ground	D. Loughman[d] and P. Lauridson[d]

Colorado: M. Crosby[b], J. Gammonley[b], J. Hicks[b], D. Kenvin[b], M. Middleton[b], M. Szymczak[b], R. Garcia, D. Graf, C. Lapp, T. Rintz, K. Sacilatto, J. Saylor, A. Shuffelberher, J. Zumbolo

Michigan: R. Matthews[d], G. Belyea[b], E. Flegler[b], R. Ainslie[b], A. Karr[b], J. Niewoonder[b], S. MacKinnon[b], and T. Gierman[b]

Minnesota

Air	D. Stoltman[b] and J. Lawrence[b]
Ground	S. Kelly, J. Holler, R. Papasso, E. Rozowski, K. Svendsgaard, J. Artmann, W. Brininger, S. Revering, G. Tischer, and S. Zodrow

Nebraska
Data Analysis P. J. Gabig[d]
Air N. Lyman[b] and D. Benning[d]
Ground N. Lyman[b] and R. Wood[b]

Nevada: N. Saake[b]

Northeastern U.S.
Data Analysis: H. Heusmann[b] and J. Sauer[d]
Connecticut: Names not available.
Delaware: T. Whittendale[b]
Maryland: D. Brinker[b], T. Decker[b], T. DeWitt[b], B. Evans[b], C. Harris[b], B. Harvey[b], D. Heilmeier[b], W. Henry[b], R. Hill[b], L. Hindman[b], B. Joyce[b], M. Mause[b], B. Perry[b], D. Price[b], G. Timko[b], and D. Webster[b]
Massachusetts: H. Heusmann[b]
New Hampshire: Names not available.
New Jersey: T. Nichols[b], P. Castelli[b], L. Widjeskog[b], D. Wilkinson[b], M. Craddock[b], J. Garris[b], R. Raftovich[b], N. Zimpfer[b], B. Kirkpatrick[b], J. Mangino[b], R. Hall[b], and T. Walker
New York: staff and volunteers from NY Department of Environmental Conservation
Pennsylvania: J. Dunn[b], J. Gilbert[b], K. Jacobs[b], M.J. Casalena[b], C. Thoma[b], B. Palmer[b], B. Drake[b], T. Hardisky[b], A. Keister[b], S. Klinger[b], D. Diefenbach[b], S. Repasky[b], W. Dingman[b]
Rhode Island: C. Allin[b], B. Tefft[b], C. Brown[b], T. Dudek[b], L. Suprock[b]
Vermont: B. Crenshaw[b] and J. Mlcuch[b]
Virginia: Names not available.

Oregon: B. Bales[b], E. Miguez[b], D. Budeau[b], P. Stevenson[b], M. St. Louis[b], T. Collom[b], D. Humphreys[b], E. Rickerson[b,] and E. Henning[b]

Washington: D. Base[b], J. Bernatowicz[b], S. Fitkin[b], P. Fowler[b], J. Hickman[b], T. McCall[b], M. Monda[b], J. Musser[b], J. Tabor[b], S. Zender[b], T. Hames[b], and M. Murphy[b]

Wisconsin
Air L. Waskow[b], J. Evrard[b], R. McDonough[b], G. Stacey[b], W. Hall[b], and P. Samerdyke[b]
Ground K. Belling[b], T. Bahti[b], J. Cole[b], G. Dahl[b], G. Dunsmoor[b], B. Hanson[b], K. Jonas[b], D. Evenson[b], R. Gatti[b], J. Huff[b], M. Kastler[b], K. Morgan[b], A. Nelson[b], M. Sparrow[b], M. Verdon[b], P. David[b], J. Denomie[b], M. Falck[b], A. Kitchen, M. McMurray, L. Nieman, J. Ruwaldt, D. Trudeau, and G. VanVreede

Wyoming: L. Roberts[b]

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[a]Canadian Wildlife Service
[b]State, Provincial, or Tribal Conservation Agency
[c]Ducks Unlimited - Canada
[d]Other organization
All others - U.S. Fish and Wildlife Service

Appendix B. Individuals that supplied information on status of geese and swans.

Coordinated Flyway-wide Surveys: K. Gamble, T. Moser, J. Peterson, J. Serie, D. Sharp, R. Trost

Equations to predict goose and swan recruitment using data from satellites: S. Sheaffer[d], R. Trost, and L. Strong[d]

Data from satellites: L. Strong[d]

Information from the Breeding Population and Habitat Survey: see Appendix A

Atlantic Population of Canada Geese: J. Goldsberry, W. Harvey[b], L. Hindman[b], J. Hughes[a], A. Reed[a], and J. Rodrigue[a]

Atlantic Flyway Resident Population of Canada Geese: C. Allin[b], P. Castelli[b], G. Chasko[b], P. Corr[b], G. Costanzo[b], L. Garland[b], H. W. Heusmann[b], L. Hindman[b], K. Jacobs[b], W. Lesser[b], E. Robinson[b], and T. Whittendale[b]

Southern James Bay Population of Canada Geese: J. Leafloor[b] and K. Ross[a]

Mississippi Valley Population of Canada Geese: J. Berquist[b], D. Fillman[a], J. Leafloor[b], and K. Ross[a]

Mississippi Flyway Population Giant Canada Geese: J. Berquist [b], E. Flegler[b], D. Graber[b], M. Hartman[b], J. Lawrence[b], R. Pritchert[b], and G. Zenner[b]

Eastern Prairie Population of Canada Geese: D. Andersen[d], K. Dickson[a], R. Foster, M. Gillespie[b], D. Humburg[b], D. Rusch[d], and P. Telander[b]

Western Prairie and Great Plains Populations of Canada Geese: J. Gabig[b] and M. Kraft[b]

Tall Grass Prairie Population of Canada Geese: R. Alisauskas[a], R. Case[b], K. Dickson[a], and R. Kerbes[a]

Short Grass Prairie Population of Canada Geese: K. Dickson[a] and J. Hines[a]

Hi-Line Population of Canada Geese: J. Hansen[b], M. Szymczak[b], and S. Tessman[b]

Rocky Mountain Population of Canada Geese: T. Aldrich[b], J. Hansen[b], J. Herbert[b], N. Saake[b], M. Szymczak[b], and G. Will[b]

Pacific Population of Canada Geese: A. Breault[a], B. Bales[b], D. Kraege[b], N. Saake[b], G. Will[b], and D. Yparraguirre[b]

Dusky Canada Geese: B. Eldridge, M. Drut, B. Larned, D. Logan[d], M. Naughton, R. Oates, T. Rothe[b], R. Trost, and D. Youkey[d]

Lesser Canada Geese: B. Conant, R. King, R. Oates, and M. Spindler

Cackling Canada Geese: T. Bowman, C. Dau, B. Eldridge, R. Oates, B. Platte, and B. Stehn

Greater Snow Geese: A. Reed[a], G. Gauthier[d], and N. Plante[a]

Mid-Continent Population of Lesser Snow Geese: K. Dickson[a], R. Foster, M. Gillespie[b], D. Humburg[b], R. Rockwell[d], and P. Telander[b]

Western Central Flyway Population of Lesser Snow Geese: R. Alisauskas[a], K. Dickson[a], R. Kerbes[a], and K. Warner[a]

Appendix B. Continued.

Western Canadian Arctic Population of Lesser Snow Geese: J. Hines[a]

Ross= Geese: R. Alisauskas[a], K. Dickson[a], R. Kerbes[a], and K. Warner[a]

Pacific Population of Greater White-Fronted Geese: T. Bowman, C. Dau, B. Eldridge, B. Platte, R. Oates, and B. Stehn

Mid-Continent Population of Greater White-Fronted Geese: R. Alisauskas[a], R. Case[b], K. Dickson[a], J. Hines[a], R. Kerbes[a], and K. Warner[a]

Pacific Brant: R. Anthony[d], R. Oates, and R. King

Emperor Geese: T. Bowman, C. Dau, B. Eldridge, R. King, B. Platte, R. Oates, and B. Stehn

Western Population of Tundra Swans: C. Dau, B. Eldridge, R. Oates, and B. Stehn

Eastern Population of Tundra Swans: J. Hines[a] and R. Oates

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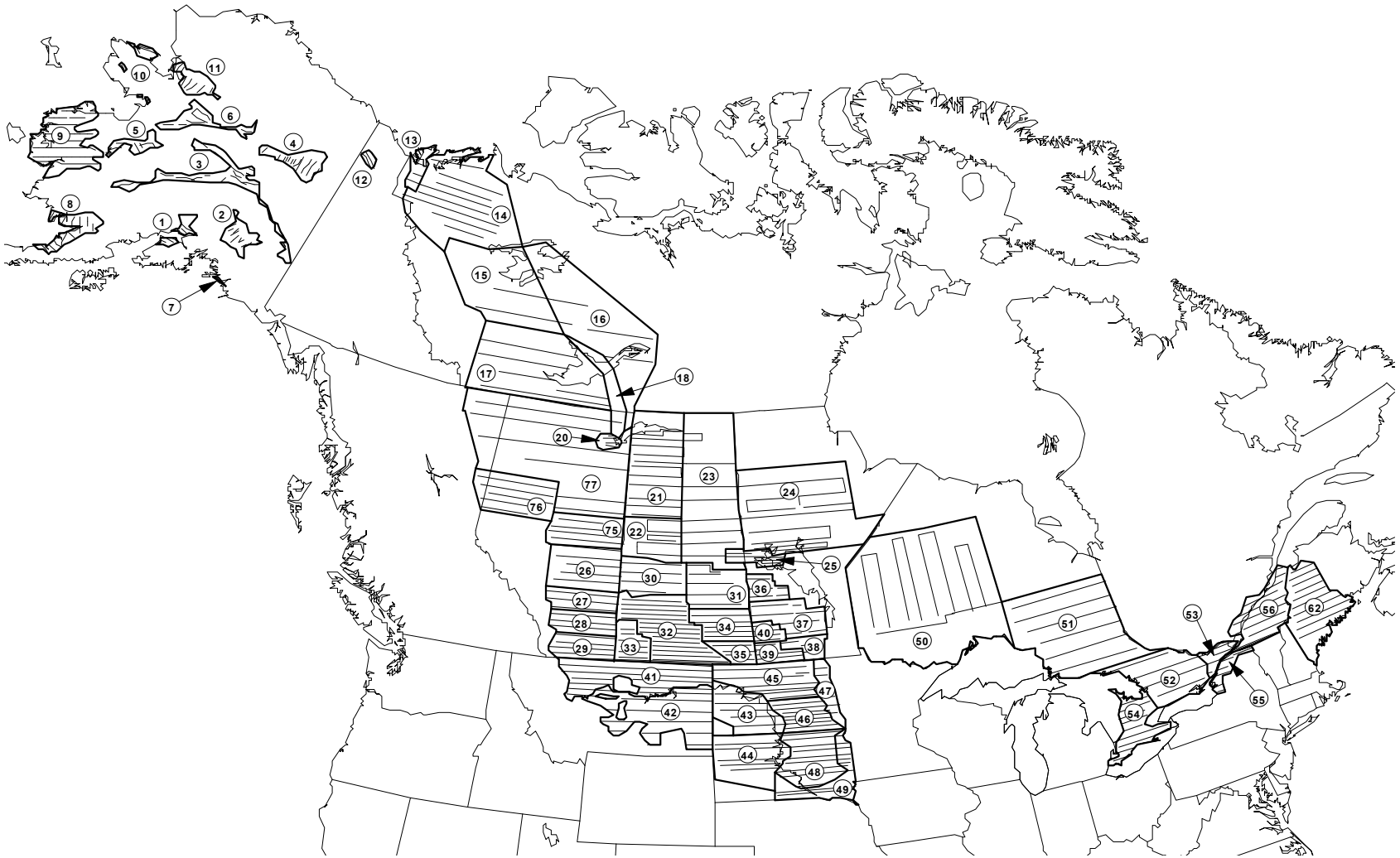
[a]Canadian Wildlife Service
[b]State, Provincial, or Tribal Conservation Agency
[c]Ducks Unlimited - Canada
[d]Other organization
All others - U.S. Fish and Wildlife Service



Appendix C. Transects and strata for the areas of the Breeding Waterfowl and Habitat Survey.

Appendix D. Estimated number of May ponds and standard errors (in thousands) in portions of Prairie Canada and the northcentral U.S.

	Prairie Canada		Northcentral U.S.[a]		Total[a]	
Year	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$
1961	1977.2	165.4				
1962	2369.1	184.6				
1963	2482.0	129.3				
1964	3370.7	173.0				
1965	4378.8	212.2				
1966	4554.5	229.3				
1967	4691.2	272.1				
1968	1985.7	120.2				
1969	3547.6	221.9				
1970	4875.0	251.2				
1971	4053.4	200.4				
1972	4009.2	250.9				
1973	2949.5	197.6				
1974	6390.1	308.3	1840.8	197.2	8230.9	366.0
1975	5320.1	271.3	1910.8	116.1	7230.9	295.1
1976	4598.8	197.1	1391.5	99.2	5990.3	220.7
1977	2277.9	120.7	771.1	51.1	3049.1	131.1
1978	3622.1	158.0	1590.4	81.7	5212.4	177.9
1979	4858.9	252.0	1522.2	70.9	6381.1	261.8
1980	2140.9	107.7	761.4	35.8	2902.3	113.5
1981	1443.0	75.3	682.8	34.0	2125.8	82.6
1982	3184.9	178.6	1458.0	86.4	4642.8	198.4
1983	3905.7	208.2	1259.2	68.7	5164.9	219.2
1984	2473.1	196.6	1766.2	90.8	4239.3	216.5
1985	4283.1	244.1	1326.9	74.0	5610.0	255.1
1986	4024.7	174.4	1734.8	74.4	5759.5	189.6
1987	2523.7	131.0	1347.8	46.8	3871.5	139.1
1988	2110.1	132.4	790.7	39.4	2900.8	138.1
1989	1692.7	89.1	1289.9	61.7	2982.7	108.4
1990	2817.3	138.3	691.2	45.9	3508.5	145.7
1991	2493.9	110.2	706.1	33.6	3200.0	115.2
1992	2783.9	141.6	825.0	30.8	3608.9	144.9
1993	2261.1	94.0	1350.6	57.1	3611.7	110.0
1994	3769.1	173.9	2215.6	88.8	5984.8	195.3
1995	3892.5	223.8	2442.9	106.8	6335.4	248.0
1996	5002.6	184.9	2479.7	135.3	7482.2	229.1
1997	5061.0	180.3	2397.2	94.4	7458.2	203.5
1998	2521.7	133.8	2065.3	89.2	4586.9	160.8
1999	3862.0	157.2	2842.3	256.8	6704.3	301.1

[a] No comparable survey data available for the northcentral U.S. during 1961-73.

Appendix E. Breeding population estimates (in thousands) for total ducks[a] and mallards for states, provinces, or regions that conduct spring surveys.

	British Columbia[b]		California		Colorado		Michigan		Minnesota		Nebraska	
	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards
1955	c										101.5	32.0
1956											94.9	25.8
1957											154.8	26.8
1958											176.4	28.1
1959											99.7	12.1
1960					51.1	32.4					143.6	21.6
1961					58.7	32.4					141.8	43.3
1962					72.7	59.4					68.9	35.8
1963					78.0	62.1					114.9	37.4
1964					110.8	64.0					124.8	66.8
1965					111.9	60.2					52.9	20.8
1966					100.8	57.8					118.8	36.0
1967					122.2	69.7					96.2	27.6
1968					145.4	73.3			368.5	83.7	96.5	24.1
1969					138.1	57.5			345.3	88.8	100.6	26.7
1970					114.8	46.5			343.8	113.9	112.4	24.5
1971					121.4	48.3			286.9	78.5	96.0	22.3
1972					94.6	45.0			237.6	62.2	91.7	15.2
1973					112.3	45.2			415.6	99.8	85.5	19.0
1974					129.0	56.9			332.8	72.8	67.4	19.5
1975					156.7	38.2			503.3	175.8	62.6	14.8
1976					142.0	34.6			759.4	117.8	87.2	20.1
1977									536.6	134.2	152.4	24.1
1978					145.1	42.6			511.3	146.8	126.0	29.0
1979					103.2	30.9			901.4	158.7	143.8	33.6
1980					110.7	32.0			740.7	172.0	133.4	37.3
1981					188.4	36.4			515.2	154.8	66.2	19.4
1982					70.2	30.1			558.4	120.5	73.2	22.3
1983					130.6	44.2			394.2	155.8	141.6	32.2
1984					109.9	39.3			563.8	188.1	154.1	36.1
1985									580.3	216.9	75.4	28.4
1986					105.0	42.0			537.5	233.6	69.5	15.1
1987					125.4	62.0			614.9	192.3	120.5	41.7
1988	6.0	0.6			123.1	63.4			752.8	271.7	126.5	27.8
1989	5.5	0.5			122.9	48.2			1021.6	273.0	136.7	18.7
1990	5.9	0.6			131.9	56.5			886.8	232.1	81.4	14.7
1991	7.4	0.7			124.1	49.8			868.2	225.0	126.3	26.0
1992	7.7	0.7	497.4	375.8	101.3	46.6	822.8	360.9	1127.3	360.9	63.4	24.4
1993	7.1	0.6	666.7	359.0	145.6	68.7	667.8	386.5	875.9	305.8	92.8	23.8
1994	7.8	0.6	483.2	311.7	141.3	68.9	698.0	399.9	1320.1	426.5	118.9	17.5
1995	8.7	0.9	589.7	368.5	123.5	54.5	718.7	515.3	912.2	319.4	142.9	42.0
1996	8.3	0.6	795.8	535.6	142.8	60.1	643.0	338.8	1062.4	314.8	132.3	38.9
1997	8.1	0.6	824.3	514.9	107.5	51.9	779.4	445.8	953.0	407.4	128.3	26.1
1998	9.2	1.1	686.3	360.5	89.1	44.8	945.5	445.3	739.6	368.5	155.7	43.4
1999	8.3	0.8	824.6	534.5	101.0	50.2	649.5	419.5	716.5	316.4	251.2[d]	81.1[d]

[a]Species composition for the total duck estimate varies by region.

[b]Index to waterfowl use in prime waterfowl producing areas of the province.

[c]Blanks denote that the survey was not conducted, results were not available, or survey methods changed.

[d]Results are not comparable to earlier estimates due to major changes in the survey methodology.

Appendix E. Continued.

	Nevada		Northeastern United States[e]		Oregon		Washington		Wisconsin		Wyoming	
	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards	Total Ducks	Mallards
1955												
1956												
1957												
1958												
1959	14.2	2.1										
1960	14.1	2.1										
1961	13.5	2.0										
1962	13.8	1.7										
1963	23.8	2.2										
1964	23.5	3.0										
1965	29.3	3.5										
1966	25.7	3.4										
1967	11.4	1.5									246.0	
1968	10.5	1.2									333.0	
1969	18.2	1.4									265.0	
1970	19.6	1.5									382.0	101.0
1971	18.3	1.1									365.0	107.0
1972	19.0	0.9									278.0	90.0
1973	20.7	0.7							326.5	94.9	293.0	115.0
1974	17.1	0.7							320.4	97.5	318.0	122.0
1975	14.5	0.6							414.2	110.7	283.0	65.0
1976	13.6	0.6							279.4	73.6	276.0	69.0
1977	16.5	1.0							231.8	59.4	305.0	71.0
1978	11.1	0.6							240.8	79.5	323.0	77.0
1979	12.8	0.6					98.6	32.1	322.6	95.2	310.0	72.0
1980	16.6	0.9					113.7	34.1	284.3	137.7	306.0	103.0
1981	26.9	1.6					148.3	41.8	464.4	116.0	307.0	79.0
1982	21.0	1.1					146.4	49.8	233.6	95.0	299.0	67.0
1983	24.3	1.5					149.5	47.6	235.0	111.8	306.0	103.0
1984	24.0	1.4					196.3	59.3	249.4	95.4	585.0	114.0
1985	24.9	1.5					216.2	63.1	262.9	95.1	288.0	64.0
1986	26.4	1.3					203.8	60.8	332.1	158.8	356.0	73.0
1987	33.4	1.5					183.6	58.3	369.7	137.9	340.0	80.0
1988	31.7	1.3					241.8	67.2	275.0	129.4	408.0	98.0
1989	18.8	1.3	1144.8	589.9			162.3	49.8	397.6	160.0	266.0	85.0
1990	22.2	1.3	1042.3	665.1			168.9	56.9	394.6	154.7	382.0	88.0
1991	14.6	1.4	1849.2	779.2			140.8	43.7	415.5	162.9	330.0	74.0
1992	12.4	0.9	1090.2	562.2			116.3	41.0	538.2	256.1	313.0	98.0
1993	14.1	1.2	1198.4	683.1			149.8	55.0	346.0	171.2	196.0	77.0
1994	19.2	1.4	1348.1	853.1	391.3	82.8	123.9	52.7	525.1	276.6	353.6	89.6
1995	17.9	1.0	1441.2	862.8	282.2	63.6	147.3	58.9	572.2	217.5	494.9	104.4
1996	26.4	1.7	1432.3	848.5	417.4	101.1	163.3	61.6	677.3	292.1	589.0	99.9
1997	25.3	2.5	1404.9	795.1	472.4	113.8	172.8	67.0	381.3	172.9	617.0	125.1
1998	27.9	2.1	1443.8	775.1	425.1	123.5	185.3	79.0	427.5	165.9	824.1	131.4
1999	29.9	2.3	1520.8	879.7	593.5	121.9	200.2	86.2	434.4	221.6	740.8	124.8

[e]Includes all or portions of Delaware, Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.

Appendix F. Breeding population estimates and standard errors (in thousands) for 10 species of ducks from the traditional survey area, 1955-1999 (strata 1-18, 20-50, 75-77).

	Mallard		Gadwall		American wigeon		Green-winged teal		Blue-winged teal	
Year	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$
1955	8777.3	457.1	651.5	149.5	3216.8	297.8	1807.2	291.5	5305.2	567.6
1956	10452.7	461.8	772.6	142.4	3145.0	227.8	1525.3	236.2	4997.6	527.6
1957	9296.9	443.5	666.8	148.2	2919.8	291.5	1102.9	161.2	4299.5	467.3
1958	11234.2	555.6	502.0	89.6	2551.7	177.9	1347.4	212.2	5456.6	483.7
1959	9024.3	466.6	590.0	72.7	3787.7	339.2	2653.4	459.3	5099.3	332.7
1960	7371.7	354.1	784.1	68.4	2987.6	407.0	1426.9	311.0	4293.0	294.3
1961	7330.0	510.5	654.8	77.5	3048.3	319.9	1729.3	251.5	3655.3	298.7
1962	5535.9	426.9	905.1	87.0	1958.7	145.4	722.9	117.6	3011.1	209.8
1963	6748.8	326.8	1055.3	89.5	1830.8	169.9	1242.3	226.9	3723.6	323.0
1964	6063.9	385.3	873.4	73.7	2589.6	259.7	1561.3	244.7	4020.6	320.4
1965	5131.7	274.8	1260.3	114.8	2301.1	189.4	1282.0	151.0	3594.5	270.4
1966	6731.9	311.4	1680.4	132.4	2318.4	139.2	1617.3	173.6	3733.2	233.6
1967	7509.5	338.2	1384.6	97.8	2325.5	136.2	1593.7	165.7	4491.5	305.7
1968	7089.2	340.8	1949.0	213.9	2298.6	156.1	1430.9	146.6	3462.5	389.1
1969	7531.6	280.2	1573.4	100.2	2941.4	168.6	1491.0	103.5	4138.6	239.5
1970	9985.9	617.2	1608.1	123.5	3469.9	318.5	2182.5	137.7	4861.8	372.3
1971	9416.4	459.5	1605.6	123.0	3272.9	186.2	1889.3	132.9	4610.2	322.8
1972	9265.5	363.9	1622.9	120.1	3200.1	194.1	1948.2	185.8	4278.5	230.5
1973	8079.2	377.5	1245.6	90.3	2877.9	197.4	1949.2	131.9	3332.5	220.3
1974	6880.2	351.8	1592.4	128.2	2672.0	159.3	1864.5	131.2	4976.2	394.6
1975	7726.9	344.1	1643.9	109.0	2778.3	192.0	1664.8	148.1	5885.4	337.4
1976	7933.6	337.4	1244.8	85.7	2505.2	152.7	1547.5	134.0	4744.7	294.5
1977	7397.1	381.8	1299.0	126.4	2575.1	185.9	1285.8	87.9	4462.8	328.4
1978	7425.0	307.0	1558.0	92.2	3282.4	208.0	2174.2	219.1	4498.6	293.3
1979	7883.4	327.0	1757.9	121.0	3106.5	198.2	2071.7	198.5	4875.9	297.6
1980	7706.5	307.2	1392.9	98.8	3595.5	213.2	2049.9	140.7	4895.1	295.6
1981	6409.7	308.4	1395.4	120.0	2946.0	173.0	1910.5	141.7	3720.6	242.1
1982	6408.5	302.2	1633.8	126.2	2458.7	167.3	1535.7	140.2	3657.6	203.7
1983	6456.0	286.9	1519.2	144.3	2636.2	181.4	1875.0	148.0	3366.5	197.2
1984	5415.3	258.4	1515.0	125.0	3002.2	174.2	1408.2	91.5	3979.3	267.6
1985	4960.9	234.7	1303.0	98.2	2050.7	143.7	1475.4	100.3	3502.4	246.3
1986	6124.2	241.6	1547.1	107.5	1736.5	109.9	1674.9	136.1	4478.8	237.1
1987	5789.8	217.9	1305.6	97.1	2012.5	134.3	2006.2	180.4	3528.7	220.2
1988	6369.3	310.3	1349.9	121.1	2211.1	139.1	2060.8	188.3	4011.1	290.4
1989	5645.4	244.1	1414.6	106.6	1972.9	106.0	1841.7	166.4	3125.3	229.8
1990	5452.4	238.6	1672.1	135.8	1860.1	108.3	1789.5	172.7	2776.4	178.7
1991	5444.6	205.6	1583.7	111.8	2254.0	139.5	1557.8	111.3	3763.7	270.8
1992	5976.1	241.0	2032.8	143.4	2208.4	131.9	1773.1	123.7	4333.1	263.2
1993	5708.3	208.9	1755.2	107.9	2053.0	109.3	1694.5	112.7	3192.9	205.6
1994	6980.1	282.8	2318.3	145.2	2382.2	130.3	2108.4	152.2	4616.2	259.2
1995	8269.4	287.5	2835.7	187.5	2614.5	136.3	2300.6	140.3	5140.0	253.3
1996	7941.3	262.9	2984.0	152.5	2271.7	125.4	2499.5	153.4	6407.4	353.9
1997	9939.7	308.5	3897.2	264.9	3117.6	161.6	2506.6	142.5	6124.3	330.7
1998	9640.4	301.6	3742.2	205.6	2857.7	145.3	2087.3	138.9	6398.8	332.3
1999	10805.7	344.5	3235.5	163.8	2920.1	185.5	2631.0	174.6	7149.5	364.5

Appendix F. Continued.

	Northern shoveler		Northern pintail		Redhead		Canvasback		Scaup	
Year	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$
1955	1642.8	218.7	9775.1	656.1	539.9	98.9	589.3	87.8	5620.1	582.1
1956	1781.4	196.4	10372.8	694.4	757.3	119.3	698.5	93.3	5994.1	434.0
1957	1476.1	181.8	6606.9	493.4	509.1	95.7	626.1	94.7	5766.9	411.7
1958	1383.8	185.1	6037.9	447.9	457.1	66.2	746.8	96.1	5350.4	355.1
1959	1577.6	301.1	5872.7	371.6	498.8	55.5	488.7	50.6	7037.6	492.3
1960	1824.5	130.1	5722.2	323.2	497.8	67.0	605.7	82.4	4868.6	362.5
1961	1383.0	166.5	4218.2	496.2	323.3	38.8	435.3	65.7	5380.0	442.2
1962	1269.0	113.9	3623.5	243.1	507.5	60.0	360.2	43.8	5286.1	426.4
1963	1398.4	143.8	3846.0	255.6	413.4	61.9	506.2	74.9	5438.4	357.9
1964	1718.3	240.3	3291.2	239.4	528.1	67.3	643.6	126.9	5131.8	386.1
1965	1423.7	114.1	3591.9	221.9	599.3	77.7	522.1	52.8	4640.0	411.2
1966	2147.0	163.9	4811.9	265.6	713.1	77.6	663.1	78.0	4439.2	356.2
1967	2314.7	154.6	5277.7	341.9	735.7	79.0	502.6	45.4	4927.7	456.1
1968	1684.5	176.8	3489.4	244.6	499.4	53.6	563.7	101.3	4412.7	351.8
1969	2156.8	117.2	5903.9	296.2	633.2	53.6	503.5	53.7	5139.8	378.5
1970	2230.4	117.4	6392.0	396.7	622.3	64.3	580.1	90.4	5662.5	391.4
1971	2011.4	122.7	5847.2	368.1	534.4	57.0	450.7	55.2	5143.3	333.8
1972	2466.5	182.8	6979.0	364.5	550.9	49.4	425.9	46.0	7997.0	718.0
1973	1619.0	112.2	4356.2	267.0	500.8	57.7	620.5	89.1	6257.4	523.1
1974	2011.3	129.9	6598.2	345.8	626.3	70.8	512.8	56.8	5780.5	409.8
1975	1980.8	106.7	5900.4	267.3	831.9	93.5	595.1	56.1	6460.0	486.0
1976	1748.1	106.9	5475.6	299.2	665.9	66.3	614.4	70.1	5818.7	348.7
1977	1451.8	82.1	3926.1	246.8	634.0	79.9	664.0	74.9	6260.2	362.8
1978	1975.3	115.6	5108.2	267.8	724.6	62.2	373.2	41.5	5984.4	403.0
1979	2406.5	135.6	5376.1	274.4	697.5	63.8	582.0	59.8	7657.9	548.6
1980	1908.2	119.9	4508.1	228.6	728.4	116.7	734.6	83.8	6381.7	421.2
1981	2333.6	177.4	3479.5	260.5	594.9	62.0	620.8	59.1	5990.9	414.2
1982	2147.6	121.7	3708.8	226.6	616.9	74.2	513.3	50.9	5532.0	380.9
1983	1875.7	105.3	3510.6	178.1	711.9	83.3	526.6	58.9	7173.8	494.9
1984	1618.2	91.9	2964.8	166.8	671.3	72.0	530.1	60.1	7024.3	484.7
1985	1702.1	125.7	2515.5	143.0	578.2	67.1	375.9	42.9	5098.0	333.1
1986	2128.2	112.0	2739.7	152.1	559.6	60.5	438.3	41.5	5235.3	355.5
1987	1950.2	118.4	2628.3	159.4	502.4	54.9	450.1	77.9	4862.7	303.8
1988	1680.9	210.4	2005.5	164.0	441.9	66.2	435.0	40.2	4671.4	309.5
1989	1538.3	95.9	2111.9	181.3	510.7	58.5	477.4	48.4	4342.1	291.3
1990	1759.3	118.6	2256.6	183.3	480.9	48.2	539.3	60.3	4293.1	264.9
1991	1716.2	104.6	1803.4	131.3	445.6	42.1	491.2	66.4	5254.9	364.9
1992	1954.4	132.1	2098.1	161.0	595.6	69.7	481.5	97.3	4639.2	291.9
1993	2046.5	114.3	2053.4	124.2	485.4	53.1	472.1	67.6	4080.1	249.4
1994	2912.0	141.4	2972.3	188.0	653.5	66.7	525.6	71.1	4529.0	253.6
1995	2854.9	150.3	2757.9	177.6	888.5	90.6	770.6	92.2	4446.4	277.6
1996	3449.0	165.7	2735.9	147.5	834.2	83.1	848.5	118.3	4217.4	234.5
1997	4120.4	194.0	3558.0	194.2	918.3	77.2	688.8	57.2	4112.3	224.2
1998	3183.2	156.5	2520.6	136.8	1005.1	122.9	685.9	63.8	3471.9	191.2
1999	3889.5	202.1	3057.9	230.5	973.4	69.5	716.0	79.1	4411.7	227.9

Appendix G. Breeding population estimates and standard errors (in thousands) for the 10 most abundant species of ducks in the eastern survey area, 1990-99[a].

	Mallard		American black duck		Gadwall		American Wigeon		Green-winged teal		Blue-winged teal		Scaup		Ring-necked duck		Goldeneye		Bufflehead	
Year	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$
1990	208.6	47.7	160.9	33.5	11.2	9.7	31.0	22.6	47.1	8.6	135.7	56.2	10.9	6.3	92.1	28.3	73.3	22.2	99.9	22.9
1991	169.8	34.5	126.0	35.3	7.4	4.5	45.4	21.8	42.2	14.4	43.5	16.4	5.1	4.5	158.1	30.2	138.4	44.3	94.1	32.1
1992	362.2	54.1	160.3	33.1	4.9	2.4	15.4	9.3	43.8	13.9	65.6	23.2	9.9	6.5	251.6	62.3	241.0	55.2	59.0	13.7
1993	333.8	49.7	124.6	25.6	1.9	1.1	9.4	7.4	47.4	9.9	288.6	235.3	6.8	5.2	248.1	65.1	90.2	32.6	13.1	3.6
1994	238.6	28.8	116.3	20.7	0.0	0.0	18.9	9.6	169.2	24.0	81.9	31.7	16.7	12.2	163.5	62.6	55.0	17.4	33.4	14.0
1995	212.6	41.1	234.5	46.6	30.6	29.0	13.8	7.9	96.2	14.1	62.0	20.5	5.0	3.9	195.6	51.0	9.2	3.7	26.5	8.8
1996	322.7	56.7	136.7	29.9	6.6	5.0	31.5	16.8	143.9	58.9	22.4	13.0	6.3	6.5	244.1	64.9	125.4	69.8	49.0	12.5
1997	254.1	42.0	123.0	26.1	2.7	1.3	19.8	10.9	111.6	24.9	16.7	7.2	27.1	17.2	295.5	106.3	80.0	27.6	19.5	6.6
1998	309.1	68.4	175.7	27.2	4.0	2.5	21.0	9.6	142.1	72.5	14.6	8.9	20.5	10.5	176.9	44.7	103.8	27.7	40.1	10.0
1999	244.7	37.9	126.2	30.2	13.7	9.6	77.1	42.8	184.8	49.5	1.6	1.6	1.5	1.5	212.6	68.5	307.7	101.9	63.5	20.5

[a]Maine estimates were included beginning in 1995. Therefore, estimates from 1990-94 are not comparable to those from 1995-99.

Appendix H. Estimated number of July ponds and standard errors (in thousands) in portions of Prairie Canada and the northcentral U.S.

	Prairie Canada		Northcentral U.S.[a]		Total[a]	
Year	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$	$\hat{N}$	$\hat{SE}$
1961	562.0	50.9				
1962	814.2	62.0				
1963	1813.2	98.7				
1964	1308.3	60.0				
1965	2231.0	113.9				
1966	1979.2	111.7				
1967	1498.4	94.5				
1968	802.9	50.7				
1969	1658.6	90.6				
1970	2613.3	143.9				
1971	2016.7	112.2				
1972	1312.5	77.8				
1973	1735.5	146.8				
1974	2753.2	136.1	609.6	45.1	3362.8	143.4
1975	2410.1	121.1	922.8	51.6	3332.9	131.7
1976	2137.6	101.6	786.8	46.8	2924.4	111.8
1977	1391.2	74.1	469.4	38.6	1860.6	83.6
1978	1520.3	63.5	697.1	41.4	2217.4	75.8
1979	1803.0	88.7	754.6	38.5	2557.6	96.7
1980	898.8	52.0	336.1	14.3	1234.9	53.9
1981	873.0	43.6	457.6	22.7	1330.6	49.2
1982	1662.0	85.9	882.2	50.3	2544.2	99.5
1983	2264.1	108.8	957.9	51.7	3221.9	120.4
1984	1270.3	90.1	1270.6	67.1	2540.9	112.4
1985	1563.1	91.2	753.5	39.3	2316.5	99.3
1986	1610.0	71.4	1056.9	46.1	2666.9	85.0
1987	1225.7	69.2	858.0	31.0	2083.7	75.8
1988	1009.2	63.8	518.7	26.4	1527.9	69.0
1989	932.4	47.9	731.3	32.8	1663.7	58.0
1990	1297.6	70.5	663.2	42.0	1960.7	82.1
1991	2562.8	127.2	865.0	40.9	3427.8	133.7
1992	1272.6	56.0	664.2	24.8	1936.8	61.2
1993	2292.5	102.6	1384.8	65.4	3677.4	121.7
1994	2329.9	105.7	1079.7	43.2	3409.6	114.2
1995	1773.4	95.3	1576.5	69.6	3350.0	118.0
1996	2648.2	94.2	1218.2	64.9	3866.4	114.3
1997	2489.7	96.5	1347.1	54.1	3836.8	110.6
1998	2850.7	149.0	1353.3	56.8	4203.9	159.5
1999	2776.2	144.5	2432.0	227.3	5208.2	269.3

[a]No comparable survey data available for the northcentral U.S. during 1961-73.

Appendix I. Percent of the area that was snow-covered, water-covered, and open land in regions of the Canadian Arctic, as determined from satellite imagery during early May (EM), early June (EJ), and late June (LJ), 1998, and the range observed during 1980-1997.

	% snow (range)			% open (range)			% water (range)		
Region	EM	EJ	LJ	EM	EJ	LJ	EM	EJ	LJ
Anderson River	39 (12-95)	4 (4-52)	4 (4-29)	18 (3-56)	60 (19-73)	60 (15-73)	43 (0-51)	36 (10-65)	36 (9-71)
Banks Island	76 (47-96)	59 (38-90)	26 (14-59)	4 (1-53)	7 (1-47)	37 (11-73)	20 (0-32)	35 (0-51)	37 (6-70)
North-central[a]	86 (44-90)	64 (50-89)	47 (35-68)	3 (1-55)	21 (5-40)	15 (5-44)	12 (1-27)	16 (3-38)	38 (7-51)
Mid-central[b]	71 (27-95)	32 (28-85)	15 (13-69)	1 (1-73)	32 (7-62)	35 (8-52)	28 (0-28)	36 (3-38)	50 (16-65)
South-central[c]	30 (14-88)	3 (3-73)	2 (1-25)	24 (4-84)	55 (16-64)	60 (13-77)	47 (2-63)	43 (10-65)	38 (20-71)
Southampton Island	64 (14-94)	55 (16-93)	35 (5-70)	1 (0-85)	2 (1-55)	14 (0-79)	35 (0-47)	44 (3-54)	52 (0-62)
Ungava Peninsula	39 (2-96)	3 (1-84)	5 (1-45)	15 (1-93)	70 (1-54)	65 (23-65)	46 (1-54)	26 (3-58)	30 (28-57)
Baffin Island	72 (26-94)	77 (31-89)	53 (28-72)	2 (1-72)	7 (2-47)	7 (4-45)	26 (2-31)	16 (5-47)	40 (16-54)

[a] Region of Northwest Territories that includes Ellesmere, Devon, and Somerset islands.

[b] Region of Northwest Territories that extends from the town of Coppermine east to Queen Maud Gulf, and south to the Chesterfield Inlet.

[c] Region of Northwest Terrritories, northern Saskatchewan, and northern Manitoba that extends from Great Slave Lake east to the western shore of Hudson Bay between Chesterfield Inlet and Cape Churchill.

Appendix J. Canada goose population indices (in thousands) during 1969-99. Population names as abreviated in text.

Year	Population												
	AP[a,b]	AFRP[a]	SJBP[a]	MVP[a]	MFGP[a]	EPP[a,h]	WPP/GPP[c]	TGPP[c]	SGPP[d]	HLP[d]	RMP[d]	Dusky[d]	Cackling[e]
1969/70									151.2	44.2	25.8	22.5	
1970/71								133.2	148.5	40.5	25.4	19.8	
1971/72						142.6		160.9	160.9	31.4	36.6	17.9	
1972/73						151.0		148.4	259.4	35.6	37.1	15.8	
1973/74						134.6		160.5	153.6	24.5	42.8	18.6	
1974/75						162.1		133.5	123.7	41.2	46.7	26.5	
1975/76						233.6		203.7	242.5	55.6	51.6	23.0	
1976/77						199.8		171.3	210.0	67.6	54.3	24.1	
1977/78						227.9		215.5	134.0	65.1	59.0	24.0	
1978/79						131.6		187.6	163.7	33.8	62.9	25.5	
1979/80								165.9	213.0	67.3	78.1	22.0	64.1
1980/81						159.9		257.7	168.2	94.4	94.7	23.0	127.4
1981/82						161.6	175.0	284.7	156.0	81.9	64.3	17.7	87.1
1982/83						221.5	242.0	171.8	173.2	75.9	68.2	17.0	54.1
1983/84						168.9	150.0	264.9	143.5	39.5	55.5	10.1	26.2
1984/85						194.7	230.0	207.0	179.1	76.4	90.3	7.5	25.8
1985/86						247.9	115.0	198.2	181.0	69.8	68.3	12.2	54.4[i]
1986/87						247.3	324.0	163.2	190.9	98.1	71.5		51.4[i]
1987/88	118.0					257.6	272.1	315.8	139.1	66.8	71.4	12.2	63.9[i]
1988/89		396.0		712.0		278.1	330.3	224.2	284.8	100.1	73.9	11.8	74.6[i]
1989/90		236.6	82.4	893.2		297.0	271.0	159.0	378.1	105.9	102.4	11.7	90.3[i]
1990/91		305.7	108.1			295.0	390.0	315.5	508.5	116.6	86.7		88.9[i]
1991/92		439.2	91.6	866.5		261.5	341.9	280.4	620.2	140.5	115.7	18.0	97.8[i]
1992/93	91.3	646.8	77.3	617.8		206.4	318.0	238.7	328.2	118.5	74.7[f]	16.7	120.3[i]
1993/94	40.1	647.5	95.7	838.1		331.6	272.5	236.8	434.1	164.3	77.3	11.0	137.7[i]
1994/95	29.3	779.2	94.0	915.8		284.7	352.5	247.8	697.8	174.4	91.8	8.5	164.3[i]
1995/96	46.1	932.6	123.0	678.8		259.0	403.3	270.3	561.2	167.5	117.0		195.8[i]
1996/97	63.2	1013.3	95.1	735.9	967.0	256.3	453.4	272.3[g]	460.7	148.5	98.5	11.2[h]	157.1[i]
1997/98	42.2	970.1	117.1	444.0	1359.2[h]	160.0	482.3	335.3[g]	440.6	191.0	105.4	21.3[h]	193.3[i]
1998/99	77.5	999.5	136.6	969.5	1380.2[i]	270.5	467.2	548.2[g]	403.2	119.5	114.4	13.8[h]	195.5[i]

[a] Surveys conducted in spring
[b] Number of breeding pairs
[c] Surveys conducted in December
[d] Surveys conducted in January
[e] Surveys conducted in November
[f] Survey incomplete
[g] Survey was incomplete in Mississippi Flyway
[h] Indirect or preliminary estimate
[i] Revised population index - accounting for indicated breeding pairs (R. Trost *pers. comm.*)

Appendix K. Population indices (in thousands) for snow geese, greater white-fronted geese, brant, emperor geese, and tundra swans during 1969-99. Population names are abbreviated as in text.

Year	Snow Geese				White-fronted Geese		Brant		Emperor	Tundra Swans	
	GRTR[a]	MCP[b]	WCFP	WAWI	MCP[c]	PP[c]	ATLB[d]	PACB[d]	Geese[a]	Western[d]	Eastern[d]
1969/70	89.6	818.7						141.7		31.0	55.0
1970/71	123.3	1067.3					151.0	149.2		98.8	58.2
1971/72	134.8	1331.8					73.0	124.8		82.8	63.4
1972/73	143.0	1025.3	11.7				41.0	125.0		33.9	57.2
1973/74	165.0	1189.7	16.3				88.0	130.7		69.7	64.2
1974/75	153.8	1096.9	26.4				88.0	123.4		54.3	66.6
1975/76	165.6	1562.4	23.2				127.0	122.0		51.4	78.6
1976/77	160.0	1150.3	33.6				74.0	147.0		47.3	76.2
1977/78	192.6	1967.0	31.1				46.0	162.9		45.6	70.3
1978/79	170.1	1285.5	29.4				44.0	129.4		53.5	78.6
1979/80	180.0	1387.7	30.5	528.1		73.1	69.0	146.4		65.2	63.7
1980/81	170.8	1406.3	37.6	204.2		93.5	97.0	194.2	93.3	83.6	93.0
1981/82	163.0	1794.0	50.0	759.9		116.5	106.0	121.0	100.6	91.3	73.1
1982/83	185.0	1755.5	33.4	354.1		91.7	124.0	109.3	79.2	67.3	87.0
1983/84	225.4	1494.4	43.0	547.6		112.9	127.0	133.4	71.2	61.9	81.1
1984/85	260.0	1973.1	41.4	466.3		100.2	146.0	144.8	58.8	48.8	94.3
1985/86	303.5	1449.3	55.4	549.8		93.8	110.0	136.2[e]	42.0	66.2	90.9
1986/87	255.0	1913.8	63.6	521.7		107.1	111.0	108.9	51.7	52.8	94.5
1987/88		1750.5	46.2	525.3		130.6	131.0	147.0	53.8	59.2	77.4
1988/89	363.2	1956.1	67.6	441.0		161.5	138.0	135.2	45.8	78.7	90.6
1989/90	368.3	1724.3	38.2	463.9		218.8	135.4	151.6	67.6	40.1	89.7
1990/91	352.6	2135.8	100.9	708.5		240.8	147.7	131.7	70.9	47.6	97.4
1991/92	448.1	2021.9	80.0	690.1		236.5	184.8	117.7	71.3	63.7	110.1
1992/93	498.4	1744.2	45.1	639.3	622.9	230.9	100.6	124.4	52.5	62.6[f]	76.6
1993/94	591.4	2200.8	84.9	569.2	676.3	295.1	157.2	130.0	57.3	79.4	84.5
1994/95	616.6	2725.1	146.4	478.2	727.3	324.8	148.2	133.7	51.2	52.9[f]	81.3
1995/96	669.1	2398.1	93.1	501.9	1129.4	277.5	105.9	126.9	80.3	98.1	79.0
1996/97	657.5	2850.9	127.2	366.3	742.5	344.1	121.5	157.9	57.1	122.5	86.1
1997/98	695.6	2977.2	103.5	416.4	622.2	319.0	138.0	138.4	39.7	70.5	96.5
1998/99	800.4[g]	2575.7	236.4	354.3	1058.3	413.1	171.6	129.2	54.6	119.8	109.0

[a] Surveys conducted in spring
[b] Surveys conducted in December
[c] Surveys conducted in autumn
[d] Surveys conducted in January
[e] Beginning in 1986, counts of brant in Alaska are included in the total
[f] Survey was incomplete
[g] Preliminary estimate