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Waterfowl studies in Ontario, 1973–81

Occasional Paper
Number 54
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Introduction

by D.G. Dennis

As a result of the Migratory Birds Convention in 1916 and the subsequent Migratory Birds Convention Act of 1917, the Canadian government is charged with the responsibility of protecting populations of migratory birds from indiscriminate slaughter and of ensuring their survival and perpetuation.

The Canadian Wildlife Service (CWS) is the agency that is ultimately responsible for initiating the required management actions. At present, excessive hunting mortality is largely controlled through the Migratory Birds regulations. The effective management of game-bird populations requires a good knowledge of populations and population trends, productivity, habitat use, mortality factors, and the impacts of man's activities. Such information enables effective regulations to be set and other management actions, such as protection and management of habitat, to be implemented.

In recent years more and more information on waterfowl populations has been gathered by CWS in order to improve its capacity to manage such populations effectively.

The present publication presents reports on the results of various waterfowl studies and surveys conducted by the staff of CWS Ontario Region. Some of the studies are of a continuing nature; others were initiated during the period 1973–81. In some respects the report is an update of information provided in an earlier publication concerning waterfowl studies throughout eastern Canada, edited by H. Boyd (1974). The report makes information about Ontario waterfowl and CWS waterfowl studies available to interested persons and agencies, many of whom play a direct role in waterfowl management.

Although some of the data presented are almost a decade old, we feel publication of the work is still relevant and provides useful background to aid our understanding of current problems. As an example, the field information for *The change in status of Mallards and Black Ducks in southwestern Ontario* was gathered in the autumn of 1973, but the paper is especially appropriate in terms of current concern about the status of Black Ducks in North America.

The papers are grouped into three broad categories that include information about waterfowl use of various habitats during the portions of the year mainly outside the breeding season.

The papers provide certain benchmarks for numbers of waterfowl in breeding and migrant groups, against which future population trends and the effects of habitat management and change may be measured. In addition, several of the papers assess changes in use and populations since Boyd's publication.

Studies are currently being carried out that will attempt to clarify the effects of altered habitats as well as unrelated environmental change such as wetland acidification. Population monitoring of breeding pairs described by Boyd (1974) is continuing and is discussed in this publication.

Literature cited

Boyd, H. (Ed.) 1974. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Part I Waterfowl breeding populations

Waterfowl densities in northwestern Ontario during the 1979 breeding season

by D.G. Dennis and N.R. North

1. Abstract

As part of a continuing Canadian Wildlife Service program to evaluate the potential of Ontario for waterfowl production, a portion (91 314 km^2) of the northwest part of the province was surveyed during the spring of 1979, by means of ground counts on 291 randomly selected 64-ha plots. The waterfowl species most commonly observed included, in descending order of abundance, Mallard (23.9%), Ring-necked Duck (19.1%), Common Goldeneye (13.2%), and Common Merganser (10.7%). Estimated waterfowl density was 311 pairs per 100 km^2, the highest density in any area that had been surveyed in Ontario. Earlier surveys estimated waterfowl pairs per 100 km^2 to be 114 in the Precambrian Shield, 133 in the clay belt section, and 152 in the part of the province south of 46°15′.

2. Introduction

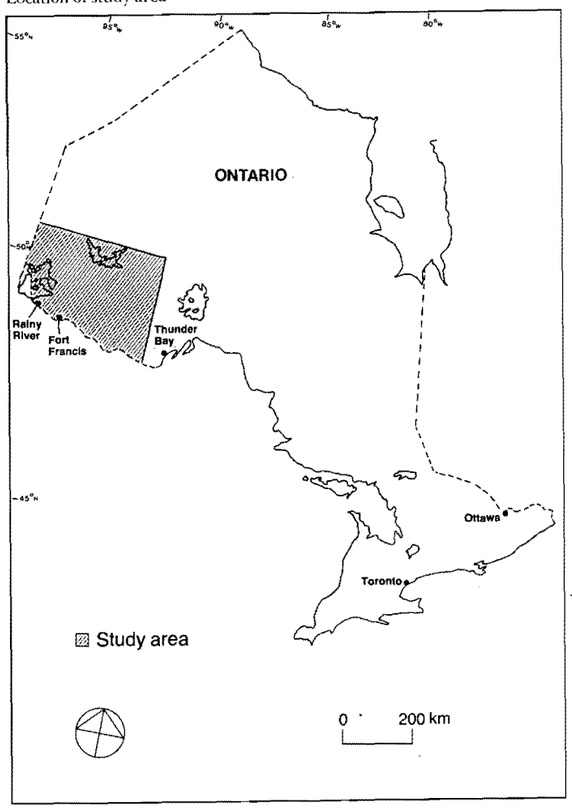
In 1970 the Canadian Wildlife Service (CWS) began a program to evaluate the waterfowl production potential of Ontario. Since that time a number of surveys using ground plots have been conducted in south-central Ontario and portions of the Precambrian Shield and clay belt sections of northeastern Ontario (Dennis 1974*a*).

The large northwestern area south of 50°45′N and west of 90°W extending to the Manitoba border remained unsampled from the ground, although it has some access by road (unlike the northern peatlands). Aerial surveys of the area had been conducted by the US Fish and Wildlife Service irregularly in the early 1950s and annually between 1955 and 1973 (Wellein and Newcomb 1954; Boyd, this publication), and by the Ontario Ministry of Natural Resources (Simkin 1959). Detailed recent information concerning waterfowl numbers and species composition was lacking. A ground survey program was established for the area during the spring of 1979 to document the numbers of breeding waterfowl. This is a report of the results of that survey.

3. Area surveyed

The area surveyed (Fig. 1) covers approximately 90 000 km^2. Forest types grade from Great Lakes – St. Lawrence in the south through a transition zone to the true boreal forest in the north (Rowe 1959). The relief is fairly flat to undulating. Many lakes and moderate densities of beaver ponds are present. In the transitional prairie zone near Rainy River considerable agriculture occurs, on class 2 and class 3 soils (Lands Directorate 1977). To the north and east of Fort Frances the soil mantle is generally thin and of low productivity, and much of the area has been logged in the last two decades.

Figure 1
Location of study area



4. Methods

The survey was implemented in a similar fashion to those described by Dennis (1974*b*). Four hundred and fifty-one 64-ha plots were selected at random throughout the area to be surveyed. Because of the lack of roads, most of the randomly chosen plots were not accessible on the ground. They were therefore replaced by the nearest alternative sites adjacent to roads that appeared similar to the original locations, based on interpretation of the topographic, forest, and drainage patterns on National Topographic Maps (1:50 000).

Canada having adopted the metric system (SI) in 1973, plot sizes were modified to 800 metres per side rather than the one half mile (805 m) used in the earlier surveys (Dennis 1974*a*). The habitat on the area subtended by each plot was classified into five categories with the aid of provincial air photo coverage at a scale of 159 m = 1 cm, as in the previous north-central Ontario survey (Dennis 1974*a*).

In ascending order of attractiveness to waterfowl, the classes were as follows:

1. no wetland habitat visible;
2. deep lakes with no visible aquatic plant communities;
3. a stream or river with no visible aquatic plant communities;
4. marsh habitat with beds of vegetation entirely connected with a shoreline;
5. marsh habitat with distinct beds of vegetation not entirely connected with a shoreline.

The categories were sampled as follows: 20% of class 1, 50% of classes 2, 3, and 4, and 100% of class 5. A total of 291 plots was selected for actual survey.

Potential breeding pairs were calculated as described by Dzubin (1969), each male seen alone, as part of a pair, or in a flock of five males or less being considered to represent a pair. Pair numbers per 100 km^2 were calculated by initially expanding numbers of pairs observed in each habitat class back to 100%. For example, the expansion for class 1 was five-fold because only 20% of the class 5 plots were sampled. Pair numbers for all classes were then summed and proportional calculations made to arrive at pairs per 100 km^2.

All accessible plots were visited between 9 and 25 May. Most of the time there were three teams of two observers. On a few occasions we used two teams, with either two or three observers depending on vehicle availability. The techniques used to survey plots were described by Dennis (1974*b*). The observers drove to the site, analysed an aerial photograph to locate potential waterfowl sites on the plot and then conducted detailed searches of the potential areas. Surveys were completed either on foot or by canoe depending on the technique judged most suitable for the specific site. All observations of waterfowl, and other details concerning habitat, weather, and waterfowl behaviour were recorded.

5. Results and discussion

Of the 291 plots selected, 266 were accessible and were surveyed. Figure 2 depicts the plot locations and the presence or absence of waterfowl. The proportion of plots that contained waterfowl generally increased from east to west. Table 1 shows the relative numerical distribution of waterfowl on the sampled plots in descending order of abundance for each habitat class expressed as potential breeding pairs. The assumption that the birds were likely to breed where they were seen is probably quite reasonable for common species of dabbling ducks but may be less valid for species of diving ducks with unbalanced sex ratios such as the Lesser Scaup (*Aythya affinis*) and Ring-necked Duck (*Aythya collaris*) (Bellrose 1976). Palmer (1976) argued that sex ratio discrepancies may be more apparent than real for the Ring-necked Duck and that males may represent pairs in most instances.

Based on breeding ranges mapped in Godfrey (1966) and Palmer (1976), all species observed with the exception of the Greater Scaup (*Aythya marila*) breed in the area surveyed. Observations of flock size and behaviour suggested that some of the Lesser Scaup and Buffleheads (*Bucephala albeola*) were probably on passage, especially during the early part of the survey period. Common Goldeneye (*Bucephala clangula*), Common Merganser (*Mergus merganser*), Red-breasted Merganser (*Mergus serrator*), Hooded Merganser (*Mergus cucullatus*), Bufflehead, and Greater Scaup do not normally breed as yearlings (Bellrose 1976). The later breeding age of these species has not been considered when results were tabulated, as the study was designed to document relative numbers of pairs rather than production of broods.

Class 1 plots (those with no apparent waterfowl habitat) contained few birds, with only one indicated pair of ducks present on 20 plots (Table 1).

Class 2 plots, with deep lakes, contained approximately one third of the Common Mergansers and more than one quarter of the Common Goldeneyes. In addition, 15 potential breeding pairs of Mallards (*Anas platyrhynchos*) were seen. In many instances, the Mallards were closely associated with summer resort areas and, although migratory, were using handouts from local residents as a significant portion of their diet.

Class 3 plots, containing a river or stream system with no visible aquatic plant communities, contained the lowest waterfowl densities of the four classes with waterfowl habitat.

Class 4 plots, including wetlands with marsh edges or vegetation entirely associated with the shoreline, held 13 species of dabbling and diving ducks.

Class 5 plots, including wetlands with distinct beds of either emergent or submergent aquatic vegetation, comprised 143 (53.7%) of the total 266 plots, and held 515 (74.7%) of the total of 689 indicated pairs. The intensive sampling of class 5 resulted in a considerable increase in the efficiency of the survey.

Of the total waterfowl observed on all plots, the greatest proportion were Mallard (23.9%) followed by Ring-necked Ducks (19.1%). Common Goldeneye and Common Merganser made up 13.2 and 10.7% respectively.

Table 1
Numbers of potential pairs of waterfowl per habitat class as indicated by observed male waterfowl on 266 surveyed plots

Species	Habitat class I	II	III	IV	V	Total	Percentage
Mallard	1	15	6	6	137	165	23.9
Ring-necked Duck	0	2	0	16	114	132	19.1
Common Goldeneye	0	28	2	10	51	91	13.2
Common Merganser	0	33	4	8	29	74	10.7
Hooded Merganser	0	6	0	2	28	36	5.2
Red-breasted Merganser	0	8	0	3	20	31	4.5
Blue-winged Teal (*Anas discors*)	0	0	0	0	32	32	4.6
Green-winged Teal (*A. crecca*)	0	0	0	3	24	27	3.9
Bufflehead	0	7	0	0	27	34	4.9
Black Duck	0	0	1	3	11	15	2.2
Lesser Scaup	0	0	0	4	11	15	2.2
Greater Scaup	0	0	0	0	6	6	0.9
Wood Duck (*Aix sponsa*)	0	1	0	1	11	13	1.9
American Wigeon	0	0	0	0	10	10	1.5
Pintail	0	0	0	1	1	2	0.3
Mallard × Black Duck	0	0	0	1	0	1	0.1
Gadwall (*Anas strepera*)	0	0	0	2	0	2	0.3
Canada Goose (*Branta canadensis*)	0	0	0	0	1	1	0.1
Unidentified	0	0	0	0	2	2	0.3
Total pairs	1	100	13	60	515	689	99.8
Number of surveyed plots	20	61	16	26	143	266	
Total plots	103	108	29	52	159	451	

Figure 2
Plot distribution and waterfowl occurrence in northwestern Ontario

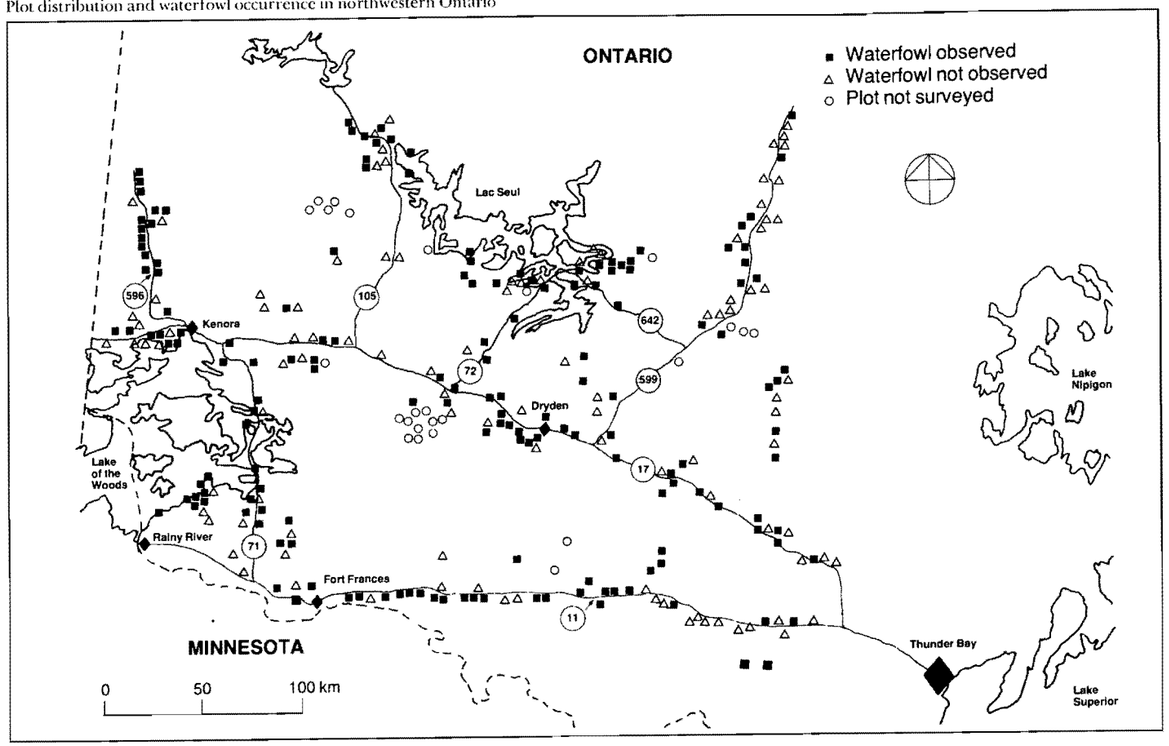


Figure 3
Distribution of plots containing Mallards and Black Ducks

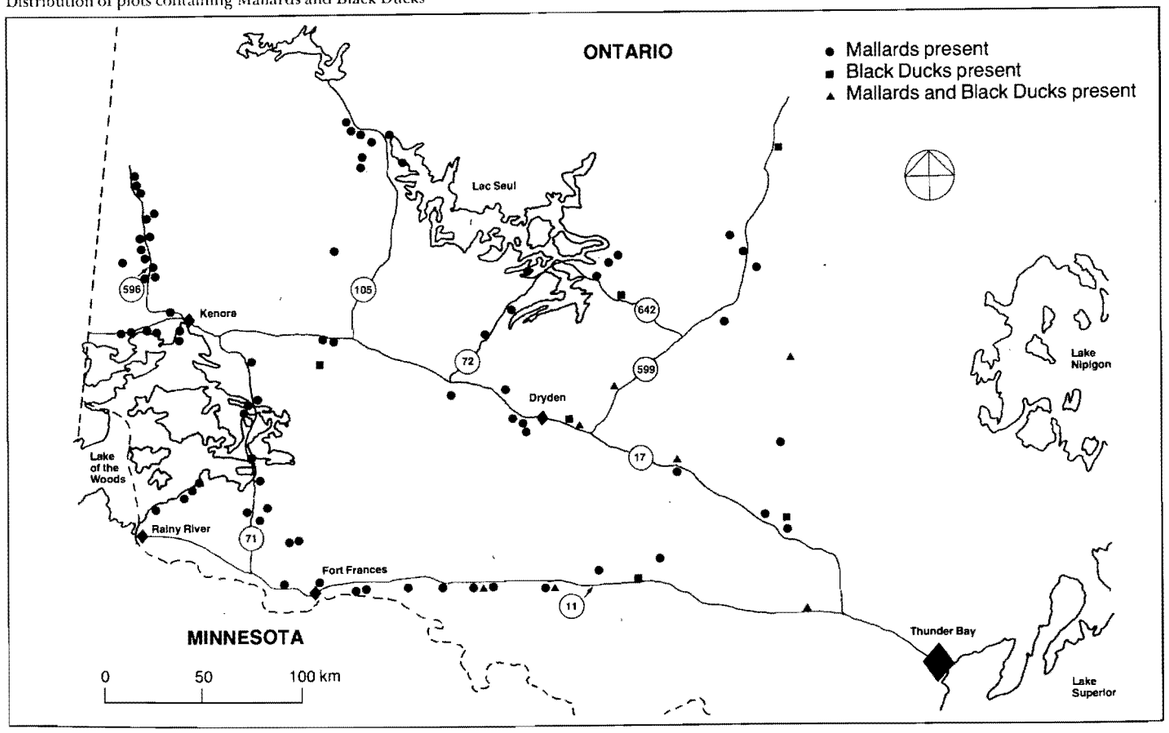


Figure 3 shows the distribution of plots containing Mallards and Black Ducks (*Anas rubripes*) on the surveyed area. Black Duck abundance declined from the east to the west as the southwestern edge of their breeding range was approached. Mallards were common throughout the surveyed area but were proportionally more abundant in the west, as no Black Ducks were observed in any of the plots near the west edge of the area.

Table 2 compares the relative abundance of pairs of waterfowl per 100 km^2 in northwestern Ontario in 1979 with numbers of pairs found in the north-central portion of the province in 1973 (Dennis 1974*a*).

The figures for Mallards and Black Ducks suggest lower numbers of Black Ducks and much higher Mallard numbers in northwestern Ontario than in the north-central portions of the province. There were 56 pairs of Ring-necked Ducks per 100 km^2 in the northwest, compared with 29 in the Precambrian Shield and 12 in the clay belt. All species other than Black Duck, American Wigeon (*Anas americana*), and Pintail (*Anas acuta*) were more numerous in northwestern Ontario than in the clay belt. The numbers of Pintails seen in both surveys were so small that the difference between the estimates is insignificant.

In summary, data from waterfowl sample plots indicated 311 pairs per 100 km^2 in the northwest, 114 in the Precambrian Shield, and 133 in the clay belt sections of the province. Data from southern Ontario, using a different sampling scheme, showed 152 pairs of waterfowl per 100 km^2 (Dennis 1974*b*). These results suggest that northwestern Ontario has a much higher density of breeding waterfowl than any other portion of Ontario sampled by earlier CWS ground surveys. The only section of Ontario accessible by road still to be surveyed is between Thunder Bay and Marathon, an area generally considered to have numbers and species of waterfowl similar to the Precambrian Shield. Future surveys in the remainder of the province will require different survey techniques because of the lack of road access.

Table 2
Estimated numbers of pairs of waterfowl per 100 km^2 in northwestern Ontario in 1979 compared with the Precambrian Shield and clay belt sections of north-central Ontario in 1973

Species	Northwestern Ontario	Precambrian Shield	Clay belt
Mallard	72	7	23
Black Duck	7	28	31
Mallard × Black Duck	1	0	0
Gadwall	1	0	0
American Wigeon	4	0	18
Green-winged Teal	11	1	10
Blue-winged Teal	12	0	6
Pintail	1	0	2
Wood Duck	6	2	0
Greater Scaup	2	1 (Both species)	0
Lesser Scaup	7		0
Ring-necked Duck	56	29	12
American Goldeneye	45	25	28
Bufflehead	15	3	0
Common Merganser	39	4	0
Red-breasted Merganser	15	0	0
Hooded Merganser	16	14	3
Unidentified duck	1	0	0
Canada Goose	T*	0	0
Total	311	114	133

*T = trace (<0–5).

6. Literature cited

Bellrose, F.C. 1976. Ducks, geese and swans of North America. Stackpole, Harrisburg, PA. 544 pp.

Boyd, H. US Fish and Wildlife Service estimates of duck numbers in northwestern Ontario, 1955–73. This publication.

Dennis, D.G. 1974*a*. Waterfowl observations during the nesting season in Precambrian and clay belt areas of north-central Ontario. Pages 53–56 *in* Boyd, H. ed. Waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G. 1974*b*. Breeding pair surveys of waterfowl in southern Ontario. Pages 45–52 *in* Boyd, H. ed. Waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Pages 278–280 in Saskatoon wetlands seminar. Can. Wildl. Serv. Rep. Ser. No. 6. 262 pp.

Godfrey, W.E. 1966. The birds of Canada. Queen's Printer, Ottawa. 428 pp.

Lands Directorate, 1977. Soil capability for Agriculture — Ontario. Map 1:1 000 000. Environment Canada, Ottawa.

Palmer, R.S. 1976. Handbook of North American Birds. Vol. 3. Waterfowl, part 2. Yale University Press, London, UK. 560 pp.

Rowe, J.S. 1972. Forest regions of Canada. Information Canada, Ottawa. 172 pp.

Simkin, D.W. 1959. Waterfowl breeding ground survey in the Sioux Lookout district 1959. Ont. Dep. Lands and Forests. Unpubl. rep. 5 pp.

Wellein, E.G.; Newcomb, W. 1954. Aerial waterfowl breeding ground surveys in northern Saskatchewan and western Ontario — 1953. Pages 103–107 *in* Waterfowl populations and breeding conditions, summer 1953. US Dep. Inter. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 25. Washington, DC. 250 pp.

US Fish and Wildlife Service estimates of duck numbers in northwestern Ontario, 1955–73

by H. Boyd

1. Abstract

The US Fish and Wildlife Service flew aerial line transect surveys over 685 076 km^2 of the boreal forests of northwestern Ontario in late May each year from 1955 to 1973 (except in 1971) from which they estimated the numbers of breeding pairs of ducks. The mean total was 782 000 pairs, the range from 270 000 in 1957 to 1 318 000 in 1968, with a trend corresponding to an increase of 25 000 pairs a year. Dabbling ducks (*Anas* sp.) made up 32.2% of the estimated total (Mallard 17.8%, Black Duck 9.4%), pochards (*Aythya* sp.) 20.3% (scaup 13.9%, Ring-necked Duck 5.2%), Common Goldeneye 19.6%, and mergansers 22.6%. The observed densities were lower than those reported from other parts of Ontario. The Black Duck was the only species showing a statistically significant increase over the entire period. There was no evidence of displacement of Black Ducks by Mallard and fluctuations in the two species were positively correlated.

2. Introduction

In 1955, the US Fish and Wildlife Service (USFWS) embarked on a very extensive series of aerial line transects sampling large parts of north-central US, much of western Canada, and Alaska, to provide estimates of waterfowl breeding populations in those parts of North America where most ducks are produced. The transects were flown in fixed-wing aircraft at 30–45 m above ground, and all waterfowl seen within an estimated 200 m of either side of the aircraft were counted. The sampling scheme involved a double sampling plan with stratification. The observations were adjusted to allow for differences in the visibility of different species in various habitat types, ducks being harder to see in forested regions than in open prairies or tundra. The statistical procedures used in estimating stratum totals from the observations are described by Martin *et al.* (1979). The field procedures were standardized in accordance with instructions in an unpublished USFWS manual, so as to reduce as far as possible the effects of differences between observers and of day-to-day flying conditions.

Among the areas selected for sampling the USFWS included a large part of northwestern Ontario, "stratum 50", extending about 700 km east from the Manitoba border and up to 735 km from north to south (Fig. 1). Most of this stratum, estimated by the USFWS to include 685 076 km^2, is boreal forest, with many lakes and rivers, and few roads and people. In the south this gives way to Great Lakes – Laurentian forest, also with much water, rather more fertile and heavily exploited by the logging industry. Exploratory surveys were flown in 1953 (Wellein and Newcomb 1954), as a result of which this region was given low priority by the USFWS, being surveyed only in May for breeding ducks, with no follow-up in July to estimate production. That low priority was emphasized by the USFWS decision to discontinue the survey of stratum 50 after 1973. Yet the 18 years' data from 1955 to 1973 (no survey having been flown in 1971) form by far the longest run of information on breeding ducks from any part of Ontario, and are of considerable regional interest. They therefore merit a brief review in the context of the other reports in this publication, even though CWS took no part in the aerial surveys. The 1955–73 results are of particular relevance to the ground-based survey of northwestern Ontario in 1979 (Dennis and North, this publication).

The aerial survey results, as is usually the case in forested areas, show great year-to-year variability in the estimates for many species, though yielding relatively stable estimates of the total numbers of ducks. Much of this variability is due to chance, as on transects where few ducks are recorded the addition or omission of a few individuals can make substantial differences to the estimated regional totals, the extrapolation factors being very large. For that reason most of the results reported below deal with estimates referring to tribes or genera rather than individual species.

Since ending the stratum 50 surveys in 1973, the USFWS has used an unchanging set of species estimates for the stratum in compiling its annual estimates for "North America". Those estimates are the arithmetic means for the entire 18 seasons, including zeros for years in which no individuals of a particular species were detected. I have not followed that practice here, believing it preferable to avoid means for infrequently recorded species and for those seen in most years to calculate means from positive records only.

3. Results

3.1. Gross changes in duck numbers

The total numbers of ducks estimated to have been present in stratum 50 varied between 270 000 pairs in 1957 and 1 318 000 pairs in 1968 (Table 1), the estimates for 12 of the 18 years lying close to a trend line with a slope corresponding to a gain of 25 000 pairs a year. The numbers of all three tribes represented in the samples fluctuated widely with coefficients of variation of 45.7% for the Anatini, 48.4% for the Aythyini, and 45.7% for the Mergini, compared with a CV of 34.1% for total ducks. The Anatini showed a mean annual gain of 11 200 pairs and the Mergini of 15 700 pairs, but the Aythyini showed no significant trend. Individual species or species groups (scaups, scoters, mergansers)

Figure 1
USFWS stratum 50 in northwestern Ontario, with the area sampled by ground survey in 1979

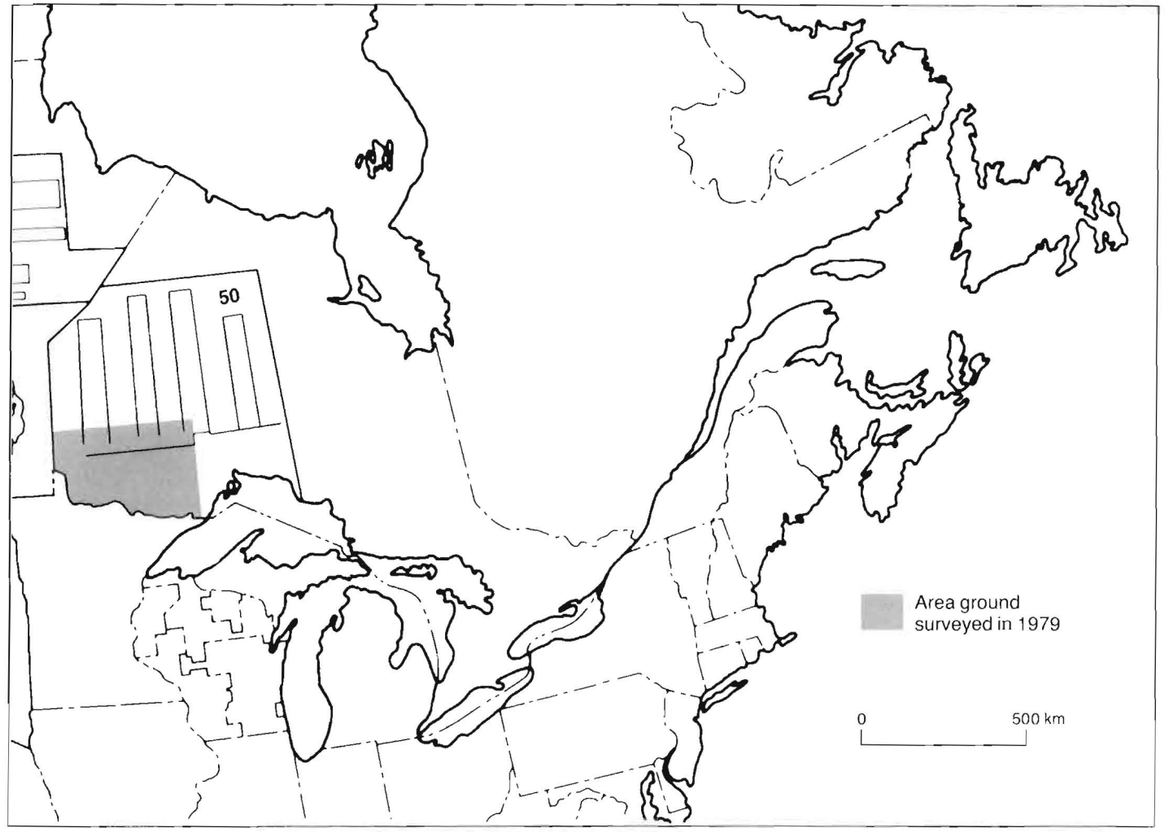
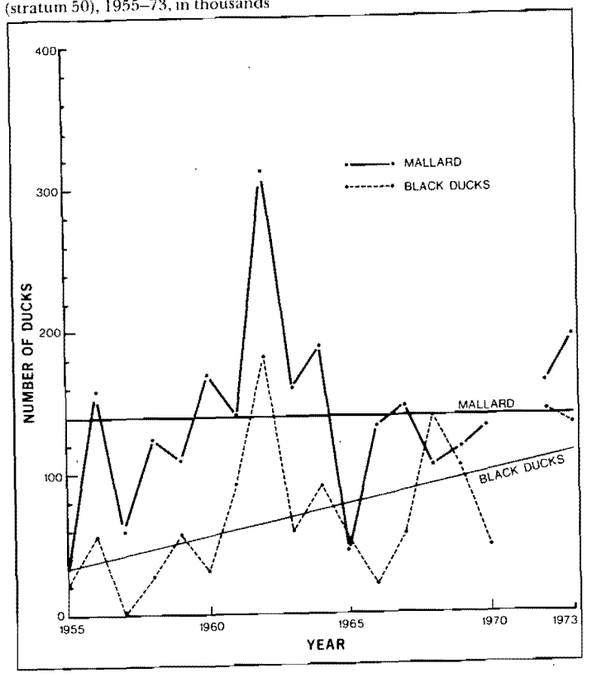


Table 1
Occurrences and estimated numbers of breeding pairs of ducks seen in stratum 50, northwest Ontario, 1955–73, and known breeding status

Species	Years seen (max. 18)	Thousands of breeding pairs: Mean	sE	Min.	(year)	Max.	(year)	Known breeding status in northwestern Ontario (after Peck and James 1983)
Mallard *Anas platyrhynchos*	18	139.0	59.2	35.3	(1955)	195.8	(1973)	Widespread
Black Duck *A. rubripes*	17	73.3	47.0	20.9	(1955)	183.0	(1962)	Common except in far west
Gadwall *A. strepera*	4			2.8	(1973)	17.7	(1967)	Not known to breed
American Wigeon *A. americana*	14	15.6	8.7	3.1	(1960)	33.8	(1968)	Sparingly throughout
Pintail *A. acuta*	11	7.7	3.6	2.5	(1966)	14.2	(1959)	Very few records, in south only
Green-winged Teal *A. crecca*	11	34.2	28.0	11.3	(1968)	113.6	(1970)	Sparingly throughout
Blue-winged Teal *A. discors*	4			6.2	(1968)	48.3	(1970)	Thinly scattered
N. Shoveler *A. clypeata*	2			2.2	(1960)	5.7	(1967)	Not known to breed
Tribe Anatini *Anas* sp.	18	256.1	117.1	59.8	(1957)	557.3	(1962)	
Redhead *Aythya americana*	2			3.1	(1969)	10.6	(1960)	No breeding records
Canvasback *A. valisineria*	6			1.6	(1963)	113.7	(1960)	No breeding records
Scaup *A. marila* and *affinis*	18	109.2	65.2	22.6	(1955)	159.5	(1972)	Lesser breeds. Greater perhaps in north
Ring-necked Duck *A. collaris*	15	48.6	50.3	1.8	(1956)	194.0	(1966)	Thinly scattered
Tribe Aythyini *Aythya* sp.	18	153.6	74.4	70.7	(1955)	303.9	(1966)	
Goldeneye *Bucephala clangula*	17	153.0	130.0	7.7	(1965)	529.9	(1968)	Abundant, esp. in south
Bufflehead *B. albeola*	16	26.6	25.0	3.8	(1965)	103.6	(1970)	Thinly scattered
Oldsquaw *Clangula hyemalis*				3.9	(1972)	15.5	(1968)	Not recorded in area
Scoters *Melanitta* sp.	12	12.6	16.0	1.2	(1957)	61.5	(1968)	A few White-winged
Mergansers *Mergus* sp.	18	171.8	61.6	84.0	(1959)	269.2	(1969)	Hooded in S.; Common widespread; Red-breasted less common
Tribe Mergini*	18	376.2	171.8	108.0	(1957)	856.2	(1968)	
Ruddy Duck *Oxyura jamaicensis*	5			5.3	(1953)	38.0	(1961)	Very few; irregular
Total ducks	18	782.0	266.9	269.6	(1957)	1318.4	(1968)	

*Calculated as means of annual totals for each tribe, not as sums of species means.

Figure 2
Estimated number of Mallards and Black Ducks in northwestern Ontario (stratum 50), 1955–73, in thousands



peaked in 11 different years and troughed in 12, only 1958 and 1964 recording neither a high nor a low.

Over the whole period the dabbling ducks (Anatini) made up 32.7% of the estimated total population, the pochards (Aythyini) 19.6%, and the Mergini 48.1%. Using the trend lines to estimate the proportions at the beginning and end of the period, in 1955 the Anatini accounted for 28.8%, the Aythyini 27.7%, and the Mergini 43.4%; in 1973 the Anatini were 34.7%, the Aythyini 14.8%, and the Mergini 50.5%.

Within the Anatini the Mallard was by far the most numerous (Table 1), 54.3% of the total, with the Black Duck accounting for 30.3%, the Green-winged Teal 13.4%, and the American Wigeon 6.1%. In the light of changes in their relative abundance in other parts of Ontario, it is important to note that the numbers of Black Ducks and Mallard (Fig. 2) varied together ($r = 0.69, p<0.001$) and that the Black Duck gained on the Mallard, increasing at an average of 4500 pairs a year while the Mallard showed no net gain. The relative frequency of other species accords quite well with their known status in northwestern Ontario (Peck and James 1983).

Scaup made up 71% of the Aythyini. It is not possible to distinguish between the Greater Scaup (*Aythya marila*) and the Lesser Scaup (*A. affinis*) in a brief glimpse from the air. Though proved breeding records of both are few in western Ontario, published records suggest that most, if not all, scaup breeding in stratum 50 would have been *A. affinis*, *A. marila* occurring only in the Hudson Bay Lowland and perhaps along some of the northwest-flowing rivers (Peck and James 1983). The Ring-necked Duck, 31.6% of the total Aythyini, now breeds extensively in Ontario, though was not known to breed before 1919. The Canvasback has not been proved to breed in the province and the Redhead does so only in the south (Peck and James *loc. cit.*) The casual occurrence of these species amongst the ducks identified from the air is consistent with their recorded status.

The dominance of Goldeneye (43%) and the three species of mergansers (45.7%) amongst the Mergini seen is also in accordance with information from other sources. The massive change in the estimates of Goldeneyes from less than 8000 to 530 000 (CV 81.5%) makes it impossible to be sure what was happening to them. The much scarcer but still appreciable numbers of Buffleheads (7.1% of the Mergini) appeared to be increasing by about 2200 pairs a year. So little is known about the breeding status of scoters anywhere in eastern Canada that the aerial observations cannot be interpreted with confidence, though the most likely species to occur is the White-winged, at the eastern limit of its mid-Canadian range.

The combined total of mergansers varied little more (CV 35.8%) than the total of all ducks. Without information on individual species this does no more than suggest that these birds were holding their own, rather than increasing along with *Bucephalus albeola* and perhaps *B. clangula*.

3.2. Comparison with 1979 ground survey

The sample-plot survey of 91 314 km^2 of northwestern Ontario in 1979 described by Dennis and North (this publication) gives a more up-to-date and reliable estimate of duck numbers, though with its own limitations. The area they surveyed lies in the southern part of stratum 50 and might be expected to hold more ducks than in the north, which is less fertile. Table 2 compares the 1979 results with those for 1955–73, including projections to 1979 of trends in the earlier period. There is a close resemblance between the two sets of data in the relative abundance of the three tribes and in the species detected, subject to the previously discussed limitations on identifying scaups and mergansers from the air. The only clear difference is the occurrence of Wood Ducks in 1979, not seen in any of the aerial surveys.

Table 2
Density, in pairs per 100 km^2, of ducks in northwestern Ontario in 1955–73, compared with that in 1979 (Dennis and North, this publication)

	1955–73				
		Range		Projected	
Species	Mean	Min.	Max.	1979	1979
Mallard	20	5	29	29	72
Black Duck	11	3	27	21	8
(and hybrids)					
Gadwall	—	<1			1
Wigeon	2	<1	5		4
Green-winged Teal	5	2	17		11
Blue-winged Teal	—	1	7		12
Pintail	1	<1	2		1
Anatini	37	8	81	62	108
	32.4%			35.6%	34.7%
Wood Duck	0				6
Greater Scaup	16	3	50		2
Lesser Scaup					7 } 9
Ring-necked Duck	7	<1	28		56
Aythyini	22	10	44	22	65
	19.3%			12.6%	20.9%
Goldeneye	19	1	77		45
Bufflehead	4	<1	15		15
Hooded Merganser					16
Common Merganser	25	12	39		39 } 70
Red-breasted Merganser					15
Mergini	55	16	125	90	130
	48.2%			51.7%	41.8%
Total ducks	114	39	192	174	311

In general, the densities recorded in 1979 were higher than any in 1955–73 and higher than the projections for 1979 from the earlier trends, the latter not corresponding well with the observations.

The most important discrepancy in Table 2 is in the relative abundance of Black Ducks and Mallards. The 1979 survey indicates a 9:1 preponderance of Mallards, instead of the average ratio of less than 2:1 in 1955–73, with the density of Mallards far higher than any recorded earlier and that of Black Ducks less than the previous average, though falling within the recorded range. These disparities could be accounted for in alternative ways. Most probably, the growing advantage of Mallards over Black Ducks apparent in other parts of Ontario became effective in the northwest after 1973. Alternatively, the excess of Mallards found in 1979 was due to the location of the surveyed area, close to the southwestern limits of the Black Duck's range, and may not have applied in northern stratum 50.

4. Literature cited

Dennis, D.G.; North, N.R. Waterfowl densities in northwestern Ontario during 1979 breeding season. This publication.

Martin, F.W.; Pospahala, R.S.; Nichols, J.D. 1979. Assessment and population management of North American migratory birds. Pages 187–239 *in* Cairns, J., Jr.; Patil, G.P.; Waters, W.E. eds. Environmental biomonitoring, assessment, prediction, and management. Statistical Ecology Ser., Vol. 11. Int. Co-op. Publ. House, Fairland, MD.

Peck, G.K.; James, R.D. 1983. Breeding birds of Ontario: nidiology and distribution. Vol. 1: Non passerines. R. Ont. Mus. Life. Sci. Misc. Publ. Toronto, Ont.

Wellein, E.G.; Newcomb, W. 1954. Aerial waterfowl breeding ground surveys in northern Sasakatchewan and western Ontario. Pages 103–107 *in* Waterfowl populations and breeding conditions in summer 1953. US Dep. Inter. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 25, Washington, DC. 250 pp.

Waterfowl production of moraine areas in the vicinity of London, Ontario

by D.G. Dennis and N.R. North

1. Abstract

Numbers of pairs of breeding waterfowl were documented by ground counts on four study areas near London, Ontario in 1977, 1978, and 1979. Detailed brood surveys were conducted during 1978. The study was designed to document fluctuation in pair numbers over several years and to relate pairs present during the spring to subsequent brood production.

From 1977 to 1978, Mallards declined from an estimated 114 pairs to 46; Blue-winged Teal from 45 to 29 pairs, and Wood Ducks from 21 to 11 pairs. Canada Geese increased from 4 to 12 pairs. The decline in breeding ducks was largely because of below normal precipitation. Canada Geese were not affected by drought because of their use of permanent wetlands for nesting. In 1979 numbers of Mallards and Blue-winged Teal were little changed from 1978, while Wood Ducks returned to 1977 levels and Canada Goose numbers continued to expand.

Observed brood production was similar to that documented by other studies of Blue-winged Teal (42.9%) and Wood Duck (37.5%). Brood success of Mallard (75.9%) was higher than reported recently from other parts of North America. The high Mallard brood success may account for the population expansion of the species in recent decades in southern Ontario.

2. Introduction

Southwestern Ontario contains some of the most productive soils in Canada, based on soil classifications conducted by the Canada Land Inventory (Hoffman 1967). Cox (1972) estimated that approximately 50% of the original 2.3 million hectares of wetlands in southern Ontario had been destroyed by draining and filling. Wetland destruction has continued and in a recent discussion paper prepared by the Ontario Ministry of Natural Resources (1981) it was estimated that only 13 to 22% of the original wetlands remain. In certain locations, such as moraine areas where drainage has thus far proven infeasible or uneconomic, numbers of permanent and semipermanent wetlands continue to exist and produce waterfowl. Wetlands in moraine areas are now the most important natural areas for waterfowl production in southwestern Ontario. They are productive because they are shallow, occur on fertile soils, and are subject to the nutrient recycling that occurs during periodic droughts (Green *et al.* 1964).

The waterfowl production of small wetlands in southwestern Ontario inland from the Great Lakes shoreline marshes has not been extensively studied and reported. Dawson (1958) investigated duck use of wetlands, and Jacks (1971) studied waterfowl productivity of several recently constructed Conservation Authority impoundments in the late 1960s. Collins (1970) studied waterfowl production of certain small wetlands in the Oak Ridges moraine near Aurora and the Galt-Paris moraines near Brantford, Cambridge, and Guelph as well as a section of the Haldiman Clay plain near Cayuga. Neither Collins (1970) nor Dawson (1958) related waterfowl brood production to numbers of pairs present prior to brood production. As Jacks' (1971) work was conducted on recently impounded areas, her results concerning broods per pair may not represent typical waterfowl production areas.

In response to requests from various private and public agencies for waterfowl production data in southern Ontario, as well as the need for information to be used for a National Waterfowl Management Plan, the Canadian Wildlife Service (CWS) initiated a study in the spring of 1977. As general information was available on waterfowl pairs present in southern Ontario during the spring (Dennis 1974), the study was designed to document the relationship between pairs present during the spring and subsequent brood production, as well as local fluctuations in breeding pairs over several years.

3. Description of study area

During the spring of 1977, four study areas were selected near London. Aerial photographs of the Ingersoll, Westminster, and St. Thomas moraines were examined in detail and four areas with relatively high wetland density and diversity were delineated, following the 1000 m Universal transverse mercator grid lines on 1:25 000 National Topographic System mapsheets. Individual wetlands were outlined directly on aerial photographs (scale 1:16 900), taken in 1972. The study areas were all readily accessible from well-travelled roads and represented some of the best waterfowl production habitat in close proximity to London (Figs. 1, 2). Some of the natural wetlands on all study areas had been altered by filling or drainage. A few wetlands had been artificially created either as dug farm ponds or by road construction.

The largest study area was located mainly within the Ingersoll moraine and encompassed 16 km^2 adjacent to the southwest corner of the town of Ingersoll. It contained 81 wetlands ranging in size from 7.2 ha to less than 0.1 ha, 50.3 ha in all, representing 3.1% of the whole area. Seventy-three of the wetlands were used by waterfowl during the time of our observations. Four wetlands in the study area were destroyed by ditching and draining between the 1977

Figure 1
Location of the study areas in southern Ontario

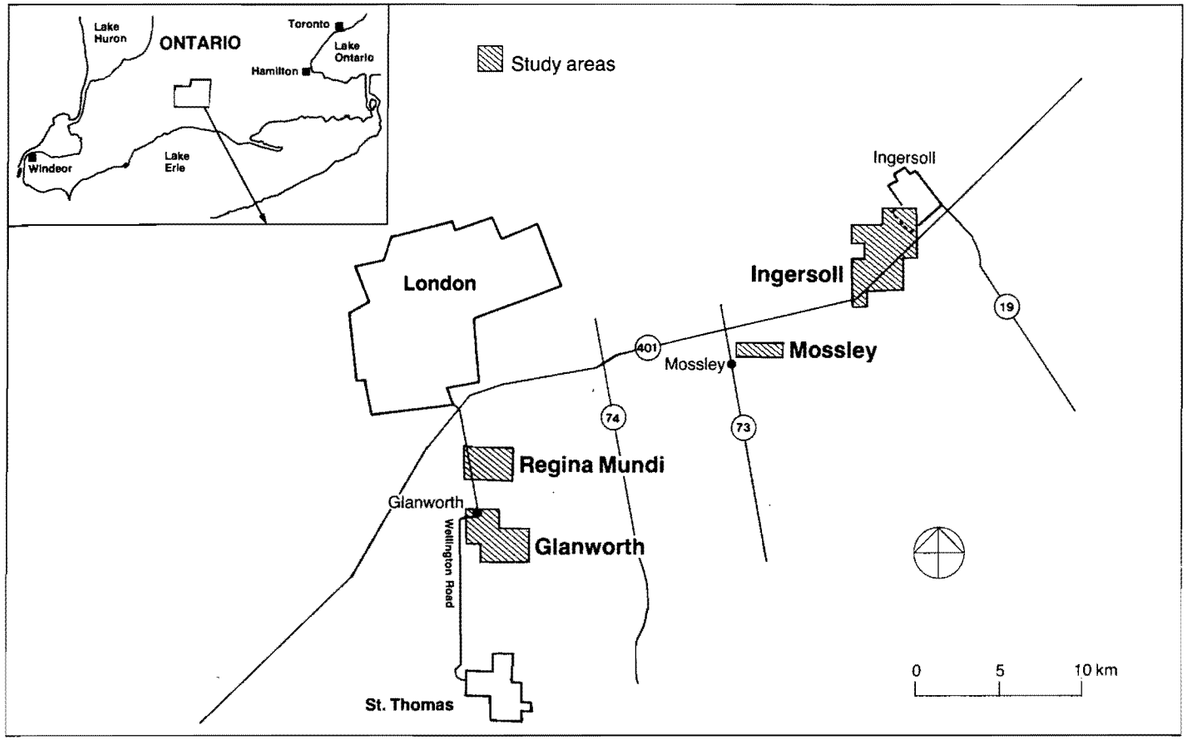
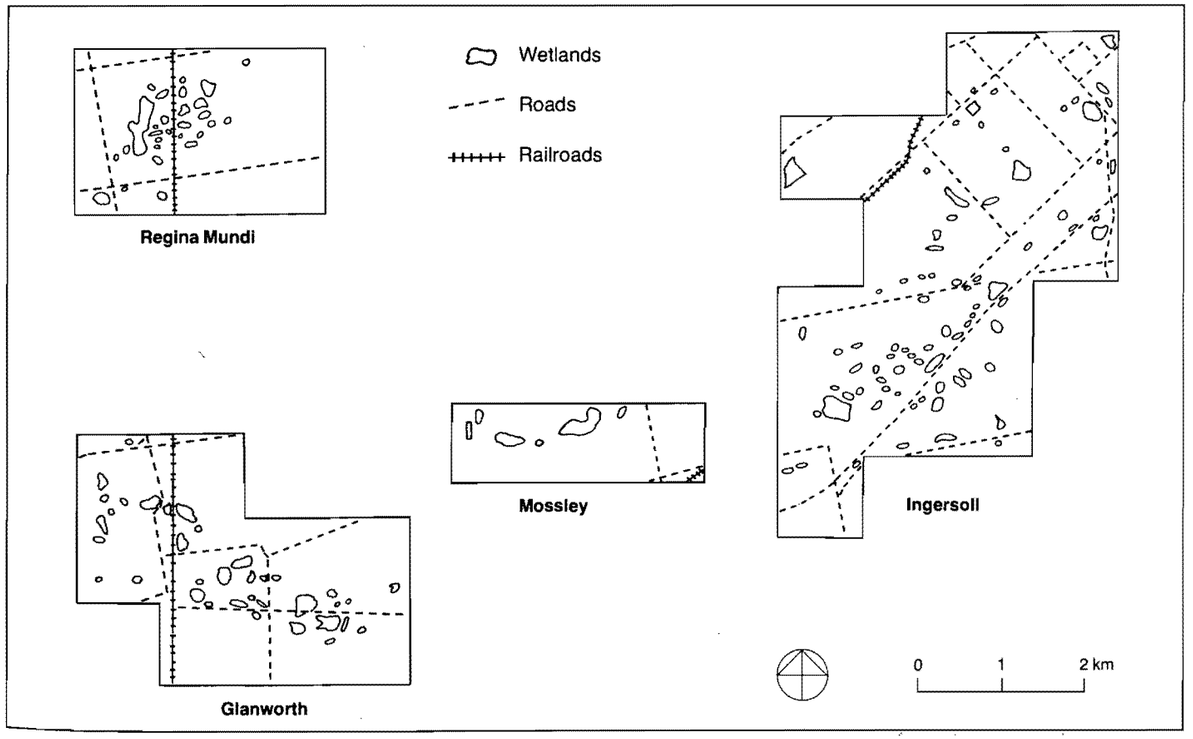


Figure 2
Wetland distribution within the four study areas



and 1978 surveys, and one of the largest and most productive was completely drained during 1978. Filling with refuse continued at three wetlands during our study period.

The next largest study area, of 9.0 km^2, was located beside the south boundary of the village of Glanworth and was contained within the boundaries of the St. Thomas moraine. There were 36 wetlands within the study area, of between 4.7 ha and 0.1 ha, 35.6 ha in all, 11.9% of the total area. Thirty-one of the wetlands were used by waterfowl during the study. One was filled during the study period and another was slightly modified by the alteration of a ditch.

The third study area (Regina Mundi) was located approximately 4 km north of Glanworth and occupied 6.0 km^2 of the Westminster Moraine. It contained 28 wetlands, ranging in size from 10.5 ha to less than 0.1 ha, 27.7 ha in all, 4.6% of the study area. Twenty-six were used by waterfowl. Filling continued at two of the wetlands during the study period.

The fourth study area was located 0.2 km northeast of the village of Mossley and occupied 3.0 km^2. All six of its wetlands were used by waterfowl and they ranged in size from 4.5 ha to less than 0.1 ha, 13.9 ha in all, 1.5% of the study area. The water level in one wetland area was slightly lowered by ditching in 1977.

4. Methods

The wetlands of each study area were classified using the system devised by Martin *et al.* (1953). Eight of their categories were used (Table 1).

During 1977 five waterfowl pair surveys were conducted on the four areas at approximately 10-day intervals between 13 April and 27 May. In 1978 only four surveys were conducted, from 18 April to 25 May, as it appeared that a considerable number of the birds observed during the first survey in 1977 might still have been migrants. During 1979 one pair count was conducted during the period 18–23 April. Time required for a complete survey of all four areas was normally 3 days.

Small isolated wetlands were normally surveyed by one observer while the large wetlands or those with dense vegetation were usually surveyed by two people. Labrador or Golden Retrievers were often used to flush birds from dense cover. Counting was done by checking open water areas with 7×35 binoculars, followed by walking through the thick cover to flush the remaining birds. The survey usually spanned the period 08:00 to 17:00. Surveys were conducted under all weather conditions except heavy rain or fog.

Individual wetlands were surveyed to minimize the likelihood of counting birds more than once during each survey of the entire study area. An attempt was made to observe birds without flushing them. If the birds were flushed they were watched until they either landed on another wetland or disappeared from view. When wetlands were revisited, it was carefully considered whether waterfowl seen could have been counted previously. No doubt some birds were occasionally counted more than once, especially when birds flushed by the observer landed on wetlands that were distant but still within the study area boundary. Such duplicate counts were partially compensated by the fact that some birds were not counted during each survey because they were either temporarily absent from the study area, or were not detected even though present.

To determine the potential number of breeding pairs in each study area, only pairs, lone males, and flocked males in groups of five or less were used, (Dzubin 1969*a*). Additional observations concerning nest locations, predation, and any unusual behaviour were also recorded in field notebooks.

Coulter and Miller (1968) found that the first Mallard broods in Vermont hatched about 15 May and the last about 15 July, thus we selected the period from 1 June to 31 July for southern Ontario brood counts. Five brood surveys were conducted at 10-day intervals at all wetlands with the potential to contain waterfowl broods. Counts were completed between 06:00 and 11:00 and areas of greatest brood probability were counted earlier in the day. During a brood survey each wetland was scanned from a distance using 10×50 binoculars or a $20\times$ to $45\times$ spotting scope. The wetland was then systematically searched by walking the perimeter and quietly wading to those areas that could not be readily observed from the shore. Broods observed were identified according to the species of hen accompanying the ducklings. All broods were aged by the method of Gollop and Marshall (1954).

5. Results and discussion

5.1. Wetland types

Table 1 records the percentages of each wetland category (Martin *et al.* 1953) found on the four study areas.

The Ingersoll area had the highest proportion of open fresh water (24%) and the only fresh meadow (5%) of any of the four areas. The Mossley area had a relatively similar proportion of shallow fresh marsh (16%), deep fresh marsh (23%), and seasonally flooded basins (19%), with a greater proportion (37%) of wooded swamp. Regina Mundi had the greatest proportion of deep fresh marsh (39%) and the only bog of any area surveyed. Over half of the wetlands in the Glanworth area (60%) were classified as wooded swamp; the next most common wetland type, seasonally flooded basins, comprised only 15% of the total.

Kantrud and Stewart (1977) found that in North Dakota 60% of the dabbling ducks occupied seasonal wetlands. Such wetlands are extremely important in years with ample precipitation. The pattern is probably similar for southwestern Ontario and thus areas with a high proportion of seasonal wetlands should be capable of producing larger quantities of waterfowl during wet years. Seasonal wetland types on the four study areas included shallow fresh marsh, wooded swamp, shrub swamp, seasonally flooded basin, and fresh meadow. In the last 15 years many seasonal wetlands, such as seasonally flooded basins and fresh meadows, have been regularly tilled as a result of the general change from mixed farming to intensive grain monocultures, in which fall ploughing is common. Krapu (1974) determined that frequently tilled wetlands did not produce sufficient protein to supply the needs of Pintail (*Anas acuta*) hens during egg laying. It is likely that the value of certain seasonal wetland types to breeding waterfowl has decreased in recent years because of the greater tillage associated with intensified agriculture in southern Ontario.

Table 1
Types and abundance of wetlands in the four study areas near London, Ontario. Categories from Martin *et al.* (1953)

Locality (total wetland area, ha)	Shallow fresh marsh		Wooded swamp		Shrub swamp		Open fresh water		Deep fresh marsh		Seasonally flooded basin		Fresh meadow		Bog	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Ingersoll 50.3	6.0	*12*	8.0	*16*	9.1	*18*	12.1	*24*	3.4	*7*	9.4	*19*	2.4	*5*	0.0	*0*
Mossley 13.9	2.3	*17*	5.2	*37*	0.0	*0*	0.7	*5*	3.2	*23*	2.6	*19*	0.0	*0*	0.0	*0*
Regina Mundi 27.7	0.3	*1*	0.0	*0*	5.8	*21*	2.6	*9*	10.7	*39*	7.3	*26*	0.0	*0*	1.0	*4*
Glanworth 35.6	1.5	*4*	21.4	*60*	1.8	*5*	1.9	*5*	3.6	*10*	5.5	*15*	0.0	*0*	0.0	*0*

Table 2
Mean number of indicated pairs observed on four study areas, 1977–79

Species	Year	Ingersoll	Mossley	Regina Mundi	Glanworth	Total
Mallard	1977	50.7	28.7	25.7	8.7	113.8
	1978	29.0	4.3	5.3	7.3	45.9
	1979	21.0	2.0	15.0	5.0	43.0
Black Duck	1977	1.0	0.3	0.7	0.0	2.0
	1978	0.3	0.0	1.0	0.0	1.3
	1979	2.0	0.0	1.0	0.0	3.0
Black + Mallard	1977	0.3	0.3	0.3	0.0	0.9
	1978	1.0	0.0	0.0	0.0	1.0
	1979	0.0	0.0	0.0	0.0	0.0
Green-winged Teal	1977	5.3	0.3	2.7	0.0	8.3
	1978	2.3	0.0	1.3	1.0	4.6
	1979	0.3	0.0	0.0	0.0	0.3
Blue-winged Teal	1977	20.3	5.0	13.0	6.3	44.6
	1978	4.0	1.0	7.6	16.3	28.9
	1979	1.0	2.0	12.0	10.0	25.0
Wood Duck	1977	5.3	9.7	0.0	5.7	20.7
	1978	5.6	2.0	2.0	1.7	11.3
	1979	7.0	4.0	2.0	5.0	18.0
Canada Goose	1977	1.0	0.0	1.3	2.0	4.3
	1978	1.7	1.3	3.3	5.3	11.6
	1979	3.0	0.0	5.0	9.0	17.0

5.2. Breeding pair numbers

Waterfowl were observed on 136 of the 151 wetlands on the four study areas at some time during the 3-year study period. Table 2 shows the mean numbers of pairs observed on the study areas each year for the six species of waterfowl regularly observed during the study. Mallards (*Anas platyrhynchos*), Black Ducks (*A. rubripes*), Blue-winged Teal (*A. discors*), Wood Ducks (*Aix sponsa*), and Canada Geese (*Branta canadensis*) were considered to breed regularly. Green-winged Teal (*Anas crecca carolinensis*) were not considered regular breeders as no broods were observed and the four study areas are slightly outside the normal breeding range of the species (Godfrey 1966).

Table 2 includes data from three counts conducted between 3 May and 27 May 1977; three between 26 April and 25 May 1978; and a single count during the period 18 to 23 April 1979. Data from Coulter and Miller (1968), as well as direct observations of lone territorial drakes, suggest that the count dates encompassed the principal nesting period. Observations suggested that earlier counts in each year included a proportion of transient migrants, especially among late-nesting species such as Blue-winged Teal.

Between 1977 and 1978 there was a decline in numbers of Mallards, Blue-winged Teal, and Wood Ducks and an increase in Canada Geese. The decrease in Mallards and increase in Canada Geese are statistically significant at the 95% level using Student *t* test (Snedecor 1956). Neither Black Ducks nor Black/Mallard combinations were present in sufficient numbers to detect trends. The reduction in Mallards, Blue-winged Teal, and Wood Ducks is probably related to changes in precipitation, and to a lesser extent temperature, over a number of years. For example, the Canada meteorological summary for London (1975, 1976, 1977) indicates that in 1975 southern Ontario had total precipitation considerably above normal until the end of August. During 1976 precipitation was well above normal throughout the year. In 1977 there was below normal precipitation to the end of May, with above normal temperatures during April and May. We believe that the unusually heavy precipitation in 1975 and 1976 resulted in above normal waterfowl production because fewer ponds dried out during the late spring and early summer, the time of principal brood production. In 1977 more ponds dried out and production was much reduced, at least for Mallards and Blue-winged Teal. As a consequence, 1978 spring breeding populations were smaller than in 1977.

An additional cause for the decline of all species of ducks on the Mossley area was the increased agricultural effluent in two wetlands on the area. In 1977 some effluent was entering the wetland system adjacent to a hog farm. It appeared to enrich the system and make it more attractive to waterfowl. The ponds supported a luxuriant growth of aquatics such as Duckweed (*Lemna* sp.). Coulter and Miller (1968) mention that species such as Mallards have home ranges of up to five square miles (13 km^2). Waterfowl whose home range was not on the Mossley study area were attracted to the pond system receiving the effluent, probably because the nutrient levels were optimum to produce large numbers of invertebrates attractive to ducks (Swanson 1977).

In 1978 effluent was more regularly spread on the fields surrounding the wetland system and the quantity reaching the system apparently increased, based on odour and the decline in aquatic vegetation. In addition, effluent

was further concentrated in the upper portion of the system by a new ditch that lowered water levels. Levels of effluent that were toxic to many invertebrates were probably exceeded and thus the attractiveness of the upper part of the wetland system to waterfowl declined.

Canada Goose numbers in southwestern Ontario were and are expanding. Because the species is not dependent on invertebrates to rear broods it can utilize relatively unproductive permanent wetlands provided that suitable grazing areas are present. Thus, Canada Geese are not affected by moderate droughts.

The single count for 1979 suggests that Mallard and Blue-winged Teal numbers remained relatively constant. Wood Ducks rebounded to approximately 1977 levels and Canada Goose numbers continued to expand.

Relative species' proportions on the study areas are undoubtedly related to certain wetland types. For example, the absence of any wooded swamp on the Regina Mundi study area resulted in relatively low use by Wood Ducks. Using the four study areas to provide a range of wetland numbers and densities, the numbers of ducks seen (all species combined) were positively correlated with the numbers of wetlands present ($r = 0.57, p<0.05$) and with the total area of wetlands ($r = 0.75, p<0.10$), and perhaps inversely related to the mean size of wetland ($r = -0.56, p<0.20$).

5.3. Brood production

Twenty waterfowl nests were located on the four study areas during the breeding pair counts. All of the 7 Canada Goose nests and the 1 Wood Duck nest hatched successfully. Only 4 of the 12 Mallard nests hatched; 4 were abandoned; 2 were destroyed by predators and the fates of 2 were unknown.

Table 3 shows the maximum number of indicated waterfowl pairs present based on the highest count in 1978 and the subsequent brood production for the four study areas. Because of the relatively small number of broods present, it was usually possible to identify repeat observations of a brood based on species, number of ducklings, and the age class when the brood was previously observed.

That 10 Mallard broods were produced on Regina Mundi from 8 indicated pairs is probably a result of the fact that Regina Mundi and Glanworth were separated only by approximately 2.5 km. As suggested previously, home ranges of Mallards can encompass 13 km^2 and it is possible that home ranges for several pairs included parts of both areas. Although there were 9 indicated pairs on the Glanworth area, only 3 broods were seen, and it seems probable that some of the Mallard broods observed on Regina Mundi were the offspring of pairs that were principally observed in the Glanworth area.

The larger number of Blue-winged Teal broods than pairs on Mossley may be a result of Blue-winged Teal males residing on territory outside the study area. Perhaps the reverse situation occurred on the Glanworth area, where approximately 19 pairs were present and only 6 broods were seen. Dzubin (1969*b*) states that "pairs or drakes may utilize one or two ponds exclusively for a short time during the laying period. Before or after this period 6 to 10 other ponds are occupied for requisites during any one time interval of the day." It is also possible that low Blue-winged Teal production on Glanworth was the result of high nest destruction during the harvesting of hay by two farmers on the study area. One farmer mentioned that he had inadvertently destroyed several Blue-winged Teal nests while cutting hay during the year of the study.

In general, ultimate success of Mallard pairs at producing a brood is considerably higher than the success of only 4 of the 12 Mallard nests discovered on the study areas would suggest. Bellrose (1976)* found a mean success rate for 7700 Mallard nests in a variety of habitats of 45.9%.

*All statements in this section attributed to Bellrose are from his 1976 reference.

Table 3
Relationship of brood production to indicated pairs on the London study areas, 1978

	Ingersoll		Mossley		Regina Mundi		Glanworth		Total	
Species	Indicated pairs	Broods produced	Indicated pairs	Broods produced	Indicated pairs	Broods produced	Indicated pairs	Broods produced	Pairs	Broods
Mallard	31	23	6	5	8	10	9	3	52	41
Black Duck	1	0	0	0	1	0	0	0	1	0
Black + Mallard	2	1	0	0	0	0	0	0	2	1
Blue-winged Teal	7	3	2	4	14	5	19	6	38	18
Wood Duck	7	1	3	0	3	2	3	1	12	4
Canada Goose	3	3	2	1	4	1	6	3	13	7

Table 4
Number of young per brood on the London study areas, 1978

	Ingersoll		Mossley		Regina Mundi		Glanworth		Average no.*
Species	No. of broods	No. of young	No. of broods	No. of young	No. of broods	No. of young	No. of broods	No. of young	of young /brood
Mallard	23	126	5	30	10	57	3	21	5.7
Black + Mallard	1	7	0	0	0	0	0	0	7.0
Blue-winged Teal	3	16	4	30	5	41	6	47	7.4
Wood Duck	1	4	0	0	2	17	1	12	8.3
Canada Goose	2	6	1	2	1	8	3	11	3.9

*Size of brood is based on number of young present on last date brood was observed and identified as such.

Coulter and Miller (1968) found that renesting was attempted by 57% of 30 marked Mallard hens whose nests were destroyed. In the present study, a total of 54 indicated pairs eventually produced 41 broods for an overall brood success of 75.9%, higher than the 49% reported by Keith (1961) for Brooks, Alberta and the 48% reported by Stoudt (1971) for the Redvers area in southeastern Saskatchewan. Perhaps brood production per hen is higher in southern Ontario than elsewhere because a high percentage of birds renest. There is a game-farm component in southern Ontario Mallards as a result of large numbers of birds being released by aviculturalists and other private and government groups. State game agencies in the vicinity of the Great Lakes released approximately 400 000 Mallards between 1940 and 1970 (Role of hand-reared ducks in waterfowl management, 1971). Perhaps the game-farm component contributes to Ontario Mallard renesting behaviour. In any event, such high brood production in Mallards may explain the six-fold expansion that occurred in Ontario between 1951 and 1971 (Collins 1974).

Total Blue-winged Teal brood success consisted of 42 pairs producing 18 broods. According to Bellrose, Blue-winged Teal nest success averages only 35%. Strohmeyer (1967) found that 18% of the nests that hatch were renests, thus our rate of 42.9% brood success is about as expected.

Brood success for Wood Ducks on the study area was at least 25%, as a total of 16 indicated pairs produced 4 broods. Two broody hens were observed on the Mossley study area on several occasions and although broods were not observed we believe that they were present but obscured by the thick cover, thus overall brood success for Wood Ducks is probably 37.5%. Bellrose reported nesting success in various studies that ranged from 40 to 55%.

Of the 15 pairs of Canada Geese on the study areas, 7 produced broods. The remaining birds were probably subadults that did not attempt to nest. As previously mentioned, all of the seven goose nests that were found on the areas hatched. Canada Goose populations have been expanding in southern Ontario in recent years and part of the successful population expansion is undoubtedly because of high nesting success. Bellrose states that an average of 69.3% of Canada Goose nests hatched in eight separate studies covering nearly 2500 nests of giant Canada Geese.

Table 4 illustrates the number of waterfowl produced on the four areas and the average number of young per brood. Most final observations of broods were of age classes IIC or III (Gollop and Marshall 1954) and thus probably represent quite closely the actual production of flying young. For example, Bellrose records a loss of only 3.3% of Mallard ducklings between age classes II and III.

The mean Mallard brood size of 5.7 slightly exceeded the results of CWS surveys conducted on the Lake Erie and Lake St. Clair marshes in southern Ontario, in which 188 class IIC or older broods averaged 5.2 young per brood. However, the average brood size in our study areas is slightly less than the general average of 5.9 reported by Bellrose for class III broods, thus high production in Ontario is not due to high duckling survival.

Blue-winged Teal averaged 7.4 young, the same size as reported by Bellrose for class III broods.

Bellrose states that 52 broods of class III Wood Ducks averaged 5.4 young, while our small sample of 4 Wood Duck broods averaged 8.3.

For Canada Geese in general, Bellrose suggests that an average of 4.0 reached flight stage, similar to the 3.9 that occurred on the four study areas.

6. Comment

By the standards of waterfowl studies conducted in the more productive prairie portions of the North American continent, sample sizes in the present study appear small. The difficulty in conducting waterfowl studies in the less productive, extensively modified portions of the North American continent has deterred other workers. Much of the information required for waterfowl management decisions in the near future must come from studies such as the present, where sample sizes are too small to be statistically significant in many instances. Collectively, such studies yield a cumulative source of information that will in future provide a valid basis for management decisions.

Future work requirements to expand the knowledge of waterfowl production include documentation of the kinds and proportions of wetlands that exist in southern Ontario and studies of the production that occurs on specific types, such as beaver ponds. Currently plans are progressing for a wetlands inventory for southern Ontario and plans will be implemented to document waterfowl production from geographic areas containing beaver ponds in future years.

7. Summary

1. The destruction of wetland habitat and intensified agricultural tillage will continue to reduce the natural waterfowl production capacity of moraine areas in southern Ontario.

2. A shortage of rainfall during the 1977 brood-rearing period depressed the 1978 breeding populations of Mallards, Blue-winged Teal, and Wood Ducks. The effect of the shortage on local Canada Goose populations was negligible.

3. Agricultural effluent favourably influenced waterfowl use in one wetland system in 1977; as effluent levels continued to increase in 1978 waterfowl use decreased.

4. Mallards had an extremely high success at eventually producing a brood even though initial nests were not particularly successful. The game-farm genetic background of some of the southern Ontario stock may result in a high number of renesting attempts.

5. Canada Goose numbers were rapidly expanding during the study period, because of high nesting success and because goose production is not affected by reduced rainfall.

6. Brood sizes for Mallards, Blue-winged Teal, and Canada Geese were similar to the averages for other areas of North America.

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9. Literature cited

Bellrose, F.C. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA. 544 pp.

Bennett, C.L. 1967. A new method for estimating numbers of duck broods. J. Wildl. Manage. 31:555–562.

Canada, Atmospheric Environment Service. 1975–77. Annual meteorological summary Rep. for 1975, 1976, 1977, London Airport.

Collins, J.M. 1970. To determine the need and opportunity to improve and develop small wetlands in southwestern Ontario. Can. Wildl. Serv. Rep. mimeo. London, Ont. 35 pp.

Collins, J.M. 1974. The relative abundance of ducks breeding in southern Ontario in 1951 and 1971. Pages 32–44 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Coulter, M.W.; Miller, W.R. 1968. Nesting biology of Black Ducks and Mallards in northern New England. Vermont Fish and Game Dep. Bull. No. 68–72.

Cox, E.T. 1972. Estimates of cleared wetlands in southern Ontario. Ont. Min. Nat. Resour. Unpubl.

Dawson, J.B. 1958. A study of some wetlands in southern Ontario with special reference to ducks. M.S.A. thesis. Univ. of Toronto. 186 pp.

Dennis, D.G. 1974. Breeding pair surveys of waterfowl in southern Ontario. Pages 45–52 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dzubin, A. 1969*a*. Assessing breeding population of ducks by ground counts. Pages 178–230 *in* Saskatoon Wetlands Seminar. Can. Wildl. Serv. Rep. Ser. No. 6. 262 pp.

Dzubin, A. 1969*b*. Comments on carrying capacity of small ponds for ducks and possible effects of density on Mallard production. Pages 138–160 *in* Saskatoon Wetlands Seminar. Can. Wildl. Serv. Rep. Ser. No. 6.

Godfrey, W.E. 1966. The birds of Canada. Queen's Printer. Ottawa, Ontario. 428 pp.

Gollop, J.B.; Marshall, W.H. 1954. A guide for aging duck broods in the field. Mississippi Flyway Counc. Tech. Sect. Rep. 14 pp.

Green, W.E.; MacNamara, L.G.; Uhler, F.M. 1964. Water off and on. Pages 557–568 *in* Linduska, J. ed. Waterfowl tomorrow. US Dep. Inter. Washington, DC.

Hoffman, D.W. 1967. Canada Land Inventory, Soil capability for agriculture. Mapsheet 401. Queen's Printer, Ottawa.

Jacks, J. 1971. A study of some factors affecting utilization of two new impoundments by waterfowl. M.Sc. thesis, York Univ. Toronto. 166 pp.

Kantrud, H.A.; Stewart, R.E. 1977. Use of natural basis wetlands by breeding waterfowl in North Dakota. J. Wildl. Manage. 41:243–253.

Keith, L.B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Manage. No. 6. 88 pp.

Krapu, G.L. 1974. Feeding ecology of Pintail hens during reproduction. Auk. 91:278–290.

Martin, A.C.; Hotchkiss, N.; Uhler, F.M.; Bourn, W.S. 1953. Classification of wetlands of the United States. US Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 20. 14 pp.

Ontario Ministry of Natural Resources. 1981. Towards a wetlands policy for Ontario. September, 1981. Unpubl. rep. 15 pp.

Role of hand-reared ducks in waterfowl management: a symposium. 1971. Max McGraw Wildlife Foundation. Dundee, IL. 174 pp.

Snedecor, G.W. 1956. Statistical methods. Iowa State College Press. Ames, IA. 534 pp.

Stoudt, J.N. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. US Fish and Wildl. Serv. Resour. publ. 99. 58 pp.

Strohmeyer, D.L. 1967. The biology of renesting by the Blue-winged Teal (*Anas discors*) in northwest Iowa. Ph.D. thesis, Univ. of Minnesota, Minneapolis, MN. 103 pp.

Swanson, G.A. 1977. Diel food selection of Anatinae on a waste-stabilization system. J. Wildl. Manage. 41(2):226–231.

Part II

Waterfowl population trends

Population trends of the five most common duck species breeding in southern Ontario, 1971–76

by R.K. Ross, D.G. Dennis, and G. Butler

1. Abstract

Trends in the populations of the five duck species breeding most abundantly in southern Ontario were examined for the period 1971–76 using systematic ground survey data from a maximum of 463 study plots, each of 64 ha. Total duck numbers increased because of increases of Mallards, Blue-winged Teal, and Wood Ducks. Those species were either responding positively to changes in the environment, e.g. increased beaver activity, or were expanding into previously unoccupied habitat. Black Ducks and Green-winged Teal appeared to be declining, although those trends could not be demonstrated statistically. The only species that showed a clear relationship between duck abundance and habitat change in the study plots was the Blue-winged Teal. Such a correlation also proved significant for total duck numbers, and points to the likelihood of population declines in the near future if there is net habitat deterioration. Monitoring of waterfowl populations in southern Ontario will continue at regular intervals and detailed habitat data will be collected to learn more about the requirements of each species and the impacts of habitat change.

2. Introduction

Southern Ontario is among the most highly populated and industrialized regions in Canada. Continuing development will undoubtedly further diminish wildlife habitat and result in a concomitant decline in animal populations. The status of breeding waterfowl in southern Ontario is a source of concern to the Canadian Wildlife Service (CWS) and in 1970 a program to establish a breeding pair index was begun. Surveys in 1971 and 1972 formed the baseline for future comparisons (Dennis 1974). Further surveys were completed in 1974 and 1976. This paper discusses trends in the populations of the five commonest species of ducks: Mallard (*Anas platyrhynchos*), Black Duck (*A. rubripes*), Blue-winged Teal (*A. discors*), Green-winged Teal (*A. crecca*), and Wood Duck (*Aix sponsa*). Where possible, findings have been related to habitat change.

Previous studies of waterfowl population trends in southern Ontario (Stirrett 1954, Cringan 1960, Collins 1974) did not cover a random cross-section of waterfowl habitats and were not based on completely comparable samples. Although evidence from those studies has often been compelling, no statistical testing was practicable. The present study has been based on samples spread throughout southern Ontario (south of Lake Nipissing) and not restricted to major wetlands. Comparability of the data has been assured by following a standardized survey methodology and schedule.

3. Methods

Study plot selection and field methodology have been described by Dennis (1974). Briefly, 463 square plots, 800 m per side, were laid out systematically over southern Ontario in two strata based on Mallard kill densities (i.e. the relative numbers of Mallard reported shot by respondents in the National Harvest and Species Composition surveys carried out annually by CWS). The high density stratum (24 868 km^2) contained 399 plots and the low density stratum (26 376 km^2) 63 (see Table 1). Each plot was thoroughly searched by a team of two observers, often accompanied by a Labrador retriever. The survey period extended from the third week of April to the fourth week of May and the timing of plot surveys was correlated with a corn heat unit map of southern Ontario (Dean 1969), so as to maintain roughly similar phenologies within the survey and between surveys. Due to problems of accessibility, weather, and manpower restrictions, the number of plots surveyed in each year varied (Table 1), thus complicating analysis when comparing survey results between years.

Densities of breeding waterfowl were measured using the "indicated pair" as the basic unit. Indicated pairs were determined by the presence of males, either singly or in flocks of five or less, as suggested by Dzubin (1969). As Black Duck males and females are often indistinguishable in the field, population levels for that species have been based on the total number seen and not on indicated pairs. We have assumed that Black Ducks are similar in breeding behaviour to Mallards, for which the percentage of indicated pairs to total birds is quite constant (66%, 1971; 65%, 1972; 62%, 1974; 69%, 1976).

To assess if waterfowl population levels have been changing over the years, it was first necessary to determine if the survey results were comparable from one year to the next. Given the standardized methodology, there are only two essentially independent factors that are capable of biasing results — time of day and state of phenology. Both have been shown by Dzubin (1969) to affect breeding pair surveys on the prairies.

To establish if hour and phenology were significantly affecting results of this study, the following analytical procedure was developed to isolate the effects of each:

(1) All surveys were assigned to one of two time categories (before and after 10:30 EST).

(2) Each spring's work was divided into six approximately weekly periods and an index of the state of waterfowl breeding phenology developed for each period. This index was based on the nesting chronology of the Mallard, which is the most common and observable of the region's waterfowl.

Table 1
Numbers of plots and area of coverage during surveys in 1971, 1972, 1974, and 1976

Year	Stratum	Stratum area (km^2)	Number of plots	Sample area (km^2)
1971	1	26 376	63	41.4
1971	2	24 868	399	258.4
1972	2	24 868	280	181.3
1974	2	24 868	85	55.0
1976	2	24 868	278	180.0

Table 2
Example of multiple contingency test for differential annual bias in survey results for Mallard (data from Appendix 1). Probabilities were determined by Fisher exact tests

	No. of indicated pairs			No. of indicated pairs	
Conditions*	1971	1972	Conditions	1972	1974
a	34	30	a	11	8
b	7	4	b	2	3
	$p = 0.745$			$p = 0.630$	
Conditions	1974	1976	Conditions	1971	1974
a	11	4	a	1	2
b	2	3	b	10	11
	$p = 0.290$			$p = 1.000$	
Conditions	1972	1976	Conditions	1971	1976
a	38	32	a	35	21
b	9	8	b	4	3
	$p = 1.000$			$p = 1.000$	

*a, same phenology; same time.
b, same phenology; morning survey first year, noon survey second year.

The number of pairs observed each week was compared with the total number of single and flocked males seen in the same period; the greater the proportion of pairs seen, the earlier that week would be in the phenological cycle as fewer females would be incubating and thus hidden on the nest. Relative phenology (advanced, retarded, same) can then be established for any two weeks from different years through use of the Fisher exact test to assess if the proportion of pairs was similar or not.

(3) Pairwise comparisons between years of survey results (indicated pair totals) were then made for a given plot and species and each comparison assigned to one of 54 cells based on the 2 years being compared (1971–72, 1972–74, 1974–76, 1971–74, 1971–76, 1972–76), the time (morning–noon, noon–morning, same time) and relative phenology (advanced, retarded, same). A series of contingency tables was then assembled to compare ratios of numbers of indicated pairs detected on a group of plots in two different years under a given set of conditions (e.g. same phenology, same time of day) with results from another group of plots in the same 2 years under different conditions (e.g. same phenology, morning and noon times). By controlling for either relative phenology or timing, the effects of the other factor could be determined by a series of Fisher exact tests. As multiple contingency tables were used, a modified significance level ($\alpha_{0.05} = 0.05/n$, where n = number of tests, Cooper 1968) was required to eliminate the possibility of spurious significance. A maximum of six such tables (the number of inter-year comparisons) were available to compare any two sets of conditions (e.g. Table 2); certain comparisons could not be made because of inadequate samples in those cases and often less than the maximum six tables were available for a given comparison (see data in Appendix 1). No significant effects of either time of day or relative phenology on survey results were demonstrated. Dzubin (1969) indicated that such biases were due to the clumping of drakes either through their tendency to move to common loafing areas in the afternoon or, later in the cycle, through formation of local post-breeding flocks. Presumably the effects of such activities have been offset in the present study by the use of a large number of surveyed plots covering all habitat types and not just those perceived as good breeding habitat.

Having established the effective comparability of the results from year to year, the overall trends in populations were assessed over the full duration of 1971 to 1976; fluctuations within the study period were not tested. A nonparametric trend analysis was developed because parametric methods, including ANOVA and Pearson correlations, could not be applied due to the large numbers of nil observations, the suspect frequency distributions of the samples, and the variable number of surveys per plot. Instead, Thiel slope estimators (Hollander and Wolfe 1973), which are unbiased and particularly robust, were calculated for indicated pair numbers against time for those plots sampled in 1971, 1972, and 1976 or in 1971, 1972, 1974, and 1976. The significance of the population trend indicated by the mean slope for a given species was then assessed by comparing the set of slopes to zero using the Wilcoxon matched pair signed rank test (Seigel 1956).

Effects of habitat shifts on waterfowl were examined by comparing the calculated Thiel slope estimators of change in waterfowl breeding density for those plots showing major habitat modifications of a beneficial nature with those considered to have detrimental changes. These comparisons, using Mann-Whitney U tests (one-tailed), were performed for each of the five species under study as well as for pooled results.

4. Results

4.1. Population trends

Results for the five most common duck species are summarized in Table 3 and Figure 1. For each species, the 1971 breeding density (Dennis 1974) was used as the baseline and the ratio of results of that survey to each of the others has been applied to project the population densities in other years. The Wilcoxon values (Z) for each graph indicate the significance of the trend in population and were calculated using data for all available plots.

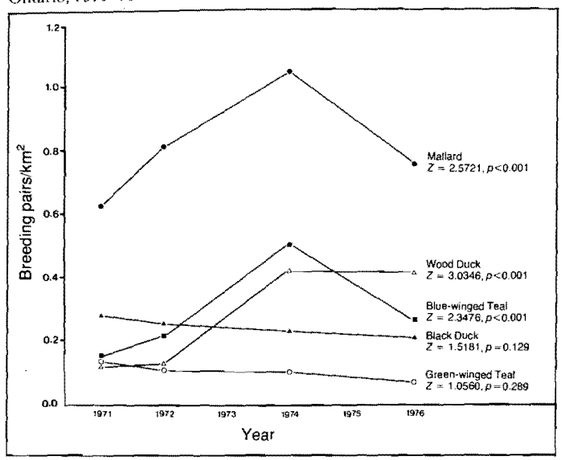
Figure 1 shows that populations of Mallards, Blue-winged Teal, and Wood Ducks all increased significantly in southern Ontario during the 6-year period 1971–76, but numbers of Black Ducks and Green-winged Teal showed no significant change (though the graphs suggest slow steady declines).

The exceptionally high values for Mallards and Blue-winged Teal in 1974 were possibly due to sampling error in that year, when only 85 plots were surveyed (Table 1). Mallards occurred on 55 of those plots; a single plot yielded 20

Table 3
Population density of the five most common duck species during 4 years of the survey (baseline value for 1971 from Dennis 1974)

Species	Survey year 1971	1972	1974	1976	Mean slope	Significance (Wilcoxon test) p
Mallard	0.62	0.82	1.05	0.75	+0.041	0.001
Black Duck	0.27	0.25	0.23	0.20	−0.105	0.129
Green-winged Teal	0.14	0.11	0.10	0.06	−0.047	0.289
Blue-winged Teal	0.15	0.22	0.51	0.26	+0.103	0.001
Wood Duck	0.13	0.13	0.41	0.39	+0.103	0.001

Figure 1
Population trends of the five most common species of waterfowl in southern Ontario, 1971–76



indicated pairs, elimination of which would reduce the population density estimate to 0.88 pairs/km^2. Blue-winged Teal occurred on 27 plots in 1974 and field workers suspected that the migration was late, leading to slightly inflated population estimates due to the presence of migrant birds early in that survey. The rise in Wood Ducks between 1972 and 1974 appears accurate as the 1974 level was quite comparable to that in 1976.

4.2. Influence of habitat change

To aid in determining the reasons for any shifts in waterfowl population densities, observations of gross habitat changes were recorded during the field work. Habitat shifts were categorized according to whether they were likely to reduce or enhance waterfowl breeding capability. This classification was based on the amount of both standing water and shoreline modification. Improved capability usually occurred as a result of elevated water levels, new ponds, or increased cover along the water's edge. Factors reducing capability included lowered water levels, drainage of marshes and ponds, urbanization, cottage development along shorelines, and clear-cutting of forest near wetlands. Of the 278 plots for which waterfowl trend data were available, 67 showed some marked shift in capability during the 6-year study period; 25 were considered beneficial, 42 detrimental. Of the plots with improved habitat, 7 (28%) were due to man-induced factors, such as the digging of ponds, the remainder being due to natural causes, such as beaver activity. In deteriorating habitat, 33 plots (79%) were affected by human activity such as draining ditches, channelling streams, erecting buildings, and clear-cutting forests; natural factors, including reduced beaver activity and natural low water, had altered the remaining 9.

The effects on waterfowl were examined by comparing shifts in duck numbers with the perceived change in waterfowl breeding capability of the habitat. In Table 4 the mean slopes of change in duck densities are compared for enhanced and reduced habitat capability; plots in which a given species was not recorded during any of the surveys were excluded from the calculations as they were considered functionally incapable of supporting that duck. Results of the tests for individual species showed statistically significant responses to habitat change only by the Blue-winged Teal.

Table 4
Comparisons of mean slopes of waterfowl breeding density changes with respect to major habitat shifts on study plots

Species	Mean slope: Improving habitat	Mean slope: Deteriorating habitat	Wilcoxon value Z	Significance (Wilcoxon test) p
Mallard	0.090	0.032	0.282	0.389
Black	0.174	0.087	0.492	0.311
Blue-winged Teal	0.346	0.042	1.704	0.044
Green-winged Teal	0.067	0.013	0.712	0.238
Wood Duck	0.203	0.109	0.948	0.171
Pooled results	0.169	0.053	1.694	0.045

Numerically, the slopes for all the other species were also greater in improved habitat, the lack of statistical significance probably being more a reflection of inadequate sample size than of biological reality. A test of pooled results (all slopes for all species) indicated a significant response by overall duck numbers to habitat alterations. The fact that such a relationship can be demonstrated in the face of rising duck numbers suggests that the carrying capacity of southern Ontario is being approached and that habitat will soon become limiting for many duck species.

5. Discussion

Population trends of the major waterfowl species found in the present study largely agreed with those inferred by Collins (1974) from a less systematic investigation. Results for each species are discussed in the following sections with particular reference to Collins' work.

5.1. Mallard and Black Duck

Mallards continued to rise in numbers (Table 3) but at a much slower rate than the six-fold increase in 20 years (1951–71) implied by Collins' results. The form of the graph in Figure 1 suggests that the population peak for southern Ontario may have been approached, if not already reached. Collins attributed part of the earlier rise to captive-reared birds released to the wild by various state and private agencies around the Great Lakes; most of those release programs had been discontinued by 1971. Collins also considered as important the growth of wetland habitat due to increasing beaver activity. The considerable adaptability of the Mallard (Bellrose 1978) could facilitate successful range expansion.

Collins' observation of an approximately 50% decrease over 20 years in the numbers of Black Ducks implied an annual rate of decline sufficiently small to be missed in the present study; Figure 1 does show a smooth decrease though it was not statistically significant.

Collins considered that competition from Mallards was contributing to the Black Duck's decline, which seems plausible given the high rate of co-occurrence of the two species. In those parts in the present study for which trend data are available, Blacks and Mallards both occurred on 59 plots and occurred separately on 5 and 124 plots respectively; Mallard-only plots were concentrated in the heavily cultivated sections of southwestern Ontario. In the area of sympatry, there appears to be considerable similarity in niches. As the species are largely segregated on the wintering grounds, competition, if it occurs, would probably happen on the breeding territories and perhaps take the form of competitive exclusion from optimum nest sites and, possibly, food resources. We would therefore expect population trends on the plots where both species occurred to be negatively correlated. Instead these sets of values are positively correlated ($r_s = 0.280$, $p<0.05$) for the 59 plots and this suggests insignificant ecological interaction between Blacks and Mallards at the present population levels. There remains the possibility that, prior to the arrival of the Mallard, Black Ducks occupied habitat that became marginal when competitive interaction between the two species took place. At present, however, it appears that introgression of the Mallard and Black Duck has been causing the decline of the Black Duck, through swamping of its gene pool by that of the more abundant Mallard (Heusmann 1974; Dennis *et al.*, this publication).

5.2. Blue-winged Teal

Results of this study confirm the continuing rise in abundance of Blue-winged Teal observed by Collins (1974), the rate of increase (approximately 10% per annum) appearing to be greater than it was earlier (33% in 20 years). Cringan (1960) considered the rise to be a result of the clearing of forest for agriculture. As the Blue-winged Teal prefers open habitat such as ponds and streams in pastures, such land clearing would be beneficial, at least initially. Also, the maintenance of increasing amounts of standing water by beaver should prove advantageous to all waterfowl. The Blue-winged Teal appears to be the most opportunistic species as it was the only one for which we could demonstrate a significant response to habitat change.

5.3. Green-winged Teal

As with the Black Duck, Figure 1 illustrates a steady, though not statistically significant, downward tendency. Collins' results also suggested a decrease although the numbers he recorded were very small (six in 1951 and one in 1971). The Green-winged Teal population in North America had actually risen during the period from 1955 to 1974 (Bellrose 1978); the species is, however, at the edge of its range in southern Ontario (Godfrey 1966) and fluctuations in breeding density contradictory to those of the main population could well occur.

5.4. Wood Duck

The Wood Duck increased significantly during the study period. Collins' data also implied an increase between 1951 and 1971 which he explained as a response to management activities in the United States and to the increase in habitat caused by beaver activity in eastern Ontario. As Table 4 suggests that Wood Ducks are relatively sensitive to habitat change, not unexpected for an obligate cavity nester, we must assume that the species has been expanding into a still unoccupied niche and is insulated for the present time from declining habitat quality and quantity. Doubtless the decline in beaver activity projected by Novak (1972) will ultimately affect the Wood Duck.

6. Conclusions

Total duck numbers showed a rising trend in southern Ontario during the period 1971–76, due to increases in Mallards, Blue-winged Teal, and Wood Ducks, which were expanding into apparently unoccupied niches. Black Ducks and Green-winged Teal showed statistically insignificant declines, which may presage a more definable response in the coming years. Figure 1 suggests that numbers of all three species with expanding populations were tending to stabilize between 1974 and 1976. It is therefore possible that habitat saturation is being reached and the adverse influence of habitat degradation will soon be felt by those species.

The breeding pair census methodology has been proven an effective means of monitoring waterfowl populations in southern Ontario. Surveys will be undertaken regularly in the coming years and much more detailed habitat information will be collected to enable discrimination of habitat preferences of the various species and to develop predictive models of the birds' responses to declines in environmental quality. Particular emphasis will also be placed on resurveying of the low density stratum, which was only covered in 1971 and might show considerable gains given saturation of the high density stratum.

7. Literature cited

Bellrose, F.C. 1978. Ducks, geese and swans of North America. 2nd ed. (rev.) Stackpole Books, Harrisburg, PA. 543 pp.

Collins, J.M. 1974. The relative abundance of ducks breeding in southern Ontario in 1951 and 1971. Pages 32–44 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–1973. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Cooper, D.W. 1968. The significance level in multiple tests made simultaneously. Heredity 23:614–617.

Cringan, A.T. 1960. Some changes in the status of the Mallard in southern Ontario. Midwest Fish and Wildl. Conf. 9 pp.

Dean, W.G. 1969. Economic atlas of Ontario. 1st ed. Univ. Toronto Press. 113 sections.

Dennis, D.G. 1974. Breeding pair surveys of waterfowl in southern Ontario. Pages 45–52 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–1973. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; Fischer, K.L.; McCullough, G.B. The change in status of Mallards and Black Ducks in southwestern Ontario. This publication.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Pages 178–230 *in* Saskatoon wetland seminar. Can. Wildl. Serv. Rep. Ser. No. 6. 262 pp.

Godfrey, W.E. 1966. The birds of Canada. Natl. Mus. Can. Bull. 203. 428 pp.

Hollander, M.; Wolfe, D.A. 1973. Nonparametric statistical methods. John Wiley & Sons, New York. 503 pp.

Heusmann, H.W. 1974. Relationships between Black Ducks and Mallards in the Northeast. Wildl. Soc. Bull 2(4):171–176.

Novak, M. 1972. The beaver in Ontario. Ont. Min. Nat. Res. Unpubl. rep. 20 pp.

Seigel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company, New York. 312 pp.

Stirrett, G.M. 1954. Waterfowl breeding ground survey in southern Ontario, 1954. Can. Wildl. Serv. Completion Rep. No. 396.

Appendix 1
Inter-year comparisons of pooled survey results to examine the effects of variations in phenology and survey hour, showing numbers of indicated pairs

Relative phenologies compared	Survey times compared	Years compared 1971–2	1972–4	1974–6	1971–4	1972–6	1971–6
Mallard							
Same	Morning/noon	7–4	2–3	2–3	1–2	9–8	4–3
	Noon/morning	4–5	3–2	1–0	5–3	15–3	3–2
	Same	34–30	11–8	11–4	10–11	38–32	35–21
Advanced	Morning/noon	1–2	2–0				
	Noon/morning	1–0	0–1		0–1		
	Same	4–1	2–4		0–1		
Retarded	Morning/noon	3–0		1–1	2–0	4–3	3–2
	Noon/morning	2–2		0–4	1–0	5–0	10–2
	Same	4–8	2–1	6–7	4–1	13–10	22–14
Black Duck							
Same	Morning/noon	4–4	3–1	0–3		2–4	1–2
	Noon/morning	2–2	1–1	2–0	1–0	4–3	2–5
	Same	15–12	5–3	3–4	6–3	11–11	11–14
Advanced	Morning/noon		1–0		1–0		
	Noon/morning		2–0				
	Same				1–2	0–2	
Retarded	Morning/noon						
	Noon/morning	1–2		0–1			1–0
	Same	1–4					2–0
Green-winged Teal							
Same	Morning/noon	2–1	1–2	0–1	0–1	3–2	1–0
	Noon/morning	3–2	1–1		1–0	1–3	2–1
	Same	8–8	2–3	2–4	4–3	5–5	4–10
Advanced	Morning/noon						
	Noon/morning						
	Same						
Retarded	Morning/noon						
	Noon/morning						
	Same	1–1					
Blue-winged Teal							
Same	Morning/noon	1–3	1–0	4–3	1–1	4–3	4–1
	Noon/morning	4–2	2–1	1–2	3–0	10–1	8–2
	Same	16–8	9–4	4–7	11–3	18–17	17–11
Advanced	Morning/noon						0–1
	Noon/morning			1–0			1–1
	Same			1–1			3–1
Retarded	Morning/noon	0–1					1–2
	Noon/morning	2–1					3–0
	Same	4–4					1–0

Appendix 1, cont'd

Relative phenologies compared	Survey times compared	Years compared 1971–2	1972–4	1974–6	1971–4	1972–6	1971–6
Wood Duck							
Same	Morning/noon	2–1	4–0	1–2		4–0	3–2
	Noon/morning	0–1	2–2	3–0	3–0	9–1	10–0
	Same	6–6	8–2	8–8	11–3	17–7	20–9
Advanced	Morning/noon					3–0	
	Noon/morning					0–1	
	Same					2–4	
Retarded	Morning/noon	1–0		0–1			1–0
	Noon/morning						
	Same	2–1		1–0		1–0	1–0

The change in status of Mallards and Black Ducks in southwestern Ontario

by D.G. Dennis, K.L. Fischer, and G.B. McCullough

1. Abstract

Waterfowl hunting club data for southern Ontario for the period 1941 to 1973 were analysed to document the timing and the relative rates of change in the populations of Mallards and Black Ducks. In 1941, the proportion of Mallards killed per Black Duck was 0.5 or less throughout the hunting season; in 1973, in excess of four Mallards per Black Duck were taken early in the season and between two and three in the mid and late season. Annual variation may be a result of relative production of each species but long term trends may be related to increased areas of corn, harvesting techniques, and the establishment of field feeding traditions by the two species. Field feeding increases Mallard and Black Duck contacts during the time of pair formation and has resulted in hybridization of the two species and the subsequent loss of some Black Duck populations.

2. Introduction

Considerable evidence suggests that Black Ducks (*Anas rubripes*) have declined in southern Canada since the 1930s (Munro 1968) and Cringan (1960) has described an increase in Mallards (*A. platyrhynchos*) in southern Ontario. Surveys conducted in 1971 by Collins (1974) showed a 50% decrease in Black Duck numbers and a 600% increase in Mallards from 1951 to 1971.

Few data are available from the 1940s and early 1950s concerning the rates of change in the populations of the two species. In many instances, however, waterfowl hunting-club records contain information about the numbers and species of birds bagged in years for which scientific data are unavailable and so can provide an indication of relative abundance. This paper describes an analysis of records from the Long Point and Lake St. Clair areas in southern Ontario to obtain measurements of the timing and relative rates of population change of Mallards and Black Ducks. Possible causes for the changes are suggested.

3. Methods

Most hunting clubs have a caretaker who is competent to identify waterfowl and a few clubs have kept precise and accurate bag records for years. Data covering the period from 1941 to 1973 were assembled from five different hunting clubs in marsh areas near Long Point and Lake St. Clair (Fig. 1).

The ratios of Mallards to Black Ducks in the bag were plotted for all clubs for three periods in each autumn from 1941 to 1973. The three periods comprise a) the opening of hunting season until 20 October, i.e. the period immediately prior to the main movement of immigrants of both species into the marshes; b) 21 October – 15 November, the period that encompasses the greatest concentration of migrant ducks; and c) 16 November to the end of the hunting season (normally about mid-December) or the period when the majority of the migrant birds leave. The time periods were established based on aerial survey data gathered while evaluating waterfowl use of habitat along the Lake Erie and Lake St. Clair shorelines since 1968 (Dennis and Chandler 1974).

4. Results

Figure 2 shows the ratio of Mallards to Black Ducks for the three periods. The total number of waterfowl represented by the graphs in Figure 2 include 26 016 Mallards and 30 146 Black Ducks, distributed in a fairly uniform manner throughout the 33 years. The percentages of ducks in each of the three parts of the hunting season are a) 16.7%, b) 40.0%, and c) 42.4%. The proportion of days hunted during each part are a) 18.6%, b) 41.3%, and c) 40.1%. The resemblance between the percentages of birds bagged and of hunting effort suggests that the size of the kill is generally related to hunting effort rather than to bird abundance.

In a study of private marshes of over 101 ha in southwestern Ontario, Bryant (1965) found an annual hunting intensity of 22 hunter days per 100 ha, and a hunter success of over four birds per hunter day when the daily bag was five. At such low hunting intensity and high success there is a close relationship between kill and effort expended, thus hunting results may provide a reasonably accurate sample of sought-after waterfowl such as Mallards and Black Ducks.

Figure 2 shows a gradual increase in the ratio of Mallards to Black Ducks in each period of the season throughout the entire 33 years. The rate of increase in the ratio during the late 1950s and 1960s was greatest in the early part of the season "A", when a greater proportion of the waterfowl present are probably those reared locally. However, a gradual increase in the proportion of Mallards is also evident in periods "B" and "C".

5. Discussion

The Canadian Wildlife Service (CWS) began conducting waterfowl wing surveys and analysing the data by zone in 1968. Figure 3 shows the Mallard proportion in the kill for period "A" from 1968 to 1973, as well as the ratio of the age ratios of Mallards and Black Ducks from the Lake Erie and Lake St. Clair zone. The age ratio changes each year in the same direction as the species ratio. Therefore it is probable

Figure 1
Hunt club locations in southern Ontario

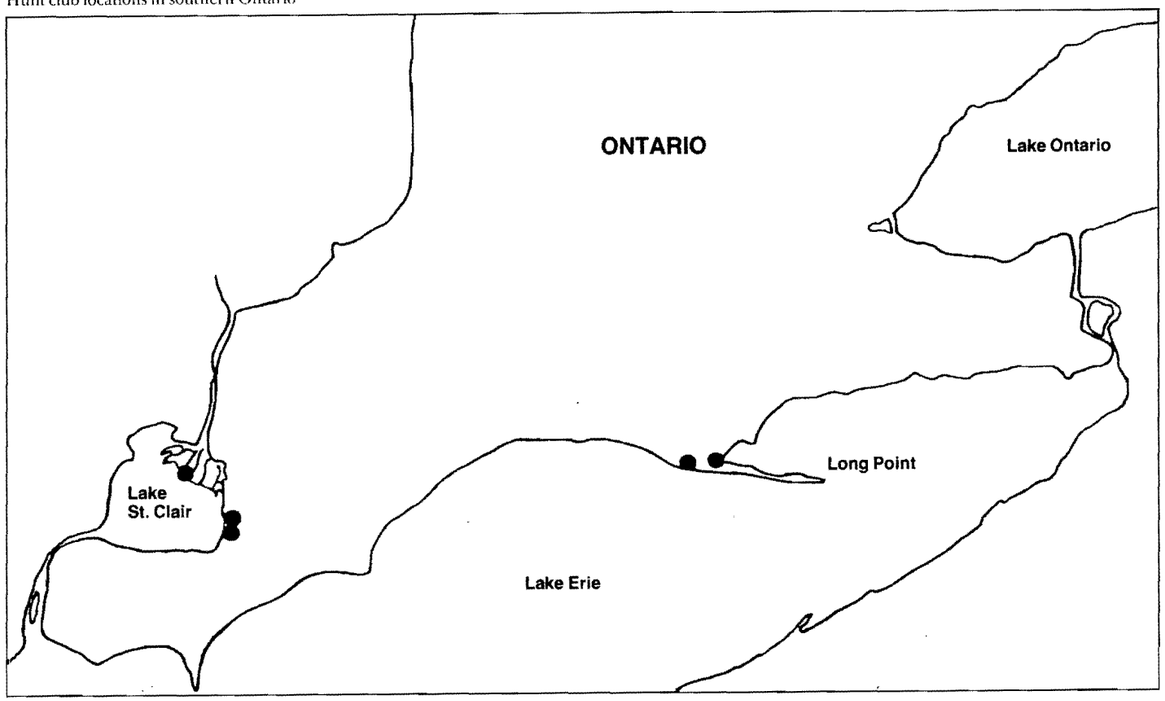


Figure 2
The ratio of Mallard to Black Ducks for three periods during the hunting season

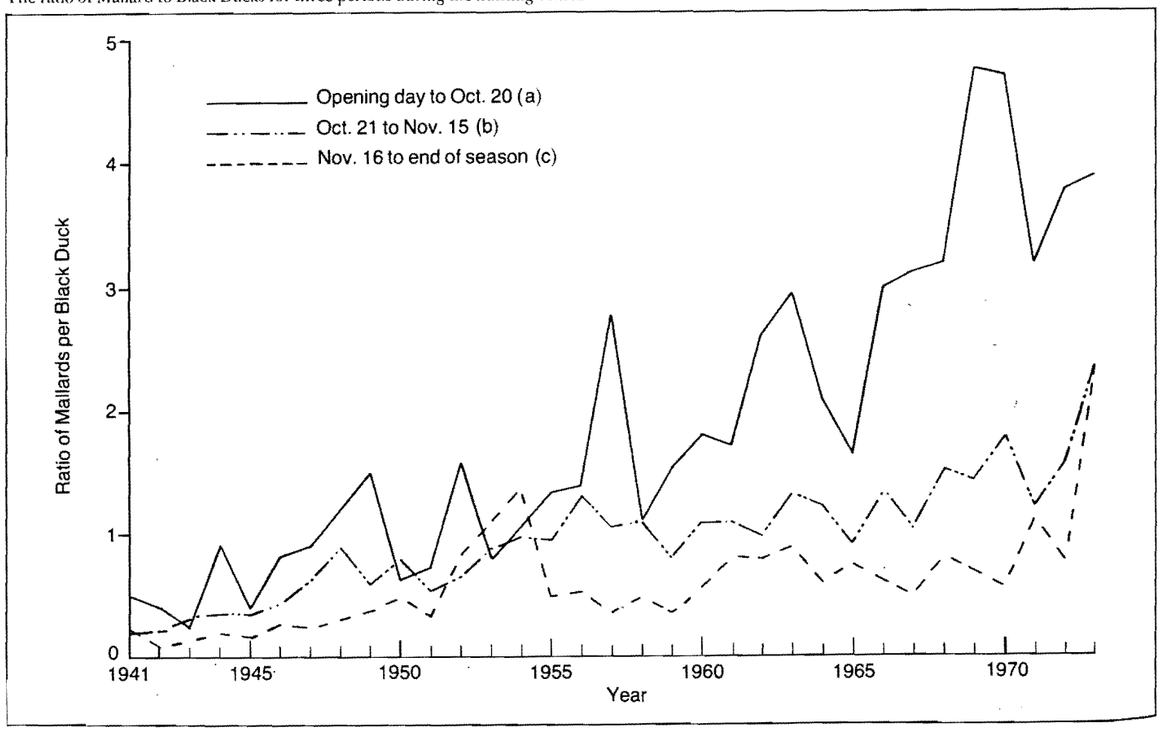
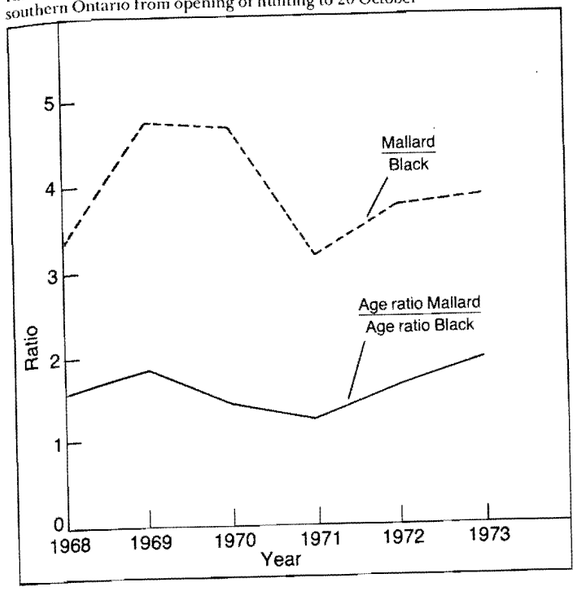


Figure 3
Ratios of Mallard to Black Ducks and their age ratios for ducks bagged in southern Ontario from opening of hunting to 20 October



that much of the year-to-year variation in the ratios in Figure 2 depends on the relative annual production of each species. Factors that influence migration, such as major weather patterns, also affect the year-to-year variation in the two species as they occur in the bag.

Reasons for the longer term numerical change in Mallards and Black Ducks have been suggested by several authors. Martinson *et al.* (1968) considered that hunting mortality had controlled population levels in Black Ducks in recent years. Cringan (1960) suggested that changes in habitat in southern Ontario from a forested to an agricultural landscape might favour prairie ducks such as the Mallard. He also indicated that artificial stocking of Mallards, especially in adjacent states, was partially responsible for their increase. Collins (1974) suggested that increased numbers of beaver ponds in the 1950s were partially responsible for the spread of Mallards into the interior of the province. Heusmann (1974) suggests that habitat changes, artificial stocking, and hybridization are all responsible for the changes in the ratio of the two species in Massachusetts. He mentions the absence of insect vectors for disease in park situations where Mallards have become common breeders as an additional factor favouring the Mallard in urban environments. Johnsgard (1959) records that C.E. Goodwin observed a resident population of Mallards and Black Ducks in the Toronto area and noted that Black and Mallard Ducks hybridized freely after the introduction of both species in 1931. Mallards increased rapidly in proportion to Black Ducks. Goodwin postulated that a selection against Black Ducks might be operating through a tendency toward random mating of female Black Ducks with Mallard drakes.

We believe that the changes illustrated in Figure 2 are closely tied to changes in agriculture in southwestern Ontario that resulted in additional waste grain left in fields. Increases in the amount of feeding in fields by Mallards and Black Ducks occurred because of the changes.

Field feeding has happened for many years throughout North America where concentrations of ducks occur in conjunction with available grain, either as waste or unharvested crop. Bossenmaier and Marshall (1958) mentioned that the White-water Lake area of Manitoba has long had problems with waterfowl damage to grain crops, problems that increased during the 1920s when more vulnerable grain types were planted and again in the 1940s when windrow-combine harvest became common. Day (1944) indicated that waterfowl damage to corn occurred in the western United States in the 1940s and that crop damage had occurred ever since rice and other grain crops had been planted directly in the flyways.

In the mid-1950s, prairie waterfowl populations were high (Stoudt 1971), having recovered from the dry years of the 1930s. During the mid-1950s changes were also occurring in the production of grain corn in the vicinity of Long Point and Lake St. Clair. According to data from N. Roller (pers. comm.) of the Ontario Ministry of Agriculture and Food in Toronto, 38 795 ha of grain corn were grown in 1946 in the two counties containing marshland adjacent to Long Point and Lake St. Clair. The area had increased to 65 524 ha by 1956, and to 113 548 ha by 1971. The changes in harvesting techniques during the last 40 years are of greater importance to waterfowl than the increased area. Dr. G. Jones (pers. comm.), head of research at Stewart's Seeds, Ailsa Craig, Ontario stated that corn was picked by hand until the early 1940s with very little waste. From the mid-1940s until the 1950s mechanical corn pickers were the common harvesting tool. Although these were not as efficient as human pickers, the waste grain was still limited. In the 1950s picker-shellers or combines became common and, in some instances, waste amounted to 10% of the crop. Based on personal observations a significant proportion remains in most fields.

We believe that the greater amount of available waste corn kept Mallards and Black Ducks in the north for a longer period during autumn than in earlier years. Banding data suggest the proportion of Mallards migrating through southern Ontario during autumn that are of prairie origin may approach 30% at the west end of Lake Erie. Numbers of prairie Mallard diminish rapidly towards the east and form less than 5% of the Mallards at the east end of the lake. The high prairie Mallard populations of the mid-1950s resulted in the potential for more Mallards to stop in southwestern Ontario.

The additional contacts between Black Ducks and Mallards caused by increased field feeding and greater numbers of Mallards may have broken down some of the species-isolating mechanisms that had operated previously. Lack (1971) suggests that the three main ways in which species are segregated from each other are by range, habitat, and feeding. All three isolating mechanisms are at least partially broken down by the establishment of a field-feeding tradition by Black Ducks and Mallards in the same area. Habitat is modified in that both species are not required to obtain much sustenance from marshlands and are thus able to occupy rather barren ponds between field-feeding flights. Feeding is modified from so-called pristine times because both species are now feeding on grain. When ducks are able to feed in fields it is not necessary for each species to depend on exploiting separate food niches in various marsh habitats.

We suggest that increased Mallard/Black Duck hybridization occurred and subsequent genetic swamping of southern Ontario Blacks by Mallards resulted because of the greater contact during field feeding. Phillips (1915) found that, unlike most Mallard hybrids, Mallard/Black offspring and subsequent hybrid backcrosses were completely fertile. Wright (1954) suggests that pairing in Black Ducks may

begin as early as August. Hochbaum (1944) indicated that some Mallards begin courtship in late October in Manitoba. In a study of a town flock of Mallards in the Netherlands, Lebret (1961) found that approximately 75% of the females were paired by November. Considerable pairing must occur during the period when waterfowl feed in corn fields in southern Ontario. The fact that corn retains birds into early winter and increases their potential to overwinter has resulted in greater Mallard/Black Duck contact, at least in southern Ontario, during the time of pair bond formation.

The tendency of waterfowl to utilize waste corn also enhanced their survival in southern Ontario. In the 1940s ducks were subjected to very light hunting pressure in corn fields. Based on personal observations, it is only since the 1960s that hunting pressure has become significant in corn fields in southern Ontario. Although both species will field-feed extensively, we have observed that a greater portion of Mallards feed on agricultural grains. Field-feeding behaviour has thus somewhat reduced the effect of hunting on Mallards. Black Ducks have a greater tendency to feed on invertebrates and marsh vegetation. Baited sanctuaries, which have become relatively common in southern Ontario since the 1940s, have the same potential effect on pair formation and subsequent hybridization as field feeding.

The graphs in Figure 2 suggest that in the long term the ratio of Mallards to Black Ducks will continue to increase, especially in early autumn. How improved methods of corn harvesting affect the late season contact and subsequent hybridization between the two species remains to be seen. Perhaps certain areas of northern Ontario may retain viable populations of Black Ducks because those birds retain a more traditional feeding behaviour until migration as a result of the absence of agricultural grain. Northern Black Ducks may also tend to overfly areas where field feeding occurs during migration. In addition, a greater portion of the northern Black Ducks may be paired by the time they migrate through southern Ontario. Aerial surveys (Dennis, McCullough, North, and Ross, this publication) show that autumn ratios of Mallards per Black Duck during the 1970s range from more than three in Lake St. Clair vicinity to approximately one in southeastern Ontario. It is likely that the local breeding proportions of southern Ontario Black Ducks will continue to decline and that the decline will be most rapid in southwestern Ontario.

6. Literature cited

Bossemnaier, E.F.; Marshall, W.H. 1958. Field-feeding by waterfowl in southeastern Manitoba. Wildl. Soc., Wildl. Monogr. 1. 32 pp.

Bryant, J.E. 1965. Private marshes in southwestern Ontario. Can. Wildl. Serv. Prog. Rep. 65 pp.

Collins, J.M. 1974. The relative abundance of ducks breeding in southern Ontario in 1951 and 1971. Pages 32–44 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Cringan, A.T. 1960. Some changes in the status of the Mallard in southern Ontario. Midwest Fish and Wildl. Conf. 9 pp.

Day, A.M. 1944. Control of waterfowl depredations. Trans. N. Am. Wildl. and Nat. Res. Conf. 9:281–7.

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; McCullough, G.B.; North, N.R.; Ross, R.K. An updated assessment of migrant waterfowl use of the Ontario shorelines of the southern Great Lakes. This publication.

Heusmann, H.W. 1974. Relationships between Black Ducks and Mallards in the Northeast. Wildl. Soc. Bull. 2(4):171–176.

Hochbaum, H.A. 1944. The Canvasback on a prairie marsh. Am. Wildl. Inst., Washington, DC. 201 pp.

Johnsgard, P.A. 1959. Evolutionary relationships among the North American Mallards. Ph.D. thesis, Cornell Univ. 159 pp.

Lack, D. 1971. Ecological isolation in birds. Harvard Univ. Press, Cambridge, MA. 404 pp.

Lebret, T. 1961. The pair formation in the annual cycle of the Mallard, *Anas platyrhynchos* L. Ardea 49:95–158.

Martinson, R.K.; Geis, A.D.; Smith, R.I. 1968. Black Duck harvest and population dynamics in eastern Canada and the Atlantic Flyway. Pages 21–56 *in* Barske, P. ed. Black Duck evaluation, management and research; a symposium. Wildl. Manage. Inst. 193 pp.

Munro, W.T. 1968. Canadian situation. Pages 6–10 *in* Barske, P. ed. Black Duck evaluation, management and research; a symposium. Wildl. Manage. Inst. 193 pp.

Phillips, J.C. 1915. Experimental studies of hybridization among ducks and pheasants. J. Exp. Zool. 18(1):69–144.

Stoudt, J.H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. US Bureau Sport Fish and Wildl., Resour. publ. 99. 58 pp.

Wright, B.S. 1954. High tide and an east wind. Stackpole Co., Harrisburg, PA. and Wildl. Manage. Inst., Washington, DC. 162 pp.

Part III

Waterfowl use of moulting, staging, and wintering areas

Overwintering of waterfowl adjacent to the Nanticoke Generating Station, Lake Erie, Ontario, 1978 and 1979

by G.B. McCullough

1. Abstract

During the winters of 1978 and 1979 the Canadian Wildlife Service documented the waterfowl use of the recently created ice hole adjacent to the Ontario Hydro Nanticoke Generating Station, Lake Erie. Aerial surveys were conducted over the ice hole, and ground observations made at the intake and discharge channels. Eighteen species of waterfowl and three species of gulls were observed. The numbers of waterfowl utilizing the Nanticoke ice hole were estimated at 2000+ in 1978 and 3000+ in 1979. The development of an overwintering tradition for waterfowl in the industrial environment of the Nanticoke ice hole could lead to ecological problems such as the outbreak of epizootic diseases, reduced breeding potential, or the death of birds from oil spills and starvation.

2. Introduction

Warm-water effluent discharges creating open water can affect the over-wintering of waterfowl. Pounder (1976) discussed the use of effluent discharges in Scottish coastal waters by wintering waterfowl, and Reed (1971) described the overwintering of 6000 to 8000 Mallards (*Anas platyrhynchos*) and Black Ducks (*Anas rubripes*) in western Lake Erie adjacent to a power plant thermal discharge. Goodwin *et al.* (1977) described wintering waterfowl along the Toronto waterfront associated with, among other things, three electrical generating plants. In sections of the Detroit, St. Clair, and Niagara rivers open water created by turbulence and swift currents attracts thousands of overwintering waterfowl (CWS unpubl. data, pers. obs.).

The Ontario Hydro Nanticoke Thermal Generating Station began partial operation in 1972 and reached full power in 1981. During most recent winters Lake Erie has completely frozen over except for the ice hole created by the thermal discharge of the Nanticoke Generating Station. Waterfowl overwintering at northern latitudes under crowded, stressful conditions in industrialized or urbanized environments are vulnerable to spills of chemicals and a variety of diseases. Hunt (1953, 1961) and Hunt and Cowan (1963) documented the mortality of thousands of overwintering waterfowl on the Detroit River. Local incidents involving smaller numbers of waterfowl have occurred at Simcoe, Ontario and along the Toronto waterfront.

The increase in overwintering waterfowl in southern Ontario and the potential for associated waterfowl dieoffs prompted the Canadian Wildlife Service (CWS) to document the use by waterfowl of the recently created ice hole adjacent to the Nanticoke Generating Station during the winters of 1978 and 1979.

3. Study areas and methods

The study area was located on the north shore of Lake Erie, Ontario, about 25 km eastward along the shoreline from Long Point (Fig. 1). The Ontario Hydro Generating Station is part of the Nanticoke Industrial Development, which includes a Steel Company of Canada Ltd. (Stelco) plant, a Texaco Canada Inc. refinery, and an associated industrial park.

As described by Hamley and MacLean (1979), the effluent plume, being warmer than the lake water, usually floats and is much larger on the surface than on the bottom; surface water temperatures recorded in late September 1977 were 2°C higher than bottom temperatures in 5.5 m of water. During the winters since 1972 this temperature differential has created an ice hole in Lake Erie adjacent to the Generating Station, hereafter referred to as the Nanticoke ice hole. Since 1972, the size of the ice hole has increased as hydro production has increased. The extent of the ice hole during cold weather is illustrated in Figure 2, taken in March 1978.

Aerial surveys were conducted over the Nanticoke ice hole during the winters of 1978 and 1979 using a Cessna 172. Two observers visually estimated the number and species composition of waterfowl and the number of gulls. Five surveys were conducted in 1978 and two in 1979 (Table 1). The aerial surveys did not include the intake forebays and discharge channel because of unsafe flying conditions close to the Generating Station smoke stacks. Ground observations were conducted on 8 and 24 February and 10 March 1978 to record the numbers of waterfowl and gulls utilizing the Hydro forebays and warm-water discharge channel. During the winter of 1979 Ontario Hydro, with assistance from CWS, conducted a regular census of the waterfowl utilizing the forebay and discharge channel of the Nanticoke Generating Station (Wiancko 1979).

4. Results and discussion

4.1. Aerial surveys of the ice hole

Table 1 presents a summary of the aerial observations of waterfowl in the Nanticoke ice hole made during the winters of 1978 and 1979. The 1978 aerial survey results for 18 January document total waterfowl numbers present in a strip of open water 400 m wide, approximately 300 m offshore, along the shore from Turkey Point to Port Maitland. The Nanticoke ice hole had not yet formed. The

Figure 1
Study area at the Ontario Hydro Nanticoke Generating Station on the north shore of Lake Erie, Ontario

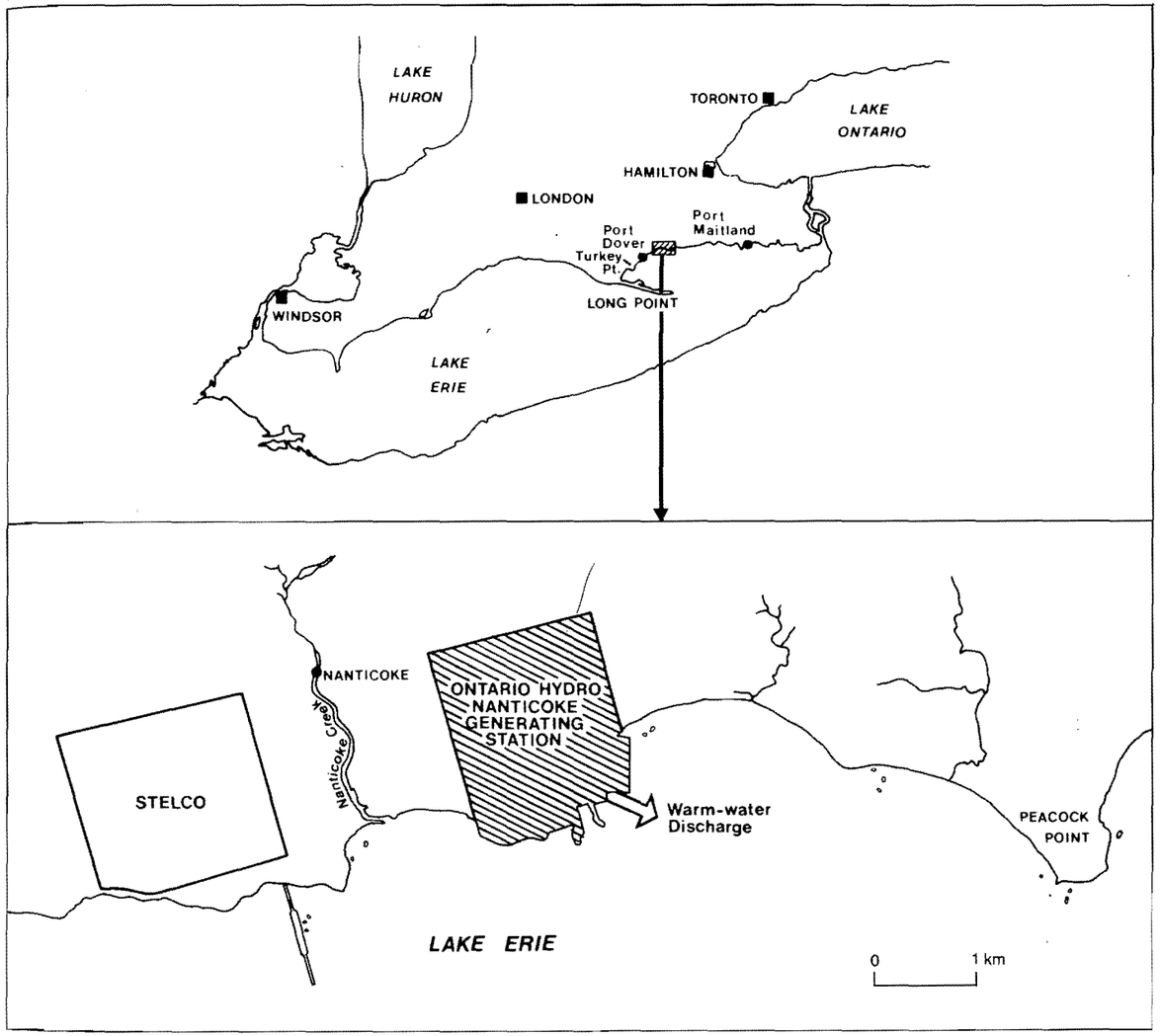


Table 1
Numbers of waterfowl and gulls observed during aerial surveys of the Nanticoke ice hole, winter 1978 and 1979

1978	Scaup	Mergansers	Goldeneye	Bufflehead	Blacks & Mallards	Pintail	Unid.	Total waterfowl	Gulls
January 18*	838	563	50	11	11	0	167	1640	1
	(855)	(2527)	(113)	(11)	(18)		(272)	(3797)	(506)
February 6	243	1022	0	0	73	0	–	1338	185
February 22	15	802	11	0	10	0	1	839	69
March 8	4	1300	37	0	10	0	212	1563	74
March 20	1571	1213	872	55	251	55	1098	5115	973

1979	Scaup	Mergansers	Goldeneye	Bufflehead	Blacks & Mallards	Unid.	Total waterfowl	Gulls
January 18†	492	598	26	0	0	418	1534	21
	(492)	(1425)	(27)	0	0	(418)	(2362)	(178)
February 22†	1524	1602	105	55	9	325	3620	77
	(1564)	(1775)	(106)	(180)	(9)	(328)	(3963)	(256)

*A 400-m wide strip of open water was present 300 m from the shore from Turkey Point to Port Maitland. The waterfowl numbers observed are for the whole survey area. The numbers in parentheses include birds in the leads and small ice holes, as well as birds in the large Nanticoke ice hole.

†On both survey days numerous small ice holes and leads were present from Port Dover to Peacock Point. The numbers in parentheses include birds in the leads and small ice holes, as well as birds in the large Nanticoke ice hole.

results of the 20 March 1978 survey undoubtedly include many early spring migrants. Spring breakup was late and early arrivals would concentrate in the only available open water, the Nanticoke ice hole. Peak spring waterfowl migration along the Great Lakes shorelines usually occurs around 1 April, with many birds moving through the area during the fourth week of March (Dennis and Chandler 1974).

Because of the lateness of freeze-up and an early spring thaw, only two aerial surveys were conducted in 1979. On both survey days numerous small ice holes and leads were present from Port Dover to Peacock Point. The waterfowl numbers recorded in Table 1 show that some birds were present in the small ice holes as well as the Nanticoke ice hole. On 19 January 1979, 65% of the waterfowl observed were in the Nanticoke ice hole. On 22 February 1979, 91% were in the ice hole.

Changing weather conditions and variations in hydro operations caused fluctuations in the size and shape of the ice hole during the winters of 1978 and 1979. During the coldest periods of these winters, the ice holes were restricted to an area of about 500 ha.

Fluctuation in the numbers of waterfowl observed in the ice hole (Table 1) can be partially explained by the movement of birds to and from the open waters of the Niagara and Detroit Rivers. A few thousand waterfowl overwinter in the open water at both those locations. The amount of movement between areas is unknown.

4.2. Ground observations

On 8 February 1978, 876 ducks, predominantly Common Mergansers (*Mergus merganser*) and Red-breasted Mergansers (*M. serrator*) (26 and 66% respectively), were observed in the Generating Station's intake forebays and warm-water discharge channel. On 10 January 1979 a peak of 300 waterfowl was observed in the forebays and discharge channel. Greatest use of the intake forebays and discharge channel occurred during the coldest periods of the winter, from mid-January to mid-February when daily mean temperatures ranged from –4°C to –20°C. Also, if schools of smelt (*Osmerus mordax*) are drawn into the intake forebays, as happened on 8 February 1978, large concentrations of waterfowl can occur.

Wiancko (1979) noted that approximately 70% of all birds observed during the winter of 1979 favoured the warm discharge waters over the intake forebays, and that peaks in abundance correlated to lake freeze-up and low air temperature. When air temperatures dropped to –14°C use of the intake forebays by waterfowl increased, probably because of increased mist formation over the discharge channel surface.

Mergansers, both Common and Red-breasted, and Greater Scaup (*Aythya marila*) were the most common ducks observed during aerial surveys in the winters of 1977/78 (54 and 21% respectively) and 1978 79 (43 and 39% respectively). Appendix 1 lists all 21 species of waterfowl and gulls that were observed utilizing the ice hole, the forebays, and discharge channel.

Palmer (1976) states that many species of waterfowl, most notably Common Mergansers and Greater Scaup, will overwinter at the northern limit of open water if they are able to obtain sufficient food. Timken and Anderson (1969) observed thousands of Common Mergansers during winter on the Upper Missouri River. The mergansers, as well as Mallards and Common Goldeneyes (*Bucephala clangula*) concentrated in the open water downstream from the large hydro dams, and fed upon gizzard shad that passed through the turbines. Hamley and MacLean (1979) have described the drawing of larval and young juvenile fish into the forebays with the cooling water for the Nanticoke Generating Station, and estimated that 95–99% of these fish were smelt. Some of them are trapped in the intake forebays, but most are killed passing through the pumps with the cooling water and are flushed out with the warm discharge water. Other fish are attracted by the warm water in the discharge channel. Common and Red-breasted mergansers, and lesser numbers of Mallards, Goldeneye, Bufflehead (*Bucephala albeola*), Greater Scaup, Redheads (*Aythya americana*), and gulls, utilize the forebays and discharge channel as feeding and loafing areas (Fig. 3).

Some scaup were seen feeding in the outlet of the discharge channel but most scaup observed during the winters of 1978 and 1979 tended to keep to the open water or to the edge of the Nanticoke ice hole farthest from the Generating Station. McCullough (1981) indicated that scaup in the vicinity of Nanticoke feed almost entirely on gastropods (100% occurrence) during autumn migrations. No birds were collected in this study to determine their winter diet, but it could be assumed that the scaup utilize available gastropods, supplemented by some fish.

5. Conclusion

Based on two winters' observations, it appears that a tradition of waterfowl overwintering in the Nanticoke ice hole is developing. The number of waterfowl utilizing the Nanticoke ice hole was approximately 2000+ in 1978 and 3000+ in 1979. Depending on weather conditions, the population of different species, hydro production, and food availability, the number of waterfowl utilizing the Nanticoke ice hole during future winters is likely to increase. Such an increase in a small restricted area could lead to ecological problems. Overcrowded conditions involving environmentally stressed waterfowl could contribute to an outbreak of epizootic diseases such as duck viral enteritis. In the industrial environment characterizing Nanticoke, a chemical or oil spill could kill thousands of waterfowl. Hunt (1953, 1961) and Hunt and Cowan (1963) have described the mortality of thousands of wintering waterfowl on the Detroit River due to diseases (aspergillosis, coccidiosis), oil pollution,

Figure 2
The Nanticoke ice hole (east to west), Lake Erie, Ontario, with Peacock Point in the foreground, 8 March 1978

Figure 3
Waterfowl and gulls in the intake forebay of the Ontario Hydro Nanticoke Generating Station, Lake Erie, Ontario, February 1978

and starvation caused by food beds freezing over. Winter is often the most stressful period for waterfowl. Prince (1979) noted that for overwintering Mallards, as temperature decreased and the daily expenditure of energy increased, a point was reached where the possibility of mortality increased as well as the potential to reduce reproductive success the following spring.

Another potential problem could result if the Hydro Generating Station were shut down during a period of extreme cold weather. During shutdown the discharge of warm water would cease, the distribution of forage fish would change, and the ice hole would shrink in size. As a result, the waterfowl utilizing the Nanticoke ice hole might not be able to reach another open water area containing adequate food resources.

This is the first study of overwintering waterfowl conducted by CWS in southern Ontario. In future, this monitoring program will be expanded to include other areas.

6. Acknowledgements

The author is most appreciative of the field assistance provided by N.R. North of CWS, and for the co-operation of Ontario Hydro, particularly M. Northfield of the Nanticoke Generating Station.

7. Literature cited

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Goodwin, C.E.; Freedman, W.; McKay, S.M. 1977. Population trends in waterfowl wintering in the Toronto regions, 1929–76. Ont. Field Biol. 31(2):1–28.

Hamley, John M.; MacLean, Neil G. 1979. Impacts of Nanticoke Industrial Development *in* the Lake Erie peninsulas: management issues and directions. Contact 11(1):81–115.

Hunt, G.S. 1953. Industrial pollution and Michigan waterfowl. Trans. N. Am. Wildl. Conf. 18:360–368.

Hunt, G.S. 1961. Waterfowl losses on the Detroit River due to oil pollution. Great Lakes Res. Div. Inst. Sci. Technol., Univ. Mich. publ. 7:10–26.

Hunt, G.S.; Cowan, A.B. 1963. Causes of deaths of waterfowl on the lower Detroit River — winter 1960. Trans. N.A. Wildl. Conf. 28:150–163.

McCullough, G.B. 1981. Migrant waterfowl utilization of the Lake Erie shore, Ontario, in the vicinity of the Nanticoke Industrial Development. J. Great Lakes Res. 7(2):117–122.

Palmer, R.S. ed. 1976. Handbook of North American Birds. Vols. 2 and 3. Yale Univ. Press, New Haven and London.

Pounder, B. 1976. Waterfowl at effluent discharges in Scottish coastal waters. Scot. Birds 9:5–36.

Prince, H.H. 1979. Bioenergetics of postbreeding dabbling ducks. Pages 103–117 *in* Bookhout, T.A. ed. Waterfowl and Wetlands — an integrated review. Proc. symp. 39th Midwest Fish and Wildl. Conf., 5 Dec. 1977, Madison, WI.

Reed, L.W. 1971. An ecological evaluation of a thermal discharge. Part VI: Use of western Lake Erie by migratory and wintering waterfowl. Inst. Water Res., Michigan State Univ. Tech. Rep. No. 18 Thermal Discharge Ser.

Timken, R.L.; Anderson, B.W. 1969. Food habits of Common Mergansers in the north central United States. J. Wildl. Manage. 33(1):87–91.

Wiancko, P.M. 1979. Overwintering of waterfowl at Nanticoke TGS 1978–1979. Ontario Hydro draft report CTS-07017-2.

Appendix 1
Species of birds observed utilizing the Nanticoke ice hole, and the intake forebays and warm-water discharge channel of the Ontario Hydro Nanticoke Thermal Generating Station during the winters of 1977–78 and 1978–79

Mute Swan (*Cygnus olor*)
Tundra Swan (*Olor columbianus*)
Canada Goose (*Branta canadensis*)
Mallard (*Anas platyrhynchos*)
Black Duck (*A. rubripes*)
Gadwall (*A. strepera*)
Pintail (*A. acuta*)
Redhead (*Aythya americana*)
Canvasback (*A. valisineria*)
Greater Scaup (*A. marila*)
Lesser Scaup (*A. affinis*)
Common Goldeneye (*Bucephala clangula*)
Bufflehead (*B. albeola*)
Oldsquaw (*Clangula hyemalis*)
White-winged Scoter (*Melanitta deglandi*)
Common Merganser (*Mergus merganser*)
Red-breasted Merganser (*M. serrator*)
American Coot (*Fulica americana*)
Greater Black-backed Gull (*Larus marinus*)
Herring Gull (*L. argentatus*)
Ring-billed Gull (*L. delawarensis*)

An updated assessment of migrant waterfowl use of the Ontario shorelines of the southern Great Lakes

by D.G. Dennis, G.B. McCullough, N.R. North, and R.K. Ross

1. Abstract

Information from aerial surveys made between 1974 and 1981 to assess waterfowl staging areas along the southern Great Lakes is presented here as revisions and additions to earlier work done by the Canadian Wildlife Service. The results of these recent surveys show that the marshes of Long Point, Lake St. Clair, Prince Edward County, and the Detroit River continue to be the areas most extensively used by waterfowl, and that they contain much important and vulnerable habitat. The marshes of Rondeau Bay and the Grand River are less heavily used, but still merit some form of protection. Some other areas with little marsh habitat, such as the east and west ends of Lake Erie, Outer Long Point Bay, the Niagara River, and the Toronto waterfront, are frequented by large concentrations of waterfowl at certain times of the year. These areas must be closely monitored for environmental mishaps such as oil spills so that appropriate action to eliminate or alleviate damage can be taken.

2. Introduction

The Canadian Wildlife Service (CWS) initially obtained aerial survey data for the distribution of migrant waterfowl along the Ontario shoreline of the lower Great Lakes during the years 1968–73. Total waterfowl days and waterfowl days per hectare for various sections of this shore were calculated for the following species and sub-groups of waterfowl: Mallard (*Anas platyrhynchos*), Black Duck (*A. rubripes*), other dabbling ducks, Canvasback (*Aythya valisineria*) and Redhead (*A. americana*), Greater and Lesser scaup (*A. marila* and *A. affinis*), mergansers, sea ducks [including scoters (*Melanitta* sp.), eiders (*Somateria* sp.), and Oldsquaw (*Clangula hyemalis*)], other diving ducks, geese, and swans. Those data plus a discussion of habitat characteristics and environmental influences were published by Dennis and Chandler (1974). Subsequent data on waterfowl numbers and habitat characteristics, up to 1981, are presented in this paper as a compendium of additions and revisions to the earlier work. Although there have been some changes in waterfowl populations and the distribution of staging over the 13-year period, the relative use of most areas has not altered significantly. Special notes have been made on cases where changes in utilization have occurred. The main purpose of the surveys has been to locate waterfowl concentrations so that priorities for acquisition and/or management of crucial habitat can be established. They may also help to determine the environmental sensitivity of the lower Great Lakes shore zone.

3. Study area and methods

Figure 1 shows the geographic boundaries of the various survey zones, identified by physiographic differences such as shoreline topography and marsh presence.

Data on waterfowl utilization were collected for most areas using the aerial survey method described by Dennis and Chandler (1974). Comments on survey biases still stand and methods of data manipulation are unaltered.

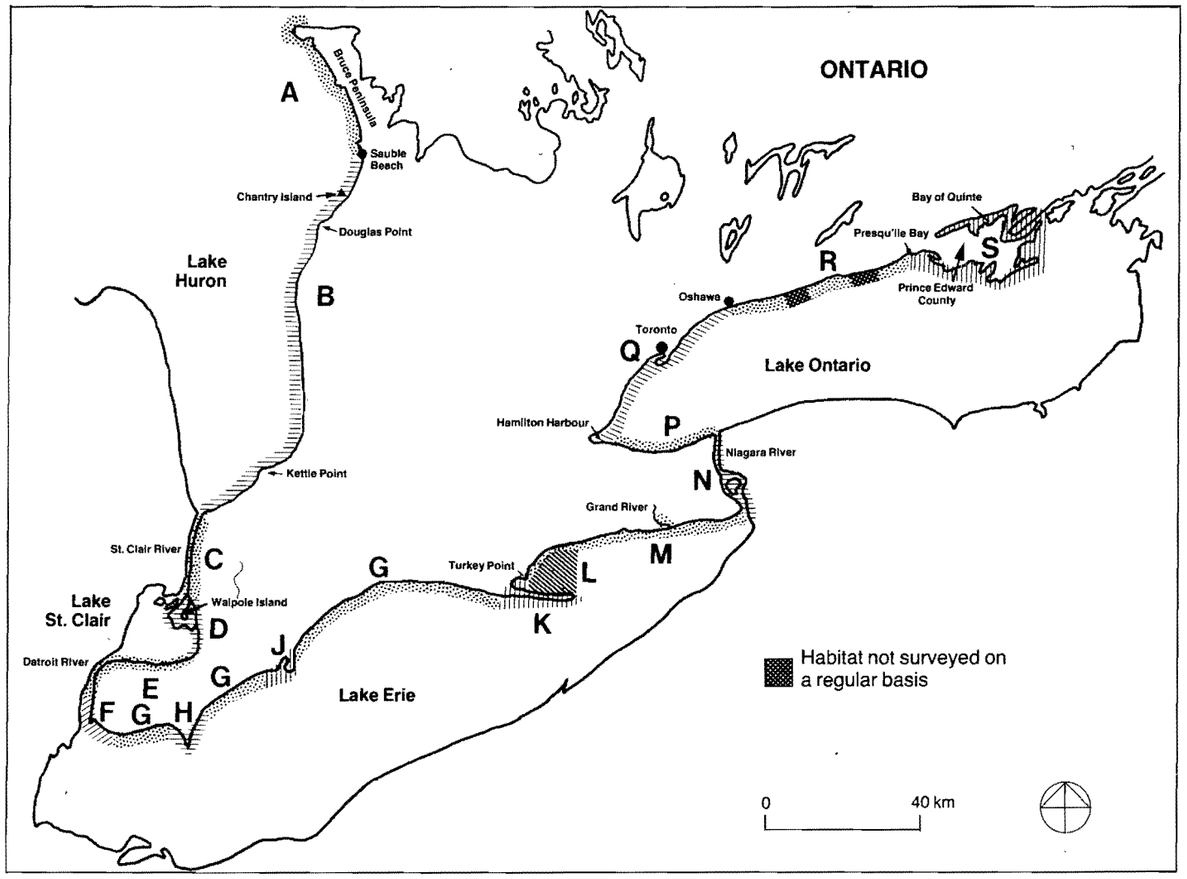
Major changes included the addition of four new survey zones along Lake Huron, the St. Clair River, and Lake Erie, areas A, B, C, and L respectively (Fig. 1). In addition, complete coverage is now available for area M, the section of Lake Erie shoreline between Turkey Point and the Niagara River.

Data for area L, the open waters of Outer Long Point Bay, excluding the shoreline strip included in area M, were collected by flying four transects located on north/south headings. Tape markings on the windows and wing struts delineated a 70° angle for the two observers. As the aircraft altimeters were in English units, the transects were flown at an altitude of 94 m which produced a transect width of 536 m. Transect lengths were measured on 1:50 000 National Topographic System maps. The area of Outer Long Point Bay was determined by using a compensating polar planimeter and the 1:25 000 topographic map 401. The number of waterfowl present in Outer Long Point Bay was determined by extrapolation from transect counts.

As described by Boyd (1974) the waterfowl day, the main measure of use, provides a simple index of the current attractiveness of a site or region to waterfowl outside the breeding season. Waterfowl days were calculated by averaging results from each successive pair of surveys, multiplying by the number of days separating the two surveys, and summing the results over the entire period of the spring or autumn.

Data for each zone have been taken from that year and season in which the most intensive coverage is available (Appendix 1). Area S is the exception as the results for the area (autumn migration) are a mixture. Part of the migration season was surveyed in 1970 and the remainder in 1971.

Figure 1
Survey areas of southern Ontario Great Lakes System



4. Results and discussion

Tables 1 and 2 outline the calculated waterfowl days for each area by waterfowl group during spring and autumn. Some area totals have not been changed since 1974 as additional surveys have not been undertaken in the interim; however, all results have been provided for ease of comparison. Tables 3 and 4 provide indices of waterfowl-use intensity based on data from the first two tables. Appendix 1 outlines the years of survey coverage.

Some species are grouped in the tables because of the small numbers that were generally present or in some instances because of similar feeding and resting behaviour or the tendency to occur in mixed flocks such as Canvasbacks and Redheads. Visually estimating proportions of species in large rafts of either Canvasbacks and Redheads or Greater Scaup and Lesser scaup is extremely difficult and thus these species are grouped despite the large numbers present in certain locations.

Area A includes a strip of open water along the east shore of Lake Huron 0.5 km wide, as well as the associated wetlands, from the tip of the Bruce Peninsula to Sauble Beach (Fig. 1). The shoreline is very irregular with much exposed limestone bedrock and has many sheltered bays and inlets with islands immediately offshore. The area has limited waterfowl use during both spring and autumn, mainly due to the scarcity of aquatic vegetation, although disturbance by pleasure craft also has a minor influence. The most abundant waterfowl using the area during spring and autumn are Common Mergansers (*Mergus merganser*). Several hundred Black Ducks and Mallards utilize the open water areas as the ice breaks up during spring. Use of the area by other species is extremely limited.

Area B consists of the 0.5 km wide coastal zone of Lake Huron extending from Sauble Beach to the start of the St. Clair River. Few bays or inlets occur in the area. Most of the surveyed section consists of open water underlain by sand which supports little aquatic vegetation. Exceptions are located around Douglas and Kettle Points and on Chantry Island where small patches of submergent and emergent aquatic vegetation are present. Although utilization by waterfowl is generally low in area B, waterfowl day totals and intensities (Tables 1–4) are higher than those for area A because of the heavier waterfowl use that occurs near the areas with aquatic vegetation. In addition to better habitat in sections of area B, Chantry Island is a Federal Migratory Bird Sanctuary where hunting and bird disturbance are prohibited. During autumn the most numerous species include Common Mergansers, Buffleheads (*Bucephala albeola*), Mallards, and Greater Scaup. In spring, Common Mergansers, Canada Geese (*Branta canadensis*), Mallards, and Black Ducks predominate.

Area C extends along the Canadian side of the St. Clair River from Lake Huron to a point halfway along Walpole Island. Little aquatic vegetation grows in the river because of the fast current (8–10 km/h) and depths that are too great for the growth of vegetation. Few sheltered areas exist but small beds of aquatics occur in the vicinity of islands in the river. Waterfowl numbers exceed 1000 during late autumn and early spring when other marshy areas with less current are frozen. Species present in approximate order of abundance include Common Mergansers, Redheads and Canvasbacks, American Wigeon (*Anas americana*), Mallards, Greater Scaup, and Lesser Scaup.

Area D, which includes the marshes of the east shore of Lake St. Clair and Walpole Island (Fig. 1), has the highest number of autumn goose, Mallard, and Black Duck days, the second greatest number of Canvasback and Redhead days during autumn, and the second highest number of waterfowl days per hectare during autumn. In addition, it has the highest spring Mallard, Black Duck, other dabbling duck, and Tundra Swan (*Cygnus columbianus*) days (Tables 1, 2, 4). Peak waterfowl numbers during spring exceed 50 000; during autumn numbers exceed 150 000. Surveys conducted in 1976 and 1977 indicate a considerable increase in fall utilization of the Lake St. Clair area, when compared with earlier

Table 1
Quantity of waterfowl days, in thousands, on the survey area, in spring.
Period includes 1 March – 1 June (93 days)

Area	Mallards	Black Ducks	Other dabbling ducks	Canvas-backs and Redheads	Scaups	Mergansers	Other diving ducks	Sea ducks	Geese	Swans	Total waterfowl*
A — Bruce Peninsula	6.6	7.3	0.2	0.0	0.0	26.7	0.8	0.0	0.3	0.0	42.1
B — Southeast shore of Lake Huron	8.8	6.7	0.3	0.0	0.0	89.1	2.0	0.4	9.9	0.3	117.8
C — St. Clair River	7.8	2.2	0.0	trace	0.1	65.6	3.3	0.8	0.0	0.0	81.1
D — East shore of Lake St. Clair	289.1	95.9	136.7	227.7	280.4	5.6	33.0	trace	378.3	135.3	1581.0
E — South shore of Lake St. Clair and north section of Detroit River	0.8	0.6	0.1	17.1	11.8	12.1	0.4	0.0	0.1	0.0	43.1
F — Lower Detroit River	19.1	3.8	4.2	237.8	20.7	28.0	10.1	0.2	49.2	0.7	383.0
G — West end of Lake Erie	122.1	25.2	7.0	6.0	50.9	205.7	56.4	1.0	45.5	27.2	580.2
H — Point Pelee	16.5	2.2	7.5	10.4	2.1	127.5	18.2	0.1	0.6	0.8	187.5
J — Rondeau Bay	14.3	4.8	16.3	39.1	14.2	40.4	16.3	0.0	6.1	4.4	157.5
K — Long Point	241.0	34.8	72.4	593.7	560.2	339.0	344.2	0.2	138.7	9.8	2335.4
L — Outer Long Point Bay	19.9	4.7	0.2	1.8	6.3	292.2	200.2	191.5	8.1	0.0	816.1
M — East end of Lake Erie and lower Grand River	9.0	2.8	4.6	4.6	94.4	306.0	136.9	0.4	16.0	5.6	591.3
N — Niagara River	0.9	4.0	0.0	0.0	5.4	203.7	42.4	30.9	0.0	0.1	288.4
P — South shore of Lake Ontario	4.4	0.8	0.0	0.2	14.1	14.2	14.1	0.8	trace	trace	51.1
Q — Burlington, Toronto, Oshawa waterfront	105.2	64.1	9.7	0.7	71.1	21.2	40.7	37.6	88.8	0.3	448.0
R — North shore of Lake Ontario	8.3	10.9	0.1	trace	8.8	0.5	17.4	4.3	trace	0.0	50.4
S — Prince Edward County	2.4	6.3	5.8	177.5	706.5	101.7	221.9	75.2	113.3	0.0	1410.6
Total	876.2	277.1	265.1	1316.6	1847.0	1879.2	1158.3	342.2	854.9	184.5	9164.6

*Includes unidentified waterfowl.

Table 2
Quantity of waterfowl days, in thousands, on the survey area, in autumn.
Period includes 16 August – 1 January (139 days)

Area	Mallards	Black Ducks	Other dabbling ducks	Canvas-backs and Redheads	Scaups	Mergansers	Other diving ducks	Sea ducks	Geese	Swans	Total waterfowl*
A — Bruce Peninsula	0.5	0.5	trace	0.0	0.2	7.4	0.4	0.0	trace	0.0	9.3
B — Southeast shore of Lake Huron	7.0	1.8	0.6	1.6	6.8	27.4	11.9	0.0	1.3	0.1	58.8
C — St. Clair River	3.1	0.1	0.0	14.6	6.2	9.0	0.5	0.0	0.0	0.0	34.2
D — East shore of Lake St. Clair	3606.4	1068.6	448.4	1137.1	36.2	4.7	66.7	trace	672.6	11.5	7 052.3
E — South shore of Lake St. Clair and north section of Detroit River	4.5	1.2	trace	68.4	3.7	32.6	0.9	0.0	0.5	0.0	112.2
F — Lower Detroit River	595.5	68.3	54.0	324.0	156.4	0.2	0.6	0.0	159.5	trace	1 360.0
G — West end of Lake Erie	5.7	1.9	0.1	0.0	16.5	60.6	6.7	0.1	44.8	0.0	136.8
H — Point Pelee	14.6	1.0	9.9	0.0	0.0	27.6	0.4	0.0	2.7	0.1	56.8
J — Rondeau Bay	143.7	44.6	59.9	13.6	27.3	5.0	8.1	0.0	2.6	1.6	306.7
K — Long Point	1542.7	677.6	1501.9	2690.7	251.2	13.0	260.8	78.5	325.7	23.8	7 654.9
L — Outer Long Point Bay	0.0	9.6	0.0	6.8	249.9	384.6	17.1	301.3	2.5	0.0	1 052.9
M — East end of Lake Erie and lower Grand River	37.8	20.7	9.4	6.5	556.7	209.8	47.5	trace	13.5	0.2	904.5
N — Niagara River	17.1	22.5	1.1	132.1	170.2	488.8	140.9	0.0	0.3	0.0	981.0
P — South shore of Lake Ontario	3.2	0.7	0.0	0.0	380.6	16.2	50.9	57.2	2.9	0.0	515.7
Q — Burlington, Toronto, Oshawa waterfront	490.2	345.3	5.3	16.3	221.6	84.7	74.9	119.1	264.5	0.0	1 635.9
R — North shore of Lake Ontario	59.9	67.5	0.0	0.5	37.5	22.5	61.2	10.0	0.9	0.0	261.8
S — Prince Edward County	91.0	86.4	15.4	84.3	1793.3	272.0	192.0	127.5	9.2	trace	2 711.4
Total	6622.9	2418.3	2106.0	4496.5	3914.3	1666.1	941.5	693.7	1503.5	37.3	24 845.2

*Includes unidentified waterfowl.

surveys. The increase is largely attributable to increased Mallard and Canada Goose populations, more use of legal baiting as a mangement tool by hunting clubs, and higher lake levels providing more open resting areas in the zones formerly choked by emergent aquatic vegetation such as cattail (*Typha* sp.). In addition, the establishment of the St. Clair National Wildlife Area in 1974 resulted in increased Mallard and Black Duck use (Dennis and North, this publication).

Areas E, F, G, H, and J were resurveyed during the autumn of 1979 and spring of 1980. Area E includes the northern portion of the Detroit River and the shoreline zone of the south side of Lake St. Clair. In general, the area has little high quality waterfowl habitat due to industrial and residential development. Waterfowl use is little changed from earlier surveys reported in Dennis and Chandler (1974), with the exception that use by Canvasbacks, Redheads, and mergansers increased many fold during both spring and autumn. The change may be a result of extensive disturbance by boat traffic in the better habitat located in area D along the east shore of Lake St. Clair. In addition, there was a general increase in Redhead and Canvasback use in the section of the Detroit River adjacent to area E.

Area F consists of the lower Detroit River and the marshes associated with the shore of Lake Erie extending eastward to the Provincial Park at Holiday Beach. Canvasback and Redhead days during spring are the second highest of any area surveyed, and the intensity of use by diving ducks during spring is the highest of any area surveyed. Although total annual use by waterfowl has not changed when compared with the data reported in Dennis and Chandler (1974), indicated autumn merganser use has decreased dramatically from 114 500 days to 200, and Black Duck use has declined from 181 300 to 68 300 days. Black Duck use also declined during spring from 14 900 to 3800 waterfowl days. Canvasback and Redhead days increased from 64 800 to 237 800. Perhaps the loss in emergent aquatic vegetation that occurred as a result of higher water levels in the Great Lakes decreased the use by dabbling ducks, but

Table 3
Intensity of use of the survey area by waterfowl in spring
(1 March – 1 June)

Area	Hectares	Waterfowl days per hectare		
		Dabbling ducks	Diving ducks*	Total waterfowl†
A — Bruce Peninsula	6 325	2.24	4.34	6.64
B — Southeast shore of Lake Huron	14 504	1.09	6.32	8.13
C — St. Clair River	2 088	4.79	33.41	33.95
D — East shore of Lake St. Clair	14 889	35.04	36.71	106.25
E — South shore of Lake St. Clair and north section of Detroit River	2 460	0.61	16.83	17.52
F — Lower Detroit River	2 365	11.46	125.50	161.95
G — West end of Lake Erie	11 178	13.80	28.63	51.91
H — Point Pelee	2 015	13.00	78.56	93.05
J — Rondeau Bay	4 727	7.49	23.27	33.32
K — Long Point	18 535	18.77	99.13	125.99
L — Outer Long Point Bay	51 620	0.48	13.37	15.81
M — East end of Lake Erie and lower Grand River	9 568	1.71	56.67	61.80
N — Niagara River	2 610	1.87	108.17	110.49
P — South shore of Lake Ontario	4 019	1.29	10.72	12.74
Q — Burlington, Toronto, Oshawa waterfront	8 288	21.59	20.66	54.05
R — North shore of Lake Ontario	1 823	10.55	16.68	27.25
S — Prince Edward County	19 466	0.74	65.89	72.46
Total	176 480	8.04	37.08	51.93

*Includes mergansers and sea ducks.
†Includes geese, swans, and unidentified waterfowl.

Table 4
Intensity of use of the survey area by waterfowl in fall
(16 August – 1 January)

Area	Hectares	Waterfowl days per hectare		
		Dabbling ducks	Diving ducks*	Total waterfowl†
A — Bruce Peninsula	6 325	0.12	1.24	1.46
B — Southeast shore of Lake Huron	14 504	0.64	3.29	4.05
C — St. Clair River	2 088	1.53	14.50	16.36
D — East shore of Lake St. Clair	14 889	344.11	83.59	473.65
E — South shore of Lake St. Clair and north section of Detroit River	2 460	2.32	42.93	45.61
F — Lower Detroit River	2 365	303.51	203.47	575.05
G — West end of Lake Erie	11 178	0.69	7.51	12.24
H — Point Pelee	2 015	12.66	13.90	28.19
J — Rondeau Bay	4 727	52.51	11.42	64.88
K — Long Point	18 535	200.81	177.71	412.99
L — Outer Long Point Bay	51 620	0.19	18.59	20.40
M — East end of Lake Erie and lower Grand River	9 568	7.08	85.76	94.53
N — Niagara River	2 610	15.60	357.06	375.84
P — South shore of Lake Ontario	4 019	0.97	125.64	128.32
Q — Burlington, Toronto, Oshawa waterfront	8 288	101.43	62.33	197.38
R — North shore of Lake Ontario	1 823	69.85	72.22	143.53
S — Prince Edward County	19 466	9.88	126.86	139.27
Total	176 480	63.16	66.37	140.78

*Includes mergansers and sea ducks.
†Includes geese, swans, and unidentified waterfowl.

permitted an increased use by diving ducks such as Redheads and Canvasbacks during spring due to more food availability in the form of deeper submergent aquatics. The change in merganser use is largely a result of the birds using deeper water further offshore and may be related to prey availability.

Area G consists of three sections of Lake Erie shoreline that are virtually devoid of marsh vegetation. Spring waterfowl use increased dramatically over that reported by Dennis and Chandler (1974) for those species such as Mallards, Black Ducks, Tundra Swans, and Canada Geese that regularly feed on waste corn in fields. The absence of hunting pressure during spring in conjunction with the greater amount of waste corn available in fields adjacent to the lake shore has been responsible for the increased use. Much more corn is grown along the shore than during the years of earlier surveys. Annual waterfowl use during spring increased from 179 200 to 580 000 waterfowl days. Autumn waterfowl use decreased during the period from 272 400 to 136 800 days largely because of decreased merganser use.

Area H includes the marshlands associated with Point Pelee National Park and Hillman Creek. Autumn waterfowl use is greatly decreased from 237 100 days reported in Dennis and Chandler (1974) to 56 800, apparently as a result of the presence of fewer waterfowl food plants in Hillman Creek. Spring use was generally reduced as well, although an increase in merganser days from 16 500 to 127 500 increased the overall day total from 126 000 to 187 500.

Area J includes the marshes of Rondeau Bay and the waters of Lake Erie adjacent to Rondeau Provincial Park. As a result of a major die-off of aquatic vegetation in Rondeau Bay, waterfowl use has decreased from earlier surveys for both spring and autumn. During spring, use by scaup and the other diving ducks decreased; in autumn, use by Canvasbacks and Redheads, scaup, and other diving ducks all decreased dramatically. Total spring use decreased from 451 200 waterfowl days to 157 500 days and the use during autumn decreased from 380 000 to 306 700 days. Mallard days during autumn increased from 33 600 to 143 700 because of baited sanctuaries operated by the Ontario Ministry of Natural Resources, and thus the total autumn waterfowl-day decrease was minimized.

Area K includes the marshes of Long Point and Turkey Point as well as the open water of Inner Long Point Bay. The most recent surveys were conducted in 1978 and 1979, when the area had the largest number of spring and autumn waterfowl days as well as the third highest number of spring diving duck days per hectare. As at Lake St. Clair, there has been a considerable increase in the use of the area in autumn. Unlike Lake St. Clair, spring use increased from the 1969–73 period. The increase in autumn occurred largely as a result of increased Mallard and Canada Goose populations, plus a massive increase in use by American Wigeon during the autumn of 1978. Increased food, both in the form of baited sanctuaries and an excellent wild rice crop (*Zizania aquatica*) in the autumn of 1978, as well as an inland drought, contributed to the increased use by dabbling ducks. During autumn, reduced numbers of Redheads and Canvasbacks were more than compensated by the increased number of dabbling ducks, as well as by an increase in the other diving ducks group. Perhaps the more liberal open-water hunting regulations that were implemented since the earlier survey period contributed to the reduced use by Redheads and Canvasbacks. The liberal regulations would have had much less effect on the marsh-dwelling Ring-necked Ducks (*Aythya collaris*) that made up the bulk of the other diving ducks during autumn. In 1979, shooting in the open waters of Long Point Bay was limited to a 300-m strip along the shoreline. In future years, use of the open water areas by Redheads and Canvasbacks may be expected to increase as a result of the reduced disturbance by hunting activities. During spring, Mallards, other dabbling ducks, Redheads and Canvasbacks, scaups, mergansers, other diving ducks [mostly Common Goldeneye (*Bucephala clangula*)] Ring-necked Ducks, and Canada Geese increased in area K. Tundra Swan and Black Duck use decreased. Swans may have been attracted away from the marshland areas to cornfields. The reduction in Black Duck numbers may represent a genuine population decrease, for which there is other evidence (Dennis, Fischer, and McCullough, this publication).

Area L comprises the open waters of Outer Long Point Bay, excluding the shoreline strip contained in area M. Average water depths were about 10.2 m according to nautical charts, with maximum depths of 36.6 m in the east-central section of the Bay.

Outer Long Point Bay had the highest reported total of sea duck days during both spring and fall of all survey areas (Tables 1, 2). The Outer Bay also has the second highest total of merganser days during the fall, and the third highest total for the spring. For total waterfowl use, the Outer Bay ranks fifth behind the large marsh/open water complexes of Lake St. Clair, Inner Long Point Bay, the Prince Edward County shoreline, and the open waters of the western Lake Ontario shoreline.

Migration chronology for the various species and groups of waterfowl was similar to information presented in Dennis and Chandler (1974).

Most waterfowl were observed in small flocks scattered over the entire bay. Although increased ship traffic in the Outer Bay due to the Nanticoke Industrial Development will not disturb the waterfowl to any great extent, increased potential for an oil spill exists because of this traffic. An oil spill in Outer Long Point Bay could affect many thousands of birds in the inner as well as the outer bay, including Canvasbacks and Redheads. Large portions of the continental populations of both those species may be present at one time.

Areas M, N, P, G were completely resurveyed during the autumn of 1980 and the spring of 1981.

Area M includes the lower Grand River and a 0.5 km strip along the shoreline of Lake Erie from the east side of Turkey Point to the inlet of the Niagara River. Habitat characteristics were described by Dennis and Chandler (1974). Peak waterfowl numbers observed in autumn approached 14 000, and spring numbers exceeded 16 000. Along the Lake Erie shoreline, large numbers of Greater and Lesser scaup, Common Goldeneye, and Common Mergansers are present, particularly during autumn. Currently, the area has the second highest spring merganser days and autumn scaup days of any area surveyed. Thermal discharge from the Nanticoke generating station never freezes, permitting ducks to remain late in the autumn and arrive early in the spring (McCullough, this publication).

The marshy section of the Grand River that extends upstream beyond the town of Dunnville provides quality dabbling duck habitat. The Grand River marshes aided by nearby baited sanctuaries hold fair numbers of Mallards in the early fall, although shooting pressure forces most birds to leave shortly after opening of the hunting season.

Area N is the Canadian side of the Niagara River extending from Lake Erie to Lake Ontario. The area has the highest autumn and the second highest spring diving duck days per hectare. Autumn use by Canvasbacks, scaups, mergansers, and other diving ducks increased dramatically from earlier surveys. Spring merganser and Oldsquaw use

increased approximately 9- and 10-fold, respectively. Since the earlier surveys there was an apparent increase in the size of a bed of submergent aquatic vegetation adjacent to Navy Island and more waterfowl foods may have resulted in the greater waterfowl use.

Area P extends from the mouth of the Niagara River to Hamilton Harbour and consists of a strip 0.5 km wide. The area is particularly notable for its fall concentrations of Greater and Lesser scaup. The autumn scaup days decreased by approximately 50% from those calculated for earlier surveys; however, the total autumn waterfowl days for the scaup group was still the third highest of all areas. Scaup use of the area peaks rapidly in mid-October and it is possible that our surveys missed the migration peak. Recently, it has become apparent that the birds are moderately disturbed by increased power boat traffic and this may limit waterfowl use.

Area Q comprises Hamilton Harbour and a shoreline strip of open water 0.5 km wide, and the associated marshes from Hamilton Harbour to and including the Second Marsh at Oshawa. In general, use of the area is similar to that reported in Dennis and Chandler (1974). However, merganser use increased during both spring and autumn and use by Canada Geese increased 8-fold in spring and approximately 5-fold in autumn. The goose increase is largely because of the species' recent population expansion in southern Ontario. Minor increases in the autumn use by Mallards and Black Ducks are a result of more restrictive firearms discharge bylaws reducing hunting pressure in conjunction with an increase in the area of corn fields for field feeding.

Area R is made up of the Lake Ontario shoreline strip from Oshawa to Prince Edward County. No new surveys have been flown.

Area S consists of the open water shoreline strip of Presqu'ile Bay and Prince Edward County including the Bay of Quinte. Waterfowl day totals for both spring and autumn for scaup were the highest of all areas. Area S also had the second highest total of sea duck days during both the spring and fall. Large numbers of Canvasbacks, Redheads, Common Goldeneyes, mergansers, and Canada Geese were also present. Fall counts were higher than in the spring. See Ross (this publication) for more details on waterfowl use throughout the Prince Edward County shoreline zone.

5. Summary

Tables 1 and 2 illustrate the quantity of waterfowl use in the various areas during spring and autumn, and Tables 3 and 4 give an indication of the intensity of use. The areas are ranked in descending order of magnitude according to total waterfowl days during the migration periods as follows: K — Long Point marshes; D — Lake St. Clair marshes; S — Prince Edward County marshes and bays; Q — Burlington, Toronto, Oshawa waterfront; L — Outer Long Point Bay; F — Lower Detroit River and associated marshes; M — northeast Lake Erie shoreline; N — Niagara River; G — west and central Lake Erie shoreline; P — south shore of Lake Ontario; J — Rondeau Bay and associated marshes; R — north shore of Lake Ontario; H — Point Pelee area; B — east shore of Lake Huron; E — south shore of Lake St. Clair, north end of Detroit River; C — St. Clair River, and A — west shore of Bruce Peninsula.

Although environmental pollution and disturbance pose a threat to all areas, other direct habitat changes that would significantly discourage waterfowl are unlikely to occur in areas A, B, C, E, G, L, N, P, Q, and R. Perhaps these areas, with the exception of L, are the most probable for an expansion of power generating facilities in southern Ontario. At each new station, use by waterfowl during the late autumn and early spring will be increased because of the warm water discharged by the station. Significant quantities of quality habitat remain in areas D, F, H, J, K, M, and S. Some habitat has been preserved by government ownership in D, H, J, and K, but more is required, and little habitat preservation is at present ensured in areas S — Prince Edward County, F — the lower Detroit River, and M — particularly the Grand River marshes. All seven areas must be given top priority in terms of habitat protection and improvement.

6. Literature cited

Boyd, H. 1974. Opportunities and needs for further research on waterfowl in eastern Canada. Pages 102–105 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shoreline of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; North, N.R. Waterfowl use of the Lake St. Clair marshes during migration in 1968–69, 1976–77, and 1982. This publication.

McCullough, G.B. Overwintering of waterfowl adjacent to the Nanticoke Generating Station, Lake Erie, Ontario, 1978 and 1979. This publication.

Ross, R.K. Migrant waterfowl use of the major shorelines of eastern Ontario. This publication.

Appendix 1
Years of survey coverage

Area	Spring	Autumn
A — Bruce Peninsula	1974	1973
B — Southeast shore of Lake Huron	1974	1973
C — St. Clair River	1974	1973
D — East shore of Lake St. Clair	1977	1976
E — South shore of Lake St. Clair and north section of Detroit River	1980	1979
F — Lower Detroit River	1980	1979
G — West end of Lake Erie	1980	1979
H — Point Pelee	1980	1979
J — Rondeau Bay	1980	1979
K — Long Point	1979	1978
L — Outer Long Point Bay	1978	1977
M — East end of Lake Erie and lower Grand River	1981	1980
N — Niagara River	1981	1980
P — South shore of Lake Ontario	1981	1980
Q — Burlington, Toronto, Oshawa waterfront	1981	1980
R — North shore of Lake Ontario	1972	1971
S — Prince Edward County	1976	1970 and 1971

Waterfowl use of the Lake St. Clair marshes during migration in 1968–69, 1976–77, and 1982

by D.G. Dennis and N.R. North

1. Abstract

The marshlands associated with Lake St. Clair are used extensively by waterfowl during spring and autumn migrations. Regular aerial waterfowl surveys were conducted at Lake St. Clair during the springs of 1969, 1977, and 1982 and the autumns of 1968, 1976, and 1982. Many changes in marsh management and habitat quality occurred during the 14 years spanned by the surveys.

The purpose of the study was to document and explain the corresponding changes in waterfowl use.

Factors contributing to increased waterfowl use were larger local Mallard and Canada Goose populations, more baited sanctuaries, increase in quantity of waterfowl food plant species as a result of higher lake levels, and the establishment of a National Wildlife Area closed to hunting.

Factors that reduced waterfowl use included habitat destruction caused by agricultural drainage; marina developments on wetlands, with resulting increased boat traffic disturbing waterfowl; increased public hunting on areas that had previously been hunted at a low intensity; and population declines in species such as Black Ducks and Ruddy Ducks.

2. Introduction

In Ontario, south of James Bay, the most extensive and highest quality habitat suitable for migratory waterfowl is provided by the large shoreline marshes associated with Lake Erie and Lake St. Clair. The marshland along the east shore of Lake St. Clair currently serves as the most important staging area in southern Ontario for Mallards (*Anas platyrhynchos*), Black Ducks (*A. rubripes*), Canada Geese (*Branta canadensis*), and Tundra Swans (*Olor columbianus*) (Dennis, McCullough, North, and Ross, this publication). In addition, large proportions of the North American populations of Canvasbacks (*Aythya valisineria*), Redheads (*Aythya americana*), and Tundra Swans use the marshes during the staging periods.

All wetlands in southern Ontario face intense pressures threatening their survival because of agricultural, industrial, recreational, and urban demands. Between 1965 and 1978, 24.7% of the privately owned St. Clair marshes were destoyed, largely by conversion to farmland (McCullough 1981). The Canadian Wildlife Service (CWS) has recognized the need to provide wetlands with protection and environmentally sound management. Before such management can occur a great deal of inventory work must be conducted. In an initial attempt to establish the value of the habitat at Lake St. Clair to waterfowl, regular aerial surveys were conducted during the autumn of 1968 and the spring of 1969. The area was intensively resurveyed in the autumn of 1976 and the spring of 1977 and again in the spring and autumn of 1982. The present paper examines changes in waterfowl use as a result of changes in both habitat and management practices in the general area. Figure 1 depicts the marsh areas included in the surveys.

3. Study area

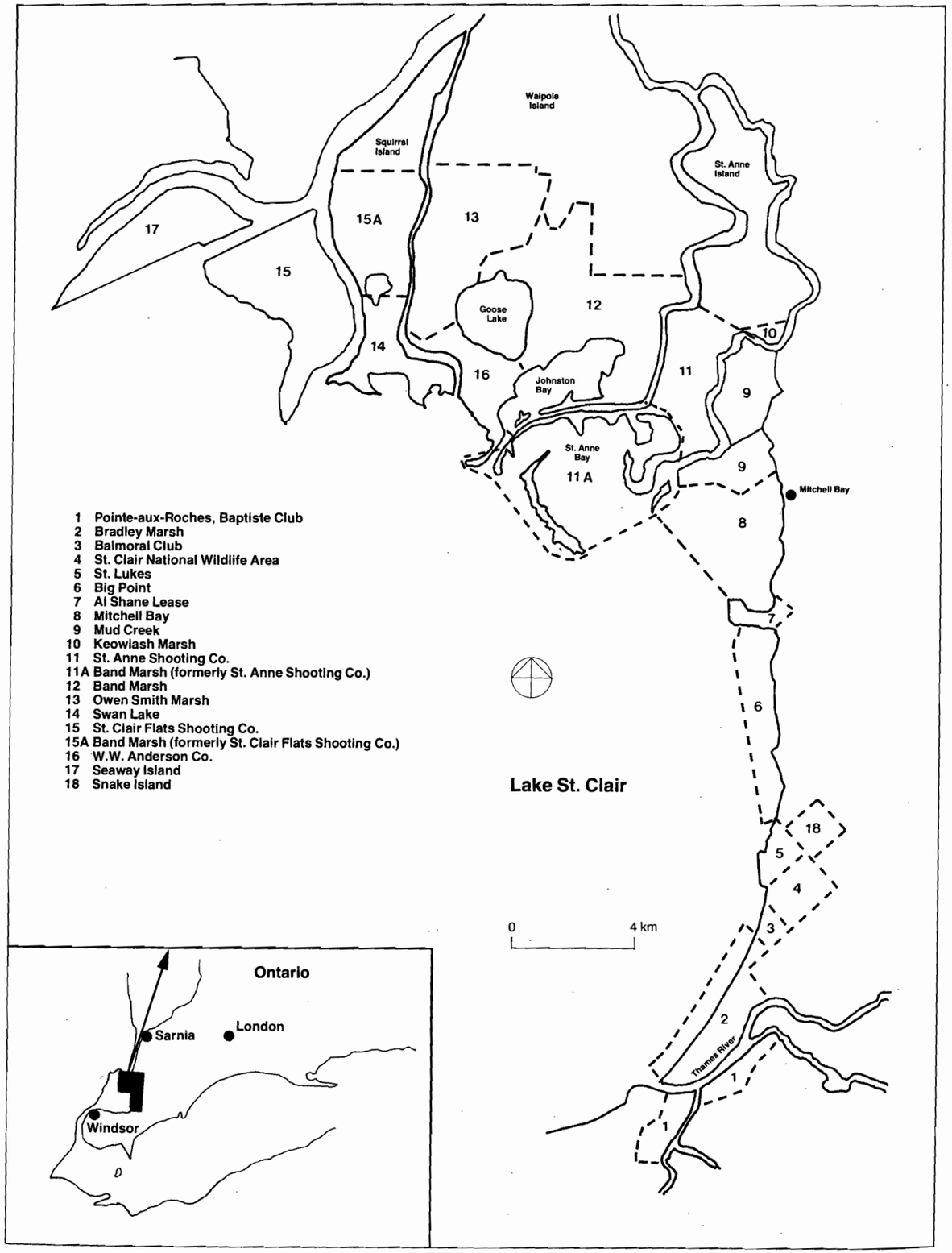
At present, the Lake St. Clair marshes, including the Walpole Indian Reservation lands, occupy approximately 12 000 ha. The marsh land is essentially table-top flat, interrupted by old beach ridges along the east shore of Lake St. Clair. The marshland within the Walpole Island Indian Reserve is the southern extremity of the St. Clair river delta.

Man-made dykes occur throughout the marsh areas and may be a metre or two above marsh level. Approximately 39% of the marshes are dyked to control water levels to improve waterfowl hunting and muskrat production. Marsh drainage between 1965 and 1978 occurred almost exclusively (90.9%) on dyked marsh (McCullough 1981).

The St. Clair marsh complex may be characterized by three physiognomic types. These are dense emergent marsh of a continuous nature; emergent marsh zones interspersed with small ponds, bays, and channels; and open water marsh zones. In the emergent marsh zone the principal plant species are cattail (*Typha* sp.), with sedge meadow complexes and Phragmites patches occurring in many areas. In the small ponds adjacent to the emergent marsh zone, bulrush (*Scirpus* spp.), burreed (*Sparganium* spp.), pickerel weed (*Pontedaria cordata*), water-lily (*Nymphaea* spp.), water milfoil (*Myriophyllum* spp.), coontail (*Ceratophyllum demersum*), and sparse stands of pondweed (*Potamogeton* spp.) occur. Extensive open water areas are present in the vicinity of the Big Point Club on the mainland, and Johnston Bay, St. Anne's Bay, and Goose Lake on Walpole Island. The open water zones contain valuable waterfowl food plants such as wild celery (*Valisineria americana*), sago pondweed (*Potamogeton pectanatus*) as well as bulrush and other pondweeds. In a few locations, such as Goose Lake, extensive submerged beds of musk grass (*Chara* spp.) occur.

Currently all marshland at Lake St. Clair is maintained principally for the purposes of waterfowl hunting, with the exception of a 240 ha area operated as a National Wildlife Area. Most areas are operated by clubs in which annual memberships are required and hunting activities are regular but of low intensity. In a few locations, especially on the portions of Walpole Island not leased to hunting clubs, public hunting occurs.

Figure 1
Marsh locations along the east shore of Lake St. Clair



4. Methods

The data in all tables are based on 12 aerial surveys conducted in 1968–69, 12 in 1976–77, and 12 in 1982. In fact 23 surveys were flown in 1968–69, but the 12 dates that corresponded most closely with the survey dates in 1976–77 and 1982 were selected to facilitate comparisons.

The surveys were normally conducted by two observers in a fixed-wing aircraft at an altitude of approximately 100 m. A predetermined route was followed in each survey. In 1968–69 a Cessna 172 on wheels was used. In 1976–77 we used a Lake Amphibian because of its safety over water at low altitudes and its stability at slow speeds. In 1982 a Cessna 185 on floats was used, for the same reasons.

In all tables autumn is considered to include the period 1 September – 16 December and spring includes 17 March – 7 June. The six surveys flown in the autumn were fairly uniformly spaced throughout the autumn with the exception of two surveys completed during the week of 1 November in an attempt to catch the peak of fall waterfowl use. In the spring, three of the six surveys were conducted within 12 days of 1 April to emphasize the period of peak migration when most of the spring waterfowl use occurred.

Relative waterfowl use of the various marsh units was determined by calculating "waterfowl days" from the aerial survey data. Waterfowl days were calculated by averaging duck numbers between two survey days and multiplying the average by the total number of days between the surveys. Totals for the spring or autumn were obtained by summing the results for the entire survey period, as in Dennis and Chandler (1974).

Records of changes in marsh vegetation and management practices were made in conjunction with other CWS activities such as waterfowl banding and aerial photo interpretation associated with habitat assessment, from conversations with marsh managers, and from direct observations during the aerial surveys.

5. Results and discussion

Large numbers of ducks, Canada Geese, and Tundra Swans use the St. Clair marshes. Estimated peak numbers were approximately 60 000 in the spring and nearly 150 000 birds in the autumn.

During the 14 years spanning the three survey periods, a variety of natural and man-made changes occurred that altered the value of the Lake St. Clair marshes as waterfowl habitat. One of the most important changes was the increased use of legally baited areas to attract and hold birds. A legally baited area is one in which waterfowl food may be placed, under a federal permit, for the purposes of attracting waterfowl during the hunting season. Hunting is prohibited within 400 m of the bait. During the first survey period, legally baited areas that were extensively used by waterfowl were uncommon but by 1976–77 baited sanctuaries were a routine technique to manage waterfowl for hunting purposes. Baited areas had increased further by 1982, largely because they are a cost effective way to improve hunting success. The high real estate values in the general area effectively prohibit the purchase of large tracts of marshland specifically to maintain hunting opportunities. Baited sanctuaries allow greater utilization of existing marshlands and make their operation as hunting clubs more feasible.

The effects of Great Lakes water levels were dramatically different during the first two survey periods, although actual water levels were not greatly different at the time of survey. For example, the mean level was 174.79 m above sea level (ASL) in October 1968, 175.14 m in October 1976, and 174.96 m in October 1982. The water level increased from a low of 174.05 m ASL in 1964 to a high of 175.30 m ASL in October 1973. The gradual trend to high water in 1973 from the low in 1964 led to a severe cattail die-off between the two early survey periods. The result was a great increase in the quantities of open water in those marshes without complete water-level control. Greater quantities of high quality waterfowl foods, such as wild celery and various species of pondweeds, occurred in the open water areas that resulted from the cattail die-off. In the deeper areas the higher lake levels probably reduced the quantity of high quality duck foods because of reduced light penetration. Only small areas of cattail died off after 1976. Figure 2 illustrates the changes in vegetation with sections of aerial photos taken by Energy, Mines, and Resources in 1968 and 1976 for two portions of marshland. Section A is located on Squirrel Island and shows the beneficial effects of high water reducing cattail, which resulted in improved marsh – open water interspersion. Section B is at the south edge of the Big Point Club and shows the elimination of vegetation as lake levels increased in the deep water areas.

Between 1968 and 1976 approximately 525 ha of marsh were drained for agriculture. At the same time a marina was completed and subdivisions were developed on an additional 80 ha near Mitchell Bay and the mouth of the Thames River. Approximately 400 additional hectares were drained by 1982. Much of the drained land was used for corn production, and portions were operated as dryland waterfowl hunting clubs during the autumn.

In 1974 CWS purchased approximately 240 ha two kilometres north of the Thames River, and management changed from that of a hunting club to a National Wildlife Area on which hunting is prohibited.

On the Walpole Reserve, leases were not renewed on portions of two private hunting clubs totalling approximately 2800 ha. The Walpole Indian Band began to manage the 2800 ha as part of their public hunting area and hunting pressure greatly increased.

One additional factor changing the use of the wetlands by waterfowl has been a dramatic increase in pleasure boat traffic.

5.1. Changes in the use of the entire area

Table 1 summarizes use of the Lake St. Clair marshes by the major species and groups of ducks, geese, and swans during autumn and spring in 1968–1969, 1976–77, and in 1982. In autumn total waterfowl use rose by 27% from 1966 to 1976 and by a further 10% (of the 1968 base) by 1982. Mallard numbers nearly doubled by 1976 while the combined numbers of Black Ducks and other dabblers fell by 49%; from 1976 to 1982 they showed little further change. Changes in autumn use by the four principal diving duck species were small, though there was an 80% decline in other divers from 1968 to 1976, largely restored by 1982. Geese (nearly all *Branta canadensis*) increased by 61% to 1976 and by a further 130% to 1982. There were few swans in autumn in 1968 but appreciable numbers in 1976 and 1982.

Duck days in the spring of 1969 were 20.7% of those in autumn 1968. In general, spring use is a better indication of the intrinsic value of the marshes to waterfowl, as management practices that increase bird numbers for hunting are not usually implemented during the spring. Spring waterfowl migration occurs more rapidly than in autumn and the impression given by spring waterfowl days is rather less favourable than in autumn. The apparent changes in total

Figure 2
Examples of changes in vegetation and interspersion: A) shallow marsh areas in the Swan Lake Club on Squirrel Island, and B) deep marsh areas in the Big Point Club between 1968 and 1976

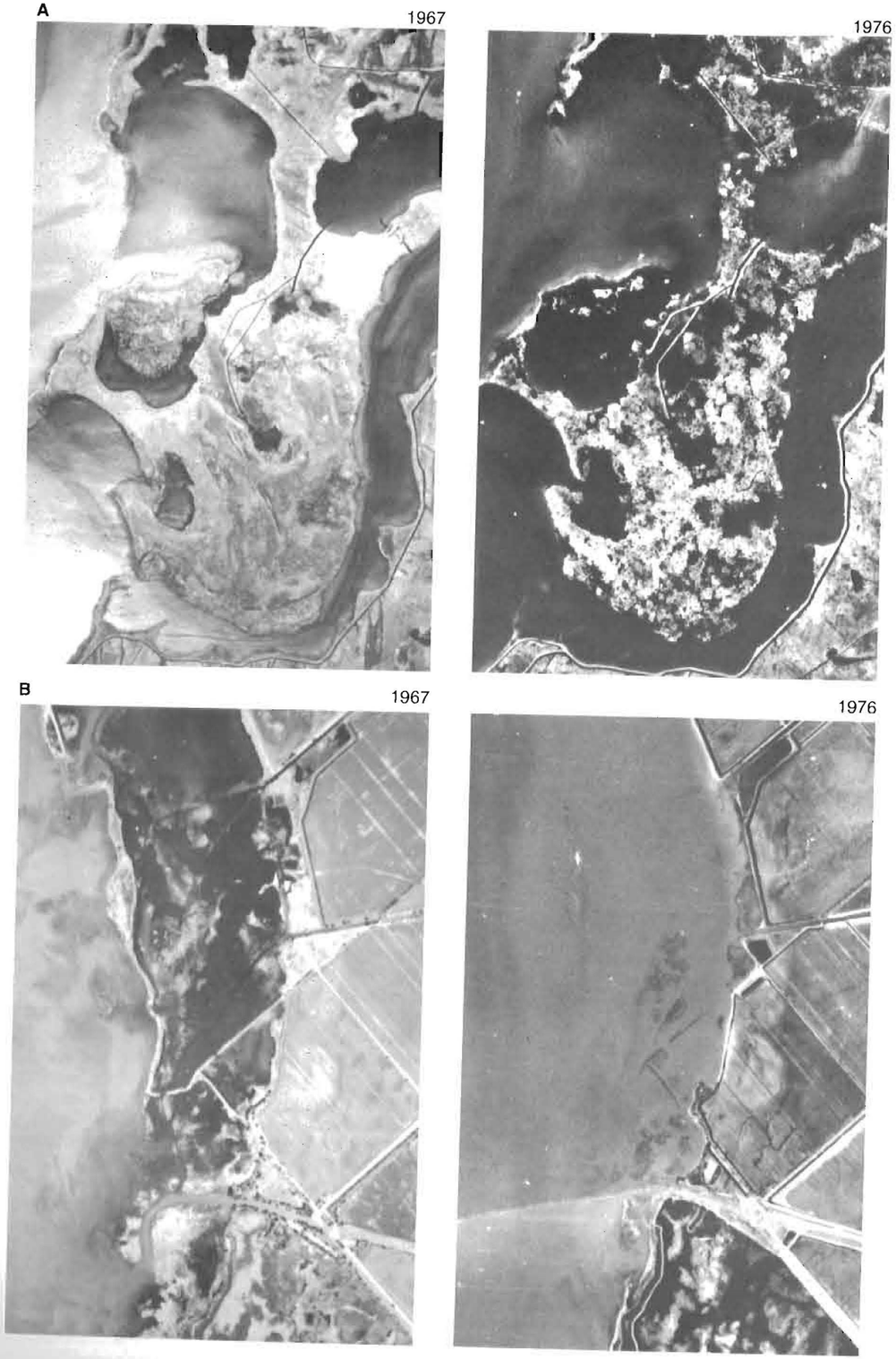


Table 1
Waterfowl use of the Lake St. Clair marshes in autumn and spring in 1968–69, 1976–77, and 1982; in thousands of waterfowl-days

	Seasonal waterfowl use						% change in waterfowl use			
	Autumn (1 Sept. – 16 Dec.)			Spring (17 Mar. – 7 June)			Autumn			Spring
Species groups	1968	1976	1982	1969	1977	1982	1968–1976	1968–1982	1969–1976	1969–1982
Mallards	1632	3217	3253	188	238	172	97.0	99.0	26.6	–8.5
Black Ducks	1027	940	949	108	69	88	–8.5	–7.6	–36.1	–18.5
Other dabbling ducks	612	365	362	391	106	81	–40.4	–40.8	–72.9	–79.3
Canvasbacks, Redheads	1041	1106	893	111	171	236	6.2	–14.2	23.4	67.4
Greater and Lesser scaup	44	36	46	100	158	204	–18.2	4.5	58.0	104.0
Other diving ducks	243	48	209	23	31	106	–80.2	–14.0	34.8	360.9
Total ducks	4599	5712	5712	951	776	887	24.2	24.2	–18.4	–6.7
Geese	373	602	1084	138	259	198	61.4	190.6	87.7	43.5
Swans	1	9	15	122	104	157	800.0	1400.0	–14.8	28.7
Total waterfowl	4973	6323	6811	1211	1139	1242	27.1	37.0	–5.9	2.6

spring waterfowl use were small. The marshes in spring were used much less by dabbling ducks, other than Mallards, from 1969 to 1977, although they had recovered some of their value for those species in 1982. By 1982, Mallard numbers had fallen below their 1969 level. Diving duck use increased in spring from 1969 to 1977 and increased even more from 1977 to 1982. The number of Canada Geese using the marshes in spring increased by 88% from 1969 to 1977 but in 1982 were only 43% higher than in 1969, not showing the accelerated growth seen in autumn. Lake St. Clair has long been one of the major haunts of Tundra Swans in spring. Evidently it still is, though the substantial growth in the numbers of swans wintering in the US Atlantic coast states during the last 20 years has not been reflected in the swans' use of Lake St. Clair. We believe that the failure of the recorded numbers to keep pace with population growth is due to a change in local distribution that began in the early 1960s. Swans began to spend less time in lakeshore marshes and more in poorly drained areas in agricultural land throughout southwestern Ontario (Gunn 1971). Thus they have become less likely to be encountered during the aerial surveys associated with lakeshore marshlands.

High lake levels increased the carrying capacity of the marshes, temporarily helping to offset losses caused by drainage. The effects of reduced areas of emergent marsh are directly reflected by the decreased numbers of true marsh-dwelling species, such as the American Wigeon (*Anas americana*), Gadwall (*Anas strepera*), Green-winged Teal (*Anas crecca*) and Wood Duck (*Aix sponsa*).

The increase in number of Mallards in spring from 1969 to 1976 corresponds to their increase as breeding birds in Ontario (Collins 1974), which seems now to have slowed down. The much more striking increase in autumn over the same period was probably a result of the widespread local use of baiting with grain to attract and hold field-feeding ducks and geese during the hunting season. This may have helped to enlarge the spring population by encouraging longer stopovers and increasing the waterfowl tradition in the general area.

The large decrease in Black Duck numbers in spring from 1969 to 1977 similarly corresponds to their widespread decline over much of Ontario and adjacent states. Their partial recovery locally by 1982 is not known to have been matched elsewhere, and may be a result of the surveys missing a rapid migration peak during the spring of 1977.

In general, diving duck habitat increased in quality as a result of greater areas of open water with submergent species of plants that are favoured foods of waterfowl. The increases in numbers of diving ducks in spring reflect this improvement. In autumn greater disturbance by boat traffic and increased hunting pressure in some areas otherwise preferred by diving ducks helped to prevent corresponding growth in diving duck use, though by 1982 most of the species other than Canvasbacks and Redheads seem to have adapted successfully to the changed circumstances. Most of the autumn declines from 1968 to 1976 were due to major reductions in Ruddy Ducks (*Oxyura jamaicensis*) and Ring-necked Ducks (*Aythya collaris*). Over their entire range Ruddy Ducks have been decreasing but Ring-necks increasing (Bellrose 1978). We believe that reduced use in autumn by both species may have been due to competition by other species, leading to less food in deeper waters. In addition, greatly increased numbers of Mallard exploited the new shallow marsh zones that resulted from high lake levels.

5.2. Changes in individual marsh areas

Changes in waterfowl use of the marshes depicted in Figure 1 are summarized in Tables 2 and 3. The following notes deal with some apparent reasons for the recorded changes.

Area 1 — Pointe-aux-Roches and Baptiste Club (283 ha)

The increase in use from 1968–69 to 1976–77, especially by Mallards, was a function of habitat improvement due to high water levels. The subsequent decline that had occurred by both spring and autumn of 1982 was a result of drainage of 60 ha, though the numbers of Mallards and Black Ducks were sustained in autumn by a baited sanctuary.

Area 2 — Bradley Marsh (550 ha)

About 80% of the wetland was drained for agriculture by 1977. Subsequent management for fall hunting switched to a combination of legally baited sanctuary areas and partially flooded corn fields. This increased the numbers of the principal field-feeders — Mallards, Black Ducks, and Canada Geese — in autumn, but the loss of most of the marsh greatly reduced duck numbers in spring.

Area 3 — Balmoral Club (81 ha)

A large increase in autumn use from 1968 to 1976 was achieved by means of a baited sanctuary area but the larger attractions on area 2 seem to have drawn off many of the field-feeding species by 1982. There was little change in spring use of this small area, other than some increase in visits by Canada Geese in 1977.

Area 4 — St. Clair National Wildlife Area (240 ha)

This was a private hunting club until purchased by CWS in 1974. Hunting has been prohibited since the creation of the NWA. Initially this led to a dramatic increase in use by Mallards and Black Ducks. Both are species that utilize adjacent baited areas and feed in fields extensively; however, even when feeding on grain they also consume quantities of marsh-grown foods. As a result of the quick consumption of marsh plants by these two dominating species, the numbers of other dabbling ducks using the area in the fall fell after the establishment of the NWA, as did the number of Mallards and Black Ducks returning in the spring. In an effort to increase long-term use by true marsh-dwelling species (that do not also feed in fields) the water level was lowered temporarily during the summer of 1981 to establish good quality aquatic vegetation. In the spring of 1982 corn fields in the vicinity were heavily flooded and attracted large numbers of Mallards, Canada Geese, and Tundra Swans, thus decreasing Mallard numbers observed within the boundaries of the marsh.

Area 5 — St. Lukes (170 ha)

Changes in waterfowl use in this area are very different from those in area 4, in that increased autumn use from 1968 to 1976 by Mallards and decreased use by Black Ducks may partially reflect the local population changes in the two species. Decreases in Mallard numbers by the autumn of 1982 may be a reflection of the greater attractions in area 2. Spring use had increased by 1977 for all species of dabbling ducks because of food resources remaining from the previous autumn. Further increases had occurred by the spring of 1982 for all species other than Mallards. Spring use by geese had decreased in both 1977 and 1982 because the geese tended to concentrate on the wheat fields adjacent to area 2. Management of area 5 was not greatly changed during the period.

Area 6 — Big Point (885 ha)

Area 6 does not have water-level control and large increases in the amount of quality waterfowl foods such as sago pondweed and wild celery occurred when extensive beds of emergent vegetation, largely cattails, were killed by high lake levels. Autumn use by all species of dabbling ducks, as well as by Canvasbacks and Redheads, increased considerably from 1968 to 1976, both because of better foods available in the open water and a shift of much of the hunting activity to areas adjacent to upland crop fields.

In autumn 1982, reduced numbers of Mallards and Black Ducks, and greater numbers of all species of diving ducks, Canada Geese, and swans used the area. High water has continued to modify the area, so that more extensive beds of submergent aquatics useful as food for diving ducks now exist. The dramatic increase in "other diving ducks" is a result of the return of Ring-necked and Ruddy ducks to the area (Dennis and Chandler 1974). The elimination of a major baited area, in association with a dryland hunting club nearby, partially accounts for the reduced use by Mallards and Black Ducks, while geese and swans had increased because of increased populations using the region.

During spring the use by Mallards and Black Ducks was relatively unchanged from 1969 to 1977. Use by other dabbling ducks and Canvasbacks and Redheads dropped greatly, probably because of extensive food exploitation by the increased numbers of birds during autumn. Both Canada Goose and Tundra Swan use had increased. Swans shifted from area 11, on St. Anne Island, and from areas 12 and 13 (located on Walpole and Squirrel islands). Goose use also shifted from area 12. These shifts may have been a result of greater waste grain available in close proximity to area 6 as well as greater disturbance on the Walpole Reserve during spring because of activities associated with muskrat trapping. In 1982 dabblers were scarcer than in 1977 but diving ducks had further increased. Swans and Canada

Table 2
Waterfowl use of individual marshes on the shore of Lake St. Clair in autumn 1968, 1976, 1982; in thousands of waterfowl days to nearest thousand, "tr" <0.5. See Figure 1 for locations. Totals do not include "tr"

	Mallards			Black Ducks			Other dabbling ducks			Canvasbacks and Redheads			Scaups		
	68	76	82	68	76	82	68	76	82	68	76	82	68	76	82
1. Pointe-aux-Roches, Baptiste Club	9	45	41	2	2	5	13	18	tr	0	0	0	0	0	0
2. Bradley Marsh	411	589	1080	120	111	150	96	tr	5	tr	0	0	tr	0	0
3. Balmoral Club	8	166	59	2	15	1	tr	5	20	0	0	0	0	0	0
4. St. Clair N.W.A.	73	487	227	13	56	79	60	18	15	0	1	0	0	0	0
5. St. Lukes	25	80	66	14	4	13	19	17	4	0	0	0	0	3	0
6. Big Point	97	594	333	143	184	175	92	120	116	317	509	846	tr	6	46
7. Al Shane Lease	4	105	62	2	28	16	13	9	17	5	tr	tr	0	0	0
8. Mitchell Bay	9	14	15	0	3	1	1	6	12	66	4	17	0	7	0
9. Mud Creek	147	148	108	66	36	17	42	40	48	tr	0	12	tr	0	tr
10. Keowiash Marsh	3	26	3	1	7	tr	tr	3	1	0	0	0	0	0	0
11. St. Anne Shooting Co.	328	350	412	283	160	105	134	6	54	604	0	2	42	0	0
11A. Band Marsh		71	14		16	1		26	17		276	10		8	tr
12. Band Marsh	16	88	137	78	30	166	16	26	11	30	205	6	1	1	0
13. Owen Smith Marsh	436	325	570	115	135	146	55	5	28	0	tr	0	0	0	0
14. Swan Lake	13	38	12	41	79	7	5	10	3	5	26	tr	1	1	0
15. St. Clair Flats Shooting Co.	28	23	34	106	23	28	54	5	9	8	19	tr	tr	4	0
15A. Band Marsh		52	18		37	16		47	1		18	tr		tr	0
16. W.W. Anderson Co.	5	1	61	1	tr	23	2	0	1	0	41	tr	0	6	0
17. Seaway Island	12	15	1	37	14	tr	9	4	0	6	7	tr	0	0	0
18. Snake Island	8	0	0	3	0	0	1	0	0	0	0	tr	0	0	0
Total	1632	3217	3253	1027	940	949	612	365	362	1041	1106	893	44	36	46

	Other diving ducks*			Total ducks			Geese			Swans			Total waterfowl		
	68	76	82	68	76	82	68	76	82	68	76	82	68	76	82
1. Pointe-aux-Roches, Baptiste Club	tr	0	0	24	65	46	0	0	0	0	tr	0	24	65	46
2. Bradley Marsh	0	0	0	627	700	1235	108	336	770	tr	tr	tr	735	1036	2005
3. Balmoral Club	0	0	0	10	186	80	0	1	2	0	0	0	10	187	82
4. St. Clair N.W.A.	5	tr	1	151	562	322	6	4	0	tr	1	0	157	567	322
5. St. Lukes	tr	tr	0	58	104	83	0	0	0	0	0	0	58	104	83
6. Big Point	89	6	110	738	1419	1626	22	18	68	1	8	10	761	1445	1704
7. Al Shane Lease	0	0	0	24	142	95	0	0	tr	0	tr	5	24	142	100
8. Mitchell Bay	1	tr	1	77	34	46	tr	0	0	0	0	0	77	34	46
9. Mud Creek	2	tr	tr	257	224	185	0	0	0	0	0	0	257	224	185
10. Keowiash Marsh	0	tr	0	4	36	4	tr	0	0	0	0	0	4	36	4
11. St. Anne Shooting Co.	127	tr	84	1518	516	657	0	0	0	tr	0	0	1518	516	657
11A. Band Marsh		11	1		408	43		0	0		0	0		408	43
12. Band Marsh	1	4	8	142	354	328	1	1	tr	tr	0	0	143	355	328
13. Owen Smith Marsh	0	tr	tr	606	465	744	236	235	238	0	0	0	842	700	982
14. Swan Lake	tr	15	tr	65	169	22	0	0	tr	tr	0	0	65	169	22
15. St. Clair Flats Shooting Co.	18	1	3	214	75	74	tr	0	6	tr	0	0	214	75	80
15A. Band Marsh		5	tr		159	35		7	0		tr	tr		166	35
16. W.W. Anderson Co.	0	6	0	8	54	85	0	0	0	0	0	0	8	54	85
17. Seaway Island	0	tr	1	64	40	2	0	0	0	0	0	0	64	40	2
18. Snake Island	0	0	0	12	0	0	0	0	0	0	0	0	12	0	0
Total	243	48	209	4599	5712	5712	373	602	1084	1	9	15	4973	6323	6811

*Includes mergansers and Oldsquaws.

Table 3
Waterfowl use of individual marshes on the shore of Lake St. Clair in spring 1969, 1977, 1982; in thousands of waterfowl days to nearest thousand, "tr" <0.5. See Figure 1 for locations. Totals do not include "tr"

	Mallards			Black Ducks			Other dabbling ducks			Canvasbacks and Redheads			Scaups		
	69	77	82	69	77	82	69	77	82	69	77	82	69	77	82
1. Pointe-aux-Roches, Baptiste Club	4	11	2	4	tr	tr	9	10	2	0	0	0	tr	1	1
2. Bradley Marsh	55	14	16	5	6	1	68	14	6	0	0	tr	1	0	tr
3. Balmoral Club	tr	1	1	0	tr	tr	tr	2	tr	0	tr	0	0	1	2
4. St. Clair N.W.A.	34	15	8	12	2	1	90	3	9	0	0	2	0	0	0
5. St. Lukes	5	16	5	tr	tr	tr	6	13	14	0	0	tr	tr	tr	2
6. Big Point	13	19	16	15	13	11	101	3	1	23	6	20	3	8	22
7. Al Shane lease	3	4	tr	7	2	tr	1	24	5	1	0	1	1	0	0
8. Mitchell Bay	0	1	1	0	tr	tr	2	2	1	27	24	10	16	3	50
9. Mud Creek	4	3	1	4	tr	tr	7	3	1	0	tr	14	8	tr	7
10. Keowiash Marsh	0	16	tr	tr	11	0	1	4	tr	0	0	tr	0	0	1
11. St. Anne Shooting Co.	18	93	39	18	17	12	6	10	2	55	tr	tr	26	1	tr
11A. Band Marsh		2	20		3	29		2	6		17	32		23	32
12. Band Marsh	10	12	12	30	4	9	32	10	16	22	95	62	19	82	31
13. Owen Smith Marsh	21	15	13	4	3	2	55	1	1	1	3	2	2	8	1
14. Swan Lake	1	5	11	tr	4	8	tr	1	9	tr	tr	2	5	1	0
15. St. Clair Flats Shooting Co.	11	6	2	8	2	tr	8	4	tr	9	17	2	18	12	1
15A. Band Marsh		2	5		1	tr		tr	4		8	54		9	46
16. W.W. Anderson Co.	9	1	4	1	tr	13	5	0	1	1	4	1	tr	3	2
17. Seaway Island	tr	2	tr	tr	1	1	tr	0	0	2	tr	1	1	6	6
18. Snake Island	tr	0	16	tr	0	1	tr	0	3	0	0	33	0	0	tr
Total	188	238	172	108	69	88	391	106	81	141	174	236	100	158	204

	Other diving ducks*			Total ducks			Geese			Swans			Total waterfowl		
	69	77	82	69	77	82	69	77	82	69	77	82	69	77	82
1. Pointe-aux-Roches, Baptiste Club	1	1	2	18	23	7	tr	4	4	tr	2	0	18	29	11
2. Bradley Marsh	tr	1	tr	129	35	23	tr	105	89	1	1	1	130	141	113
3. Balmoral Club	0	tr	tr	0	4	3	tr	9	tr	4	3	tr	4	16	3
4. St. Clair N.W.A.	0	tr	3	136	20	23	57	24	0	10	7	2	203	51	25
5. St. Lukes	0	tr	5	11	29	26	12	1	1	1	1	tr	24	31	27
6. Big Point	1	5	11	156	54	81	18	104	89	7	52	26	181	210	196
7. Al Shane lease	tr	tr	0	13	30	6	0	2	1	0	3	19	13	35	26
8. Mitchell Bay	0	2	1	45	32	63	0	0	0	0	0	−1	45	32	64
9. Mud Creek	1	1	1	24	7	24	0	0	0	43	0	4	67	7	28
10. Keowiash Marsh	0	0	1	1	31	2	0	0	0	0	2	0	1	33	2
11. St. Anne Shooting Co.	2	1	5	125	122	58	1	0	0	8	19	0	134	141	58
11A. Band Marsh		9	18		56	137		0	1		tr	1		56	139
12. Band Marsh	10	2	11	123	205	141	46	tr	1	30	15	2	199	220	144
13. Owen Smith Marsh	tr	4	12	83	34	31	0	8	0	16	0	tr	99	42	31
14. Swan Lake	tr	1	4	6	12	34	0	tr	12	1	tr	3	7	12	49
15. St. Clair Flats Shooting Co.	5	1	16	59	42	21	2	0	tr	0	0	0	61	42	21
15A. Band Marsh		1	9		21	118		1	0		0	2		22	120
16. W.W. Anderson Co.	3	1	1	19	9	22	2	0	0	1	0	tr	22	9	22
17. Seaway Island	tr	1	3	3	10	11	0	0	0	tr	0	0	3	10	11
18. Snake Island	0	0	3	0	0	56	0	0	0	0	0	96	0	0	152
Total	23	31	106	951	776	887	138	259	198	122	104	157	1211	1139	1242

*Includes mergansers and Oldsquaws.

Geese were fewer than in 1977 but Big Point remained one of their principal regional haunts.

Area 7 — Al Shane Lease (202 ha)

The area was a dyked marsh with water-level control during 1968–69 but by 1976 the dyke had been breached and a marsh complex containing better quality plant interspersion resulted. Subsequently, use by Mallards and Black Ducks increased.

By autumn 1982 numbers of Black Ducks and Mallards had decreased while other dabbling ducks had increased. The marsh was in an optimum stage of succession as a result of high lake levels and thus was probably more attractive to the true marsh-dwelling species of dabbling ducks such as American Wigeon and Gadwall. Spring Black Duck use decreased from 1969 to 1982, reflecting population changes. Spring use by other dabbling ducks increased from 1969 to 1977, reflecting the better quality duck foods that were present, but decreased again by 1982, when Tundra Swans made this one of their preferred areas. Swans were able to forage in deeper waters than the dabbling ducks, where available food was less depleted by heavy duck use in autumn.

Area 8 — Mitchell Bay (688 ha)

The habitat in area 8 remained relatively unchanged during the 14 years. Adjacent marina developments on 6.5 ha of marsh (McCullough 1981) resulted in a great increase in pleasure boat traffic, especially near the peak of migration in late October. Canvasbacks and Redheads had decreased by the autumn of 1976. Partial recovery in 1982 may have been helped by regulations restricting offshore shooting. Spring use by most species was little changed. Use by scaup decreased from 1969 to 1977, then advanced to much higher levels in 1982, perhaps partly because of fewer Canvasbacks and Redheads. In southern Ontario, scaup tend to avoid areas used by large numbers of those species.

Area 9 — Mud Creek (687 ha)

Few management changes occurred between 1968 and 1976 but 350 ha of dyked marsh had been drained by 1982. This reduced the numbers of Mallards and Black Ducks in 1982 less than might have been expected, and other dabbling ducks had increased slightly. After drainage, bird use shifted to the undyked portion of the marsh, previously less favoured than the dyked marsh. The area is little used by diving ducks and not frequented by geese. Tundra Swans were abundant in spring 1969 but later largely abandoned the area, as part of the regional redistribution noted previously.

Area 10 — Keowiash Marsh (71 ha)

Area 10 is the north part of the marshland associated with St. Anne Island. Generally, water levels were held higher during the 1970s than in the 1968–69 period. Use by all species of dabbling ducks increased during both spring and autumn from 1968 to 1977, largely as a result of the creation of better marsh interspersion and a variety of plant species that were preferred waterfowl food. But by 1982 duck numbers had returned to 1968–69 levels, perhaps because less baiting was being done and the plant succession had advanced to a stage where quality duck foods were less available.

Area 11 — St. Anne Shooting Company (809 ha) and *11A Band Marsh (2105 ha)*

Areas 11 and 11A are located on St. Anne Island. Area 11A was part of area 11 during the 1968–69 survey period when the area was a leased hunting club. During the 8 years separating the first two surveys, area 11A reverted to the Walpole Indian Band and was used as a public hunting area. Autumn waterfowl use declined for all species except Mallards because of the heavier hunting pressure and associated disturbance on area 11A. In 1982, numbers of dabbling ducks, except for Black Ducks, had increased again as a result of a general shift during autumn from the Band marsh to the Company marsh, where hunting pressure was less. In spring, use by all dabbling ducks increased from 1969 to 1977, as did use by Tundra Swans, perhaps because of greater quantities of waterfowl foods remaining from the previous autumn. There was a considerable decrease in spring use by Canvasbacks and Redheads and a slight decrease in use by scaup. Probably the reduced use by the two groups was the result of fewer quality diving-duck foods, caused by deeper water reducing the extensive stands of submerged aquatics. In spring 1982 total duck use resembled that in spring 1977, although the majority of ducks were found on the Band Marsh, rather than the Company property.

Area 12 — Band Marsh (2198 ha)

Area 12 is managed by the Walpole Indian Band for public hunting. Although few major management changes were implemented during the survey period, high lake levels in conjunction with a dyked pumping system effectively opened many areas choked by cattails, and plant species useful as waterfowl foods invaded the area. For that reason, use increased from 1968 to 1976 for all species that occurred in significant numbers during autumn, with the exception of Black Ducks. Spring use by Canvasbacks, Redheads, and scaup had increased by 1977, whereas use by Black Ducks, other dabbling ducks, geese, and swans had all decreased. The geese and swans shifted to marshes such as area 6 and to fields further south. Fewer food resources remained for other dabbling ducks because of greater Mallard use during autumn. The decline in Black Duck use probably reflects a general population decline.

The apparently large increases in Mallards and Black Ducks by autumn 1982 and the reductions in other species are misleading because a survey on 12 December, when all marshes were almost entirely frozen, found a concentration of 24 150 birds on area 12 and only 72 waterfowl on the remainder of Walpole Island. The previous highest count on area 12 was 4414, early in the hunting season. The December concentration was confined to an ice hole, inaccessible to hunters.

Area 13 — Owen Smith Marsh (688 ha)

The area is a dyked marsh with good water control, leased as a hunting club from the Walpole Indian Band. In the early 1960s intensive marsh management was done on the area with much mechanical cutting of cattail and other emergent vegetation. The area was thus quite attractive to waterfowl during the 1968–69 survey period and was little changed during the 1976–77 period. Autumn use by Mallards and other dabbling ducks declined, though in general, autumn use is relatively constant. Spring use by other dabbling ducks and Tundra Swans decreased dramatically by 1977. The further increase in autumn use by most species by 1982 is probably a result of ducks being displaced from adjacent areas by disturbance.

Area 14 — Swan Lake Club (894 ha)

Area 14 is an undyked leased hunting club. During the 8-year period between the first two surveys the habitat improved greatly as a result of high lake levels. Both spring and autumn use by most of the abundant species or species groups increased. From 1976 to 1982 autumn use declined considerably, perhaps because of less baiting and additional hunting pressure. Increased use by the spring of 1982 may have occurred because of greater food availability as a result of lower autumn bird use.

Area 15 — St. Clair Flats Shooting Company (1193 ha) and 15A Band Marsh (712 ha)

During the 1968–69 survey, both areas 15 and 15A were leased by the St. Clair Flats Shooting Company. In the mid-1970s, area 15A reverted to the Walpole Band and was used as a public shooting area. High lake levels improved the marsh quality in both areas. If the two areas are considered as one unit for the period 1968 to 1976–77, little net change in waterfowl use occurred during autumn. Mallard numbers increased but the increase was approximately equalled by a decrease in Black Ducks. In spring, little net change in total waterfowl occurred; however, Canvasbacks and Redheads increased and there was a decline in Black Ducks.

For the 1982 survey, area 15 showed little net change from 1976 in total duck numbers during autumn. All dabbling duck numbers increased, partially as a result of the establishment of an effective baited sanctuary. Canvasbacks and Redheads decreased because they had shifted to offshore areas. Spring use decreased for all species.

By 1982, area 15A began to show the effects of public hunting as use by all species groups decreased during autumn. Greater remaining food resources resulted in an increase in use by most species groups during spring.

Area 16 — W.W. Anderson Company (506 ha)

The area is a leased hunting club with good water-level control. Much of the area is a dense cattail marsh with ponds cut for waterfowl hunting. In recent years some of the ponds have produced good stands of submergent aquatics such as sago pondweed. From 1968 to 1977 a number of changes in waterfowl use occurred on the area. Autumn use by Canvasbacks and Redheads increased, mainly because they were attracted to submergent aquatics in one of the larger ponds. Numbers of dabbling ducks decreased in spring while Redheads, Canvasbacks, and scaup increased.

By 1982 all dabbling ducks had increased during autumn while diving ducks decreased. Dabbling ducks increased as a result of the use of more baited sanctuaries and displacement from more heavily hunted areas in the vicinity, while diving ducks decreased because of smaller quantities of submerged aquatics in St. Anne Bay. Spring use by dabbling ducks increased as a result of the baited sanctuaries during autumn. In addition, aquatic submergent vegetation has improved in the small open water areas within the dyked areas of the marsh.

Area 17 — Seaway Island (648 ha)

Seaway Island was used as a site for disposal of dredged material when the St. Lawrence Seaway was constructed. Little net change in quality or quantity of habitat occurred during the 8 years separating the first two survey periods. Few waterfowl changes occurred except for Black Ducks, which declined during autumn in line with their generally reduced population.

In 1982, water levels were lower within the land-based portion of Seaway Island. Thus in the autumn all species, with the exception of other diving ducks (which principally used the river), had declined. Higher waters within the island boundaries, caused by melted snow during spring, resulted in only minor fluctuations between the second and third survey period.

Area 18 — Snake Island (111 ha)

Area 18 was a section of low quality dyked marsh that was drained for agriculture about 1970. Most waterfowl were attracted to the area by baited ponds during the first survey and, although waterfowl were not recorded during the 1976–77 period or in autumn 1982, it is highly likely that birds were present on the farmland sections during the morning and afternoon feeding periods. Our surveys normally occurred between the feeding periods.

Flooding during spring 1982 resulted in intensive use by a number of species, notably Mallards, Canvasbacks, and Tundra Swans. Thus, even though it has been drained for agriculture, when flooded it is still used by species such as Canvasbacks, which usually have rather specific habitat requirements for staging.

6. Summary and conclusions

A variety of factors influenced waterfowl use of the Lake St. Clair marshes during the 14-year period spanned by the surveys. The factors that increased waterfowl use included expanding populations of Mallards, Canada Geese, and Tundra Swans and the increased use of baited sanctuaries. The increased lake levels had a net positive effect, improving large areas when solid cattail stands were replaced by submerged aquatics. The creation of an area closed to hunting on area 4 had both positive and negative effects on waterfowl use. Although large increases in use by Mallards and Black Ducks initially occurred during autumn, use by other dabbling ducks dramatically decreased, in part because of exploitation of the food resources by Mallards and, to a much lesser extent, by Black Ducks. Reduced use by all numerically important species groups during spring can be explained by the depletion of food exploited by large numbers of birds during autumn.

Factors reducing waterfowl use include land drainage, marina development, increased boat traffic, increased public hunting on portions of the areas owned by the Walpole Indian Band that had been club lands, and population declines of species such as Black Ducks and Ruddy Ducks.

Present agricultural trends will probably continue, and marsh areas will be further reduced, especially on Walpole, St. Anne, and Squirrel islands. Use by most species will diminish, with the possible exception of Mallards, Canada Geese, and the open water diving ducks such as the Greater and Lesser scaup (*Aythya marila* and *A. affinis*). Those species such as Mallards and Canada Geese, which are adaptable to management by man, will continue to inhabit the Lake St. Clair area in large numbers as long as man continues to manage them for sport hunting. The mergansers will continue at a level of abundance directly related to their overall population status because it is unlikely that the open water areas of Lake St. Clair will be radically altered by man. If the effect of disturbances such as boat traffic can be controlled, and provided that the bays are not dyked, filled, or greatly polluted by agricultural chemicals, the use of shallow bays by Canvasbacks and Redheads will fluctuate approximately with their continental populations. The constantly increasing operating costs for leased hunting club lands are likely to result in additional areas reverting to the Walpole Indian Band in

future years. If the land is retained as marsh it will probably be managed as a public hunting area. Hunting pressure will increase and use by waterfowl during autumn will decrease.

If current waterfowl numbers and species diversity are to be maintained at Lake St. Clair, a means must be found to maintain the remaining marsh habitat. Management practices should not favour the adaptable winners, such as Mallards and Canada Geese, at the expense of the less adaptable marsh-dwelling species such as American Wigeon, Gadwall, and Blue-winged Teal (*Anas discors*), or the diving ducks such as Redheads and Canvasbacks. In general, waterfowl use of the area will continue to be a function of available habitat and management practices tempered by population levels.

7. Literature cited

Bellrose, F.C. 1978. Ducks, geese and swans of North America. 2nd ed., rev. Stackpole Company, Harrisburg, PA. 544 pp.

Collins, J.M. 1974. The relative abundance of ducks breeding in southern Ontario in 1951 and 1971. Pages 32–44 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shoreline of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada 1969–73. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Gunn, W.W.H. 1971. The endangered environment of the Whistling Swan. Can. Wildl. Serv. Ottawa, Ontario. Unpubl. mimeo rep. 7 pp.

McCullough, G.B. 1981. Wetland losses in Lake St. Clair and Lake Ontario. Pages 81–89 *in* Champagne, A. ed. Proc. of the Ontario Wetland Conference, Toronto, Ontario, 18–19 Sept. 1981. 193 pp.

Migrant waterfowl use of the major shorelines of eastern Ontario

by R.K. Ross

1. Abstract

During the spring and fall migration periods of 1976 and 1977, the Canadian Wildlife Service undertook a series of 19 aerial surveys of waterfowl along the shore of northeastern Lake Ontario, the Ontario shore of the St. Lawrence River, and both banks of the Ottawa River below Ottawa.

Total waterfowl days and mean daily counts per 100 ha for various survey zones were calculated for the following waterfowl groups: geese, large and small dabblers, pochards, goldeneye, sea ducks, and mergansers. Dominant species, in rank order, were Greater Scaup, Canada Goose, Common Goldeneye, Mallard, Common Merganser, and Black Duck. Atlantic Brant, Canvasback, and Redhead were also recorded in significant numbers.

Highest waterfowl numbers were concentrated in the zones around the outlet of Lake Ontario and particularly centred on Wolfe Island. During the spring, 46% of all waterfowl days spent along the southern Ontario shoreline were generated in eastern Ontario, over half of them in the vicinity of Wolfe Island. As large numbers of diving ducks use the district, conservation of their offshore feeding beds is important and requires further study. Other areas of high waterfowl concentrations include Lake St. Francis and sections of the Ottawa River (particularly in spring).

Waterfowl distribution is related to agricultural practices, urbanization, hunting pressure, sanctuary areas, and artificial feeding. Implications of future developments are also examined.

2. Introduction

Waterfowl migration through eastern Ontario, although known to be significant, has not previously been examined in detail. Earlier works have been quite local, e.g. the study by Munro (1967) of the lower Ottawa River marshes, and the compendium by Quilliam (1973) on the birds of the Kingston area. To complete the coverage, a series of surveys was flown during the spring and fall of both 1976 and 1977 covering the following shorelines: northeastern Lake Ontario from Presqu'ile Provincial Park to Kingston; the Ontario shore of the St. Lawrence River to Lake St. Francis; and the lower Ottawa River from Ottawa to the Carillon Dam. The objectives were to document the waterfowl use of the shorelines and to relate waterfowl distribution to habitat quality and availability. The influence of man-induced factors including urbanization, agricultural practices and, more directly, game management activities including sanctuaries and feeding are examined. Observations on migration phenology and gross habitat preferences are also presented. This survey aims to provide baseline waterfowl data that will be useful to those assigning priorities to habitat management activities, setting hunting regulations, and preparing environmental impact assessments of proposed developments.

3. Methods

3.1. Field procedure

The aerial surveys were usually performed by two observers in a Cessna 336 or 337 Skymaster aircraft, although a Cessna 180 and a DeHavilland DHC-2 Beaver were used occasionally. All surveys were flown at approximately 75 m agl and 160 km/h and took place between 09:00 and 15:00 EST. The following weather conditions were generally required: ceiling above 150 m, lateral visibility greater than 3 km, wind less than 40 km/h. The area included all potentially attractive habitat within 800 m of the shoreline. Flights followed a standardized path approximately 200 m off the shore and no limits were placed on observation strip width. The observers noted all waterfowl either by direct counting if numbers were small or by estimating the size of the larger flocks. Whenever practical, individuals were identified to species; however, such segregation was often not possible and more general species groupings were used (see Table 1 for breakdown). All observations were recorded on cassettes for later transcription.

Table 1
Composition of waterfowl species group categories

Name of group	Species included
Geese	Canada Goose (*Branta canadensis*), Brant (*Branta bernicla*), Snow Goose (*Anser caerulescens*).
Large dabblers	Mallard (*Anas platyrhynchos*), Black Duck (*Anas rubripes*), Gadwall (*Anas strepera*), Northern Pintail (*Anas acuta*)
Small dabblers	Green-winged Teal (*Anas carolinensis*), Blue-winged Teal (*Anas discors*), American Wigeon (*Anas americana*), Northern Shoveler (*Anas clypeata*), Wood Duck (*Aix sponsa*)
Bay ducks	Redhead (*Aythya americana*), Ring-necked Duck (*Aythya collaris*), Canvasback (*Aythya valisineria*), Greater Scaup (*Aythya marila*), Lesser Scaup (*Aythya affinis*).
Goldeneye	Common Goldeneye (*Bucephala clangula*), Bufflehead (*Bucephala albeola*).
Sea ducks	Oldsquaw (*Clangula hyemalis*), White-winged Scoter (*Melanitta deglandi*), Surf Scoter (*Melanitta perspicillata*), Black Scoter (*Melanitta nigra*).
Mergansers	Hooded Merganser (*Mergus cucullatus*), Common Merganser (*Mergus merganser*), Red-breasted Merganser (*Mergus serrator*).

3.2. Factors influencing survey results

Aerial survey data often lead to underestimation of the numbers of waterfowl present. Factors affecting survey efficiency include aircraft type, observers, species of waterfowl, and viewing conditions. These influences have been generally reviewed by other authors (see Joensen 1968, for a thorough analysis); however, several remarks are needed on the specifics of this study.

a) Aircraft type. The Cessna Skymaster's advantages lie in its excellent visibility, general quietness, safety over water (two engines), long range, and fast cruising speed for ferrying. It does, however, require the relatively high minimum survey speed of 160 km/h, and it has limited manoeuvrability. Although the faster speed undoubtedly does reduce survey efficiency through missed birds, a slower-moving, noisier aircraft such as the Beaver gives the waterfowl more warning and may cause birds to flush so far in advance of the airplane as to be missed, or misidentified.

b) Observer. Observers vary in their abilities to estimate totals, observe distant birds, and distinguish between species. I acted as the prime observer on all flights, which provided a degree of standardization. Other observers were placed on the left side of the aircraft where overall waterfowl numbers were much lower due to the deliberately chosen flight path of the survey aircraft.

c) Waterfowl species. Most of the waterfowl seen were diving ducks. Of these, the bay ducks (*Aythya* spp.), Common Goldeneye (*Bucephala clangula*), Bufflehead (*Bucephala albeola*), and mergansers (*Mergus* spp.) were excellent subjects for aerial survey because of their tendency to form highly visible flocks, preference for shallow water, and relatively minor avoidance reactions to low-flying aircraft. The exceptions were the scoters (*Melanitta* spp.) and Oldsquaw (*Clangula hyemalis*) which frequented deeper water and were more widely dispersed, making complete coverage unlikely. Also, Oldsquaw often dived before the aircraft reached them, further lowering counts. Canada Geese and the large dabbling ducks were counted fairly accurately; however, these species often preferred foraging inland and so numbers along the open water should be treated as indices.

d) Viewing conditions. Viewing conditions were controlled as much as possible by restricting the surveys to days with acceptable weather criteria; however, subtle interrelationships between lighting and wave action affected the visibility of the birds and provided the opportunity for further biases.

Table 2
Survey dates and extent of coverage (see Fig. 1 for zone names)

Date		Year	Zones covered
March	9	1977	A, C, D, F, G, I, J, L
	10	1976	A – G
	11	1976	H – N
	24	1976	A – G
	25	1976	H – J
	25	1977	A, C, D, F, G, I, J, L
April	7	1976	A – G
	8	1976	H – N
	12	1977	A, C, D, F, G, I, J, L
	29	1976	A – G
	29	1977	A, C, D, F, G, I, J, L
	30	1976	H – N
May	20	1976	A – G
	20	1977	G – L (Brant only)
	25	1976	H – N
June	3	1977	A, C, D, F, G, I, J, L
September	22	1977	A, C, D, F, G, I, J, L
	28	1976	A – G
	29	1976	H – N
October	19	1977	A, C, D, F, G, I, J, L
November	5	1976	A – G
	6	1976	H – N
	15	1977	A, C, D, F, G, I, J, L
December	1	1976	A – E
	3	1976	F – J, M, N
	8	1977	A, C, D, F, G, I, J, L
January	20	1977	A – N

Figure 1
Map of eastern Ontario showing waterfowl survey zones

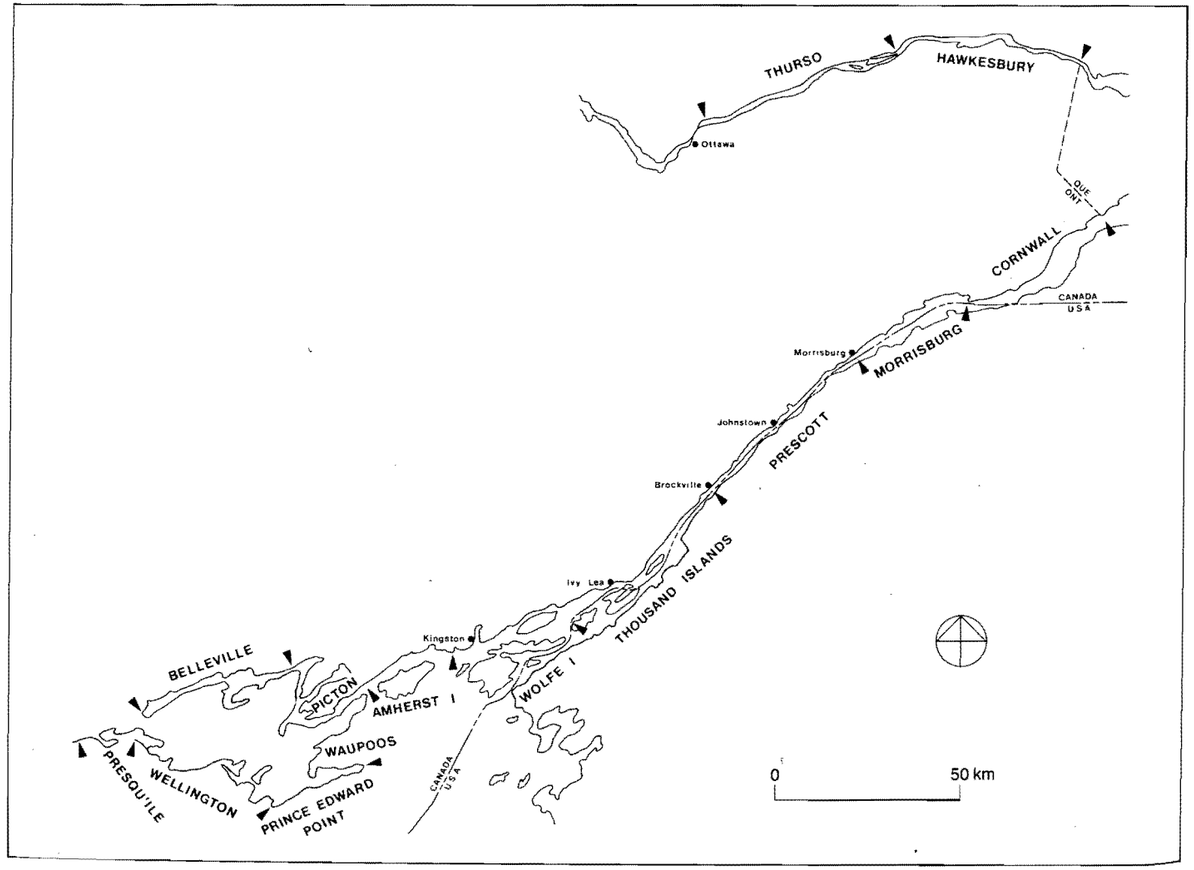


Table 3
Extent of waterfowl use of the survey zones in the spring (1 March – 1 June)

Zone	Waterfowl days (1000s)								
	Geese	Large dabblers	Small dabblers	Bay ducks	Goldeneye	Sea ducks	Mergansers	Total (including unidentified)	Rank of utilization level
Thurso	524.0	26.7	0.9	4.3	2.1	0.1	1.9	560.5	12
Hawkesbury	352.0	1.6	tr*	12.2	3.4	0.2	5.6	375.2	7
Cornwall	14.0	4.6	0.3	334.1	47.7	0.1	22.5	423.5	8
Morrisburg	427.5	5.5	0.2	17.3	4.7	tr	5.2	460.8	10
Prescott	0.8	2.6	0.1	119.9	21.4	tr	10.4	155.5	5
Thousand Islands	2.5	3.3	1.0	429.5	46.3	0.4	34.0	517.1	11
Wolfe Island	529.1	22.7	2.5	1136.4	85.1	1.5	44.1	1821.5	14
Amherst Island	27.7	4.9	1.7	334.1	55.2	17.1	18.3	459.5	9
Waupoos	71.9	1.5	0.5	452.1	41.5	33.3	22.2	623.1	13
Prince Edward Point	2.5	1.1	0.1	1.9	48.2	15.1	7.3	76.5	2
Wellington	0.3	1.3	tr	84.9	26.7	16.5	14.5	144.1	4
Presqu'ile	4.7	7.3	1.1	147.9	29.9	26.7	6.6	224.3	6
Belleville	0.8	2.4	0.4	4.1	2.6	tr	39.3	49.8	1
Picton	0.9	0.2	tr	90.7	18.2	0.3	18.5	129.0	3

*tr = trace (<0.05).

Table 4
Extent of waterfowl use of the survey zones in the fall (16 August – 1 January)

Zone	Waterfowl days (1000s)								
	Geese	Large dabblers	Small dabblers	Bay ducks	Goldeneye	Sea ducks	Mergansers	Total (including unidentified)	Rank of utilization level
Thurso	1.5	26.5	9.5	5.2	1.3	tr*	6.2	51.1	5
Hawkesbury	1.6	2.1	tr	15.3	6.4	tr	0.7	27.2	3
Cornwall	4.1	15.3	1.1	65.9	95.0	tr	71.9	257.4	10
Morrisburg	188.3	21.3	3.3	24.5	0.5	tr	50.3	288.3	11
Prescott	0.6	0.6	tr	17.4	22.5	tr	11.9	53.8	6
Thousand Islands	0.1	2.5	0.4	3.3	11.7	tr	14.9	32.9	4
Wolfe Island	120.5	216.9	24.3	1215.7	29.5	6.9	5.0	1713.3	14
Amherst Island	0.7	40.1	5.0	38.5	20.4	8.2	0.4	113.4	8
Waupoos	0.1	6.3	tr	463.4	8.9	1.1	2.2	482.1	12
Prince Edward Point	0.5	7.9	0.2	874.3	63.3	40.5	2.6	989.2	13
Wellington	tr	2.2	tr	72.8	53.1	8.3	0.3	136.9	9
Presqu'ile	tr	5.4	1.0	39.5	24.3	3.5	0.2	74.1	7
Belleville	tr	0.2	0.5	tr	tr	tr	tr	0.8	1
Picton	tr	2.3	0.8	1.0	7.0	tr	3.4	14.6	2

*tr = trace (<0.05).

3.3. Survey coverage and organization of data

The survey route was divided into small sectors characterized by landmarks and differences in physiography. All data were initially summarized by sectors, a format suitable for use in special local studies such as impact assessments. For the purpose of this report, however, the data have been lumped into broader units termed survey zones which are geographical entities of generally similar habitats (see Fig. 1). All zones were covered during the 1976 survey series; in 1977, only those zones having significant usage were resurveyed.

3.4. Timing of surveys

Surveys were flown in 1976 and 1977 during the spring, fall, and early winter. The dates are summarized in Table 2, which shows a roughly similar schedule in both years. The surveys on 2 June and 20 January provided baseline levels for summer and winter numbers respectively in the calculation of waterfowl days of utilization.

3.5. Habitat quantification

Areas of broad habitat types of importance to waterfowl have been taken from 1:50 000 topographical maps (contiguous marshes and swamps) and nautical charts of varying scale (deep-water and shallow-water marshes, and river and lake bottom of 5.5 m depth or less). Those results plus lengths of survey route per zone are presented in Appendix 1.

4. Results

General survey results have been summarized in three pairs of tables.

(1) Tables 3 and 4 describe overall waterfowl distribution by providing estimates of migrant waterfowl use of

each survey zone in the spring (1 March – 1 June) and fall (16 August – 1 January) respectively. The parameter used is the number of waterfowl days per waterfowl group by zone, as in Dennis and Chandler (1974). For this calculation, results of each successive pair of surveys were averaged, multiplied by the number of days separating the two and summed over the whole migration period. Where data from 2 years were available, means have been taken.

(2) Tables 5 and 6 facilitate interzonal comparisons by presenting measures of the intensities of zone usage in the spring and fall. The unit used is the mean daily number of waterfowl per 100 ha of surveyed habitat.

(3) Tables 7 and 8 document the timing and size of migration peaks for various waterfowl species. Also included are the identifications and totals for zones having the highest counts to demonstrate the extent of local concentrations in the birds' distributions.

4.1. Geese

The majority of geese encountered were Canada Geese (Tables 7 and 8), mostly migrants of the mid-Atlantic subpopulation. There were also two local breeding flocks along the route: approximately 35 pairs on Amherst Island, nesting in the marshes of the Nut Island Duck Club; and approximately 2500 pairs nesting in and around the St. Lawrence Parks Sanctuary (Morrisburg zone). Although Canada Geese have been recorded in every zone in the survey, highest concentrations (>100 000 goose days) were restricted to four zones, including the two along the Ottawa River (spring only), Morrisburg, and Wolfe Island. Usage of the latter two areas was due to excellent foraging opportunities (grass in the spring, corn in the fall), combined with the autumn baiting and sanctuary operations which have reinforced stopping-over. Goose concentrations along the Ottawa River in spring were probably due to staging birds taking advantage of the rich feeding grounds on nearby farmlands before migrating over the heavily forested granitic uplands immediately to the north. Low fall goose numbers along the Ottawa River probably resulted both from high hunting pressure because of easy accessibility, and from the presence of major sanctuaries immediately to the south (St. Lawrence Parks, Wilson Hill Park, NY).

Canada Geese usually appeared in eastern Ontario in mid-March and migrants remained as late as mid-May. Peak counts occurred between late April and early May, which is the duration of maximum migration (Blokpoel and Gauthier 1980). In 1977, peak counts were noted in the Wolfe Island zone on 12 April, but highest numbers in the Thurso zone were not recorded until 29 April; possibly, geese were moving from Wolfe Island to the Ottawa River as the two zones are directly along the same flight route.

Fall migration was spread over a longer period than in the spring, although numbers per survey and total goose days were considerably lower. It is not known whether the decreased utilization was the result of shorter stays, or an increased over-flying of the area by a larger proporton of the population. The flight usually commenced in late September and peaked between mid-October and early December.

Table 5
Intensity of waterfowl use per zone in the spring

	Intensity of use by waterfowl (Waterfowl days ÷ area [100 ha] ÷ survey period)				
Zone	Geese	Dabblers	Divers	Total waterfowl (including unidentified)	Rank
Thurso	101.0	5.3	1.6	108.0	8
Hawkesbury	92.9	0.4	5.7	99.0	7
Cornwall	2.5	0.9	73.5	76.9	5
Morrisburg	161.4	2.1	10.3	174.0	12
Prescott	0.8	2.7	154.7	158.6	10
Thousand Islands	0.6	1.0	122.0	123.7	9
Wolfe Island	70.9	3.4	169.9	244.2	14
Amherst Island	10.4	2.5	159.0	172.1	11
Waupoos	23.3	0.7	177.9	201.8	13
Prince Edward Point	0.9	0.4	26.0	27.4	3
Wellington	0.1	0.3	27.6	27.9	4
Presqu'ile	1.9	3.4	85.9	91.2	6
Belleville	0.1	0.3	4.4	4.8	1
Picton	0.2	tr*	27.0	27.3	2

*tr = trace (<0.05).

Table 6
Intensity of waterfowl use per zone in the fall

	Intensity of use by waterfowl (Waterfowl days ÷ area [100 ha] ÷ survey period)				
Zone	Geese	Dabblers	Divers	Total waterfowl (including unidentified)	Rank
Thurso	0.2	4.6	1.6	6.5	5
Hawkesbury	0.3	0.4	3.9	4.8	3
Cornwall	0.5	2.0	28.2	31.2	9
Morrisburg	47.4	6.2	18.9	72.6	11
Prescott	0.4	0.4	35.2	36.6	10
Thousand Islands	tr*	0.5	4.8	5.3	4
Wolfe Island	10.8	21.5	112.3	153.1	13
Amherst Island	0.2	11.3	16.9	28.3	8
Waupoos	tr	1.4	102.7	104.1	12
Prince Edward Point	0.1	1.9	234.5	236.5	14
Wellington	tr	0.3	17.3	17.7	6
Presqu'ile	tr	1.7	18.3	20.1	7
Belleville	tr	tr	tr	tr	1
Picton	tr	0.4	1.6	2.1	2

*tr = trace (<0.05).

Table 7
Summary of peak total and high zone counts for the spring survey

Species	Survey total	Maximum date	High zone count: Total	Zone	Date
Snow Goose	72	12 Apr. 1977	70	Thurso	12 Apr. 1977
Canada Goose	61 892	29 and 30 Apr. 1976	23 955	Thurso	29 Apr. 1976
Brant	4 422	20 May 1977	4 175	Amherst Is.	20 May 1977
Mallard and Black Duck	1 629	24 and 25 Mar. 1976	477	Wolfe Is.	29 Mar. 1977
Gadwall	19	29 and 30 Apr. 1976	13	Wolfe Is.	29 Apr. 1976
Pintail	1 072	29 and 30 Apr. 1976	990	Thurso	29 Apr. 1976
Wigeon	115	29 and 30 Apr. 1976	109	Presqu'ile	29 Mar. 1976
Teal sp.	195	7 and 8 Apr. 1976	90	Wolfe Is.	7 Apr. 1976
Canvasback	3 675	17 Apr. 1977	3 107	Wolfe Is.	17 Apr. 1977
Redhead	997	24 and 25 Mar. 1976	937	Presqu'ile	29 Mar. 1976
Ring-necked Duck	78	24 and 25 Mar. 1976	78	Presqu'ile	24 Mar. 1976
Scaup sp.	77 728	24 and 25 Mar. 1976	34 237	Wolfe Is.	12 Apr. 1977
Scoter sp.	885	20 and 25 May 1976	703	Wellington	25 May 1976
Oldsquaw	4 307	9 Mar. 1977	2 840	Waupoos	9 Mar. 1977
Common Goldeneye	11 352	24 and 25 Mar. 1976	2 804	Wolfe Is.	7 Apr. 1976
Bufflehead	1 437	24 and 25 Mar. 1976	615	Presqu'ile	29 Mar. 1976
Merganser sp.	6 076	7 and 8 Apr. 1976	1 715	Belleville	29 Mar. 1976

Table 8
Summary of peak total and high zone counts for the fall survey

Species	Survey total	Maximum date	High zone count: Total	Zone	Date
Snow Goose	0	–	0	–	–
Canada Goose	5 929	19 Oct. 1977	3 353	Morrisburg	19 Oct. 1977
Brant	25	28 and 29 Sept. 1976	25	Prince Edward Point	29 Sept. 1976
Mallard and Black Duck	6 928	11 Nov. 1977	5 792	Wolfe Is.	11 Nov. 1977
Gadwall	50	11 Nov. 1977	50	Cornwall	11 Nov. 1977
Pintail	94	19 Oct. 1977	77	Wolfe Is.	22 Sept. 1977
Wigeon	411	22 Sept. 1977	314	Wolfe Is.	19 Oct. 1977
Teal sp.	715	28 and 29 Sept. 1976	428	Wolfe Is.	28 Sept. 1976
Canvasback	852	5 and 6 Nov. 1976	817	Wolfe Is.	9 Nov. 1976
Redhead	3 680	15 Nov. 1977	3 680	Wolfe Is.	15 Nov. 1977
Ring-necked Duck	142	5 and 6 Nov. 1976	141	Thurso	5 Nov. 1976
Scaup sp.	68 654	19 Oct. 1977	37 309	Wolfe Is.	19 Oct. 1977
Scoter sp.	52	19 Oct. 1977	42	Wolfe Is.	19 Oct. 1977
Oldsquaw	1 299	11 Nov. 1977	1 241	Prince Edward Point	11 Nov. 1977
Common Goldeneye	5 093	1 and 3 Dec. 1976	1 925	Cornwall	11 Nov. 1977
Bufflehead	1 643	5 and 6 Nov. 1976	807	Prince Edward Point	6 Nov. 1976
Merganser sp.	5 243	8 Dec. 1977	2 998	Morrisburg	8 Dec. 1977

Numbers then dropped off with freeze-up and the coming of the snow.

The Atlantic Brant was a much less common migrant than the Canada Goose and was only recorded in the Cornwall zone and along northeastern Lake Ontario. The North Channel above Amherst Island held by far the highest number (4175 of the survey total of 4422, 20 May 1977) and the Kingston Field Naturalists have for many years recorded large counts in this area in the spring (Quilliam 1973, Weir 1975). Spring migration occurred mostly during late May although a few birds were found in early June (Quilliam 1973). Only one flock (25–29 September 1976, Prince Edward Point) was noted during the fall. In both seasons, most birds were either rafting offshore or sitting on small islands; in no cases were brant found feeding on fields.

Snow Geese, which occurred only sporadically and in small numbers along the route, were noted solely in the spring; however, Quilliam (1973) presented records from the Kingston area for both migrations. She suggests that those sightings were mostly of *A. c. caerulescens*, based on the presence of blue-phase birds. The 1977 observations in the Thurso and Cornwall zones (70, 12 April and 25, 29 April, respectively) were of white birds that appeared quite large in comparison to the accompanying Canada Geese (*B.c. interior*) and thus probably belonged to *A. c. atlantica*. In recent years Greater Snow Geese have been noted more regularly to the west of their main route through Cap Tourmente, Québec (P. Dupuis, pers. comm.).

4.2. Large dabblers

Large dabblers were widespread in the spring and fall along the survey route and inland. The highest spring concentrations (Tables 3 and 5) occurred in zones having extensive marshes and nearby grain fields (Thurso, Wolfe Island, and Presqu'ile): smaller but still significant flocks were evident on the Morrisburg and Amherst zones. Casual observation and reports of naturalists indicated that dabblers in general also gather in large numbers on sheetwater formed by flooding rivers southeast of Ottawa. In the fall, large dabblers were concentrated in the zones noted above, with the exception of Presqu'ile, and overall levels and intensities of use were usually much higher (Tables 4 and 6). Particularly dramatic increases occurred in the three zones that provide sanctuaries where the waterfowl are fed (Morrisburg, Wolfe Island, Amherst Island); such concentrations of ducks were probably caused by the high hunting pressure characteristic of eastern Ontario (Freemark and Cooch 1978).

Black Ducks and Mallards were the predominant species and followed the general pattern of distribution described above. The start of spring migration was difficult to distinguish as both species overwintered in modest numbers, particularly around northeastern Lake Ontario. Numbers started to rise by mid-March and peaked within the following 3 weeks (Table 7) after which migrants moved north and local birds dispersed onto breeding territories. The first aggregations of post-breeders were observed on Wolfe Island during the survey on 1 June 1977. Mallard and Black Ducks were also widespread during the fall migration, when numbers were higher and the flight was more prolonged. The fall migration was well under way by mid-September and numbers quickly rose to high levels, peaking in early November (Table 8); most of the migrants left by late December.

As Black Ducks and Mallards are always closely associated, I have prepared Table 9 which gives the percentages of each species for all observations from three groups of survey zones over two spring and three autumn periods. Although these fractions show considerable variation, reflecting differences in migration phenology and in the composition of breeding and wintering populations, several trends seem evident. In all cases but one, the Thurso and Hawkesbury zones had the highest percentages of Black Ducks and the zones west of Brockville the lowest. Results from the remaining zones are largely intermediate, although with some extreme values. The percentages for the last fall survey periods were largely similar to those for the corresponding early spring periods, implying stability in the wintering flock composition. Also clear was a decline in the relative frequency of Black Ducks during the spring migration, and a corresponding increase through the fall flight. This indicates the slightly earlier peak of migration of Blacks in the spring, their later fall peak, and more abundant over-wintering.

The Gadwall was only seen in the Cornwall, Morrisburg, Wolfe Island, Amherst, and Prince Edward Point zones, which generally agrees with their known breeding areas on Lake St. Francis and northeastern Lake Ontario (Godfrey 1966). Counts in eastern Canada have increased considerably in recent years (Henny and Holgersen 1973) even though absolute abundance is still quite low. Spring records tended to be from late April and May, albeit in low numbers. Fall records were also infrequent and occurred sporadically until the middle of November. Other observers have regularly found Gadwall as late as December in the Kingston area (Quilliam 1973).

Percentage of Black Ducks and Mallards for various eastern Ontario survey zone groups and time periods

Zone group	Species	Percentage (*N*)				
		1 March – 15 April	16 April – 1 June	16 Sept. – 15 Oct.	16 Oct. – 15 Nov.	16 Nov. – 15 Dec.
Thurso Hawkesbury	Black	84 (389)	64 (35)	34 (102)	74 (619)	100 (62)
	Mallard	16 (75)	36 (20)	66 (201)	26 (221)	0(0)
Cornwall Morrisburg Prescott	Black	82 (427)	80 (91)	18 (124)	47 (367)	80 (102)
	Mallard	18 (96)	20 (23)	82 (577)	53 (422)	20 (26)
All zones west of Prescott	Black	72 (772)	46 (57)	25 (468)	41 (4341)	72 (985)
	Mallard	28 (306)	54 (67)	75 (1396)	59 (6303)	28 (374)

The Northern Pintail, which breeds locally in eastern Ontario, could often be found in large flocks (>500 individuals) during the spring. Most were seen in the Thurso, Morrisburg, Wolfe Island, and Presqu'ile zones. Although small flocks and individuals occurred throughout the survey period, a pronounced migration peak passed through rapidly during late April (Table 7). In the fall, numbers were much lower and pintails were sighted sporadically in various zones into December.

4.3. Small dabblers

Although their patterns of distribution were quite similar to those of the large dabblers, small dabblers were recorded in much lower numbers (Tables 3 and 4), mainly because they avoid the open water over which much of the survey was flown.

Green-winged Teal were encountered in small numbers. Spring sightings were mostly in late March and April. In the fall, highest counts were usually made in late September (Table 8) and some individuals were still noted into early November.

The Blue-winged Teal, which is a common breeder in the area, also was sighted only occasionally along the survey route. During the spring survey, the first migrants were seen in mid-April. In the fall, individual flocks of over 100 birds were recorded during the latter half of September (Table 8), particularly in the Thurso, Wolfe Island, and Amherst Island zones, and numbers then declined very rapidly due to the early migration of the species.

The American Wigeon was perhaps the most effectively surveyed of the smaller dabblers because of its distinctive appearance and preference for open water. The wigeon occurred throughout the surveyed area in the spring although in moderately low numbers. They appeared after mid-March, reached maximum numbers late in the month (Table 7), and were mostly gone by May. Wigeon were more common during the fall flight, which started in late September and ended by mid-November (Table 8). Although widespread in occurrence, this species made heaviest use of the Thurso, Morrisburg, Wolfe Island, and Amherst Island zones. The particularly large total for Wolfe Island was mostly found in Bayfield Bay where wigeon flocked with Redheads, Canvasbacks, and American Coots (*Fulica americana*).

Two other small dabblers that breed in the area are the Northern Shoveler and the Wood Duck, the latter being moderately common (Dennis 1974). Too few were seen during the survey to warrant any comment.

4.3.1. Bay ducks

The bay ducks comprised the most important group in the eastern Ontario survey district. They were widespread in occurrence during the migration but showed a marked preference for large open water bodies; major concentrations were found on Lake Ontario, Lake St. Francis, and in some wider sections of the St. Lawrence River (Tables 3 and 4).

The two species of scaup made up over 90% of all bay ducks, the Greater Scaup being the most abundant of all waterfowl species recorded on the survey. Small numbers of Greater Scaup (500, 20 January 1977) over-wintered in eastern Lake Ontario, as well as on the fast flowing water in the Ivy Lea area of the Thousand Islands. Numbers rose through March to a maximum in early April (Table 7); singles and small flocks could still be seen in late May. During early spring the birds initially used any relatively shallow open water available, particularly in the Cornwall and Presqu'ile zones. As break-up continued, they gradually accumulated in other heavily used zones (N.B. Thousand Island, Wolfe Island, Amherst, Waupoos; Table 3) when those shorelines became available. The autumn migration commenced in the latter half of September and peaked variably in the different zones between September and early November.

Numbers were greatly reduced by December and most of those remaining probably over-wintered. Surveys in the fall showed different patterns of scaup distribution than in the spring. The Prince Edward Point zone, which was unused in the spring, held very high numbers in the fall. Conversely, counts in the Thousand Islands and Amherst Island zones were much lower in the autumn (cf. Tables 3 and 4). There were also behavioural changes. In the fall, scaup grouped together during the day into large, densely packed rafts; a single flock estimated at 19 000 was noted near Wolfe Island on 19 October 1977. In the spring, a more diffuse grouping pattern and more continuous feeding activity was evident. These changes can be attributed, at least partially, to the relatively high hunting pressure characteristic of eastern Ontario, which could cause movements of birds out of areas of high hunter accessibility and limited foraging habitat (i.e. Thousand Islands and Amherst zones). Such pressure would restrict nearshore foraging by the birds thus encouraging the formation of offshore loafing flocks.

Both species of scaup occurred in eastern Ontario although it was impossible to differentiate them conclusively from the air. Quilliam (1973) noted that Greater Scaup predominate during the spring, and that the ratio of Greater to Lesser scaup in the fall was unclear because of the limited opportunities to view offshore rafts. However, half the 189 scaup wings returned from around northeastern Lake Ontario during the hunting seasons of 1975–76–77 belonged to Lesser Scaup (CWS National Harvest Survey, S. Wendt, pers. comm.). Whether this indicates differential vulnerabilities or a seasonal shift in the Lesser Scaup's migration route into eastern Ontario during the fall remains a question for future study.

The Canvasback was an uncommon species whose zones of concentration were generally similar to those of the scaup, although much more restricted. Both Canvasback and Redhead tended to gather in more protected bays and were less likely to be seen on the open lake than were scaup.

Zones where flocks of more than 50 Canvasbacks have been noted include Cornwall (Lake St. Francis), Prescott (near Johnstown), generally throughout the Thousand Islands, Wolfe Island, Waupoos, Yeo Lake (inland from the Wellington zone), and Presqu'ile Bay. They arrived early in the spring (late February, Quilliam 1973) and rapidly rose in numbers to a peak in the first half of April (Table 7). In the fall, Canvasbacks were regularly noted on only five sites (Lake St. Francis; Bayfield Bay, Wolfe Island; Cataraqui River Mouth; Yeo Lake; Presqu'ile Bay). The birds apparently arrived in early October and most departed by late November, leaving a few to over-winter near Ivy Lea and around Lake Ontario (9, 20 January 1977). Survey numbers were generally much lower in the fall (Tables 7 and 8) although Ontario Ministry of Natural Resources workers recorded up to 10 000 on Lake St. Francis in mid-November 1976 (Sprigings 1977).

The Redhead was similar to the Canvasback in distribution, order of abundance, and migrational phenology. Distinguishing the Redhead from scaup was often difficult in less than optimum light conditions, thus making underestimates of the proportion of the Redheads likely. This was a particular problem in the spring when the bay duck species tended to mix in large loose flocks. Two pairs of Redheads sighted near the South Lancaster Marsh in Lake St. Francis during the survey of 20 May 1976 were probably local breeders (Godfrey 1966).

The Ring-necked Duck, described by Quilliam (1973) as a very common spring migrant and uncommon fall transient in the Kingston area, was noted only erratically and in small numbers on the survey (Tables 7 and 8). Such results may reflect the species' preference for small water bodies and the inability of observers to distinguish Ring-necked Ducks from scaup. Quilliam (1973) described its spring and fall passages as rather similar in timing to those of the Canvasback.

4.3.2. Goldeneye

The *Bucephala* spp. were the second most abundant duck group observed during the survey and were more evenly distributed along the route than the bay ducks (Tables 3 and 4).

Common Goldeneye comprised between 75 and 90% of the goldeneye seen. They wintered commonly wherever open water was found along the survey route. On 20 January 1977, large wintering groups were detected below the Cornwall Dam (1066); along the channel between Morrisburg and Brockville (1273); and around Ivy Lea (545), Amherst Island (415), the southwest side of Prince Edward County (328), and Presqu'ile (537). Numbers started rising in early March and peaked in early April, after which they declined rapidly; only a few probable non-breeders remained by late April. In fall, goldeneyes arrived throughout October and, in zones that later froze over, showed a slight peak in abundance in early December. In zones that remained open in the winter, numbers continued to rise until wintering levels were reached (total from winter survey — 5166, 20 January 1977). The pattern of distribution was largely similar to that in the spring except in those zones between Brockville and eastern Prince Edward County where, for unknown reasons, autumn usage was much lower (cf. Tables 3 and 4).

Although its phenology was similar, the Bufflehead was much less abundant than the Common Goldeneye during both migrations. The Bufflehead was noted regularly in the Cornwall zone and in the zones between Brockville and Presqu'ile (except for the Bay of Quinte). The highest numbers occurred along the southern and western shores of Prince Edward County and around Presqu'ile, where some also over-wintered (90, 20 January 1977). Habitat selection was largely similar to that of the Common Goldeneye, which prefers large bays and open, relatively shallow water, with the exception that the Bufflehead appeared to favour shallower water closer to shore (often within 20 m).

4.3.3. Sea ducks

The sea ducks were most common in the Lake Ontario zones, where they forage over a wide range of depths, often far from shore.

The Oldsquaw was the most often recorded sea duck although counts per zone tended to be variable, as the species was distributed irregularly in flocks of varying sizes, sometimes as much as 10 km off-shore. They regularly wintered throughout northeastern Lake Ontario (Quilliam 1973); a total of 865 were found on 20 January 1977, of which 645 occurred in the Prince Edward Point zone. During the spring, numbers of Oldsquaw seen also fluctuated. The peak zone count of 2840 came on 9 March 1977 along an ice front that passed in front of Waupoos Bay; those were probably over-wintering birds concentrated by weather and ice conditions. In the previous year, the peak zone count (1801) was recorded on 29 April in the Presqu'ile zone and was comprised of densely packed flocks, possibly massed together for migration. Observers at Prince Edward Point (Weir 1972) have found flocks of over 2100 on 19 May 1972. The only predictable aspect of the Oldsquaw spring passage was that virtually all birds left by late May. Only two were noted near Wolfe Island on 3 June 1977.

During the fall survey, Oldsquaw were first sighted in early October, after which counts rose unpredictably to a survey peak of 1241 (11 November 1977). Weir, in Arbib (1978), recorded 4050 Oldsquaw at Prince Edward Point during the Christmas bird count on 17 December 1977.

Of the three species of scoters observed during the survey, the White-winged Scoter was the most frequently encountered, comprising over 50% of all records. The scoters shared a similar distribution and count variability with the Oldsquaw, except that their abundance was usually much lower, particularly in the winter. Numbers of scoters were higher in the spring than in the fall and peak counts occurred in mid-May (Table 7). For more detail on the scoter passage through the Kingston and Prince Edward County areas, see Quilliam (1973) and Sprague (1969) respectively.

4.3.4. Mergansers

Mergansers were very common and widespread throughout the survey route. Total fall utilization was much lower than in the spring, when concentrations of greater than 15 000 duck-days occurred in seven zones (in contrast to such autumn utilization levels in only the two zones around the Cornwall Dam). The Common Merganser made up 80% of the mergansers seen and was found in habitat similar to that of the Common Goldeneye. The less common Red-breasted Merganser tends to restrict itself more to large water bodies and was only observed in high numbers (2700)

on 8 December 1977 above the Cornwall Dam (Morrisburg zone). The Hooded Merganser was rarely seen, reflecting its preference for smaller lakes and streams.

The spring passage of mergansers showed a rapid rise through March to a peak in early April (Table 7), after which numbers declined slowly until most birds had left in late May. Although not evident from the survey data, it was possible that the Red-breasted Merganser had a slightly later migration schedule and so retarded the rate of decline of total merganser numbers late in the season. In the fall, mergansers did not appear in large numbers until the second half of October and peaked in early December (Table 8). Moderate numbers over-wintered in areas of open water, although particularly heavy concentrations (1751, 20 January 1977) were recorded in the open channel of the St. Lawrence River in the Prescott and Thousand Islands zones.

5. General discussion

5.1. Summary by zone

The surveyed area showed widespread use by migrant waterfowl although the distribution of the birds was patchy and revealed considerable variability by species and season. Factors influencing distribution include the nature and extent of feeding and roosting habitat, location along migration routes, hunting pressure and accessibility, and practices such as sanctuary and feeding. Details on waterfowl use of the 13 survey zones are summarized below.

5.1.1. Thurso and Hawkesbury zones

Large concentrations of dabbling ducks and Canada Geese (spring only) are attracted by the extensive marshes along the river and the rich neighbouring farmland. The Ottawa River area is the limit of suitable staging habitat for the northward migrating geese.

5.1.2. Cornwall zone

This area is noted for its large diving duck concentrations, particularly scaup and goldeneye, which gather on the broad, shallow waters of Lake St. Francis. Extensive beds of the aquatic vegetation undoubtedly provide excellent feeding opportunities and the size of the water body limits harassment by hunters. Large numbers of goldeneye overwinter in the open water below the Cornwall dam.

5.1.3. Morrisburg zone

This zone contains the St. Lawrence Parks, which are managed for waterfowl through sanctuary, feeding, and habitat manipulation; Wilson Hill Sanctuary is located on the adjacent American shore. Large numbers of dabblers and Canada Geese are attracted during both migrations.

5.1.4. Prescott zone

The Prescott zone receives low to moderate use, principally by diving ducks. Most of those are found in the sector between Cardinal and Johnstown where there is a wide bay with large beds of submerged vegetation. That sector is one of the first along the route to open in the spring.

5.1.5. Thousand Islands zone

Large numbers of diving ducks, including Canvasbacks and Redheads, congregate during the spring migration. The heavy use is due to the extensive submergent vegetation beds and the early break-up of some sectors in the zone. Waterfowl utilization in the fall is limited, probably because of hunting pressure. During the winter, the open water near Ivy Lea supports a medium-sized (approx. 1000) but diverse flock of ducks.

5.1.6. Wolfe Island zone

This is the single most important zone in the district and has significant spring and fall concentrations of virtually all waterfowl groups. Most abundant are the bay ducks, mainly composed of scaup, although Canvasback and Redhead numbers in the spring are significant. The high usage reflects the excellence of the habitat (open, shallow water) and the strategic location along the northwest–southeast migration line. The presence of baited sanctuaries, the island's rich croplands and the burgeoning populations of Canada Geese and Mallards have also led to a rapid increase in goose and dabbler numbers to very high levels.

5.1.7. Amherst Island zone

The Amherst Island zone has habitat comparable to that on Wolfe Island and similarly receives heavy use by bay ducks and goldeneye in the spring; also notable are the large numbers of Atlantic Brant that stage in the North Channel. During the fall, waterfowl are generally fewer except for the dabbling ducks, whose numbers rise, probably in response to legal baiting on the Nut Island Duck Club property and to large-scale cattle feeding operations.

5.1.8. Waupoos zone

The high numbers of bay ducks in both spring and fall reflect the protected location and excellent foraging opportunities. Sea ducks, mostly Oldsquaw, congregate along a large lead that forms off the bay after freeze-up.

5.1.9. Prince Edward Point zone

Most notable are the very large rafts of scaup that appear during the fall. It is not certain whether these aggregations are feeding or loafing; however, the increased fall use suggests that the relative inaccessibility of the location to hunters contributes greatly to its attractiveness to scaup.

5.1.10. Wellington zone

Moderate numbers of waterfowl are present along the Wellington zone during both migrations although usage intensities are low. Bay ducks predominate and mostly occur in Weller's Bay, which has extensive marshes and large beds of submergent vegetation.

5.1.11. Presqu'ile zone

The Presqu'ile zone holds large springtime numbers of diving ducks, including Canvasbacks and Redheads, a result of the early break-up of the rich Presqu'ile Bay. Intensity of fall usage is much lower and could be a response to hunting pressure.

5.1.12. Belleville and Picton zones

The two zones in the Bay of Quinte show an anomalous lack of waterfowl, with the exception of mergansers, even though there are vast marshes near Big and Huffs islands and in Hay Bay, and extensive water adequately shallow for foraging by divers (Appendix 1). One sees few blinds, which further suggests that duck numbers do not merit much hunting effort. This contrasts with historical observations that the Bay of Quinte was excellent for duck hunting (Peters 1951) and had large wild rice beds that are no longer evident. Surveys in 1970–71 (Dennis pers. comm.) showed higher counts of waterfowl than in 1976, the difference in numbers being outside the likely range of annual survey variability. The apparent avoidance by ducks of the Quinte zones therefore implies deteriorating habitat. Such decline in quality could be caused by pollution from agriculture which has led to rapid eutrophication of the bay (Johnson and Owen 1971). Also, the major marshes are becoming increasingly choked with *Typha*, thus reducing their attractiveness to ducks.

5.2. Provincial significance

The importance on the provincial scale of the migration through eastern Ontario can be examined through comparison with survey results of Dennis *et al.* (this publication). The spring passage through eastern Ontario contributes 44% of total waterfowl days in southern Ontario. Over half of that portion occurs in northeastern Lake Ontario and the immediate St. Lawrence River outlet. The fall flight is relatively less intense. Only 16% of the autumn waterfowl days in southern Ontario are attributable to the eastern district although use of Lake Ontario and the outlet area is similar to that of the spring. The large numbers of waterfowl in the area centred on Wolfe Island in both the spring and fall make it as important to waterfowl in eastern Ontario as Long Point and Lake St. Clair are to the southwest. This fact should not be overlooked in any management plan or impact assessment.

5.3. Management concerns

The heavy use of the eastern Ontario shoreline by a diverse group of waterfowl raises a variety of management concerns, both for the protection of the birds and for the limiting of noxious effects such as crop depredation.

The Atlantic Brant, Canvasbacks, and Redheads are consistently seen only in small numbers. Yet their utilization of the area, particularly in the spring, is significant and merits regular monitoring. Whether many individuals of those species are passing through rapidly or smaller numbers are staging for longer remains to be determined.

The converse is true for Canada Geese whose numbers in some zones have been rising with the general increase in the mid-Atlantic flock (Bellrose 1978). Blokpoel and Gauthier (1980) estimated that a minimum of 191 000 Canada Geese passed through a 190-km wide front centred on Ottawa during the spring of 1975. Shifts toward intensive corn cultivation and the increase of management activities such as sanctuaries and baiting have caused birds to stay longer in the district and led to problems of crop damage, most notably on Wolfe Island and near Morrisburg.

Conservation of dabblers and geese has been facilitated through the establishment of sanctuaries including the St. Lawrence Parks near Morrisburg, Thousand Islands National Park, Bear Point on Wolfe Island, Prince Edward Point National Wildlife Area, Point Petre Game Management Area, Weller's Bay National Wildlife Area, and Presqu'ile Provincial Park. Some of those sites provide considerable protection for dabblers and geese, and by holding birds, improve local hunting and viewing opportunities. However, diving species predominate along the survey route and their management is more difficult to effect because they remain offshore and are only indirectly helped by conventional sanctuaries and marsh management. Instead, it is crucial to maintain the quality of their underwater feeding beds, a problem that has rarely been examined from the viewpoint of duck ecology. A thorough inventory of those habitats and an understanding of their importance to diving ducks will ultimately be required before realistic management and protection of migrant divers can be attempted.

Also basic to any plan of waterfowl management and preservation is a thorough understanding of the changing environmental characteristics of the area and the ways in which they impinge on either the viability of the birds or on the carrying capacity of the habitat. The following factors, usually man-induced, are of concern.

a) Spills of oil or other toxic chemicals would clearly be disastrous during the peak migration, particularly in northeastern Lake Ontario. Such spills, either through accident or by deliberate action such as bilge pumping, occur regularly and are a source of great concern.

b) Epizootic diseases such as duck virus enteritis, fowl cholera, and botulism are possible wherever concentrations of waterfowl are high enough, e.g. in baited areas and sanctuaries.

c) Water pollution leading to high concentrations of heavy metals and other toxicants in certain fish species could be deleterious to the many mergansers passing through the area. General pollution and eutrophication in the Bay of Quinté is another example.

d) Unseasonable open water caused by the exhaust water plume from the Lennox generating station (Amherst Island zone) provides added habitat for foraging ducks by retarding freeze-up and facilitating break-up; however, the influence of the hot water on the viability of food species has not yet been studied. The proposed year-round opening of the St. Lawrence Seaway will similarly provide added open water.

e) Boat traffic will tend to disturb rafting birds, thus reducing feeding efficiency. Only in the case of winter traffic of freighters and ice breakers, as proposed for the Seaway, might any benefits accrue to the ducks.

f) Variations in water level can change the status of marshes directly and have broader influences through effects on nutrient cycling. Results may or may not be beneficial to waterfowl.

g) Land management practices such as filling in of small marshes for agriculture or housing continue to occur to the obvious detriment of waterfowl. Flood control structures such as those proposed for the South Nation River could limit sheet water for migrating dabblers and geese and reduce nutrient transfer through flood deposition and yet the increased effectiveness of cultivation might prove beneficial to field-feeding species.

h) Dyking and marsh production undertaken on the St. Lawrence Parks land near Morrisburg probably benefits most waterfowl species.

In the past, waterfowl resources have been minimally affected by the slowly paced habitat changes along the mostly rural survey route. However, judging from the apparent decline of duck numbers in the Bay of Quinté, shifts in waterfowl distribution have taken place and will continue in response to the likely accelerating rate of habitat change brought on through intensification of seaway traffic and governmental policies to encourage industrial development in eastern Ontario. Such changes will often be small but should be considered in the aggregate for their effects on the whole system. Only then can realistic assessments be prepared and effective measures adopted to conserve the major concentrations of migrant waterfowl that gather in eastern Ontario each spring and fall.

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7. Literature cited

Arbib, R.G., Jr. (ed.) 1978. Christmas bird count — Prince Edward Point, Ontario. Am. Birds 32(4):468.

Bellrose, F.C. 1978. Ducks, geese and swans of North America. 2nd ed. (rev.) Stackpole Books, Harrisburg, PA. 543 pp.

Blokpoel, H.; Gauthier, M.C. 1980. Weather and the migration of Canada Geese across southeastern Ontario in spring 1975. Can. Field. Nat. 94(3):293–299.

Dennis, D.G. 1974. Breeding pair surveys of waterfowl in southern Ontario. Pages 45–52 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–1973. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada, 1969–1973. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; McCullough, G.B.; North, N.R.; Ross, R.K. An updated assessment of migrant waterfowl use of the Ontario shorelines of the southern Great Lakes. This publication.

Freemark, K.E.; Cooch, F.G. 1978. Geographical analysis of waterfowl kill in Canada. Pages 66–77 *in* Boyd, H.; Finney, G.H. eds. Migratory game bird hunters and hunting in Canada. Can. Wildl. Serv. Rep. Ser. No. 43. 127 pp.

Godfrey, W.E. 1966. The birds of Canada. Natl. Mus. Can. Bull. 203. Ottawa. 428 pp.

Henny, C.J.; Holgersen, N.E. 1973. Range expansion and population increase of the Gadwall in eastern North America. US Fish Wildl. Serv. Res. Results and Activities, June 1973.

Joensen, A.H. 1968. Wildfowl counts in Denmark in November 1967 and January 1968 — methods and results. Dan. Rev. Game Biol. 5(5) 1–72.

Johnson, M.G.; Owen, G.E. 1971. Nutrients and nutrient budgets in the Bay of Quinte, Lake Ontario. J. Water Pollut. Control Fed. 43(5):836–853.

Munro, W.T. 1967. Changes in waterfowl habitat with flooding on the Ottawa River. J. Wildl. Manage. 31(1):197–199.

Peters, W.A. 1951. Feathers preferred. McClelland and Stewart, Toronto.

Quilliam, H.R. 1973. History of the birds of Kingston, Ontario. 2nd ed. (rev.) Kingston Field Naturalists, Kingston. 209 pp.

Sprague, T. 1969. Birds of Prince Edward County. Prince Edward Reg. Conserv. Auth. 215 pp.

Sprigings, R. 1977. Lake St. Francis waterfowl survey report, Cornwall District, second phase. Ont. Min. Nat. Resour. Unpubl. Rep. 29 pp.

Weir, R.D. 1972. Spring migration (1971) at Prince Edward Point, Ont. Can. Field-Nat. 86(1):3–16.

Weir, R.D. 1975. Spring Season 1 April – 11 June 1975. Blue Bill 22(2): 30–35.

Appendix 1
Survey of quantitative habitat characteristics per zone

Zone	Survey route length (km)	Length of shortline (km)	Habitat areas in hectares (per cent of total surveyed area)									
				Surveyed					Unsurveyed			
			Total	Water <5.5 m deep		Shallow water marsh and flats		Deep water marsh		Inland marsh		Lakes and ponds	
Thurso	125	378	5 641	3 261	(58)	1890	(34)	490	(9)	1454	(26)	7.6	(0.1)
Hawkesbury	76	181	4 118	3 406	(83)	398	(10)	314	(8)	63	(2)	60	(1)
Cornwall	61	85	5 982	5 072	(85)	149	(2)	761	(13)	443	(7)	0	
Morrisburg	52	129	2 879	2 468	(86)	396	(14)	15	(0.5)	68	(2)	0	
Prescott	48	92	1 066	977	(92)	0		89	(8)	55	(5)	33	(3)
Thousand Islands	89	250	4 545	4 351	(96)	28	(0.6)	166	(4)	673	(15)	140	(3)
Wolfe Island	184	281	8 109	7 317	(90)	609	(8)	183	(2)	1263	(16)	225	(3)
Amherst Island	83	89	2 903	2 812	(97)	91	(3)	0		487	(17)	63	(2)
Waupoos	75	79	3 356	3 230	(96)	91	(3)	35	(1)	174	(5)	7.5	(0.2)
Prince Edward Point	28	30	3 031	3 023	(100)	2	(1)	6	(0.2)	199	(7)	0	
Wellington	82	93	5 619	5 402	(96)	55	(1)	162	(3)	1298	(23)	4119	(73)
Presqu'ile	36	52	2 672	2 542	(95)	114	(4)	16	(0.6)	411	(15)	2.5	(0.1)
Belleville	84	175	11 290	9 876	(87)	639	(6)	755	(7)	2508	(22)	136	(1)
Picton	108	180	5 138	3 483	(68)	269	(5)	1386	(27)	804	(16)	94	(2)
Total	1131	2094	66 349	57 220	(86)	4731	(7)	4398	(7)	9900	(15)	4888	(7)

Use of the James Bay and Hudson Bay coasts of Ontario by dabbling ducks

by R.K. Ross

1. Abstract

A series of 16 aerial surveys of dabbling ducks was flown along the northern coast of Ontario between 18 June 1976 and 3 October 1979. These showed that dabbler distribution was concentrated along the James Bay coast; particularly important was the sector between the Albany and Attawapiskat rivers, which accounted for 50% of all dabbler use of the northern shore (9 336 800 duck days in total).

Spring distribution was concentrated at the southernmost end of James Bay. Mean counts per kilometre were relatively low as the birds mostly appeared to move through rapidly and not to stage. During the summer, highest duck numbers occurred initially along the Hudson Bay coast, where many birds moulted in brackish coastal ponds; later, the fledged birds moved to the broad marshes, particularly in James Bay. With the coming of fall, numbers rose dramatically in James Bay as migrants funnelled down the Hudson–James Bay system. As in the spring, there was a high correlation between duck usage and the amount of broad coastal marsh.

Major dabbler species in order of abundance were the Black Duck (33.8% of total dabbler days), Northern Pintail (25.6%), Green-winged Teal (23.6%), Mallard (11.8%), and American Wigeon (5.0%). Blue-winged Teal and Northern Shoveler were occasionally recorded.

2. Introduction

The abundance of waterfowl occurring along the coastal zone of James and Hudson bays was noted as early as 1743 (Rich 1949) and further documented in various early faunal accounts (Forster 1772, Swainson and Richardson 1831). Although attention has more recently been focused on the intensely hunted goose species (see Hanson *et al.* 1972, Raveling and Lumsden 1977, Prevett *et al.* 1979), information on ducks, which also occur in significant numbers, has been limited to isolated inventories, annotated lists, and anecdotal observations (Smith 1944, Manning 1952, Lumsden 1959, Peck 1972).

To achieve a clearer understanding of coastal utilization by ducks, the Canadian Wildlife Service (CWS) undertook a number of studies in association with a multidisciplinary investigation by Environment Canada of the Hudson Bay Lowland of Ontario. This report, which is based on aerial survey data, documents the spatial and temporal distribution of dabbling ducks along the Ontario coasts and attempts to relate patterns of use to major shoreline habitat types. The species observed include the Mallard (*Anas platyrhynchos*), Black Duck (*A. rubripes*), Northern Pintail (*A. acuta*), Green-winged Teal (*A. crecca*), Blue-winged Teal (*A. discors*), American Wigeon (*A. americana*), and Northern Shoveler (*A. clypeata*).

3. Methods

The James and Hudson bay coasts of Ontario have been divided into six survey zones (Fig. 1) which were chosen to be sufficiently large to avoid sampling error and yet have relatively distinctive vegetational, physiognomic, and geographical properties. Zones have been subdivided into sectors bounded by obvious landmarks and the duck observations were initially recorded by sector, thus providing a data base for future site-specific studies such as impact assessments. The data were aggregated by zone for the present study.

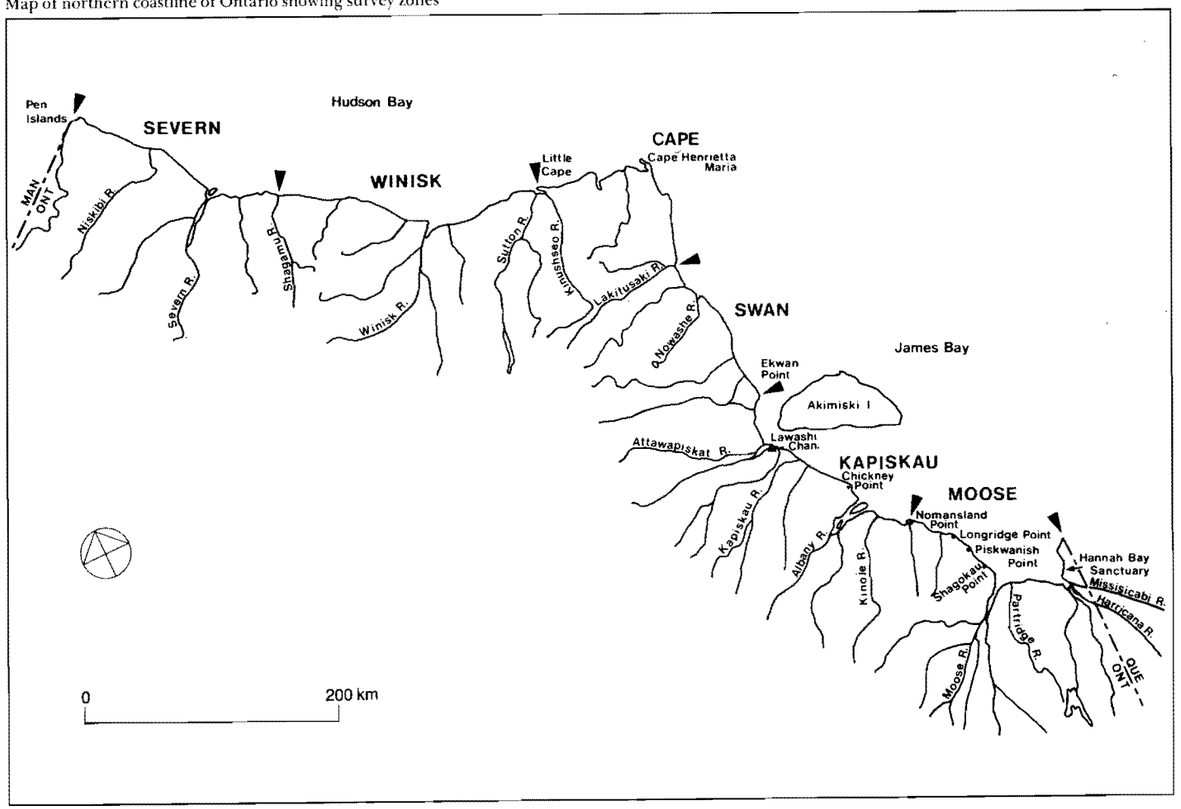
Aerial surveys were carried out by two observers, usually in a DHC Otter or a Cessna 337 Super Skymaster aircraft flying at approximately 160 km/h and 100 m asl. Because of the high costs, and the need to assess annual variations, the survey flights were spread over 4 years. Table 1 lists the 16 full and partial surveys carried out between 18 June 1976 and 3 October 1979.

Each flight followed a standardized route along the high tide line where duck concentrations were usually the highest. Occasionally slight diversions were made, particularly around river mouths, to examine flocks seen in the distance. All waterfowl seen were recorded and no lateral boundaries for sightings were imposed although observations were usually limited to within 300 m of the aircraft.

Table 1
Timing and coverage of aerial surveys

Date	Zone covered	Aircraft type
18–21 June 1976	Kapiskau, Swan, Winisk (part)	Bell 206
24–26 August 1976	All zones	Cessna 337
3–7 October 1976	All zones	DHC Otter
26 April 1977	Moose, Kapiskau	Hughes 500
17–18 May 1977	All zones	Cessna 337
26–28 July 1977	All zones	DHC Otter
15–18 August 1977	All zones	DHC Otter
28 August 1977	Moose, Kapiskau (part)	DHC Otter
3–6 October 1977	All zones	DHC Otter
16–18 May 1978	All zones	Cessna 337
27–29 June 1978	Moose, Kapiskau (part)	Bell 206
3–7 July 1978	Moose, Kapiskau (part)	Bell 206
14–19 September 1978	All zones	Piper Apache
2–8 October 1978	All zones exc. Cape (part)	DHC Otter
12 July 1979	Kapiskau (part), Swan, Cape (part)	Hughes 500
1–3 October 1979	All zones exc. Severn (part)	DHC Otter

Figure 1
Map of northern coastline of Ontario showing survey zones



In some zones the marshes and mudflats were so extensive that complete coverage of all likely habitat was impossible; however, preliminary ground observations (Ross, unpubl. data) indicated that most dabblers were found in the nearshore area of the marsh covered by the surveys. Nonetheless the figures produced from such areas should be regarded as minima.

Levels of utilization by ducks have been estimated by calculating the total number of duck days, using the method of Dennis and Chandler (1974). This figure was produced by averaging results from pairs of phenologically successive surveys, multiplying by the number of intervening days, and summing over the entire period of the spring, summer, or fall. Spring was considered to start on 1 April, when it was assumed no ducks were present (zero point), and to extend to 1 June. Because of the lack of data for early June, and evidence from casual observation that there was little change in use during the month, the 1 June baseline number is assumed to be equal to that from the first survey in June or early July. Summer covered the period from 1 June to 15 August; the count for the latter date was based on the survey of 15–18 August 1977. Fall ran from 15 August to zero points on 1 November (Cape, Winisk, and Severn zones) and 15 November (Moose, Kapiskau, and Swan zones). The unit of usage intensity was the mean daily duck count per kilometre of shoreline and was calculated by dividing total duck days by the product of the zone's length (in kilometres) and season length (in days); for this calculation the fall season was assumed to cover 92 days.

4. General habitat

Habitats of the northern coasts of Ontario and the Hudson Bay lowland backing it have been well described by several authors (Smith 1943, 1944; Zoltai 1973; Glooschenko and Martini 1978; Glooschenko 1980). For more detailed vegetational descriptions of sections of the coast, see Kershaw (1976), Riley and McKay (1980), and Ringius (1980).

The shoreline is characterized by a shallow gradient that results in extensive tidal flats. The coast can be separated into four broad categories that are useful in understanding dabbler distribution.

(*a*) Broad marsh — extensive marshes (>1 km wide) are particularly evident in James Bay and are dominated by large stands of *Puccinellia phryganodes, Hippuris vulgaris, Carex* spp., *Scirpus* spp., and *Eleocharis palustris*.

(*b*) Narrow and intermittent marsh — coastal marshes (<1 km wide) that are often highly fragmented and have dominant plant species similar to those of the broad marsh type.

(*c*) Beaches fronting meadows and brackish ponds — dominant plant species in the meadows are *Puccinellia phryganodes*, and *Potentilla anserina*. The ponds are edged with *Salix* spp. and contain much *Potamogeton filiformis* and *Zannichellia palustris*.

(*d*) No marsh — high energy beaches fronting relatively well-treed and/or well-drained habitat.

Table 2 presents the composition of the survey zones according to the above classification. A brief description of the zones follows.

Table 2
Composition by major coastal habitat types of the six survey zones

	Extent of habitat type (kilometres of shoreline)			
Name of zone	Broad marsh	Narrow intermittent marsh	Beach, ponds, meadows	No marsh
Moose	160	81	0	31
Kapiskau	198	23	0	7
Swan	74	0	63	0
Cape	47	108	27	79
Winisk	34	109	94	24
Severn	73	34	129	0

Table 3
Total dabbler use of the six survey zones along the James Bay and Hudson Bay coasts of Ontario during the spring, summer, and fall. Use measured in waterfowl days (in 1000s)

Zone	Spring	Summer	Fall	Total
Moose	198.2	145.2	1779.5	2122.9
Kapiskau	152.5	202.5	4271.1	4626.1
Swan	64.7	93.3	802.3	960.3
Cape	41.8	96.5	262.9	401.2
Winisk	34.9	167.6	232.6	435.1
Severn	60.0	235.2	495.0	791.2
Total	552.1	940.3	7844.4	9336.8

Moose zone (272 km, Quebec border to Nomansland Point). The Moose zone lies at the southernmost part of James Bay. It contains a variety of shoreline habitats ranging from rocky promontories to extensive coastal marsh associated with the Harricanaw and Moose rivers.

Kapiskau zone (228 km, Nomansland Point to Ekwan Point). The Kapiskau zone is heavily influenced by the Albany and Attawapiskat rivers which have fostered the development of a continuous and very broad band of coastal marsh (>5 km wide in places).

Swan zone (137 km, Ekwan Point to Lakitusaki River). The Swan zone extends over the intergradation of the taiga and tundra biomes. Major coastal marshes occur along the northern half of the zone; shoreline beach ridges damming small ponds are more prominent in the south.

Cape zone (261 km, Lakitusaki River to Litle Cape). The Cape zone subtends a patch of subarctic tundra. A large coastal marsh is found just west of Cape Henrietta Maria at the location of a major Snow Goose colony.

Winisk zone (261 km, Little Cape to Shagamu River). The Winisk zone contains wide coastal marshes only around the large rivers (Sutton, Kinusheo, Winisk); a narrow and highly intermittent band of marsh is found along the remaining shoreline. In the western third of the zone, old beach ridges have created highly productive brackish ponds near the shore.

Severn zone (236 km, Shagamu River to Manitoba border). The Severn zone contains large marshes around the Severn River mouth and the Pen Islands. Rich shoreline ponds are widely distributed along the remaining coast which is sandier in character than that of the Winisk zone.

5. Results and discussion

5.1. Overall dabbler distribution and habitat correlations

Table 3 presents indices of total utilization (duck days) by dabblers for the six survey zones. Intensity of utilization is illustrated in Figure 2, which charts mean daily numbers per kilometre of shoreline for total dabblers in each zone and season.

Usage was much greater in the three southern James Bay zones than in the more northerly zones ($U = 0$, $P = 0.05$, Mann-Whitney test). The Kapiskau zone accounts for 50% of all dabbler use.

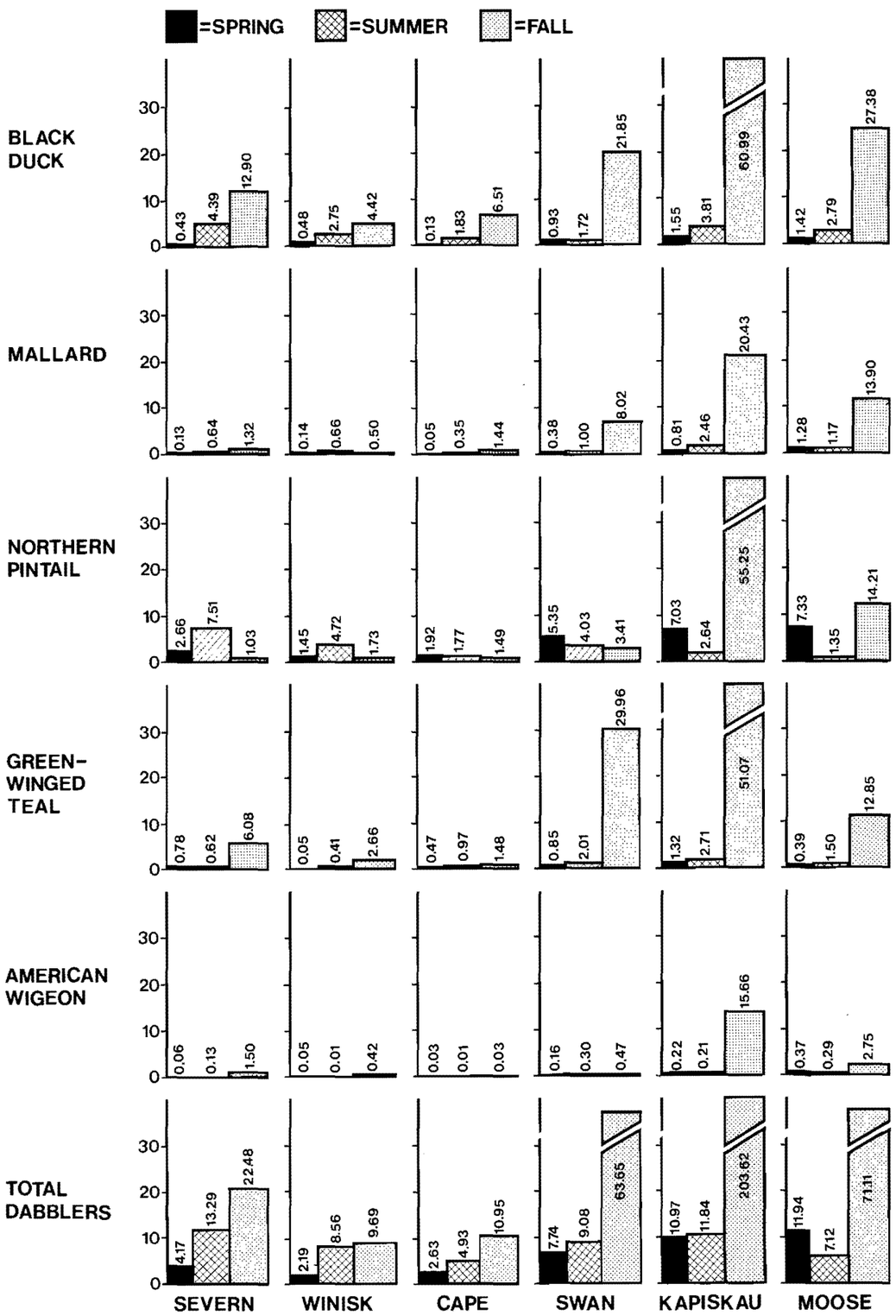
During the spring, levels and intensities of use were usually lower than in the other seasons and reflected rapid passage and relatively little staging by migrant dabblers. Because of the rapid movement of ducks, the peak of the migration might not have been surveyed in some zones.

Total use of the zones during the spring correlated strongly ($r_s = 0.943$, $P<0.005$) with the amounts of broad marsh per zone, probably indicative of the feeding opportunities that the habitat provided. That rank correlation was almost perfect except for the two southern zones whose ranks were reversed. This was probably due to the Moose zone's location at the southernmost part of the bay as it was the earliest zone to thaw and the first encountered by many northward-moving migrants. Spring use was initially restricted to stream mouths, such as the Mississicaibi River and Partridge Creek, where seeping melt water dammed by the sea ice flooded along the frozen marsh near the bush line. With the break-up of the major rivers, ducks spread throughout the marshes as they became available. The greatest concentrations occurred in Hannah Bay (Moose zone) and at Chickney Point (Kapiskau zone). Slightly lower numbers were found around other major river mouths.

Levels and intensity of summer use were mostly intermediate between those of the spring and fall. Their distribution reflected both the moulting and staging activities of the dabblers during that period. Initially, post-breeding ducks moved to the shore to moult. Particularly large numbers of moulters gathered along the Hudson Bay coast where ponds dammed by beach ridges appeared to be preferred. Although significance could not be tested, rank correlation of duck utilization agreed completely with that of pond habitat (Table 2) for the three northern zones. The Swan zone also had extensive pond habitat and yet lower duck numbers than that of the Cape zone; however, the ponds in the Swan zone were smaller and more open, often without the well-developed willow border that would provide protection for flightless birds. As the moulters regained powers of flight they moved to richer staging areas, particularly the broad salt marshes along the James Bay coast; rank order agreement between duck utilization levels and amounts of broad marsh was perfect for the three southern zones. Throughout the summer, the dabblers were relatively evenly distributed along the shoreline with few areas having large concentrations. Moulters generally gathered on the ponds of the Hudson Bay shore, some of which could contain flocks of over 300 individuals (Prevett, pers. comm.), although groups of moulters were occasionally found on the James Bay coast as far south as Hannah Bay. Staging ducks were also widespread and were most common around the river mouths. Notable numbers occurred on the slough-like ponds near the Lawashi Channel (Kapiskau zone) where flocks of over 1000 ducks gathered.

By fall, the movement from the moulting areas to the staging areas on the broad marshes was complete and levels of use by ducks correlated strongly with the amounts of broad marsh per zone ($r_s = 1.00$, $P<0.001$). Levels and intensities of utilization were the highest of the three seasons in all zones particularly in the southern zones, where migrants were concentrated as they approached the base of the migratory funnel formed by James and Hudson bays. Large numbers of dabblers occurred in virtually all suitable marshes along the shoreline, particularly those in the Kapiskau zone, where approximately 118 300 ducks were counted on

Figure 2
Graphs of intensities of seasonal use (mean duck number/km) by species and survey zone for the northern coast of Ontario



14 September 1978. Large numbers of staging ducks were also found at Hannah Bay, the mouth of Partridge Creek, the marsh from Piskwanish Point to Moose River, the marshes from Nowashe River to Lakitusaki River, mouths of the Sutton-Kinusheo, Winisk, and Severn rivers, and the marshes of the Pen Islands.

5.2. Phenology of the major species

Figure 2 presents graphs of usage intensity for the five principal dabbler species. This information plus other observations from individual surveys are summarized in the following annotated list. Survey results by zone are expressed as numbers of individuals per kilometre of shoreline.

5.2.1. Black Duck

The Black Duck (33.8% of total dabbler days) was among the most commonly encountered dabblers throughout the coastline; in the fall, it was the most abundant duck in five of the six zones. It was one of the first species to arrive in the spring although numbers did not peak until mid-May (highest zone count 2.57/km, Kapiskau, 16 May 1978), possibly because more northerly breeding birds staged along the southern part of James Bay while awaiting opening of the nesting areas. Counts declined slightly in early June as the birds moved inland to breed. Numbers then rose steadily throughout the summer in most zones with the arrival of non-breeders, post-breeders, and young-of-the-year. In the Cape and Severn zones, numbers of Black Ducks, mostly moulters, peaked in late July (3.42 and 9.63/km respectively, 26–28 June 1978); counts then declined slightly as the birds regained flying ability. Mean daily numbers in all zones climbed to much higher levels during the fall migration, peaking between mid-September (Kapiskau, Winisk, Severn) and mid-October (Moose, Swan, Cape); highest zone count was 139.04/km (Kapiskau, 14 September 1978).

Concentrations of Black Ducks tended to occur around river mouths and estuaries, usually in more saline habitats such as tide lines, saltwater and brackish ponds, and sedge meadows. During migration, locations with particularly high Black Duck counts were Hannah Bay, Partridge Creek, Shagokau to Piskwanish Point, Chickney Point, Lawashi Channel, Black Duck River, Sutton and Kinusheo Rivers, Shagamu River, Niskibi River, and the Pen Islands. Moulting concentrations were spread generally through the beach ridge pond habitat of the Winisk and Severn zones, although a single flock of approximately 300 was noted in the Hannah Bay Sanctuary (Moose zone).

5.2.2. Mallard

The Mallard (11.8% of total dabbler days) was less common than the closely related Black Duck. For each season, there was a consistent decrease from south to north in the ratios of abundance of the Mallard and the Black Duck (see Table 4). This was probably related to a reduction in breeding densities along the northern edge of the Mallard's range. In most zones, a decline in the proportion of Mallard through the seasons was apparent and was possibly due to a greater tendency towards direct southward migration from the breeding grounds. Only the Kapiskau and Swan zones showed high Mallard fractions during the summer.

Highest Mallard counts in the spring were recorded in the Moose (2.33/km) and Kapiskau zones (1.13/km) on 26 April 1977; peak counts on more northerly zones were not observed until mid-May. After a brief decline during nesting, numbers rose and in five zones peaked in mid-summer (1.31/km, Moose, 7 July 1975; 1.46/km, Swan, 21 June 1979; 0.37, Cape, 27–28 July 1977; 0.79/km, Winisk, 26–27 July 1977; 0.82/km, Severn, 27 July 1977), perhaps because of the arrival of post-breeders and the presence of broods. Only in the Kapiskau zone did numbers continue to rise throughout the summer (3.07/km, 16 August 1977). Compared to the Black Duck, the Mallard in the summer showed relatively less use of the Severn zone and more of the Swan zone. Mallard counts tended to decline in the five zones noted above until the start of the migration in mid-August when numbers rose to much higher levels (highest zone count 29.12/km, Moose, 8–15 October 1978). Timing of the peak of fall counts and the relative distribution of Mallards among the zones were similar to those of the Black Ducks.

Mallards appeared to prefer a more freshwater habitat such as pools on the coastal marsh and creeks inland from their mouths. In contrast to the Black Duck, greater proportions of the Mallards were usually found inland of the survey line; on 16 August 1977, only 13% of the 3355 Black Ducks counted were noted on the landward side of the line although 79% of the 619 Mallards were observed there. Concentrations during both migrations were generally in the same places as those of the Black Duck, except in the Severn zone where the Mallard was never found in large groups. During the summer, the species was evenly dispersed throughout the zones and was never observed in major moulting flocks.

Table 4
Ratio of Mallard to Black Duck days of use per season and zone

	Zone					
Season	Moose	Kapiskau	Swan	Henrietta Maria	Winisk	Severn
Spring	0.89	0.52	0.41	0.33	0.30	0.29
Summer	0.78	0.64	0.58	0.19	0.24	0.15
Fall	0.51	0.33	0.37	0.22	0.11	0.10

5.2.3. Northern Pintail

The Northern Pintail was a very common dabbler (25.6% of total duck days), particularly in the spring when it was the most abundant species in all zones (64% of all dabbler sightings).

During the northward migration, the pintail arrived towards mid-April and reached peak numbers in the first half of May (highest zone count 16.6/km, Swan, 17 May 1977). Numbers then started a decline which continued through the summer in all zones except Winisk and Severn. There counts actually increased as pintails gathered to moult (highest zone counts 9.45/km in Winisk and 16.86/km in Severn, 26–27 July 1977). Later in the summer, numbers dropped in the Severn, Winisk, and Swan zones when the pintail, which was an early migrant, moved south to contribute to peak counts in the Moose and Kapiskau zones (28.61/km, 28 August 1977 and 198.43/km, 14 September 1978 respectively). During the migrations, the relative distribution among the zones was largely similar to that of the Black Duck, although in the fall a much greater proportion of the pintails (91% as opposed to 71% for Black Ducks) occurred in the two southern zones. In the summer, pintail remained mostly north of Ekwan Point; 60% of total summer dabbler days for pintail occur in the Winisk and Severn zones.

During the surveys, pintails were found mainly in salt-water habitats such as mudflats, tidal pools, and brackish ponds. On migration, the species could be expected in large numbers anywhere along the Ontario coast. In the summer, moulters concentrated in flocks, some in excess of 300 birds

(Prevett, pers. comm.) on the large brackish pools along the shoreline west of Winisk. Notably high concentrations of moulters occurred around the mouths of the Shagamu and Niskibi rivers and in the vicinity of the Pen Islands.

5.2.4. Green-winged Teal

The Green-winged Teal (23.6% of total dabbler days) was intermediate in abundance between the Black Duck and the Mallard. Its relative distribution among the zones was similar to that of the Mallard.

The Green-winged Teal tended to arrive in the second half of April and to peak in abundance in mid-May (highest zone count 3.6/km, Kapiskau, 16 May 1979) after which numbers greatly declined. During the summer, counts appeared to rise slowly as the post-breeders congregated; however, results per zone were not conclusive because of the species' habit of forming large scarce flocks, distributed irregularly along the shore. In the fall, numbers increased dramatically to maxima in mid-September in the Severn and Winisk zones and as late as early October in the Swan and Moose zones (highest zone count 117.9/km, Kapiskau, 14 September 1977).

These teal were encountered most often in dense flocks on the mudflats beside streams and river mouths and occasionally in the more brackish ponds inland. Particularly high numbers were found during the fall migration around Chickney Point where over 10 000 were observed on 14 September 1978.

5.2.5. American Wigeon

Unlike the previous three species, which were common from spring to fall, the American Wigeon (5% of total duck days) was present along the coast in large numbers only during the autumn migration. In the spring and summer, small flocks, usually less than 10 individuals, were recorded sporadically along the whole shore although most were found in the more southerly zones. It was possible that wigeons moved directly to their breeding areas without staging along the coast. In the fall, numbers rose quickly in the Moose, Severn, and Kapiskau zones and accounted for 15, 7, and 74% respectively of total dabbler days for that species.

The spring migration peaked in mid-May (highest zone count, 0.96/km, Moose, 16 May 1978) as the wigeon was a late-arriving species. Numbers then declined rapidly to very low levels during the summer and rose to a peak during mid-September (highest zone count 50.98/km, Kapiskau, 14 September 1978). Several thousand wigeon were still present into October in the Moose zone (4.49/km, 8–15 October 1978).

The wigeon mainly selected rich, brackish habitat associated with stream mouths, including both mud flats and goose meadows. Some sites to which the species returned predictably during the migration included the Mississicaibi River, Partridge Creek, Kinoje River, the area from the Albany to Kapiskau Rivers, Nowashe to Lakitusaki rivers inclusive, the Sutton-Kinusheo, Shagamu, Niskibi rivers, and around the Pen Islands.

5.2.6. Northern Shoveler

Records of the Northern Shoveler were widespread although the numbers were very low. During spring, Shovelers were only noted in mid-May, usually in flocks of up to six birds. The occasional individual was seen in the summer and in the fall.

Preferred habitat appeared to be fresh or brackish ponds contained by beach ridges or at the back of the coastal marsh.

5.2.7. Blue-winged Teal

The Blue-winged Teal was seen very rarely and sporadically along the coast, most often during the migrations; they were almost never observed in flocks of more than four birds. Only the two southern zones had records for all three seasons.

Unlike the Green-winged Teal, the Blue-winged Teal appeared to prefer freshwater and slightly brackish ponds at the back of the coastal marsh.

6. Summary

Although dabblers were distributed throughout the northern coast of Ontario, most birds occurred along the James Bay shore, particularly in the Kapiskau zone which contributes 50% of total dabbler days. Dabbler use of the Kapiskau zone was estimated at 4.6 million duck days, making it of provincial importance as a staging area for ducks (cf. Dennis, McCullough, North, and Ross, this publication, for southern Ontario); moreover its heavy use by shorebirds (Morrison and Harrington 1979) and geese (Bellrose 1978) elevates that zone to international significance for migrant waterbirds in general.

Patterns and intensities of use by dabblers along the northern coast also varied widely with season. During the migrations, dabbler numbers correlated strongly with amounts of broad marsh in each zone, as those marshes apparently offer the greatest feeding opportunities. In the spring migration, numbers of ducks were particuarly concentrated in the Moose zone, which was the earliest to open and the first to be encountered by many of the migrants. Levels and intensities of use in spring were relatively low, as the ducks appeared to pass through rapidly en route to the breeding grounds. Numbers of ducks on the coast rose slightly throughout the summer. In June and July, highest concentrations were found in the Hudson Bay zones on brackish ponds contained by beach ridges, where many ducks moulted. During August, the ducks, able to fly again, moved to staging areas on the broad marshes and higher concentrations shifted to the James Bay coast. By fall, numbers of staging and migrating birds rose dramatically; use of the northern coast increased by a factor of 8.3 over summer levels. Greatest densities of ducks were observed in the southern zones (Moose and Kapiskau) and probably reflect the migratory funnel formed by the James and Hudson bays system.

Differences in the abundance and distribution of the various dabbler species were also considerable. The Northern Pintail was the most common dabbler during spring and summer as both a migrant and moulter respectively. The proportion of pintails declined in the fall as they migrated south early. The Black Duck utilized the coast the most, but this was mostly due to the large numbers that staged there during the fall. Although fewer in numbers, the Green-winged Teal showed a similar distribution pattern to that of the Black Duck over all three seasons. Less common was the Mallard, which was present in signficant numbers in the three seasons only along the James Bay coast. The American Wigeon occurred mainly during migration and then only in certain predictable sites, usually around braided stream mouths. Blue-winged Teal and Northern Shoveler were also present but numbers were very low.

The purpose of this paper has been to describe the distribution of dabbling ducks along the northern coast of Ontario. Future investigations should aim at discovering the reasons for those patterns. Particularly important would be studies of the broad saltmarsh to which duck distribution is generally correlated. Work is needed both at the ecosystem level to define the requirements of the marsh and more narrowly through investigations of waterfowl feeding ecology to establish the mechanisms of habitat selection by the ducks. Only then can effective and economical conservation strategies be developed in the face of proposed developments such as hydroelectric dams and petroleum exploration.

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8. Literature cited

Bellrose, F.C. 1978. Ducks, geese and swans of North America. 2nd ed. (rev.) Stackpole Books, Harrisburg, PA. 543 pp.

Dennis, D.G.; Chandler, R.E. 1974. Waterfowl use of the Ontario shoreline of the southern Great Lakes during migration. Pages 58–65 *in* Boyd, H. ed. Canadian Wildlife Service waterfowl studies in eastern Canada 1969–1973. Can. Wildl. Serv. Rep. Ser. No. 29. 105 pp.

Dennis, D.G.; McCullough, G.B.; North, N.R.; Ross, R.K. An updated assessment of migrant waterfowl use of the Ontario shorelines of the southern Great Lakes. This publication.

Forster, J.R. 1772. An account of the birds sent from Hudson's Bay; with observations relative to their natural history; and Latin descriptions of some of the most uncommon. Phil. Trans. R. Soc. 62:382–433.

Glooschenko, W.A. 1980. Coastal ecosystems of the James/Hudson Bay area of Ontario, Canada. Z. Geomorph. 34:214–224.

Glooschenko, W.A.; Martini, I.P. 1978. Hudsons Bay Lowlands baseline study. Proc. Symp. Coastal Zone Management, San Francisco. p. 663–679.

Hanson, H.C.; Lumsden, H.G.; Lynch, J.J.; Norton, H.W. 1972. Population characteristics of three mainland colonies of Blue and Lesser Snow Geese nesting in the southern Hudson Bay region. Ont. Fish Wildl. Res. Branch, Res. Rep. (Wildl.) No. 92. 38 pp.

Kershaw, K.A. 1976. The vegetational zonation of the East Pen Island salt marshes, Hudson Bay. Can. J. Bot. 54:5–13.

Lumsden, H.G. 1959. The status of waterfowl in the Cape Henrietta Maria region. Trans. Northeast Wildl. Conf. 10:156–164.

Manning, T.H. 1959. Birds of the west James Bay and southern Hudson Bay coasts. Nat. Mus. Can. Bull. No. 125. 114 pp.

Morrison, R.I.G.; Harrington, B.A. 1979. Critical shorebird resources in James Bay and eastern North America. Proc. 44th Int. Wildl. Nat. Res. Conf. p. 498–507.

Peck, G.K. 1972. Birds of the Cape Henrietta Maria region, Ontario. Can. Field-Nat. 86:333–343.

Prevett, J.P.; Marshall, I.F.; Thomas, V.G. 1979. Fall foods of Lesser Snow Geese in the James Bay region. J. Wildl. Manage. 43:736–742.

Raveling, D.G.; Lumsden, H.G. 1977. Nesting ecology of Canada Geese in the Hudson Bay Lowlands of Ontario: evolution and population regulations. Ont. Min. Nat. Res. Fish Wildl. Res. Rep. No. 98. 77 pp.

Rich, E.E., ed. 1949. James Isham's observation on Hudson's Bay, 1743. Champlain Society, Toronto. 394 pp.

Riley, J.L.; McKay, S.M. 1980. The vegetation and phytogeography of coastal southwestern James Bay. Life Sci. Contr. R. Ont. Mus. 124. 81 pp.

Ringius, G.S. 1980. Vegetation survey of a James Bay coastal marsh. Can. Field-Nat. 94(2):110–120.

Smith, R.H. 1943. An investigation of the waterfowl resources of the south and east coasts of James Bay, 1943. Unpubl. rep. to Can. Wildl. Serv. 63 pp.

Smith, R.H. 1944. An investigation of waterfowl resources of the west coast of James Bay. Unpubl. rep. to Can. Wildl. Serv. 80 pp.

Swainson, W.; Richardson, J. 1831. Fauna Boreali-Americana; or the zoology of the northern parts of British America, Part II. The birds. London. 523 pp.

Zoltai, S.C. 1973. Vegetative, surficial deposits and permafrost relationship in the Hudson Bay Lowlands. Pages 17–34 *in* Proc. Symp. Physical Environment of the Hudson Bay Lowland, Univ. Guelph. 125 pp.

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The interpretation of aerial surveys for seabirds: some effects of behaviour by A.J. Gaston and G.E.J. Smith. Disponible également en français.
Cat. No. CW69-1/53E. Publ. 1984.

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