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Daniel Bordage and Christine Lepage

Québec Region, 2002
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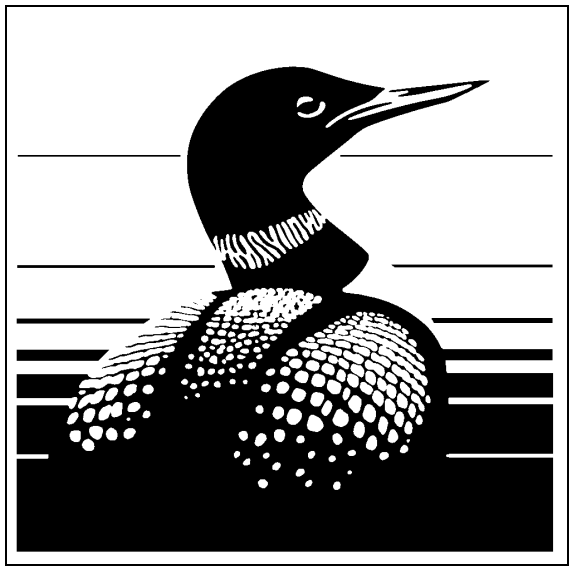
Environmental Conservation Branch



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Daniel Bordage[1] and Christine Lepage[2]

TECHNICAL REPORT SERIES No. 382
Québec Region, 2002
Canadian Wildlife Service

[1] Environment Canada, Canadian Wildlife Service, 1141 Route de l'Église,
P.O. Box 10100, Sainte-Foy (Québec), G1V 4H5
E-mail: daniel.bordage@ec.gc.ca

[2] Environment Canada, Canadian Wildlife Service, 1141 Route de l'Église,
P.O. Box 10100, Sainte-Foy (Québec), G1V 4H5
E-mail: christine.lepage@ec.gc.ca

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Environment Canada
Canadian Wildlife Service
1141 Route de l'Église, P.O. Box 10100
Sainte-Foy (Québec)
G1V 4H5
Telephone: 418-648-7225

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Readers should note that this publication uses the International System of Units: thousands are separated from hundreds by a space (53 833 km²; 1 231 448 pairs), and decimals are separated from units by a comma (9,98 pairs/100 km²; -7,8°C).

Abstract

Although the shores of the St. Lawrence River are a preferred breeding site for waterfowl, no exhaustive survey of all species present at this site during the breeding season had been conducted. In order to fill this gap, a monitoring program was developed to monitor waterfowl breeding pairs in the St. Lawrence system. The objectives of the program are to determine the distribution, breeding populations and population trends for the American Black Duck and other waterfowl species found along the shores of the St. Lawrence River and its main tributaries.

From 1990 to 1992, a ground survey of waterfowl breeding pairs was carried out annually in 168 1-km^2 quadrats distributed over five regions: Outaouais, Montréal, Québec City, Saguenay–Lac-Saint-Jean and the Estuary.

A total of 30 species of waterfowl were observed, 20 of which are known to breed in the study area. The Québec City region had the highest mean densities (11,8 indicated pairs/km^2), followed very closely by the Estuary (11,5 IPs/km^2). Next in order of density were the Montréal region (9,6 IPs/km^2), the Saguenay–Lac-Saint-Jean region (7,6 IPs/km^2) and the Outaouais region (2,5 IPs/km^2).

In terms of species, the American Black Duck was the most abundant with 15 335 indicated pairs (1990-1992 mean), or 33,3% of all indicated pairs of waterfowl observed. Mallard was a distant second with 5256 indicated pairs (11,4%), followed by Northern Pintail with 3027 indicated pairs (6,6%), Green-winged Teal with 2984 indicated pairs (6,5%) and Common Merganser with 2102 indicated pairs (4,6%). From 1990 to 1992, populations of most species of dabbling ducks appear to have increased in the study area, while only certain species of diving ducks showed an increase.

It will be important to repeat these surveys on a regular basis in order to observe long-term changes in waterfowl populations using this territory, which is exposed to a number of significant environmental stresses (urbanization, water level fluctuations, pollution, etc.). The main cases to be documented are the probable decline in American Black Duck breeding populations and the increase in Mallard and resident Canada Goose populations.

Résumé

Les rives du Saint-Laurent constituent un endroit de prédilection pour la nidification de la sauvagine, mais aucun programme d'inventaire exhaustif ne couvrait l'ensemble des espèces en période de nidification. Pour combler cette lacune, un suivi des couples nicheurs de sauvagine dans le système du Saint-Laurent a été élaboré. Les objectifs de ce suivi sont de préciser la répartition, évaluer les effectifs nicheurs et leurs tendances pour le Canard noir et les autres espèces de sauvagine fréquentant les rives du Saint-Laurent et de ses principaux tributaires.

De 1990 à 1992, l'inventaire au sol des couples nicheurs de sauvagine a été réalisé annuellement dans 168 quadrats de 1 km $\times$ 1 km répartis dans cinq régions : Outaouais, Montréal, Québec, Saguenay–Lac-Saint-Jean et Estuaire.

Trente espèces de sauvagine ont été observées, dont vingt sont reconnues comme nichant dans l'aire d'étude. La région de Québec obtient les densités moyennes les plus élevées (11,8 équivalents-couples/km^2), suivie de très près par l'Estuaire (11,5 é.-c./km^2). Suivent la région de Montréal (9,6 é.-c./km^2), du Saguenay–Lac-Saint-Jean (7,6 é.-c./km^2) et de l'Outaouais (2,5 é.-c./km^2).

Du côté des espèces, le Canard noir est le plus abondant avec 15 335 équivalents-couples (moyenne 1990-1992), soit 33,3 % de tous les équivalents-couples de sauvagine observés. Le Canard colvert suit de loin avec 5256 équivalents-couples (11,4 %), puis le Canard pilet avec 3027 équivalents-couples (6,6 %), la Sarcelle d'hiver avec 2984 équivalents-couples (6,5 %) et le Grand Harle avec 2102 équivalents-couples (4,6 %). De 1990 à 1992, les effectifs de la plupart des espèces de canards barboteurs semblent avoir augmenté dans l'aire d'étude, alors que seulement certaines espèces de canards plongeurs ont montré une augmentation.

Il sera important de reconduire ce suivi sur une base régulière afin d'observer les changements à long terme chez la sauvagine qui fréquente ce territoire soumis à plusieurs stress environnementaux d'envergure (urbanisation, variation des niveaux d'eau, pollution, etc.). Les principaux cas à documenter sont la diminution probable des effectifs nicheurs de Canard noir, l'expansion de la population de Canard colvert ainsi que de la population résidente de Bernache du Canada.

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1.0 Introduction

Every spring, the shores of the St. Lawrence River come to life with the arrival of large flocks of waterfowl (geese and ducks). For most of these birds, the St. Lawrence River is a staging area along the migratory route that will take them to their breeding grounds further north. However, for others, the shores of the St. Lawrence River are a preferred nesting and brood-rearing habitat. In the 1970s and early 1980s, the Canadian Wildlife Service (CWS) conducted an extensive waterfowl survey program, which determined that approximately 700 000 individuals passed through the shores of the St. Lawrence River (river, estuary and gulf) in the spring and fall, and that approximately 200 000 individuals wintered there (Lehoux *et al.* 1985). However, the data are now more than 20 years old and the estimates should be revised. It is known, for example, that more than 800 000 Snow Geese[1] were surveyed in the St. Lawrence River from 1998 to 2001 (unpublished CWS data), up from an estimated 213 000 between 1974 and 1978 (Lehoux *et al.* 1985). Moreover, no exhaustive survey covering all waterfowl species in the St. Lawrence River system during the breeding season was conducted at that time.

However, an exhaustive survey of the breeding populations of some species, such as the Common Eider, along the St. Lawrence River was carried out (Chapdelaine *et al.* 1986). Several studies have provided us with a better understanding of waterfowl breeding along the St. Lawrence River, either by focusing on one species in a given sector, for example American Black Ducks (Reed 1975; Bélanger *et al.* 1994), or by focusing on all species in a given sector, for example the islands located between Montréal and Trois-Rivières (Bélanger and Lehoux 1995).

The experimental program to monitor breeding pairs of American Black Duck in the boreal forest (Bordage and Plante 1997) ended in 1989 and general monitoring of this species in Eastern Canada was instituted in 1990. The annual spring survey of the Black Duck Joint Venture (BDJV), a component of the North American Waterfowl Management Plan (NAWMP), covers most of the Boreal Shield and Atlantic Maritime ecozones (Collins 2000). In the Ontario and Atlantic regions, ground surveys are

[1] See Appendix 1 for the scientific names of the species.

conducted in the regions not covered by the BDJV surveys (Dennis *et al.* 1989; Bateman and Dibblee 2000). In 1989, a proposal to monitor American Black Duck breeding pairs along the shores of the St. Lawrence River and its main tributaries in Québec was submitted to the BDJV and to the *Conseil consultatif de l'Est canadien sur la sauvagine* [Eastern Canada wildlife advisory board] (CCECS; Bordage *et al.* 1989). These two groups supported the proposal, but there was insufficient funding to carry out the monitoring. Funding was eventually provided under Phase I of the St. Lawrence Action Plan (SLAP), supplementing certain regional surpluses of the BDJV.

The primary objective of the monitoring program was to document trends in the breeding populations of American Black Duck in the St. Lawrence River system. There were also a number of secondary objectives: 1) to determine the distribution and estimate the size of American Black Duck breeding populations along the St. Lawrence River and its main tributaries; 2) to fill knowledge gaps on the distribution, population trends and estimates of breeding populations of other waterfowl species along the St. Lawrence River and its main tributaries; 3) to document habitat use by waterfowl and assess changes in their habitats along the shores of the St. Lawrence River and its main tributaries.

One of the secondary benefits of the project was to present a more complete picture of the situation of American Black Ducks in southern Québec. Following the introduction in 1984 of regulatory restrictions on the sport harvesting of black ducks in Canada, its population increased significantly from 1985 to 1989 in the boreal forest (Bordage and Plante 1997). What needs to be assessed now is how this species is faring in the St. Lawrence River system, where there is greater hunting pressure and possible competition from Mallards for the most productive habitats – one of the possible causes of the decline in the American Black Duck population (Merendino *et al.* 1993).

In order to obtain a more accurate picture of the situation, close to 200 1-km^2 study plots (or quadrats) distributed along the shores of the St. Lawrence River and its main tributaries – the Ottawa River, the Richelieu River, the Saguenay River and Lake Saint-Jean – were selected. A photo-interpretation of all quadrats and an *in situ* validation of several quadrats were carried out in 1989 in order to characterize

the survey habitats (Chauvette 1989). In 1990, the ground survey of waterfowl breeding pairs present in the survey quadrats began. It was originally planned that this survey would be repeated every year over a consecutive period of three to five years in order to establish a solid database, with subsequent surveys to be conducted every five years. In actual fact, the surveys were carried out during the first three years – 1990 to 1992 – but could not be continued after that due to insufficient funding. Publication of the results was delayed until now because of the ongoing hope of securing funding to continue the monitoring and thus provide a satisfactory time series. On the tenth anniversary of the completion of the surveys, this report finally presents the results of the distribution and abundance of breeding pairs of American Black Duck and other waterfowl species observed along the shores of the St. Lawrence River and its main tributaries from 1990 to 1992, with information on the short-term trends noted during this period, as well as a brief description of observed behaviour and habitat use.

2.0 Study area

We used the system of 1-km^2 quadrats defined by the 1000-metre Universal Transverse Mercator (UTM) grid system (North American Datum 1927, "NAD27"); this system is reproduced on 1:50 000 scale topographic maps produced by the Department of Energy, Mines and Resources of Canada. The study area consisted of all 1-km^2 quadrats that included a section of the shores of the St. Lawrence River (including the islands) and its main tributaries, namely the Ottawa River, the Richelieu River, the Saguenay River and Lake Saint-Jean, with a total area of 5333 km^2 (Figure 1). To determine the choice of quadrats in the Lake Saint-Pierre region, which is subject to a strong spring flooding, we used the approximate shore limit based on a 10-year flood.

The study area falls largely within the Mixed-Wood Plains ecozone (Bird Conservation Region [BCR] 13 – Lower Great Lakes/St. Lawrence Plain), but the northern portion also overlaps the Atlantic Maritime ecozone (BCR 14 – Atlantic Northern Forest) on the south shore and the Boreal Shield ecozone on the north shore (BCR 8 – Boreal Softwood Shield and BCR 12 – Boreal Hardwood Transition).

The study area was divided into five regions. The first, the Outaouais region, includes the section of the Ottawa River between Lake Timiskaming and the St. Lawrence River (1103 km^2). The second, the Montréal region, is the section of the St. Lawrence River that stretches from Cornwall to Pointe-du-Lac on the north shore and as far as the mouth of the Nicolet River on the south shore (1250 km^2). This region also includes the Richelieu River, from the Canada–U.S. border to the St. Lawrence River (206 km^2), covering a total area of 1456 km^2. The third, the Québec City region, is the section of the St. Lawrence River between Lake Saint-Pierre and Cap aux Oies, on the north shore, and Saint-Roch-des-Aulnaies, on the south shore (919 km^2). The fourth region encompasses Lake Saint-Jean and the Saguenay River (732 km^2). The fifth region is the Estuary, and stretches from Cap aux Oies and Saint-Roch-des-Aulnaies to Pointe-des-Monts, on the north shore, and to Matane, on the south shore (1123 km^2).

The St. Lawrence River has a total length of approximately 1200 km in Québec (total as far as Lake Ontario ≅ 1400 km) and can be subdivided into five sections: 1) the fluvial section, from Cornwall to Trois-Rivières; 2) the fluvial estuary, from Trois-Rivières to the eastern tip of Île d'Orléans; 3) the upper estuary, from the eastern tip of Île d'Orléans to the Tadoussac–L'Isle-Verte axis; 4) the lower estuary, from the Tadoussac–L'Isle-Verte axis to the Pointe-des-Monts–Grosses-Roches axis (east of Matane); 5) the gulf, from the Pointe-des-Monts–Grosses-Roches axis to the Strait of Belle-Isle in the north and to the Cabot Strait in the south (Bouchard *et al.* 1993). Tides are absent in the fluvial section, weak in the fluvial estuary and strong (4-6 m) in the upstream sections. The fluvial section and the fluvial estuary contain freshwater, the upstream part of the upper estuary as far as Rivière-Ouelle contains brackish water, and the rest of the system contains saltwater. The depth of the St. Lawrence River also varies considerably, from 10 to 12 m in the fluvial section and the fluvial estuary, to 100 to 300 m in the upper estuary and the lower estuary, to more than 400 m in the gulf. Nearly 70% of the total population of Québec lives on or near the shores of the St. Lawrence River. More than two-thirds of the waterfowl harvested in Québec by sport hunting are taken along the St. Lawrence River (Bouchard *et al.* 1993).

3.0 Methods

3.1 Sampling plan

A total of 190 quadrats, representing a sampling effort of 3,6%, were selected at random at the start of the project from among all the riparian quadrats available, i.e., 30 quadrats in each of the five regions, 19 quadrats in protected sectors and 21 quadrats in sectors where wetland management occurred. During the development of the project, it was planned to randomly distribute quadrats in sectors with special protection status (national wildlife area, provincial park, etc.) or in sectors where wetland management occurred. The trends in the waterfowl populations within these specific quadrats could thus be compared to those in the quadrats without special status, in order to verify the impact of protection or habitat management. Given the limited amount of data (three years), the size of the quadrat, which is often far larger than a protected site, especially in the case of wetland management areas, and the protection status, which varies from site to site depending on whether it is a national wildlife area, a migratory bird sanctuary, etc., it was decided to consider the protected quadrats or quadrats where wetland management occurred on the same basis as the other 150 quadrats without special protection or conservation status.

In practice, 172 quadrats were surveyed in 1990, 188 in 1991 and 188 in 1992. There are several reasons for which all of the quadrats could not be covered every year, as initially planned. The smaller number of quadrats covered in the first year of the monitoring program can be explained largely by the decision to eliminate 12 quadrats from the Outaouais region. The reason for this is that an inter-annual comparative analysis suggested that one of the observers hired lacked experience in ornithology, which was subsequently confirmed by a summary investigation. This explains the smaller number of quadrats in the Outaouais compared to the other regions (Table 1). Other reasons include: wrong location of a quadrat; difficulty in finding a vessel in order to get to the quadrat; authorization to visit Île aux Fraises denied because of the risk of disturbing the Common Eider colony; and the hard-to-reach nature of certain quadrats. In order to facilitate inter-annual comparisons, in this report, we consider only the 168 quadrats visited in each of the three years of the survey, 1990-1992, which

represents a sampling effort of 3,2% (Table 1). The location of these 168 quadrats is provided in Appendix 2.

3.2 Data collection

Each quadrat was visited once by one or two experienced observers. Each observer had a copy of an interpreted aerial photograph of the quadrat. The sightings were made on land or from the water using binoculars and telescopes and, depending on the type of environment, the quadrats were reached by foot, all-terrain vehicle, canoe or boat. The observers were not required to follow any rigorous methodology, the only requirement being that they actively survey all suitable habitats, i.e., by moving through the area, as compared to a passive method, e.g., observation from a fixed point. Each quadrat had to be covered in a single day, beginning 30 minutes before sunrise. The time required to adequately cover a quadrat was left to the observers' discretion. Each quadrat was considered covered when the observers concluded that they had been able to observe all waterfowl present in all suitable habitats. No active searches for nests were conducted.

The observers entered the following information directly on a transparency, overlaid on the copy of the interpreted aerial photograph: 1) number of males, females and individuals of unknown sex of each bird or group of birds of each species observed using a species code (Appendix 1) along with a precise indication of the birds' location; 2) a behaviour code; 3) various methodological information such as identification of the quadrat, the observers' names, the date, the survey start and end times, changes in the environment compared to the aerial photograph; 4) various weather information such as temperature, wind speed, cloud cover; and 5) tidal state. All of this information was then compiled in computer files, adding the UTM location of each waterfowl sighting as well as the type of habitat in which the birds were observed. Note that this report discusses only the species of waterfowl observed, while the observers noted all species of birds.

3.3 Processing of the data

The survey was to be carried out during the nest-building period and onset of incubation of the most abundant waterfowl species, namely American Black Ducks and Mallards, both considered early-nesting species. To determine the timing of the survey relative to this period, we calculated a phenology index (PI), corresponding to the number of paired males (1 male + 1 female) divided by the total number of males not accompanied by females (lone males and groups of males). A PI of 1,0 is considered optimal for American Black Ducks and the other species whose sex ratio is approximately 1,0. A PI of 1,0 is also considered indicative of a survey carried out when approximately half the females have started laying and the other half have started incubation. A PI significantly above 1,0 suggests a survey carried out too early, i.e. when many birds are still migrating, which can result in overestimation of the number of breeding pairs in the study area. Conversely, a PI significantly below 1,0 would suggest a survey carried out too late, i.e. when the females are in the process of incubating and their male partners have left the nesting site to moult, which results in underestimation of the number of breeding pairs.

Since the estimate of the number of pairs is based solely on the sighting of birds which happen to be present in each quadrat, we had to use a set of decision rules in order to distinguish those individuals we consider likely to be breeding in the quadrat from those still migrating or those present in the sector but not breeding there (notably immatures). In this report, all data relating to birds considered breeders are presented as indicated pairs (IPs), calculated using the standards of the BDJV helicopter survey in Eastern Canada (Appendix 3). We will refer to non-breeding birds as migrants.

Given the short three-year time series, no statistical test was performed to estimate trends or identify significant differences in mean densities from one region to another. The standard errors associated with the means presented will nevertheless make it possible to assess the accuracy of the estimates and to evaluate the significance of the inter-annual differences observed.

4.0 Results

Thirty native waterfowl species (Anatidae) were observed in the entire study area along the shores of the St. Lawrence River and its main tributaries. For the purposes of this report, only those species described in the section on breeding birds of southern Québec of the *Atlas of Breeding Birds of Southern Québec* (Gauthier and Aubry 1996) were considered likely to be breeding in the study area. There are, however, two exceptions: 1) the Snow Goose, not described in this section of the Atlas, was treated as a breeder, since a few individuals regularly breed along the St. Lawrence River (Reed 1996b); 2) the Atlantic Brant, described in this section of the Atlas, but on the basis of a single nesting record in Abitibi in an uncharacteristic habitat (Reed 1996a), was not considered here as likely to be breeding. The other four species discussed in the section of the Atlas on other breeding birds of Québec that were observed in 1990-1992 but not included in this report are King Eider, White-winged Scoter, Black Scoter and Long-tailed Duck. Note that the breeding habitat of the five species not included is located much further north. A total of 25 species were included in the analyses, for a total of 46 075 indicated pairs (1990-1992 mean; Table 2). Of this number, 21 species were observed in every year of the survey. The American Black Duck was the most abundant species with a mean population of 15 335 indicated pairs, or 33,3% of all the pairs of waterfowl observed. The Mallard was a distant second with a mean number of 5256 indicated pairs, or 11,4% of the pairs. These two species alone accounted for nearly half the pairs of waterfowl surveyed in the study area in the spring. Finally, to complete the list of the five most abundant species in our study area, the Northern Pintail accounted for 6,6%, the Green-winged Teal for 6,5% and the Common Merganser for 4,6%.

4.1 Profile of regions

Tables 3 to 7 present the estimates obtained for each of the five regions under study. The Montréal region had the largest number of indicated pairs, for a mean of 13 900 pairs (30,2% of the total population; Table 4). It is followed closely by the Estuary region ($mean_{90\text{-}92}$ = 12 954 IPs; Table 7) and by the Québec City region ($mean_{90\text{-}92}$ =

10 850 IPs; Table 5), with the Saguenay–Lac-Saint-Jean region ($mean_{90\text{-}92}$ = 5582 IPs; Table 6) and the Outaouais region ($mean_{90\text{-}92}$ = 2789 IPs; Table 3) ranking last. When a more equitable scale is used for the comparison, i.e. the number of indicated pairs observed per square kilometre of territory surveyed, the Québec City region has the highest densities ($mean_{90\text{-}92}$ = 11,8 IPs/km^2; Figure 2), followed very closely by the Estuary ($mean_{90\text{-}92}$ = 11,5 IPs/km^2). Next in order are the Montréal region ($mean_{90\text{-}92}$ = 9,6 IPs/km^2), the Saguenay–Lac-Saint-Jean region ($mean_{90\text{-}92}$ = 7,6 IPs/km^2) and the Outaouais region ($mean_{90\text{-}92}$ = 2,5 IPs/km^2). Figure 2 also shows that, on the whole, waterfowl populations increased between 1990 and 1992, except in the Estuary region, which supported relatively stable populations during these three years. Table 2 further indicates that the total number of indicated pairs of waterfowl increased 38,9% from 1990 to 1992 – 47,0% for geese, 39,2% for dabbling ducks and 36,9% for diving ducks.[1] It can also be seen from Figure 2 that the general trend of waterfowl populations largely depends on dabbling ducks. Finally, it will be noted that an increasing west-east density gradient is evident for diving ducks.

Seventeen species of waterfowl were observed in the Outaouais region in 1990-1992, but only seven species were noted in this region (indicated pairs) in every year (Table 3). The largest number of pairs of waterfowl was observed in 1991, mainly because of a high number of diving ducks. The number of indicated pairs of dabbling ducks gradually increased in this region from 1990 to 1992. The Mallard was the most abundant species in the Outaouais (18,4% of the IPs), followed very closely by the American Black Duck (17,5% of the IPs), which was the species observed in the greatest numbers (tied with the Bufflehead) in this region in 1991. The Common Merganser was the third most abundant species for the 1990-1992 period, with 12,6% of the indicated pairs.

Twenty-three species of waterfowl were observed in the Montréal region (Table 4). Only the Common Eider and the Surf Scoter were not observed (indicated pairs) in this region. Fifteen species were observed in this region in each of the three years. An important increase in the number of indicated pairs of waterfowl was observed in this region from 1990 to 1992, an increase largely attributable to dabbling ducks,

[1] Ruddy Ducks were included with the diving ducks to simplify the presentation.

whose populations increased from 7940 indicated pairs in 1990 to 15 288 indicated pairs in 1992. Dabbling ducks comprised the majority (77,1%) of the pairs observed. Mallards were the most abundant species in the Montréal region (21,5% of the IPs), followed closely by American Black Ducks (18,7% of the IPs), which was the species observed in the greatest numbers in 1990. Northern Pintail were the next most abundant, with 8,2% of the indicated pairs.

In the Québec City region, twenty species of waterfowl were noted, including fifteen in each of the three years (Table 5). A slight increase in the total number of indicated pairs was observed in this region from 1990 to 1992, but dabbling ducks, which accounted for 74,9% of individuals, saw their numbers increase by 55,3% in the same period. American Black Ducks were the most abundant species in the Québec City region, with 39,6% of all the individuals observed. Mallards were the second most abundant species, with a mean proportion of 9,3% of the indicated pairs of waterfowl in this region, followed by Northern Pintail, which accounted for 8,0% of the indicated pairs.

Nineteen species of waterfowl were observed in the Saguenay–Lac-Saint-Jean region (Table 6). Fourteen of these species were reported in this region every year. The largest number of indicated pairs in the three years of the survey was obtained in 1992, but the maximum number of geese was noted in this region in 1990, the largest number of diving ducks in 1991 and the largest number of dabbling ducks in 1992. The American Black Duck is the most abundant species in this region with 26,6% of the indicated pairs, followed a distant second and third by Green-winged Teal (11,3% of the IPs) and Common Goldeneye (10,7% of the IPs). Mallards rank sixth in abundance, accounting for only 5,6% of the indicated pairs.

Twenty species of waterfowl occur in the Estuary region, thirteen of which were observed every year (Table 7). On the whole, the waterfowl breeding population of this region has remained relatively stable. However, the number of indicated pairs of dabbling ducks in the region decreased by 20,7% during the three years of the program, while the number of diving ducks increased by 73,6% in the same period. The American Black Duck is the most abundant species in this region, accounting for half of the total waterfowl population (49,9%), followed by the Common Eider (9,6% of the IPs of

waterfowl) and Green-winged Teal (6,9% of the IPs). Mallards once again lag far behind, in seventh place, with only 3,3% of the indicated pairs.

4.2 Profile of species

Figures 3 to 31 present the 1990-1992 trends for the twenty-five waterfowl species surveyed in the five regions of the study.

As can be seen, maximum densities of geese are observed in the Québec City region, both for the Snow Goose (0,11 IP/km^2 in 1992; Figure 3) and for the Canada Goose (0,49 IP/km^2 in 1992; Figure 4). Western Québec does not appear to support large numbers of geese, since the Snow Goose is absent in the Outaouais region and in the Montréal region (except in 1992), and the Canada Goose was observed in the Outaouais only in 1992. There is no apparent trend for these two species.

For dabbling ducks, the maximum density for Wood Ducks (0,53 IP/km^2) was obtained in 1992 in the Montréal region (Figure 5). The Outaouais region ($WODU_{90\text{-}92}$ = 0,20 IP/km^2) and the Québec City region ($WODU_{90\text{-}92}$ = 0,19 IP/km^2) appear to support an equivalent number of this species, while the population decreases further to the east, and is completely absent in the Estuary region. The Wood Duck population increased significantly from 1990 to 1992 in the Montréal region, and to a lesser extent, in the Outaouais region.

Like Wood Ducks, the distribution of Gadwalls appears to be concentrated in the Montréal region, with increasing densities since 1990, reaching a maximum of 1,30 indicated pairs/km^2 in 1992 (Figure 6). A few pairs were also observed in the Québec City region ($GADW_{90\text{-}92}$ = 0,10 IP/km^2), while none were inventoried in the Outaouais, Saguenay–Lac-Saint-Jean and Estuary regions. The only trend that emerges for this species is an upward trend in the Montréal region.

American Wigeons were observed in all regions, and the maximum densities, which reached 0,81 indicated pair/km^2 in 1992, were recorded in the Montréal region (Figure 7). Although the trend pattern is not completely clear, populations in this region and in the Saguenay–Lac-Saint-Jean region appear to have increased from 1990 to 1992. Despite an apparent downward trend in the Québec City region, the fact that the standard error limits overlap does not allow us to draw such a conclusion.

Figure 8 shows that the number of indicated pairs/km^2 of American Black Duck increases from west to east along the St. Lawrence River, reaching a maximum of 6,68 indicated pairs/km^2 in 1990 in the Estuary region, and that the densities further north, in Saguenay–Lac-Saint-Jean ($mean_{90\text{-}92}$ = 2,03 IPs/km^2) are comparable to those obtained in the Montréal region ($mean_{90\text{-}92}$ = 1,79 IPs/km^2). There appears to be a general upward trend from 1990 to 1992, particularly in the Québec City region, where the species increased from 3,07 indicated pairs/km^2 in 1990 to 6,09 indicated pairs/km^2 in 1992. Only the Estuary region exhibits declining densities of American Black Duck in the same period.

A completely opposite distribution pattern can be observed for Mallards along the St. Lawrence River, with a maximum density of 3,05 indicated pairs/km^2 noted in 1992 in the Montréal region and a steady decline in numbers further east (Figure 9). Important increases in the number of Mallards are seen in the Montréal region (from 1,44 IPs/km^2 in 1990 to 3,05 IPs/km^2 in 1992), the Québec City region (from 0,70 IP/km^2 in 1990 to 1,65 IPs/km^2 in 1992) and, to a lesser extent, in the Saguenay–Lac-Saint-Jean region (from 0,31 IP/km^2 in 1990 to 0,66 IP/km^2 in 1992).

Figure 10 allows us to better appreciate the comparison between American Black Ducks and Mallards. This figure shows that the densities are comparable in the Outaouais region ($ABDU_{90\text{-}92}$ = 0,44 IP/km^2; $MALL_{90\text{-}92}$ = 0,46 IP/km^2), that they are slightly higher for Mallards in the Montréal region ($ABDU_{90\text{-}92}$ = 1,79 IPs/km^2; $MALL_{90\text{-}92}$ = 2,05 IPs/km^2), while American Black Ducks are clearly predominant in the three other regions further east. Figure 11 highlights several interesting points concerning these two species and their distribution in the St. Lawrence valley (Montréal, Québec City and Estuary regions). First, the point of intersection, i.e. the location where the combined number of indicated pairs (starting from the west) of American Black Duck exceeds the combined number of indicated pairs of Mallard, shifted from west to east from 1990 to 1992. In 1990, this point was located at Lake Saint-Pierre in the Yamachiche–Notre-Dame-de-Pierreville axis. In 1991, it was located 14 km further east, at Île aux Sternes (east of Pointe-du-Lac) in the fluvial section of the St. Lawrence River. In 1992, this point was at Île de la Batture (near Sainte-Anne-de-la-Pérade), i.e. 34 km further east than in 1991 and 48 km further east than in 1990. Another interesting piece of

information provided by Figure 11 is the comparison of the shape of the curves. It will be noted that the Mallard curves are similar in 1990 and 1991, plateauing at the boundary of UTM areas 18 and 19, i.e. in the Deschambault–Lotbinière axis. This plateau shifted fairly eastward in 1992, i.e. in the Saint-Vallier region. For American Black Ducks, the combined number of indicated pairs increased gradually in 1990, while a plateau became apparent in 1991 in the western section. In 1992, there was little increase in the number of American Black Ducks in this western section, while a notable and gradual increase could be seen only from Berthierville–Sorel.

Low densities were observed for Blue-winged Teal, with a maximum of 0,56 indicated pair/km^2 in the Saguenay–Lac-Saint-Jean region in 1992 (Figure 12). Despite the fact that the recorded numbers of this species were highly variable from year to year, an increase in the population in the Estuary region was observed. Note also that no Blue-winged Teal were observed in the Outaouais region in 1992. There is an unexpected finding in Figure 12: the maximum densities were recorded in Saguenay–Lac-Saint-Jean ($BWTE_{90\text{-}92}$ = 0,45 IP/km^2) and not in the southwestern part of the province.

With the exception of the Outaouais region, the distribution pattern for Northern Shovelers was characterized by a gradual decrease in densities from west to east, with a maximum density of 0,51 indicated pair/km^2 in the Montréal region in 1992 (Figure 13). There was no clear upward or downward trend for this species from 1990 to 1992.

The highest number of Northern Pintails was observed in the Québec City region, with a maximum density of 1,16 indicated pairs/km^2 in 1991 ($NOPI_{90\text{-}92}$ = 0,95 IP/km^2; Figure 14), followed closely by the Montréal region, with a mean of 0,78 indicated pair/km^2, and the Estuary region, with a mean of 0,71 indicated pair/km^2. No obvious population trend can be discerned for Northern Pintails from 1990 to 1992.

An increase in density from west to east is observed for Green-winged Teal, reaching a maximum in the Québec City region (1,32 IPs/km^2 in 1991; $GWTE_{90\text{-}92}$ = 0,94 IP/km^2), and then declining in the Saguenay–Lac-Saint-Jean region ($GWTE_{90\text{-}92}$ = 0,86 IP/km^2) and the Estuary region ($GWTE_{90\text{-}92}$ = 0,80 IP/km^2; Figure 15). There appears to be an upward trend for this species, particularly in the Montréal and Québec

City regions, where the densities in 1991 and 1992 are higher than those recorded in 1990.

Several species of diving ducks were not observed in certain regions in any of the survey years. This group of species with a limited distribution includes Redheads (Figure 16), Lesser Scaup (Figure 19), Common Eiders – observed only in the Estuary region (Figure 22) –, Harlequin Ducks (Figure 23), Surf Scoters (Figure 24), Barrow's Goldeneye (Figure 27) and Ruddy Ducks – included in this group in order to simplify the presentation (Figure 31).

Certain specific trends were observed for some of these species. One example is the Redhead, whose maximum density of 0,28 indicated pair/km^2 recorded in 1990 in Saguenay–Lac-Saint-Jean decreased to 0,03 indicated pair/km^2 in 1992 (Figure 16). An upward trend can be noted for Common Eiders in the Estuary region, with a maximum value of 1,79 indicated pairs/km^2 in 1992 (Figure 22), as well as for the Surf Scoter in the same region, with a maximum density of 0,45 indicated pair/km^2 in 1992 (Figure 24). However, the data for most of the species of diving ducks are associated with large standard errors, making comparisons between regions and the interpretation of trends difficult. We note the rare sighting of a pair of Harlequin Ducks in 1991 in the Montréal region (Figure 23), and a sighting of a male Barrow's Goldeneye in 1992 in the same region (Figure 27).

The Ring-necked Duck, observed in all the regions, although virtually absent from the Estuary region, attained a maximum value of 0,89 indicated pair/km^2 in the Québec City region in 1990 (Figure 17). It is, moreover, in this region that the highest mean densities were recorded ($RNDU_{90\text{-}92}$ = 0,75 IP/km^2), followed by the Montréal region with a mean density of 0,53 indicated pair/km^2. No clear population trend can be discerned based on the values observed for this species.

The Greater Scaup was almost observed only in 1991, when a relatively high density of 1,00 indicated pair/km^2 was recorded in the Saguenay–Lac-Saint-Jean region (Figure 18). The situation was similar for the Lesser Scaup in 1991, with a maximum density of 0,49 indicated pair/km^2 noted in the Québec City region and an absence of the species further east (Figure 19). These two species are difficult to differentiate and, as seen in Figure 20, nearly all records where the species could not be identified with

certainty are from 1990 and 1992. Thus, when the observations of Greater Scaup and Lesser Scaup are combined regardless of whether they are identified to the species or not (Figure 21), it is observed that the densities remain higher in 1991 and tend to increase from west to east, with the exception of the Estuary, which has densities comparable to those in the Outaouais (Figure 21).

The densities of Bufflehead generally decrease from west to east, with observed maxima of 0,53 indicated pair/km^2 in the Montréal region in 1991 ($BUFF_{90\text{-}92}$ = 0,28 IP/km^2) and of 0,52 indicated pair/km^2 in the Outaouais region the same year ($BUFF_{90\text{-}92}$ = 0,22 IP/km^2; Figure 25). No clear trend over the three years can be extrapolated from the data for the Bufflehead.

When the Estuary is excluded, an opposite distribution for the Common Goldeneye is observed, with a maximum density of 1,12 indicated pairs/km^2 in the Saguenay–Lac-Saint-Jean region in 1992 ($COGO_{90\text{-}92}$ = 0,81 IP/km^2; Figure 26). There appears to be an upward population trend for the Common Goldeneye in the Montréal, Saguenay–Lac-Saint-Jean and Estuary regions (Figure 26).

The number of observations of Hooded Merganser varied considerably from year to year, but the maximum density was reached in the Québec City region in 1992 with 0,16 indicated pair/km^2 (Figure 28). However, this species was not observed every year in any of the regions, thus making it particularly difficult to discern any trend for this species.

The Red-breasted Merganser was observed primarily in the Estuary region, with a maximum density of 1,06 indicated pairs/km^2 in 1991 ($RBME_{90\text{-}92}$ = 0,72 IP/km^2; Figure 29), and no clear population trend pattern can be discerned for this species.

Finally, the Common Merganser is one of the species for which the mean densities observed showed little variation between regions, ranging from 0,32 indicated pair/km^2 in the Outaouais and Québec City regions to 0,53 indicated pair/km^2 in the Estuary region (Figure 30). Moreover, it was in the Estuary region that the maximum density of 0,88 indicated pair/km^2 was recorded in 1991. Only in the Montréal region did there appear to be a slightly greater upward population trend for the Common Merganser.

4.3 Profile of phenology

The phenology indices obtained for each species and in each year (1990 to 1992) are provided in Table 8. In general, the majority of the species have phenology indices close to 1,00, which, it will be recalled, is considered the ideal value (see section 3.3). Very low phenology indices (> 0,50) are obtained for the Wood Duck and the Surf Scoter in each year. In contrast, Gadwalls, American Wigeons, American Black Ducks, Bufflehead, Barrow's Goldeneyes and Hooded Mergansers have very high phenology indices (> 2,00) for the same period. Particularly high indices were recorded for American Black Ducks, a species targeted by the monitoring program, in all the years (62,50 in 1990; 19,90 in 1991; 5,63 in 1992). For Mallards, phenology indices very close to 1,00 were obtained, especially in 1990 and 1991, which was also the case for the Ring-necked Duck, which had excellent phenology indices in all years (Table 8).

4.4 Profile of behaviours

The behaviours noted during the surveys are listed in Table 9, all waterfowl species and all years combined. The observers noted the behaviour of the waterfowl in 57,5% of the observations. Flight was noted (8,7% of observations), but will not be considered in our analysis, since the observers are often the instigators of this behaviour. Of the behaviours we chose to include (proportion 2 in Table 9), feeding was the most frequent, with 52,1% of the waterfowl species demonstrating this behaviour. Geese and ducks resting were observed in 20,6% of cases, while waiting (the bird stands motionless in a location; 9,7%), standing watch (the bird is actively on the lookout in order to protect its territory, the neck straight and ready to sound the alert at the least danger; 9,5%) and preening (6,2%) are behaviours observed to a lesser extent. Finally the other behaviours were observed in fairly negligible proportions.

A breakdown of the status for each of the behaviours is provided in Table 10 and in Figure 32, all species and years combined. Thus, 67,6% of the geese or ducks standing watch or waiting are considered breeders (indicated pairs), as are 61,5% of the individuals that are resting. The individuals considered migrants (non-breeders in the sector) preen (61,1%) more than the breeders, just as they apparently adopt more behaviours linked to mating (61,1%) and to activities attributed to nesting (57,4%). The

feeding behaviours seem to be equally divided between breeding individuals and migrating individuals.

Despite the fact that these are behaviours adopted by all the species of waterfowl, it seems that for a given species, breeding individuals spend more time standing watch and resting (Table 11 and Figure 33) than migrating individuals. Migrating individuals, on the other hand, apparently concentrate more on feeding than do breeding individuals of the same species. The behaviours generally associated with breeding individuals do not appear to be exclusive to them since, as can be seen from Table 11, it seems that the individuals considered migrants spend nearly twice as much time mating and engaging in behaviours linked to nesting (NE: nest building, incubation, distracting intruders, protecting territory). We note, however, that the percentage of time spent on these activities is very low (Table 11).

In terms of differences in our target species, 72,1% of migrating American Black Ducks appear to spend their time feeding, while breeding individuals feed less (40,5%), spending more time on activities such as standing watch (27,5%) and resting (23,8%; Figure 34 and Table 11). Unlike American Black Ducks, migrating Mallards feed and stand watch as much as breeding Mallards (40,5% vs 40,8% for FE and 35,7% vs 29,1% for WA), but breeding Mallards rest more than migrating Mallards (18,4% vs 7,1%; Figure 35 and Table 11). Migrating individuals apparently also adopt more breeding behaviours (MA, WA and NE) than breeding individuals.

4.5 Profile of habitats

The habitats used by waterfowl are listed in Table 12. In the Outaouais, both breeders and migrants use open water and submerged and emergent herbaceous vegetation, with breeding individuals also using forested areas and migrants also using floating herbaceous vegetation. In the Montréal region, breeders and migrants use the same habitats (submerged herbaceous vegetation, agricultural areas, open water and emergent herbaceous vegetation), but breeders prefer submerged herbaceous vegetation, while migrants prefer agricultural areas. In the Québec City region, all waterfowl species, both breeders and migrants, use the same habitats, with the same preferences for emergent herbaceous vegetation, open water and agricultural areas. In

the Saguenay–Lac-Saint-Jean region, geese and ducks primarily use open water, and submerged and emergent herbaceous vegetation, regardless of whether they are breeders or migrants. In the Estuary region, both breeders and migrants primarily use open water and emergent herbaceous vegetation, and to a lesser extent, rocky or sandy substrates.

5.0 Discussion

5.1 Profile of regions

The Outaouais region is the least densely used by waterfowl during the breeding season. It is somewhat surprising that larger numbers of Mallards, American Black Ducks and Wood Ducks were not observed, as is the case for Blue-winged Teals and Hooded Mergansers, which are not among the most common species in this region despite the fact that their breeding habitat encompasses this region (Gauthier and Aubry 1996). Given the abundance of marshes along the Ottawa River, a number of dabbler species regularly breed there (ABDU: very common breeder; MALL: very common breeder; WODU: very common breeder; BWTE: very common breeder; HOME: common breeder; *Club des ornithologues de l'Outaouais* 1985). The fact that the Bufflehead was observed in this region in non-negligible densities is questionable, since it does not breed in this region (*Club des ornithologues de l'Outaouais* 1985). While the surveys were conducted from April 23 to May 13 in this region, it is probable that the Bufflehead were merely passing through, since it is a relatively late-nesting species further to the north, i.e. starting in the second week of May (Aubry 1996). Finally, the Ottawa River is used by large numbers of diving ducks during spring migration (*Club des ornithologues de l'Outaouais* 1985), which could explain the densities of indicated pairs of Ring-necked Ducks (RNDU: irregular breeder) and Buffleheads (BUFF: non-breeder) obtained for this region. The moderately high density of Common Merganser obtained is corroborated by the literature, which recognizes it as a very common breeder in the Outaouais region (*Club des ornithologues de l'Outaouais* 1985).

The Montréal region supports relatively high numbers of Mallards (relative abundance of 22%) and American Black Ducks (19%) and smaller numbers of Northern

Pintails (8%), Gadwalls (7%), American Wigeons (6%), Ring-necked Ducks (6%) and Northern Shovelers (5%). All of the dabbling duck species were observed in the Montréal region during our surveys, and the densities obtained are fairly consistent with the literature (Cyr and Larivée 1995; Gauthier and Aubry 1996). However, Bannon (1991) considers only Mallards and American Wigeons to be "common" and classifies the other species – abundant according to our surveys – as "occasional." During a study of the islands located between Montréal and Trois-Rivières (excluding the portion of the region west of Montréal and the Richelieu River), Bélanger and Lehoux (1995) observed that Gadwalls (29%) and Northern Pintails (23%) were the most abundant breeding waterfowl; since Mallards accounted for 13% and American Black Ducks for only 2% of the waterfowl observed on these islands characterized by low vegetation, this does not appear to be a preferred Black Duck habitat. In their review of the fluvial section (excluding the Richelieu River), Lehoux *et al.* (1996) rank Mallards first with 24% of the observed waterfowl population, followed by Gadwalls with 20%, Northern Pintails with 17% and American Black Ducks with only 3%. With respect to diving ducks, the densities obtained for Greater Scaup, Bufflehead and Red-breasted Merganser appear to be primarily attributable to migrants (Lehoux *et al.* 1985; Bannon 1991; Gauthier and Aubry 1996). It is probable that only a few Ring-necked Ducks breed locally in the region (Bannon 1991) and that a number of the individuals considered breeders in our study are apparently therefore actually migrants. The low densities obtained for Redhead and Ruddy Duck undoubtedly reflect the fact that these species are known to breed in this region, but only very locally (Bannon 1991; Jauvin 1996; Lehoux *et al.* 1996; Shaffer and Rail 1996; David 1996). Finally, the case of Lesser Scaup is unique for this region, since it is reported to breed very locally (Bannon 1991; Barrette and Titman 1996), and the density obtained for scaups not identified to the species may correspond either to migrating Lesser Scaup or Greater Scaup, or to breeding Lesser Scaup.

The Québec City region supports almost five times more American Black Ducks than any other species of waterfowl (relative abundance of 40%). According to our surveys, the other abundant species in this region are Mallards (9%), Northern Pintails (8%), Green-winged Teals (8%) and Ring-necked Ducks (6%). In their review of breeding waterfowl in the fluvial estuary (corresponding to our Québec City region),

Lehoux *et al.* (1996) report the following proportions: 54% American Black Duck, 22% Northern Pintail, 13% Mallard and less than 1% Green-winged Teal. Like the Montréal region, the Québec City region supports mainly dabbling ducks; nearly all species of dabbling ducks are found in this region, except Gadwalls, which are observed in very low numbers. However, the breeding waterfowl of this region also includes several species of diving ducks (Ring-necked Ducks, Common Goldeneyes and Common Mergansers), which is confirmed by the literature (Otis *et al.* 1993; Cyr and Larivée 1995; Gauthier and Aubry 1996). The only reservations we might have concerning the densities of species that we consider more as migrants than as breeders in the Québec City region concern Greater Scaups (breeds north of the 53rd degree of latitude), Lesser Scaups (a single case of nesting in the area surrounding this region, i.e. in Rivière-Ouelle – which is actually in the Estuary region, but very close to the boundary of the Québec City region), Buffleheads (breeds in the wooded areas of northern Québec) and Red-breasted Mergansers (breed very locally and/or very irregularly south of the 47th degree of latitude) (Cyr and Larivée 1995; Gauthier and Aubry 1996; David 1996).

In the Saguenay–Lac-Saint-Jean region – the most northerly region – the American Black Duck is the most abundant species (relative abundance of 27%), followed by Green-winged Teals (11%), Common Goldeneyes (11%), Common Mergansers (6%), Blue-winged Teals (6%) and Mallards (6%). For comparison purposes, in a brood survey around Lake Saint-Jean (obviously not including the Saguenay River) in 1985 and 1986, Lupien (1987) listed the five most abundant breeding species as being the American Black Duck (28%), Mallard (22%), Blue-winged Teal (16%), Northern Pintail (12%) and Green-winged Teal (6%), all of which are dabbling ducks. The Saguenay–Lac-Saint-Jean region is more “boreal” than the other regions surveyed, which likely explains the greater abundance of species such as Common Goldeneye and Green-winged Teal – although Savard and Cormier (1995) list the latter species as uncommon. On the other hand, this region has extensive agricultural plains around Lake Saint-Jean and in the Upper Saguenay, which attracts species found in the agricultural areas further south, such as Blue-winged Teal. While we observed no Gadwall breeding pair density in this region, for any of the years, Savard and Cormier (1995) consider it a regular, albeit uncommon, breeder. We should

mention the presence of the Redhead, which might be attributable to breeding pairs, since the literature reports that it breeds in this region (Savard and Cormier 1995; David 1996). Finally, for species of diving ducks such as Greater Scaup and/or Lesser Scaup, as well as Barrow's Goldeneye, the densities observed in this region correspond more to migrants than to breeders (Cyr 1995n; Savard and Cormier 1995). The density obtained for Lesser Scaup is difficult to interpret, since the individuals observed could be either migrants or breeders, this species being reported as a rare breeder in this region (Cyr 1995o; Savard and Cormier 1995; David 1996).

Finally, the waterfowl composition in the Estuary region is slightly different. The American Black Duck is still by far the most abundant species (nearly six times more abundant than the second most abundant species in this region, with a relative abundance of 50%). The second most abundant species is the Common Eider (10%), followed by Green-winged Teal (7%), Red-breasted Merganser (6%) and Northern Pintail (6%). All of these species are known to breed in this region, except for the Red-breasted Merganser, which is identified as a common migrant only by some authors (Gendron and Gauthier 1984) or as a breeder by others (Alvo and Bourget 1996; Gosselin 1995h). Green-winged Teal and Northern Pintail are also reported only as uncommon breeders (Gendron and Gauthier 1984). In their review of waterfowl abundance (excluding Common Eiders) in the upper and lower estuary (corresponding to the Estuary region in our study), Lehoux *et al.* (1996) found that American Black Ducks accounted for 74%, and Northern Pintails and Green-winged Teals for 7% respectively. According to our surveys, this region generally supports slightly fewer species of dabbling ducks than diving ducks. However, we have a minor reservation concerning the Surf Scoter; the indicated pairs inventoried in the Estuary region undoubtedly represent migrants instead, since this species is not known to breed in this region – although some individuals summer here, probably non-breeders (Gendron and Gauthier 1984) – and the peak abundance of migrant scoters in this region occurs in mid-May (Lehoux *et al.* 1985).

5.2 Profile of species

The populations of most dabbler species appear to have increased in the study area from 1990 to 1992, especially in the Montréal region (WODU, GADW, AMWI, MALL, GWTE) and Québec City region (ABDU, MALL, GWTE). Only certain species of diving ducks have increased in number, and only in the Estuary (COEI, SUSC, COGO) and Montréal regions (COGO, COME). Several species of diving ducks were not observed in certain regions in any of the years. The diving ducks observed (GRSC, LESC, SUSC, BUFF, RBME) generally appear to have been inventoried while they were still migrating, given their presence in relatively large numbers in locations where they are not known to breed.

On average, fewer than 100 indicated pairs of Snow Geese were observed (1990-1992) in the St. Lawrence River system during the surveys. In the spring, this species disperses in large numbers (837 000 geese in 2001 and 639 000 geese in 2002; CWS 2002a) along the St. Lawrence River and estuary (from Lake Saint-François to L'Isle-Verte), but this corridor represents merely a staging area for this species, which breeds primarily in the Arctic. There is, however, some evidence of breeding by Snow Geese in the St. Lawrence estuary (Batture aux Loups Marins; Reed 1996b). It is therefore not surprising that few indicated pairs were inventoried along the St. Lawrence River and that this species is considered a breeder in the study area. Migratory movements for this species are observed in the St. Lawrence River until June (Cyr 1995a; David 1996).

Just under 1000 indicated pairs of Canada Geese were observed on average from 1990 to 1992 along the St. Lawrence River and its main tributaries. In Québec, the "migrant" Canada Goose, which breeds in the central and northern parts of the province, is composed mainly of the subspecies *Branta canadensis interior* from the Atlantic population and, in lesser numbers, further east, of the subspecies *B. c. canadensis* from the North Atlantic population (Dickson 2000). The "resident" Canada Goose, which breeds mainly in Ontario and in the northeastern United States, is composed mainly of the subspecies *B. c. maxima* (Dickson 2000). The resident Canada Goose is rapidly expanding its range and now seems well established in southern Québec (Giroux *et al.* 2001). Thus, although records of Canada Geese during the surveys from 1990-1992

may be associated with lingering migrants or unsuccessful breeders (Cyr 1995b), it is possible that certain pairs may breed in the St. Lawrence River system. We consider the indicated pairs of Canada Geese observed to be breeders that are part of the resident population.

The data obtained for Wood Ducks indicate that on average (1990-1992) approximately 900 indicated pairs of this species are found along the shores of the St. Lawrence River and its main tributaries, which makes it the least abundant dabbler species according to our surveys. The Wood Duck is an uncommon breeder in the mature hardwood forests of southern Québec; it gradually becomes less abundant at higher latitudes as conifers become predominant (St-Hilaire and Morrier 1996). This conclusion is supported by the data from ground surveys, since the maximum densities were reached in the Montréal (0,54 IP/km^2 in 1992), Outaouais (0,30 IP/km^2 in 1991) and Québec City regions (0,30 IP/km^2 in 1990). This species prefers small expanses of water located further inland to the riparian habitats of the St. Lawrence River and its main tributaries (Cyr 1995c), which explains the rather small densities observed. It is surprising that the Wood Duck was not observed in the Estuary region, since David (1996) describes it as a migrant breeder in the Lower St. Lawrence. While the density of Wood Ducks increased in the Montréal and Outaouais regions, the density observed from the BDJV surveys in the boreal forest decreased during the same period, from 0,62 IP/100 km^2 in 1990 to 0,13 IP/100 km^2 in 1992 (Bordage and Lepage 2002).

The ground survey data reveal a population of just over 1000 indicated pairs of Gadwalls along the St. Lawrence River (1990-1992 mean). Almost the entire population occurs in the Montréal region, which indicates that this species has a very localized distribution; in fact, Gadwalls breed locally in the St. Lawrence valley, mainly from Valleyfield to Trois-Rivières (Cyr 1995d; David 1996; Giroux and Rail 1996). Their numbers also appear to be on the rise in this region. It will be recalled that this species was considered rare in Québec in the 1960s (Lehoux *et al.* 1996). The wetland habitat conservation efforts undertaken along the St. Lawrence River (national wildlife areas, migratory bird sanctuaries, migratory bird no-hunting areas, ecological reserves, wildlife sanctuaries, etc.) are undoubtedly a factor in this species' success in the greater Montréal area.

The mean American Wigeon population (1990-1992) observed along the St. Lawrence River and its main tributaries was 1600 indicated pairs. In Québec, this species is concentrated along the St. Lawrence River and its main tributaries in the spring (David 1996), from the far southwestern tip of the province to as far east as Trois-Rivières according to Titman and Barrette (1996a), and Québec City according to Cyr (1995e); the results of our surveys are more consistent with the distribution described by Cyr (1995e), since the Québec City region had a non-negligible density of 0,39 indicated pair/km^2 on average from 1990 to 1992. Also, only a few individuals were reportedly observed in the Lac-Saint-Jean region (Titman and Barrette 1996a), while our data indicate that the densities observed in Saguenay–Lac-Saint-Jean in 1991-1992 ($AMWI_{91\text{-}92}$ = 0,47 IP/km^2) are comparable to those observed in the Montréal region in 1990-1992 ($AMWI_{90\text{-}92}$ = 0,59 IP/km^2). Finally, according to the ground surveys, the American Wigeon population is apparently increasing in the Montréal and Saguenay–Lac-Saint-Jean regions. It would appear from the surveys in the boreal forest for the BDJV that the American Wigeon population decreased from 1990 to 1992, from 0,13 indicated pair/100 km^2 to 0,05 indicated pair/100 km^2 (Bordage and Lepage 2002), although this species is not very abundant in the boreal forest.

The surveys established a mean American Black Duck population (1990-1992) of more than 15 000 indicated pairs along the St. Lawrence River and its main tributaries. In Québec, the American Black Duck is the most abundant waterfowl species and breeds virtually everywhere in the southern part of the province, with a mean density of approximately 15,0 pairs/100 km^2 (Bordage and Reed 1996). American Black Ducks are more abundant along both shores of the St. Lawrence River, from Québec City to Pointe-au-Père and to Baie-Comeau (Cyr 1995f), which is confirmed by our data, which reveal that the highest densities were observed in the Québec City ($ABDU_{90\text{-}92}$ = 4,67 IPs/km^2) and Estuary regions ($ABDU_{90\text{-}92}$ = 5,76 IPs/km^2). For comparison purposes, densities of 0,29 pair/km^2 were obtained in 1992 in the Boyer River watershed (on the south shore near Québec City; Maisonneuve *et al.* 1993) and 0,21 indicated pair/km^2 in the boreal forest (1990-2002 mean; Bordage and Lepage 2002), indicating that this species is present along the St. Lawrence River in high densities. From 1990 to 1992, the American Black Duck population increased in all regions except the Estuary.

By comparison, the surveys carried out in the boreal forest during the BDJV reveal a decline in the population during this period, from 22,1 indicated pairs/100 km^2 in 1990 to 16,6 indicated pairs/100 km^2 in 1992 (Bordage and Lepage 2002).

The mean Mallard population was estimated at just over 5000 indicated pairs, based on the findings of the 1990-1992 ground surveys. According to Cotter *et al.* (1996b), Mallards are widespread in the St. Lawrence Lowlands, south of the St. Lawrence River, in the Ottawa River valley and in the western section of the boreal forest. This conclusion is supported by the data from surveys along the St. Lawrence River, since the Montréal ($MALL_{90\text{-}92}$ = 2,05 IPs/km^2) and the Québec City regions ($MALL_{90\text{-}92}$ = 1,10 IPs/km^2) support the highest number of Mallards. This is confirmed by Bannon (1991), who classifies this species as a common breeder (very often observed) in the Montréal region. However, the Outaouais region had a density of only 0,46 indicated pair/km^2, which is rather low, although slightly higher than for American Black Ducks in the same region ($ABDU_{90\text{-}92}$ = 0,44 IP/km^2). From 1990 to 1992, the number of Mallards appears to have increased in all regions, and particularly in the Montréal, Québec City and Saguenay–Lac-Saint-Jean regions. It would appear that the Mallard population has been on the rise in Québec for quite some time, since Cyr (1995g) reports a significant increase in the Mallard population from 1969 to 1989. This increase would appear to have taken place mainly in southern Québec, since according to the BDJV surveys carried out in the boreal forest, the density of Mallards fell from 1,7 indicated pairs/100 km^2 in 1990 to 1,3 indicated pairs/100 km^2 in 1992 (Bordage and Lepage 2002).

While Mallards are the most abundant duck in the Outaouais and Montréal regions, the American Black Duck is the most abundant duck in the Québec City, Saguenay–Lac-Saint-Jean and Estuary regions. In addition, the line of demarcation where Mallard numbers exceed American Black Duck numbers appears to have moved eastward year after year. It will be recalled that the Mallard population was on the rise in the province from 1969 to 1989 (Cyr 1995g). As far back as 1985, it was observed that the abundance of Mallards was increasing annually in agricultural and peri-urban areas of the southwestern St. Lawrence River (Lehoux *et al.* 1985). It will be important to monitor the populations of these two species in the agricultural plains in order to track

long-term changes in their distribution. Will Mallards replace American Black Ducks in the agricultural and riparian environments of the St. Lawrence River and its main tributaries? Will American Black Ducks find themselves confined to the boreal environment or to the margins of the Mallard's habitat?

The survey data report a mean Blue-winged Teal population of approximately 1400 indicated pairs from 1990 to 1992 along the St. Lawrence River and its main tributaries. While higher densities might have been expected in western Québec – the species, which is associated with agricultural plains, is particularly abundant in the fluvial section from Montréal to Lake Saint-Pierre, at Lake Saint-François, along the Ottawa River and Upper Richelieu (Benoit and Dauphin 1996; Cyr 1995h) –, the surveys reveal that the highest density ($BWTE_{90\text{-}92}$ = 0,45 IP/km^2) is in the Saguenay–Lac-Saint-Jean region. The ground surveys also revealed an increase in the Blue-winged Teal population from 1990 to 1992 in the Estuary region, which is rather surprising given the species' range, as mentioned above. During the same period, but based on the data from the BDJV surveys in the boreal forest, the density of Blue-winged Teal rose from 0,11 indicated pair/100 km^2 in 1990 to 0,13 indicated pair/100 km^2 in 1992, which denotes a fairly stable trend in this territory (Bordage and Lepage 2002). In southern Québec as a whole, the population of this species showed a significant downward trend from 1969 to 1989 (Cyr 1995h).

According to the surveys along the St. Lawrence River and its main tributaries, the mean Northern Shoveler population was 1200 indicated pairs. Like several other species of dabbling ducks, Northern Shovelers breed primarily along the St. Lawrence River, between Montréal and Trois-Rivières (Cyr 1995i; Titman and Barrette 1996b), in the sector downstream from Québec City, as well as along the Richelieu River (Cyr 1995i). This is corroborated by the ground survey data, since the Montréal region had the largest number of Northern Shovelers ($NSHO_{90\text{-}92}$ = 0,48 IP/km^2), followed by the Québec City region, where a fairly high density was also observed ($NSHO_{90\text{-}92}$ = 0,32 IP/km^2).

The mean Northern Pintail population observed during the surveys along the St. Lawrence River is 3000 indicated pairs. David (1996) classifies this species as a common migrant breeder. In Québec, Northern Pintail frequently occurs in agricultural

areas along the fluvial section between Cornwall and Kamouraska; it is also present, but to a lesser extent, in the agricultural areas of Abitibi and Saguenay–Lac-Saint-Jean (Cyr 1995j; McNicoll and Tardif 1996). This is supported by the ground survey data, since the Montréal ($NOPI_{90\text{-}92}$ = 0,78 IP/km^2), Québec City ($NOPI_{90\text{-}92}$ = 0,95 IP/km^2) and Estuary regions ($NOPI_{90\text{-}92}$ = 0,71 IP/km^2) had the highest number of observations of pairs of Northern Pintail. A non-negligible density of Northern Pintails ($NOPI_{90\text{-}92}$ = 0,24 IP/km^2) is nonetheless found in the Saguenay–Lac-Saint-Jean region.

With respect to Green-winged Teal, the ground surveys along the St. Lawrence River and its main tributaries established the mean population at just under 3000 indicated pairs. According to these surveys, breeding populations of Green-winged Teal increase from west to east, peaking in the Québec City region ($GWTE_{90\text{-}92}$ = 0,94 IP/km^2). There are high densities in the Saguenay–Lac-Saint-Jean ($GWTE_{90\text{-}92}$ = 0,86 IP/km^2) and Estuary regions ($GWTE_{90\text{-}92}$ = 0,80 IP/km^2). This distribution is consistent with the finding by Moisan (1996) that larger numbers of Green-winged Teal breed in the northwest section of southern Québec as far as Saguenay–Lac-Saint-Jean, as well as further south, in the St. Lawrence Lowlands and Appalachians region. It is also consistent with the distribution reported by Cyr (1995k), who reports that this species breeds in large numbers from north of Trois-Rivières to Pointe-au-Père along the St. Lawrence River. The data from surveys along the St. Lawrence River also show an upward trend from 1990 to 1992 in the Montréal and Québec City regions, which does not reflect the situation in the boreal forest, where breeding populations declined from 3,5 indicated pairs/100 km^2 in 1990 to 2,2 indicated pairs/100 km^2 in 1992 (Bordage and Lepage 2002).

Of the species of diving ducks, the Redhead is not very abundant in the region surveyed, at only 150 indicated pairs (1990-1992 mean). In Québec, the Redhead's distribution is very localized in the St. Lawrence River corridor, namely at Lake Saint-François, downstream from the island of Montréal and at Lake Saint-Pierre (Bannon 1991; Shaffer and Rail 1996; David 1996). In addition, some of these authors report a confirmed breeding in the Lac-Saint-Jean region. According to Cyr (1995l), the distribution of this species extends slightly further east, since it may be possible that it breeds from Québec City to Baie-Comeau and Rimouski, including the Lac-Saint-Jean

area. According to the data collected along the St. Lawrence River and its main tributaries, only a few pairs were observed in the Montréal region ($REDH_{90-92}$ = 0,02 IP/km^2) with slightly more frequent observations in the Saguenay–Lac-Saint-Jean region ($REDH_{90-92}$ = 0,17 IP/km^2). It is therefore surprising that our data demonstrate a higher density in the Saguenay–Lac-Saint-Jean region than in the Montréal region, since this species is known to breed slightly more abundantly in the Montréal region. However, a decline in Redhead breeding populations has also been observed in the Saguenay–Lac-Saint-Jean region, although no provincial trend was detected for this species by the ÉPOQ data (*Étude des populations d'oiseaux du Québec*; Cyr 1995l) from 1969 to 1989. We note that it continues to be difficult to produce precise population estimates and annual trends for species present in such low numbers.

The mean Ring-necked Duck population observed along the St. Lawrence River and its main tributaries is estimated at 2000 indicated pairs. This species is widely distributed in Québec and breeds almost everywhere in mixed and coniferous forest environments south of the 50º N; it is slightly less common in the agricultural areas of the lowlands (David 1996; Lepage and Doyon 1996), preferring the inland lakes (Cyr 1995m). According to our survey data, this species is well distributed in the various regions, although virtually absent from the Estuary region, and is one of the most abundant diving ducks in the study area. While no discernable trend emerged from the ground survey data collected along the St. Lawrence River and its tributaries, a decline was observed in the boreal environment, where the breeding populations of Ring-necked Ducks fell from 10,8 indicated pairs/100 km^2 in 1990 to 9,0 indicated pairs/100 km^2 in 1992, according to the BDJV surveys (Bordage and Lepage 2002).

Greater Scaup and Lesser Scaup populations along the St. Lawrence River and its main tributaries are 700 and 200 indicated pairs respectively. These low numbers are corroborated by the literature. Greater Scaups are very rare during the breeding season in southern Québec (Benoit and Rail 1996; Cyr 1995n), while Lesser Scaups breed to a limited extent in northern and central Québec, and only very locally in the far southwestern section of the province (Barrette and Titman 1996; Cyr 1995o). The ground survey data reveal a Greater Scaup density of 0,35 indicated pair/km^2 in the Saguenay–Lac-Saint-Jean region from 1990 to 1992. These data probably represent

individuals or pairs en route to more northerly breeding grounds, since Cyr (1995n) reports that Greater Scaup are migrants in the southern part of the province until late May. As for Lesser Scaups, the mean density of 0,17 indicated pair/km^2 noted in the Québec City region from 1990 to 1992 is somewhat puzzling. Once again, it seems likely that they were migrants en route to more northerly sites. It is also surprising that so few pairs were observed in the Montréal region, since this species is known to breed in some locations between Lake Saint-François and Lake Saint-Pierre (Bannon 1991; Barrette and Titman 1996; Cyr 1995o). When observations of Greater Scaup and Lesser Scaup are combined, regardless of whether they are identified to the species (it being difficult to distinguish these two species), the densities tend to increase from west to east from the Montréal region to the Saguenay–Lac-Saint-Jean region. This finding is difficult to explain unless it is assumed that they are migrants en route to more northerly sites. No trend can be discerned for these two species along the St. Lawrence River, while the surveys carried out during the BDJV reveal that Greater Scaup populations apparently rose from 0,05 indicated pair/100 km^2 in 1990 to 0,17 indicated pair/100 km^2 in 1991, then to 0,26 indicated pair/100 km^2 in 1992 in the boreal environment (Bordage and Lepage 2002), an increase that is not at all corroborated by Cyr's data (1995n). In fact, Cyr reports that the population of this species is significantly in decline. The Lesser Scaup population apparently increased considerably in 1991 in the boreal environment, while breeding populations reportedly rose from 0,35 indicated pair/100 km^2 in 1990 to 1,16 indicated pairs/100 km^2 in 1991, before falling to 0,39 indicated pair/100 km^2 in 1992 (Bordage and Lepage 2002). Cyr (1995o) noted a population decline for this species from 1969 to 1989.

According to our surveys, the Common Eider population along the St. Lawrence River and its tributaries totals approximately 1200 indicated pairs. However, it is quite obvious that its distribution in the study area is limited to the Estuary region, where a mean density of 1,11 indicated pairs/km^2 was observed from 1990 to 1992. The survey carried out from 1990 to 1992 is not adequate for this species, which breeds primarily in dense colonies on several islands in the Estuary (and in the Gulf, which was not covered in our study). Yet, no island that supported a colony of Common Eider was surveyed in our study. It will also be recalled that we were denied permission to visit Île aux Fraises

– one of the islands where the Common Eider breeds in dense colonies (Gosselin 1995a; Munro 1996; BIOMQ 2002) – (see section 3.1), even though the 1-km^2 quadrat of which this island is part was selected at random to be surveyed in the Estuary region. The density obtained in the course of our surveys likely represents non-breeding individuals that frequent the coast at this period rather than breeding individuals present exclusively on the islands during the breeding season. The apparent upward trend in the Common Eider population noted in the Estuary region from 1990 to 1992 – from a mean density of 0,77 indicated pair/km^2 in 1990-1991 to a density of 1,79 indicated pairs/km^2 in 1992 – is therefore open to criticism for the reasons noted above. We note that the BIOMQ data (2002) reveal that the breeding populations fell from 48 580 pairs in 1990 to 47 602 pairs in 1992 in all the main colonies on the islands of the estuary. In 2001, the Common Eider population was 55 534 pairs in the main colonies on the islands of the estuary (BIOMQ 2002). The population of eiders in the estuary appears to have remained fairly stable for the last ten years, although some colonies decreased slightly in number (CWS 2002b).

The Harlequin Duck does not breed in the study area along the St. Lawrence River and estuary, despite the mean population of 34 indicated pairs obtained. It is found as a breeder further east, i.e. on the Gaspé Peninsula and on the North Shore, as well as further north, in the Ungava Bay, Hudson Bay and James Bay watersheds (Gosselin 1995b; Robert 1996; Robert *et al.* 2001). In 1991, a pair of Harlequin Ducks was indeed observed in the Montréal region (near Lanoraie), as well as two males in the Estuary region (Baie Sainte-Catherine), but these records cannot be considered breeding records. All of these cases involved either pairs en route to their summer grounds further east or north or non-breeding individuals.

As for Surf Scoters, the surveys along the St. Lawrence River and its main tributaries established a population of nearly 400 indicated pairs. However, this species does not breed along the St. Lawrence River, but rather along the edges of ponds and shallow lakes, in central and northern Québec, probably as far as Lake Saint-Jean (Ouellet and Bordage 1996; Savard *et al.* 1998). A small Surf Scoter population breeds in the Malbaie Lake region approximately 100 km north of Québec City (Reed *et al.* 1994; Ouellet and Bordage 1996). Gosselin (1995c) reports that this species is also

present in summer along the estuary and Gulf of St. Lawrence River, but that the breeding individuals are found inland. Pairs have been observed in the past south of the St. Lawrence River on inland lakes (Ouellet and Bordage 1996). The pairs observed along the shores of the St. Lawrence River and its main tributaries must therefore be migrants en route to their breeding grounds or immatures that frequent the shores of estuary and the gulf (Gosselin 1995c; Savard *et al.* 1998).

The Bufflehead population observed along the St. Lawrence River and its main tributaries is estimated at more than 900 indicated pairs. Like Greater Scaup, Harlequin Duck and Surf Scoter, the Bufflehead's breeding grounds are not covered by the survey of the shores of the St. Lawrence River; it breeds mainly in the boreal environment, in western Québec, as far as western Lake Saint-Jean (Aubry 1996). The indicated pairs observed along the St. Lawrence River in the spring are therefore most likely individuals heading north as the lakes and rivers thaw. In fact, Aubry (1996) reports that migrants are observed from April 10 to May 25 in southern Québec, and Gosselin (1995d) reports that the majority of summer observations along the St. Lawrence River are of non-breeding individuals.

A total of 1700 indicated pairs of Common Goldeneye were inventoried along the St. Lawrence River and its main tributaries. While this species ranks only seventh among the species inventoried, it is the third most abundant species in the boreal environment, after the American Black Duck and the Ring-necked Duck (Bordage and Lepage 2002), indicating that the shores of the St. Lawrence River and its main tributaries provide few suitable nesting habitats for this species. Its range covers primarily mixed and conifer forests (Gosselin 1995e), although its extensive breeding range extends as far north as the tree line. The small population observed along the St. Lawrence River can be explained by the fact that although the species breeds in the St. Lawrence River corridor, it prefers large mature forests that provide nesting cavities, which are fairly rare in the St. Lawrence Lowlands (Bordage 1996; Gosselin 1995e). The Common Goldeneye population along the St. Lawrence River appears to be on an upward trend in the Montréal, Saguenay–Lac-Saint-Jean and Estuary regions. This does not seem to be corroborated by the trend emerging from the surveys in the boreal environment (BDJV), where a mean density of 8,5 indicated pairs/100 km^2 was

observed in 1990, falling to 7,4 indicated pairs/100 km^2 in 1992 (Bordage and Lepage 2002).

Barrow's Goldeneye is another species for which no breeding sites were documented in the survey along the St. Lawrence River and its main tributaries. It is unlikely that this species actually breeds in the study area, even though the surveys provide an estimated population of 200 indicated pairs. The breeding range of Barrow's Goldeneyes, which has recently become better known in Québec, appears to be concentrated in the boreal environment, east of the Saguenay River and north of the St. Lawrence Estuary and Gulf (Savard 1996; Robert *et al.* 2000). Although goldeneyes reportedly arrive at their breeding grounds throughout May until early June (Benoit *et al.* 2001), and although our survey was carried out from May 5 to May 17 in the east, it seems unlikely that the observed densities of 0,16 indicated pair/km^2 in the Saguenay–Lac-Saint-Jean region and 0,09 indicated pair/km^2 in the Estuary region represent breeding birds. Rather, they would appear to represent migrants in transit (Gosselin 1995f), since the riparian habitats surveyed do not seem to correspond to the Barrow's Goldeneye breeding habitat. In fact, Robert *et al.* (2000) report that its nesting habitat consists mainly of small inland lakes and more upland sites, notably headwater lakes. Unlike Bufflehead, which is found more in western Québec during migration, the spring migration of the Barrow's Goldeneye appears to be concentrated in the eastern part of the province, where its nesting sites are found (Benoit *et al.* 2001).

The Hooded Merganser population along the St. Lawrence River and its tributaries is estimated at 200 indicated pairs. This species prefers calm, isolated bodies of water (lakes, beaver ponds, etc.) in forested areas for nesting (Bouvier and Barrette 1996; Gosselin 1995g), which may explain the small population observed during our surveys. Although it was observed in very low numbers in all regions surveyed, it is surprising that the densities observed in the Outaouais ($HOME_{90\text{-}92}$ = 0,03 IP/km^2) and Montréal regions ($HOME_{90\text{-}92}$ = 0,02 IP/km^2) were not higher, since these locations apparently support larger breeding concentrations, particularly north of the Ottawa River, where densities of 8 to 16 indicated pairs/100 km^2 have been observed in some surveys (Bouvier and Barrette 1996). While no trend can be discerned from our three years of

surveys for the Hooded Merganser, its population rose from 1970 to 1989 in Québec (Gosselin 1995g).

The Red-breasted Merganser population along the St. Lawrence River and its main tributaries is 1500 indicated pairs. While this species is reportedly an exceptional breeder south of the St. Lawrence River and west of Québec City (Alvo and Bourget 1996), the Estuary region seems to provide suitable nesting habitat (Gosselin 1995h), as the observed density reveals ($RBME_{90\text{-}92}$ = 0,72 IP/km^2). However, some authors list the Red-breasted Merganser as a migrant in the estuary (Gendron and Gauthier 1984). According to Alvo and Bourget (1996), breeding individuals settle along the edges of bays, lagoons, estuaries, lakes and rivers, both near the coasts and inland. This density may, however, include a portion of migrants, since the Red-breasted Merganser usually migrates in large numbers in the estuary in the spring (Gendron and Gauthier 1984; Lehoux *et al.* 1985; Gosselin 1995h). The low densities observed during our surveys in western Québec (Outaouais and Montréal) apparently represent exclusively migrants en route to breeding grounds in northern or eastern Québec (Gosselin 1995h).

With respect to the Common Merganser, the surveys along the St. Lawrence River and its main tributaries yielded a population estimate of just over 2000 indicated pairs. In our surveys, this species was observed throughout the various regions surveyed, with slightly higher densities in the eastern sectors (Saguenay–Lac-Saint-Jean: $COME_{90\text{-}92}$ = 0,47 IP/km^2; Estuary: $COME_{90\text{-}92}$ = 0,53 IP/km^2). Common Mergansers are in fact less abundant in the St. Lawrence Lowlands (Gosselin 1995i; David 1996), but if we include inland areas, they appear to be more abundant in the western half of southern Québec (Alvo 1996). The only upward trend in Common Merganser populations is apparently in the Montréal region (from 0,26 IP/km^2 in 1990 to 0,42 IP/km^2 in 1992). Populations in the boreal environment appear to have remained fairly stable, slightly falling from 8,4 indicated pairs/100 km^2 in 1990 to 8,2 indicated pairs/100 km^2 in 1992 (Bordage and Lepage 2002).

The mean Ruddy Duck population (1990-1992) is estimated at 11 indicated pairs. This species was observed only in the Montréal region, which is fairly consistent with the finding by Bannon (1991), who classifies this species as a rare breeder in the Montréal region. Although our surveys inventoried this species only in this region, it appears that

we might also have been able to observe it in the Outaouais, in the Lower St. Lawrence and in the Lac-Saint-Jean, other regions where it is potentially a breeder (Cyr 1995p; Jauvin 1996). It is important to bear in mind that the Ruddy Duck is a rare and localized species in Québec.

According to an analysis of the literature, of the 25 species identified as likely to breed in the study area, 20 can actually be considered breeders, for a total population of approximately 43 000 indicated pairs. The probability that Greater Scaups, Harlequin Ducks, Surf Scoters, Buffleheads and Barrow's Goldeneyes breed along the shores of the St. Lawrence River and its main tributaries is low, despite breeding records in the vicinity.

5.3 Profile of phenology

Because the surveys were optimized to coincide with the breeding seasons of American Black Ducks and Mallards (see section 3.3), they will not be ideal for all species, since some are early-nesting species (such as Wood Duck) while others are late-nesting species (such as the diving ducks). However, the majority of the species have phenology indices close to 1,00, which would suggest that, in general, the timing of the surveys was appropriate.

The phenology indices for the American Black Duck, however, seem to indicate that all of the surveys were carried out too early, at a time when the pairs were probably not yet dispersed over their breeding grounds, likely leading to an overestimation of breeding populations. In view of the fact that the American Black Duck is a species targeted by the surveys, this result is disturbing. The Mallard, on the other hand, seems to have been inventoried at the optimum time, since the phenology indices are close to 1,00, especially in 1990 and in 1991. However, it is anomalous for there to be such a large difference between these two species for all years of the survey, since their phenology is essentially the same. In fact, in Québec, the American Black Duck laying and incubation period extends from the second week of April to late July, while the Mallard laying and incubation period extends from the second week of April to the third week of July (Bordage and Reed 1996; Cotter *et al.* 1996b). Since the surveys were carried out from April 25 to May 10, 1990, from April 23 to May 17, 1991 and from April

29 to May 17, 1992, this corresponds closely to the ideal window sought for the phenology of these two species.

This large variance in the phenology indices obtained for these two species prompts us to raise questions about the data collection process, especially concerning the sex determination of American Black Ducks. Indeed, sex determination in American Black Ducks, even from ground observations, requires special attention. A more thorough examination of the 1023 American Black Duck records reveals that the sex of 68,3% of the individuals is recorded (1119 males, 1081 females and 1023 individuals of unknown sex). Of the 596 records where the sex of at least one of the American Black Ducks was noted, 548 records (92%) have the same number of males as females. Of this number, 379 records (69,2%) are apparently comprised of one male and one female and, very surprisingly, the remaining 169 records report groups ranging from two males and two females to 29 males and 29 females. Forty-eight records in three years are comprised of groups composed of an unequal number of males and females and, of this number, only 24 records are of lone males. It is very strange that such a large number of individuals (57,8% of all American Black Ducks with sex identification) are found in groups composed of equal numbers of males and females, in particular the records which differ by one male and one female. Conversely, the very low number of American Black Ducks, i.e. 170 individuals (7,7% of individuals with sex identification) in records with an unequal number of males and females (including 24 lone males) is unexpected. All this information throws into serious doubt the effort made to attempt to determine the sex of American Black Ducks during the surveys. The structure of the data seems to indicate a degree of subjective interpretation of the observations, especially for the large number of records with equal sexes; for example, it is unlikely that an observer would actually have identified each individual in a group of 58 American Black Ducks and arrive precisely at 29 males and 29 females. The phenology index for the American Black Duck therefore appears to be incorrect.

5.4 Profile of behaviours

The results of the observation of behaviour during the surveys are as follows: breeding birds (indicated pairs) rest more and stand watch more often than individuals

considered migrants (non-breeders). Migrants reportedly adopt more preening, mating and nesting behaviours than their breeding counterparts. Although standing watch is a normal activity for a breeding bird, it is rather surprising to note that breeding birds spend more time resting than migrating birds. It is also surprising that migrating individuals apparently adopt the behaviours of breeding individuals. In fact, the observation of mating and nesting behaviours by migrants is certainly unexpected.

Breeding birds are known to adopt territorial, courtship and nesting behaviours. Whether they be associated with territory defence (singing, standing watch, fighting with intruders), courtship (display and copulation), or nesting (nest building, incubation, distracting the attention of an intruder), these behaviours are generally associated with and "reserved" for breeding birds. When a bird is observed adopting such a behaviour, it is assumed that it is on its breeding site. In fact, observation of these behaviours is even used to confirm the breeding of a species in a specific location (Cadman *et al.* 1987; Brauning 1992; Gauthier and Aubry 1996). It is therefore very surprising that our results reveal that migrating birds apparently adopt mating and nesting behaviours more frequently than breeding birds. We note, however, that certain mating behaviours (courtship, defending the partner, etc.) can be observed on wintering grounds, where most pairs of Anatidae are formed, and can continue during the spring migration and the first few days on the breeding grounds (Bellrose 1980; Gauthier and Aubry 1996); this would explain why some ducks, both migrants and breeders, can be observed adopting these types of behaviours. The same is true for certain species (e.g. Barrow's Goldeneye; Savard 1996) that apparently copulate year-round. Finally, it will be recalled that some pairs are not formed until late in the spring migration (this is particularly true for diving ducks), which would explain why they were observed engaged in mating behaviours. Once again, this would explain why migrants adopt behaviours that were believed to be reserved for breeding birds. With respect to nesting activities per se, it is difficult to explain why migrants were more frequently observed adopting these behaviours than breeders, unless it is attributed to data collection errors or to incorrectly designating certain individuals as migrants when they were actually breeders.

It is noted that migrating birds generally adopt resting and feeding behaviours. In fact, they are known to rest and feed in great numbers during migration. If these birds

hope to make it to their destination, they must devote considerable time to regaining their strength and feeding in order to build up the energy needed to continue their trip to their breeding grounds. It is therefore surprising to note, according to our results, that breeding birds spent more time resting than attending to nesting activities. Once again, this may be attributable to errors in assigning behaviours: “resting” behaviour can easily have been combined with the “standing watch” behaviour, which, as we mentioned above, is an expected behaviour in breeding individuals.

In order to draw conclusions regarding the behaviours of the waterfowl observed during the surveys along the St. Lawrence River and its main tributaries, it must first of all be pointed out that the distinction between a breeding individual and a migrating individual (non-breeder) is based solely on arbitrary decision rules (indicated pairs) that are subject to errors in designation, which may explain in part certain unexpected behaviours relative to the designated status. More generally, with respect to the observation of behaviour, our survey method is subject to several problems of representativeness; bird behaviours can vary during the course of the day depending on the time, tide and temperature, all factors that were not controlled in this study. In any event, efforts were made to collect information on behaviour beginning in 1990 in order to add an extra dimension to the data analysis. This analysis confirms that improvements will have to be made before these observations of behaviour can be used with greater confidence. The results with respect to behaviour must therefore continue to be interpreted with caution.

5.5 Profile of habitats

The habitat preferences of waterfowl differ from one region to another. In fact, in the Outaouais region, in addition to aquatic habitats (open water and herbaceous vegetation), waterfowl species occur in shrub and forested areas. For the Montréal region, apart from aquatic habitats, waterfowl are observed in agricultural, forested and grassy areas. In the Québec City region, waterfowl are observed in aquatic and agricultural areas, and, to a lesser extent, shrub areas. The species of waterfowl observed in the Saguenay–Lac-Saint-Jean and Estuary regions are observed almost exclusively in aquatic habitats, although in the Estuary region, a small percentage of

waterfowl also use rocky or sandy substrates. It is normal for different types of habitats to be used, depending on the region, since the habitat compositions in each region differ. It is unfortunate that we did not have sufficient resources to quantify the size and proportions of each type of habitat in all quadrats surveyed. However, the photo-interpretation data are still available and could eventually permit more detailed analyses of habitat use by a comparison of the presence of a species in a habitat versus its availability, since this information could not be compiled.

In general, breeders and migrants used different habitats in the west (Outaouais and Montréal), while in the east (Québec City, Saguenay–Lac-Saint-Jean and Estuary), they used the same habitats. This is somewhat surprising since the birds' needs appear to be different depending on their status (breeders = nesting habitats vs migrants = feeding and staging areas). With respect to the two regions where breeding individuals used different habitats than those used by migrating individuals, we note that in the Outaouais, breeders and migrants used the same habitats (open water, submerged herbaceous vegetation and emergent herbaceous vegetation), while breeders also used forested areas and migrants also used floating herbaceous vegetation. This difference could be interpreted as follows: breeders used forested areas probably for nesting, while migrants used the emergent herbaceous vegetation for feeding. In the Montréal region, breeders and migrants were found in essentially the same habitats (submerged herbaceous vegetation, agricultural areas, open water and emergent herbaceous vegetation), while breeders showed a definite preference for submerged herbaceous vegetation and migrants showed a definite preference for agricultural areas. These differences can only be justified by different foraging preferences since in this case, the breeders certainly did not prefer the submerged herbaceous vegetation for nesting. By comparison, in a study of the islands of the St. Lawrence River between Montréal and Trois-Rivières, Bélanger and Lehoux (1995) found that 84% of waterfowl nested in tall and short grasses (herbaceous areas according to our surveys), 14% in treed areas (trees covering more than 10% of the surface area) and no nests in shrub areas (shrubs covering 10-50% of the surface area). Our data, on the other hand, report 6.5% of the breeding birds in herbaceous areas, 8,4% in forested areas and 1,8% in shrub areas, which is very different, although

the Bélanger and Lehoux study refers to nests and our study refers to breeding individuals.

Although the secondary objective of the breeding waterfowl monitoring program along the shores of the St. Lawrence River and its main tributaries was to assess habitat use by waterfowl and changes affecting these habitats over the years, our analysis summarizes only a few of the results. We observed no significant differences in habitat use between breeders or migrants, which makes it difficult to draw more explicit conclusions. It will be recalled once again that the distinction between breeder and migrant is arbitrary and that some individuals may therefore have been incorrectly assigned to one or the other of these groups. The real value of the information on habitat use continues to reside primarily in the basic data on the habitats collected in 1989 (Chauvette 1989) and the only real method for studying habitat changes in the field is to ensure that the surveys, of both birds and habitats, will be repeated in order to provide new data.

6.0 Conclusion

The surveys of breeding waterfowl along the St. Lawrence River and its main tributaries have proven to be a very useful tool for determining the distribution and estimating the size of waterfowl populations. However, the 1990-1992 time series was too short to provide significant data on upward or downward population trends. This tool will be useful only if it is repeated on a regular basis, in order to discern long-term changes and thus provide reliable data on actual population trends, changes in waterfowl distribution and habitat changes. It will be particularly important to monitor trends in resident Canada Goose populations in order to avoid the many problems encountered by our neighbours in Ontario and the United States. The target objective for this population in Québec is 0 breeding pairs. The trends in American Black Duck populations relative to Mallard populations in this part of Québec are another point of interest. The American Black Duck population in the boreal forest is doing well, according to the annual BDJV surveys, but the situation further south is unknown. The American Black Duck has been designated a priority species in eastern North America following the long-term decline observed since 1955 in its wintering habitat. The BDJV is

the only NAWMP action plan that targets a single species: the American Black Duck. The populations in the St. Lawrence valley are especially vulnerable to habitat losses, to the expansion of Mallard populations and to sport harvesting. We believe that its numbers in the St. Lawrence valley have decreased considerably over the years and are likely still on the decline.

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Figure 1. Distribution of the 168 1-km^2 quadrats surveyed each year from 1990 to 1992 along the shores of the St. Lawrence River and its main tributaries

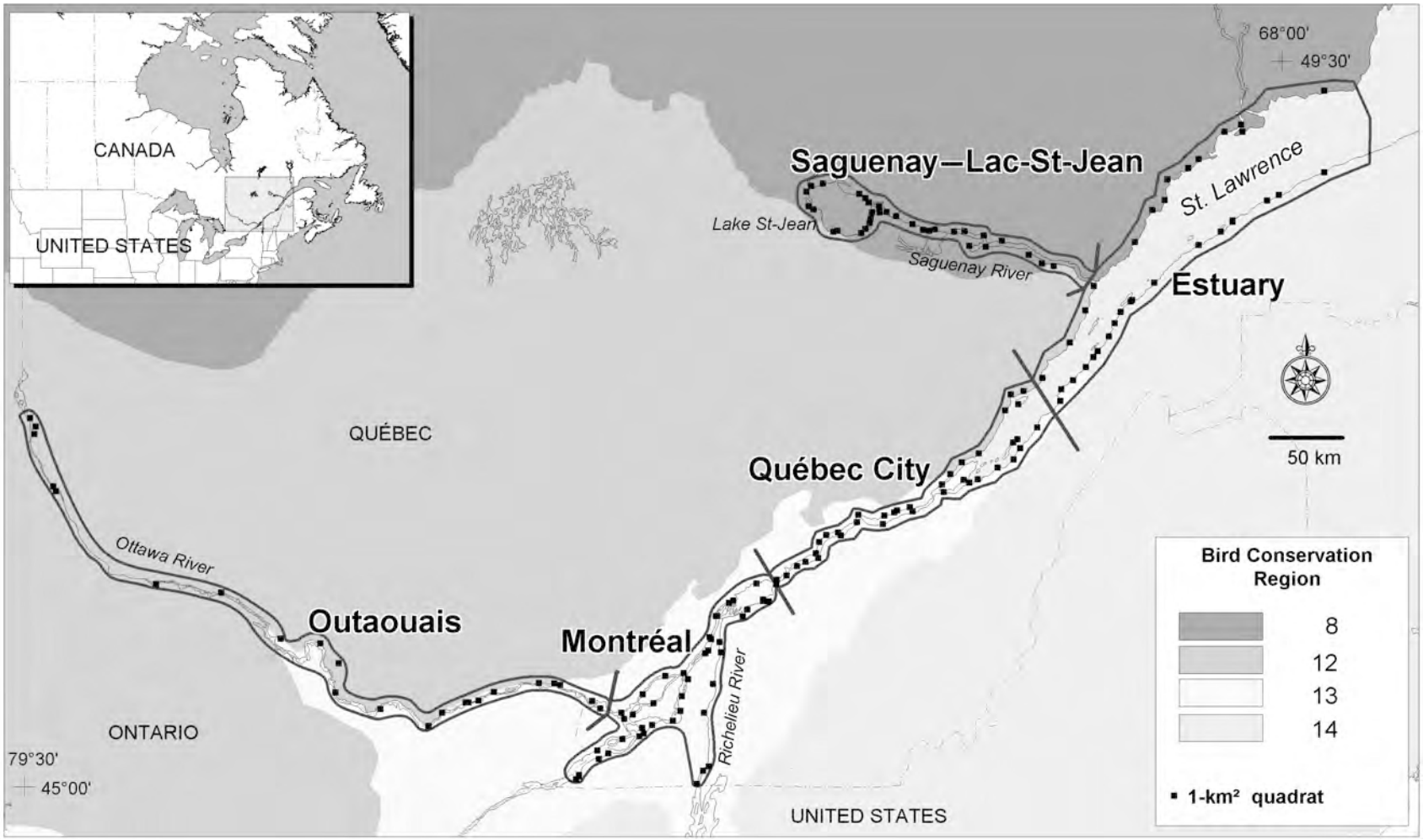


Figure 2. Mean number of waterfowl indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

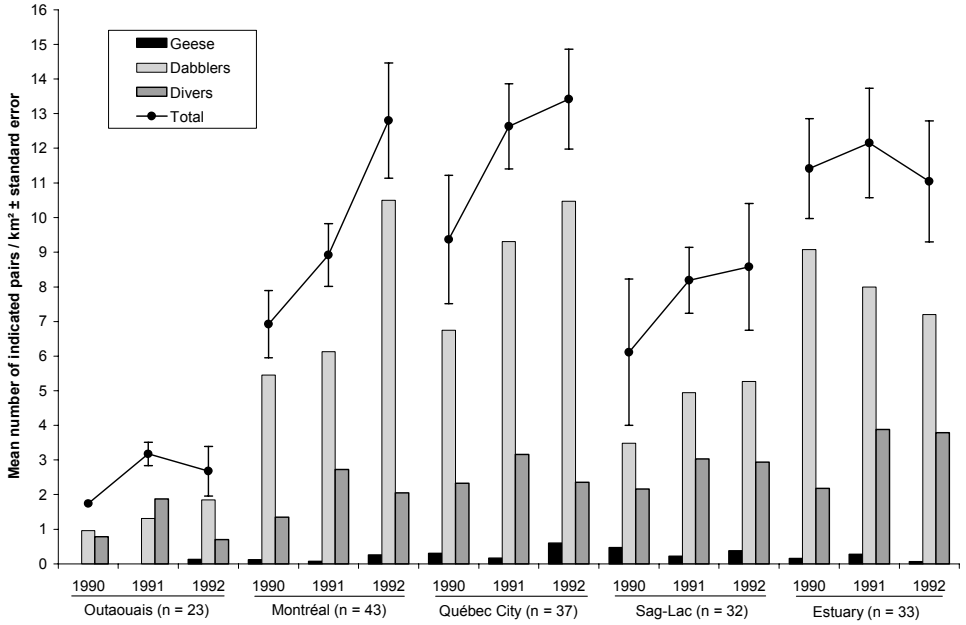


Figure 3. Mean number of Snow Goose indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

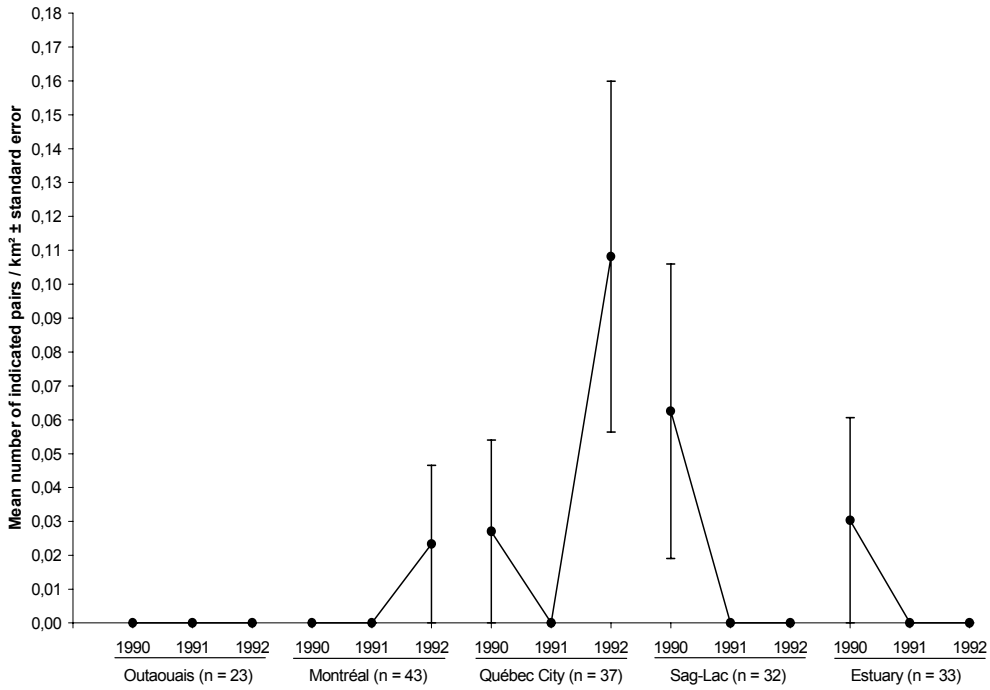


Figure 4. Mean number of Canada Goose indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

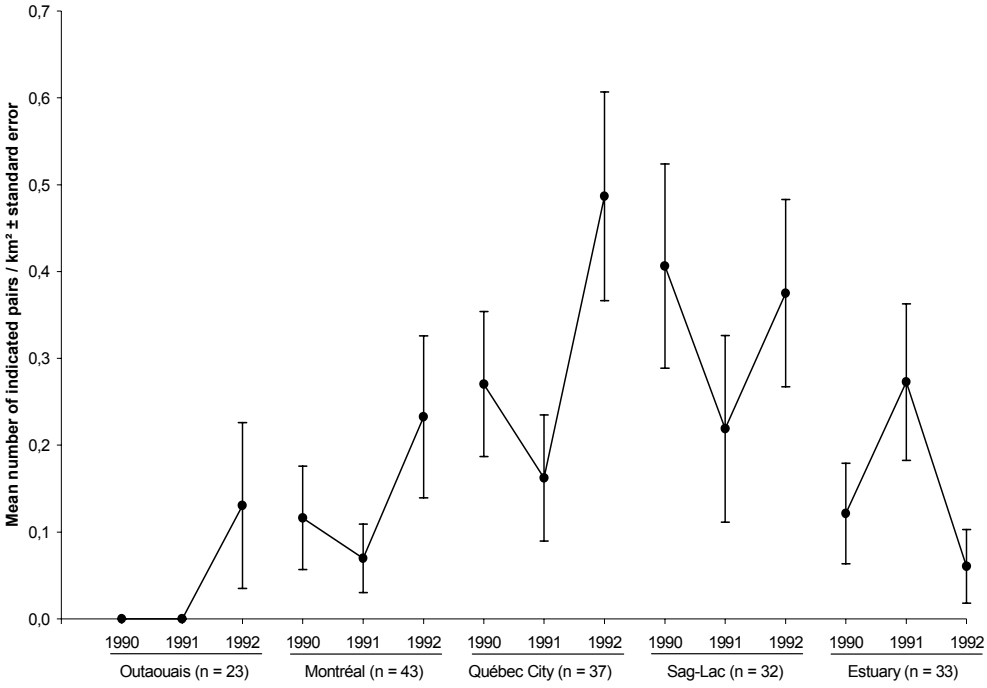


Figure 5. Mean number of Wood Duck indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

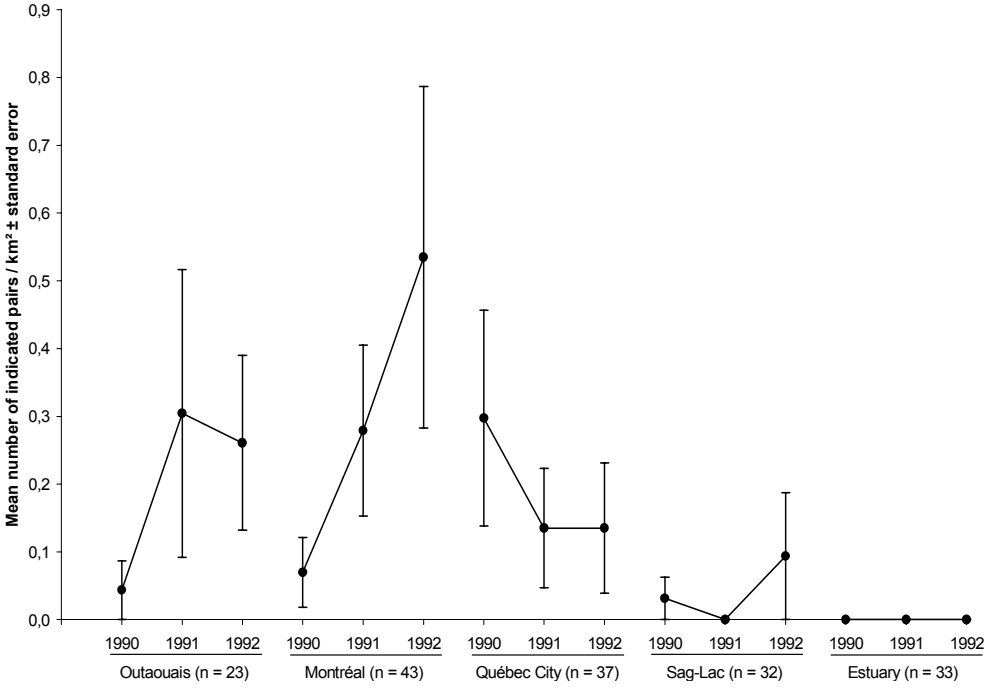


Figure 6. Mean number of Gadwall indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

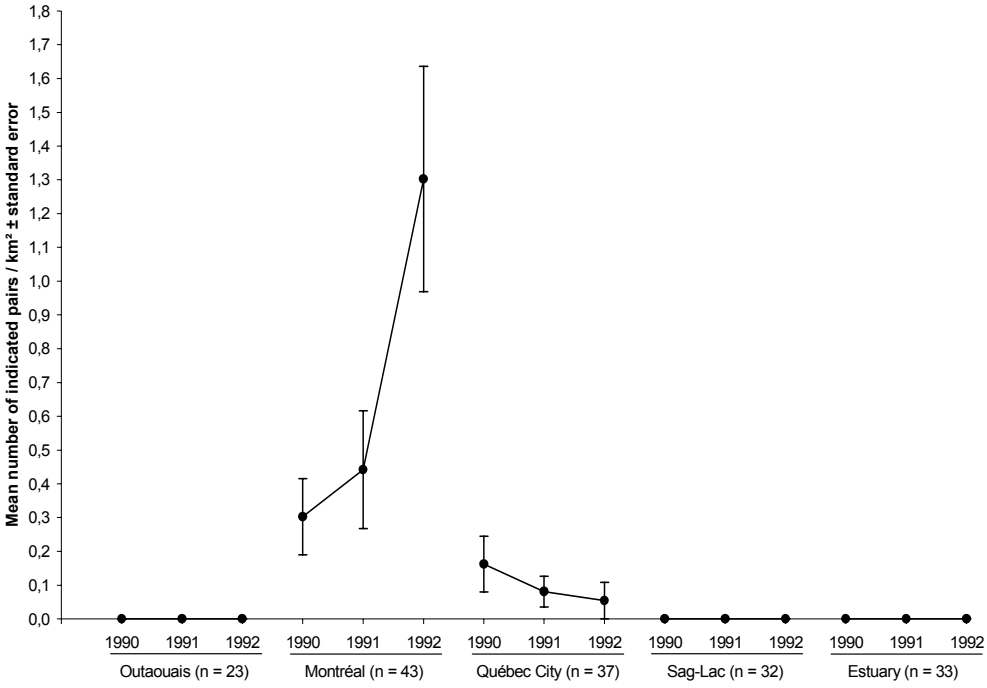


Figure 7. Mean number of American Wigeon indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

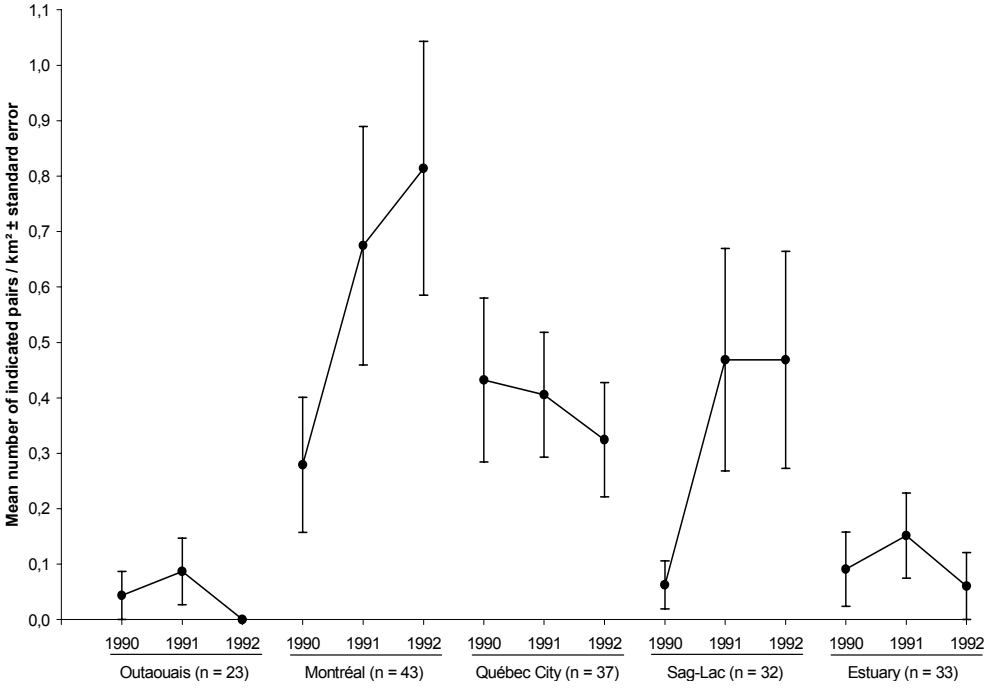


Figure 8. Mean number of American Black Duck indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

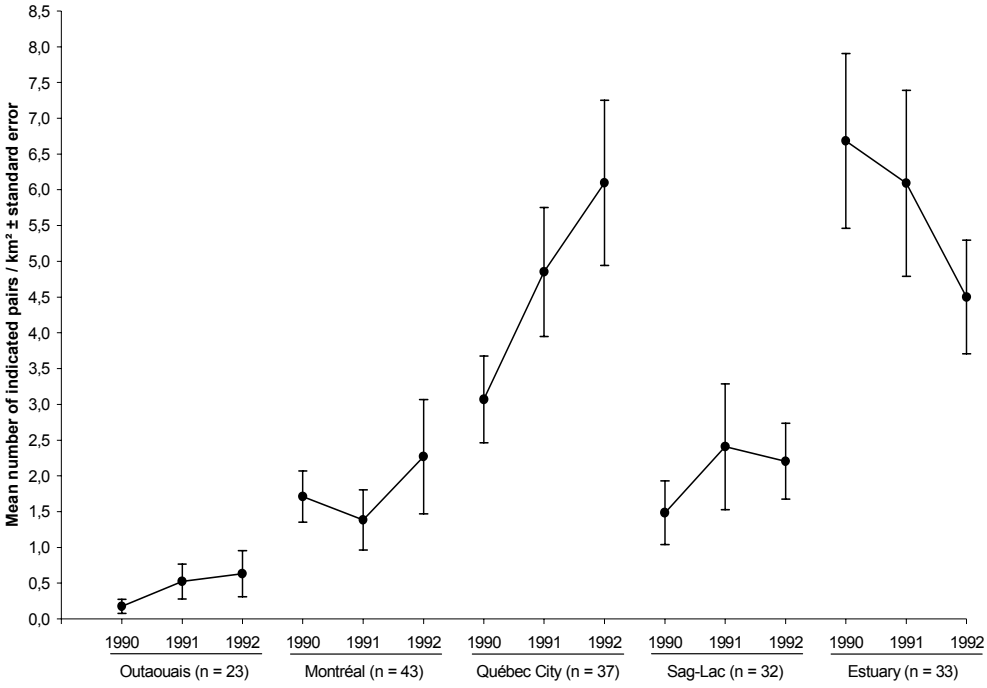


Figure 9. Mean number of Mallard indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

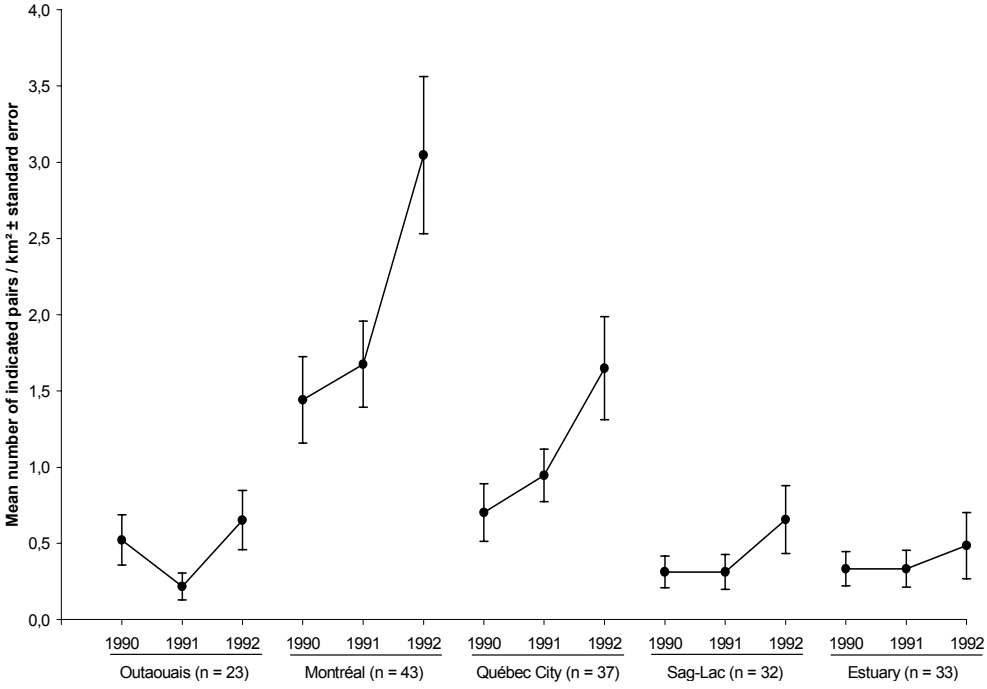


Figure 10. Comparison of the mean number of American Black Duck and Mallard indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

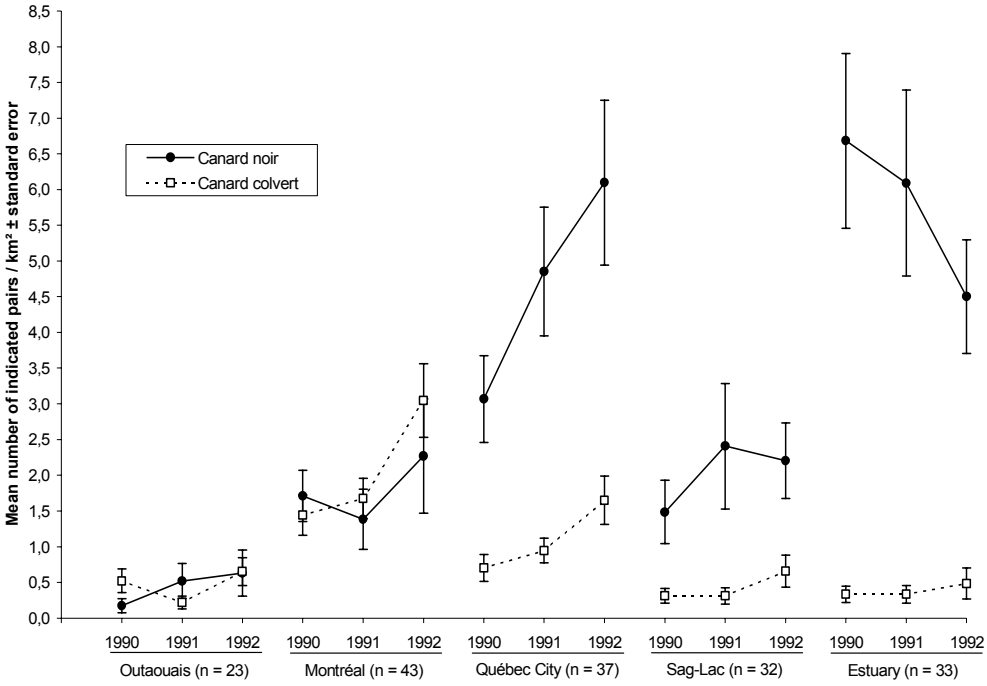
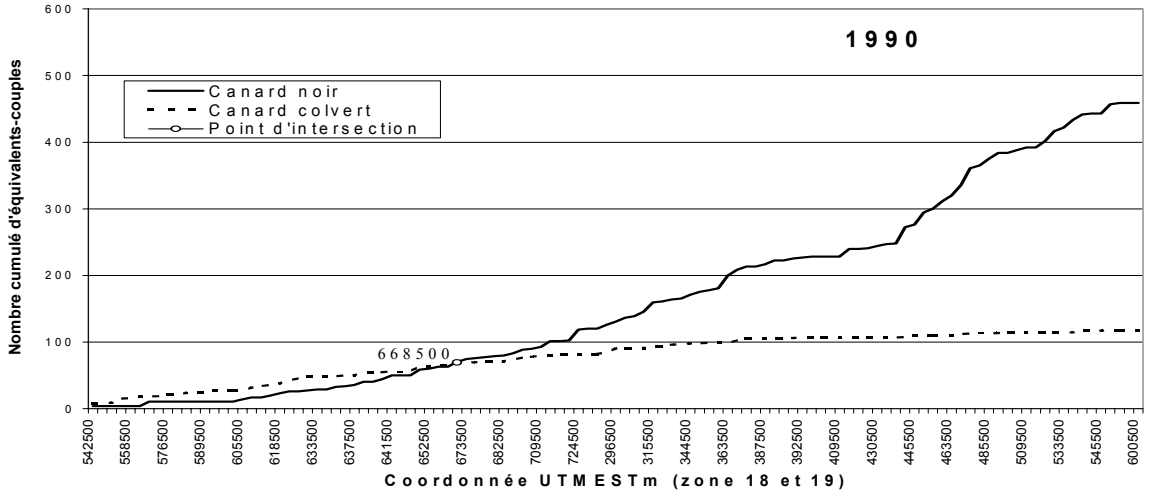
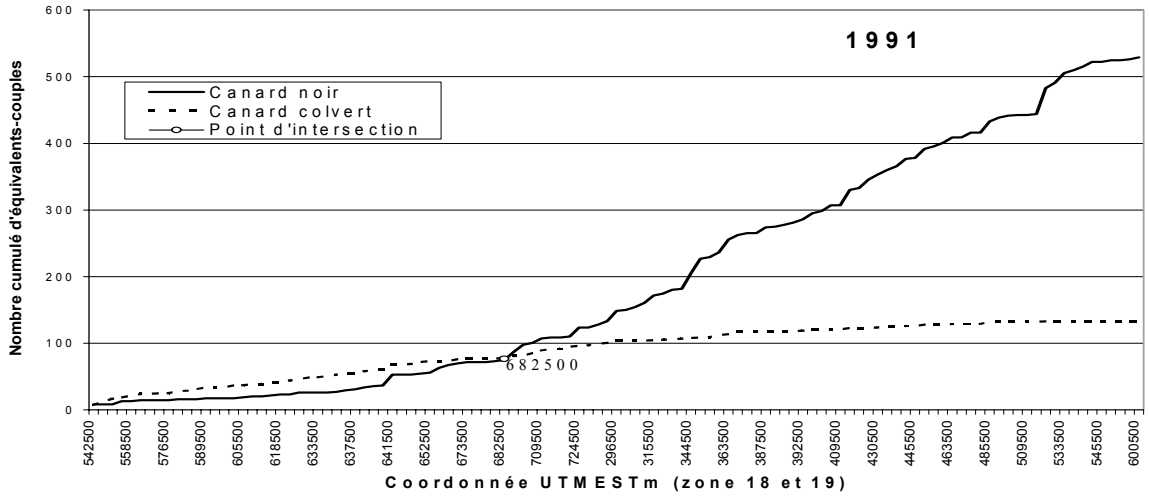


Figure 11. Cumulative number of American Black Duck and Mallard indicated pairs observed in 1990-1992 in the St. Lawrence valley; from west to east.





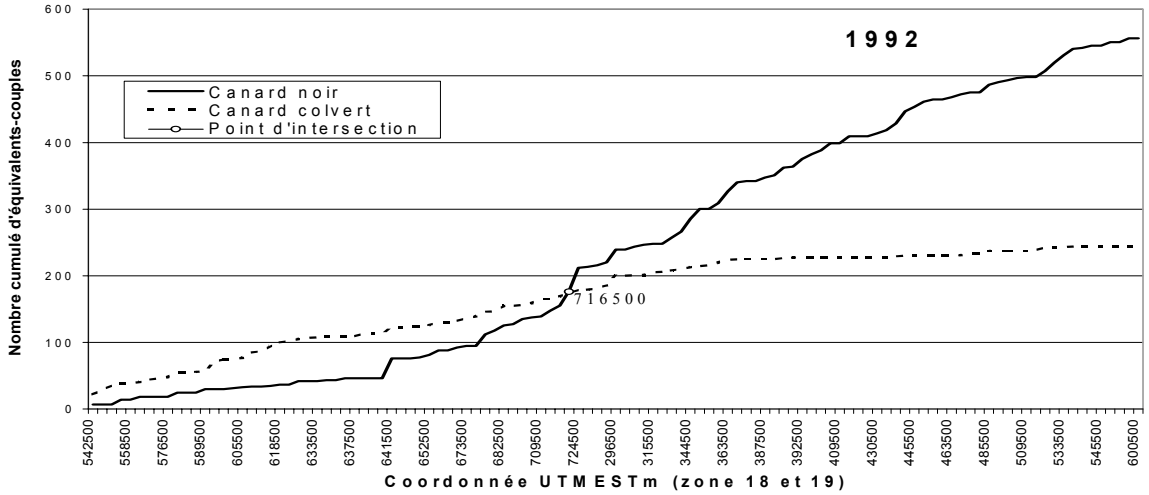


Figure 12. Mean number of Blue-winged Teal indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

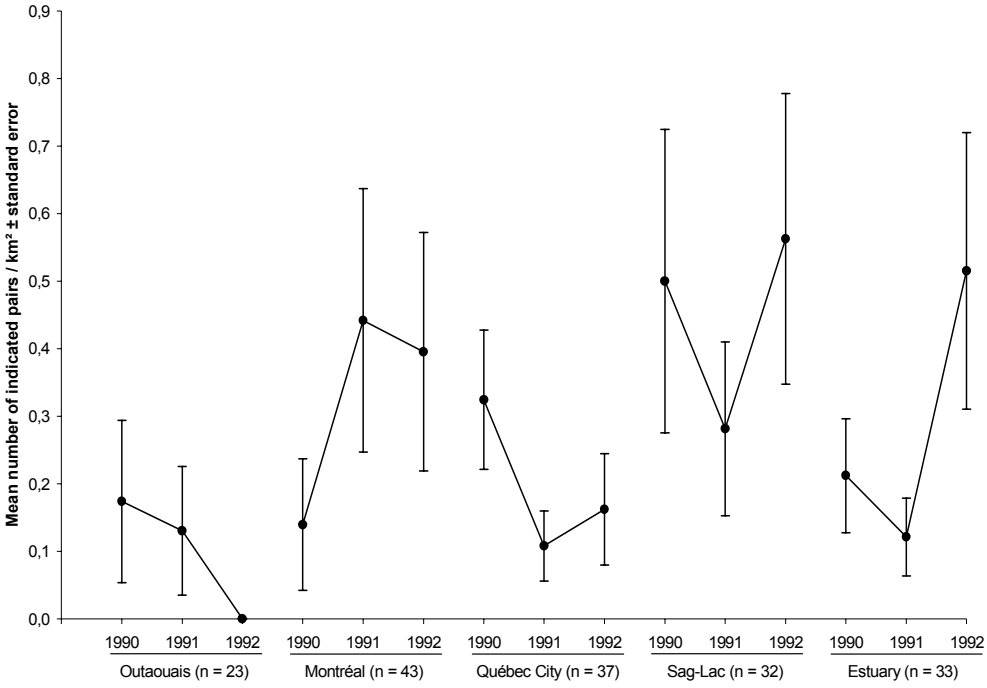


Figure 13. Mean number of Northern Shoveler indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

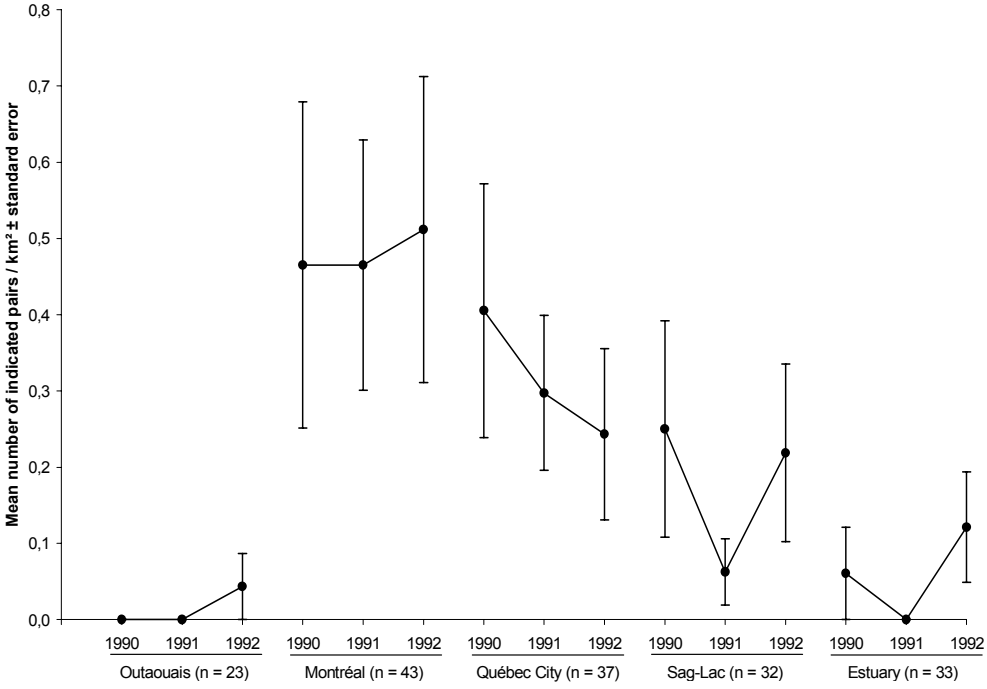


Figure 14. Mean number of Northern Pintail indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

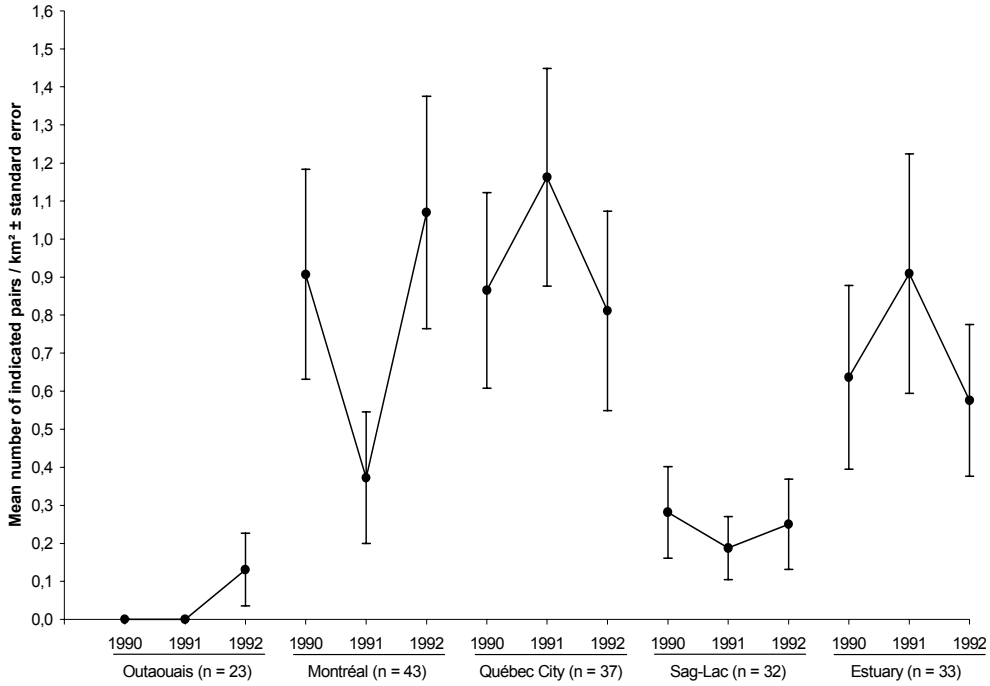


Figure 15. Mean number of Green-winged Teal indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

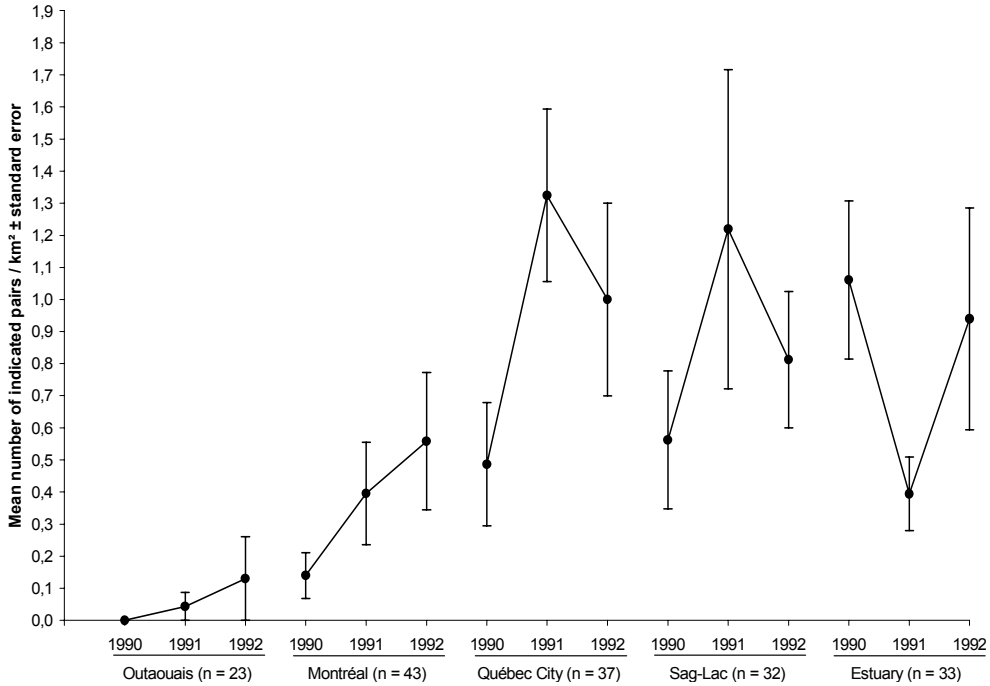


Figure 16. Mean number of Redhead indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

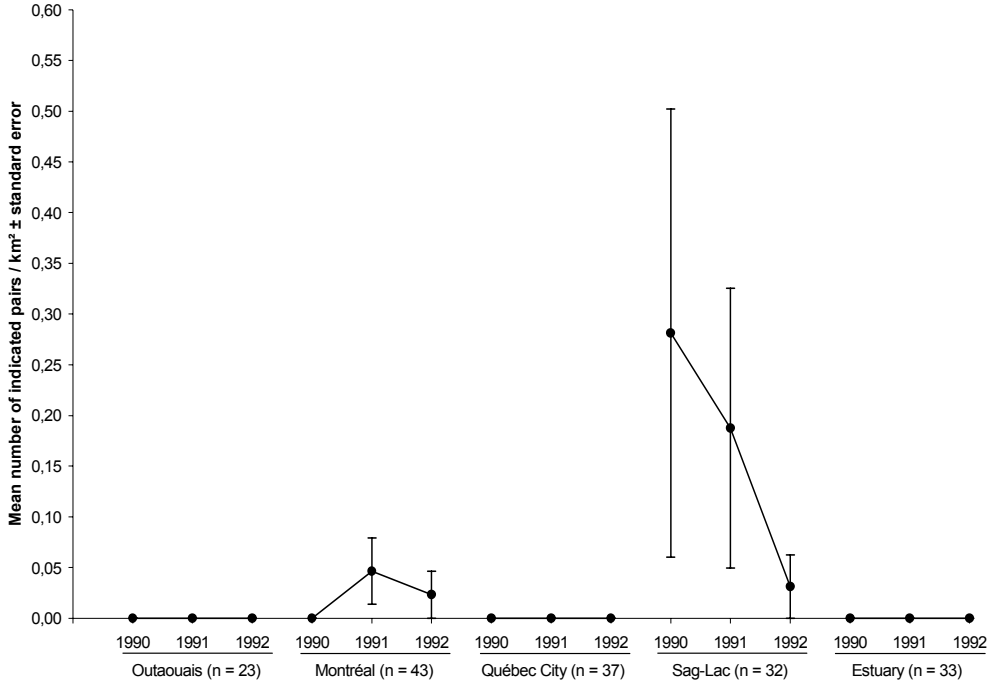


Figure 17. Mean number of Ring-necked Duck indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

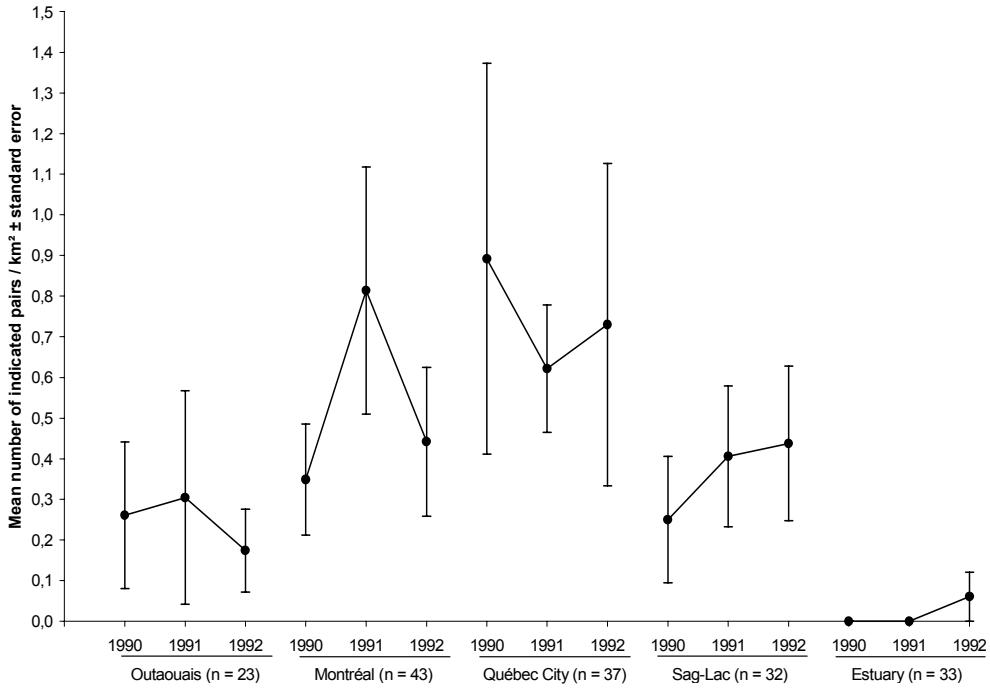


Figure 18. Mean number of Greater Scaup indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

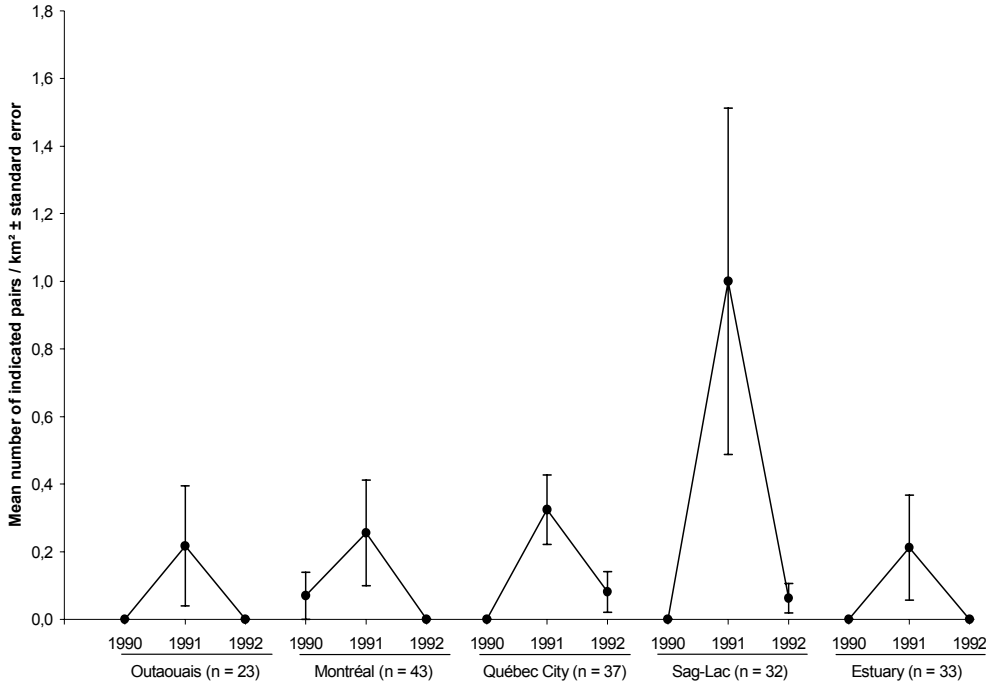


Figure 19. Mean number of Lesser Scaup indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

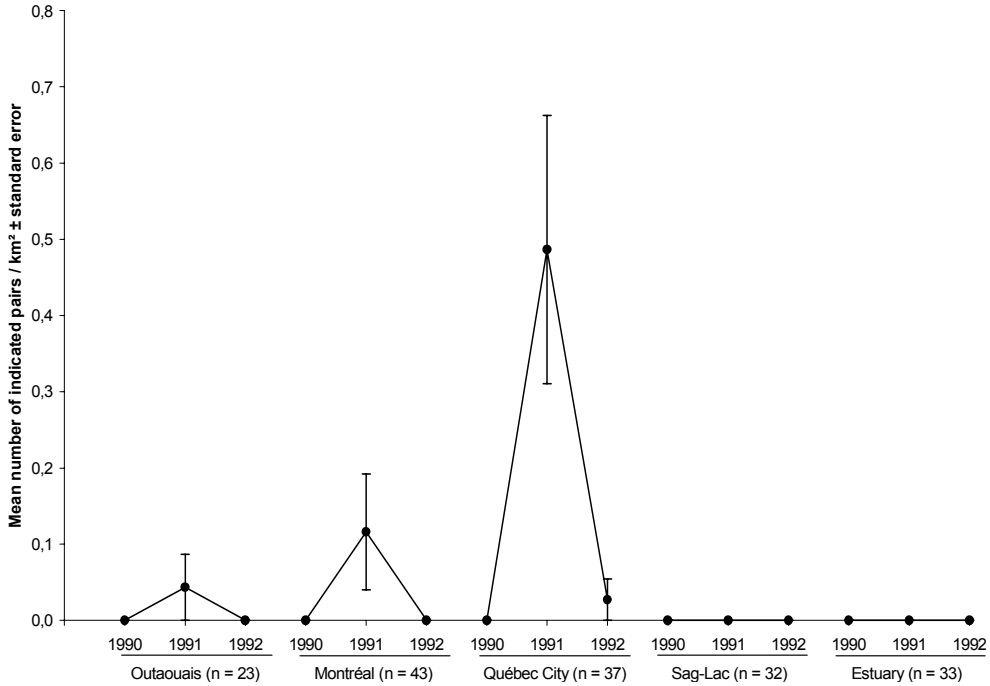


Figure 20. Mean number of Greater Scaup or Lesser Scaup indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

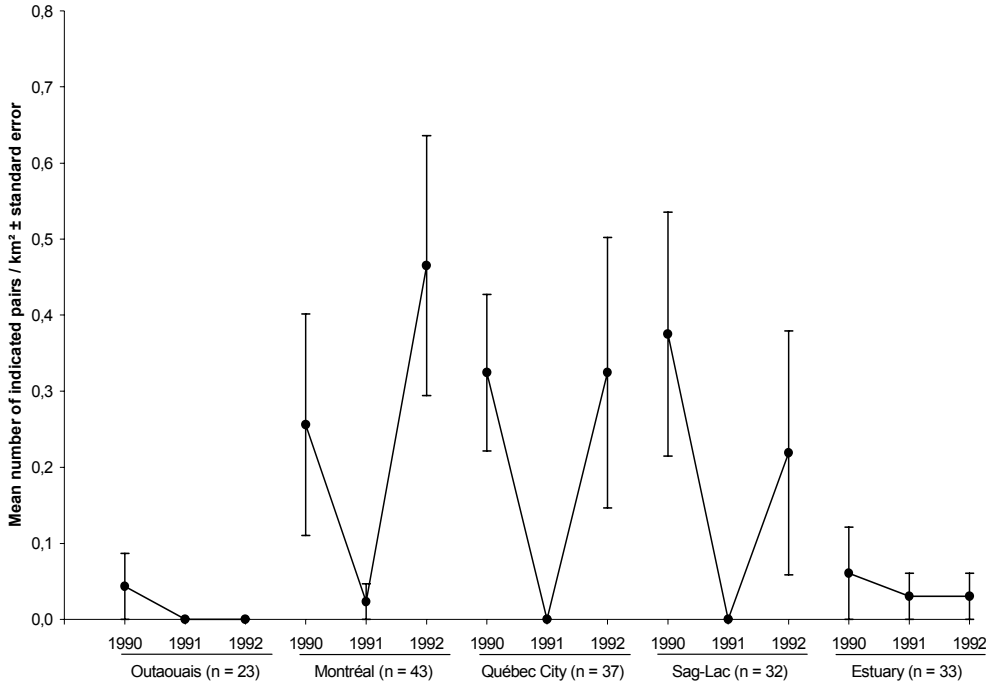


Figure 21. Mean number of Greater Scaup and Lesser Scaup indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

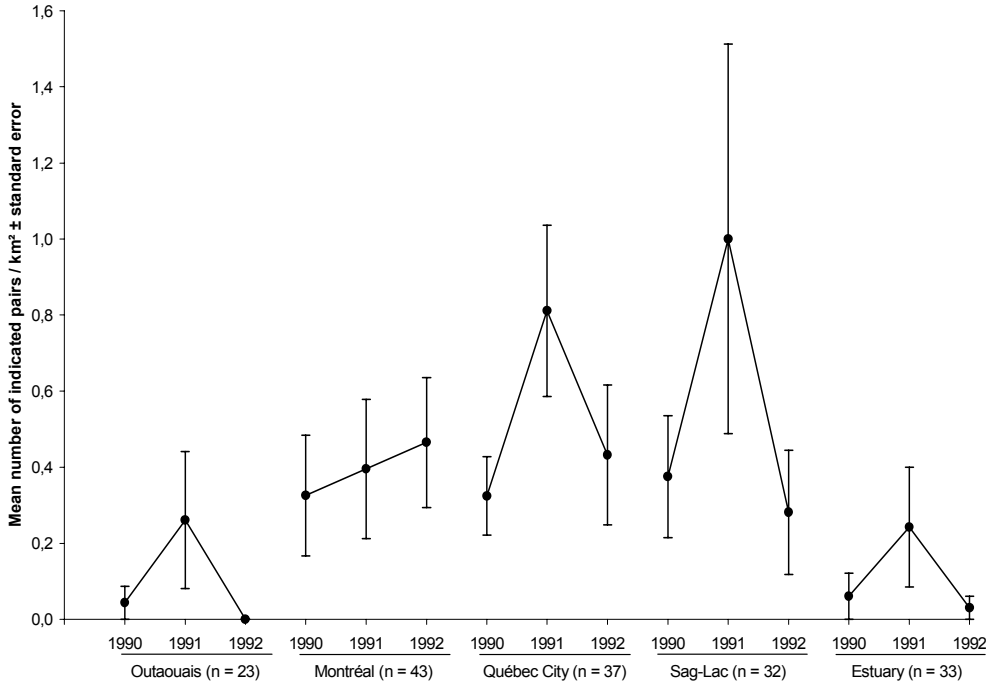


Figure 22. Mean number of Common Eider indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

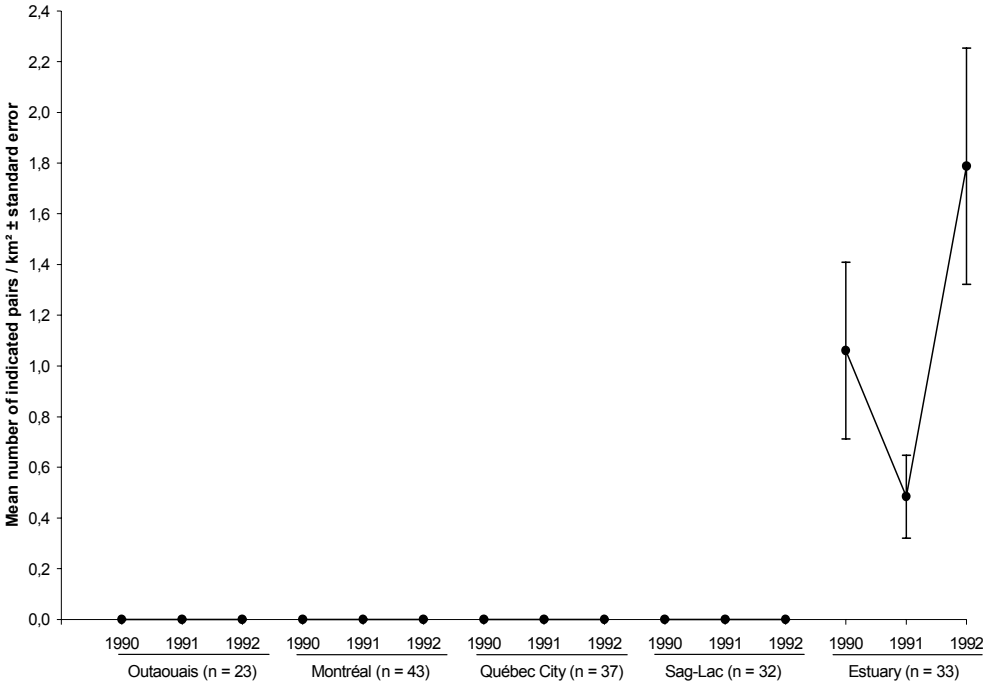


Figure 23. Mean number of Harlequin Duck indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

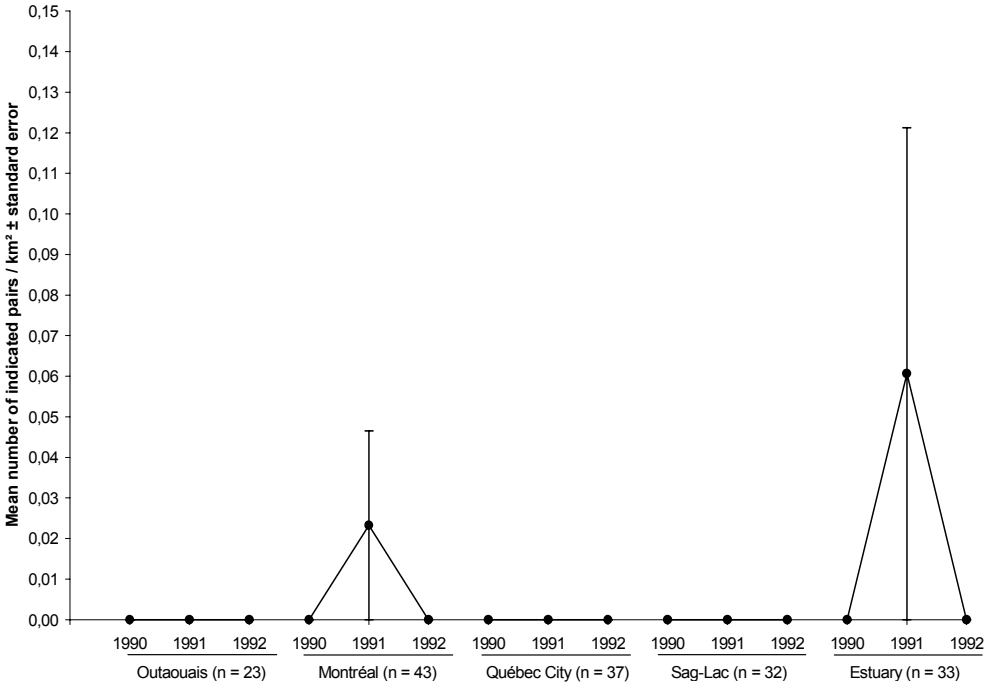


Figure 24. Mean number of Surf Scoter indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

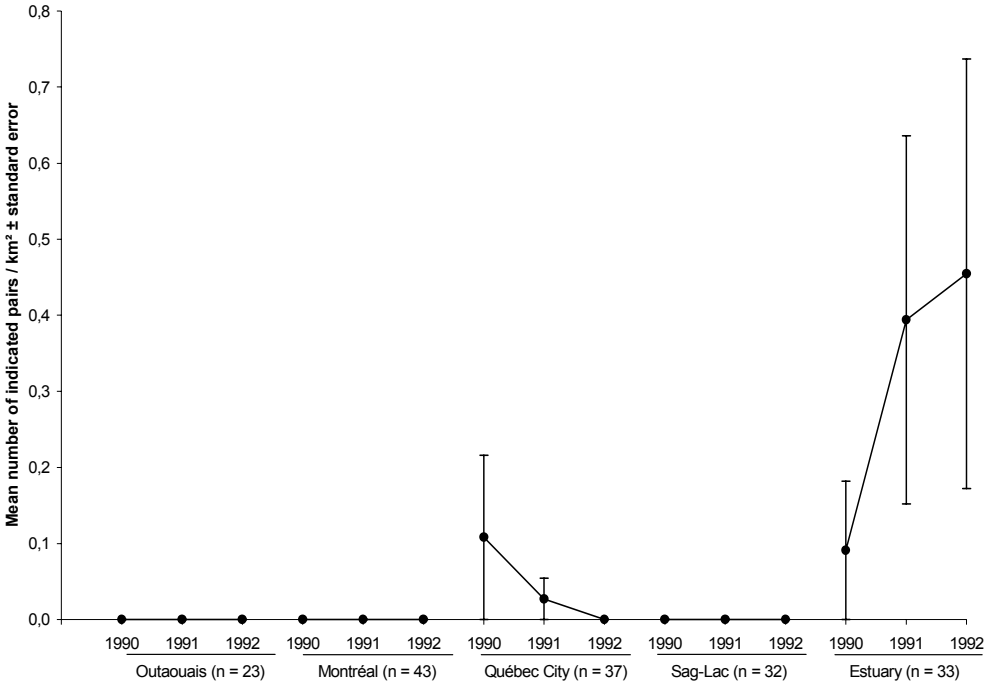


Figure 25. Mean number of Bufflehead indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

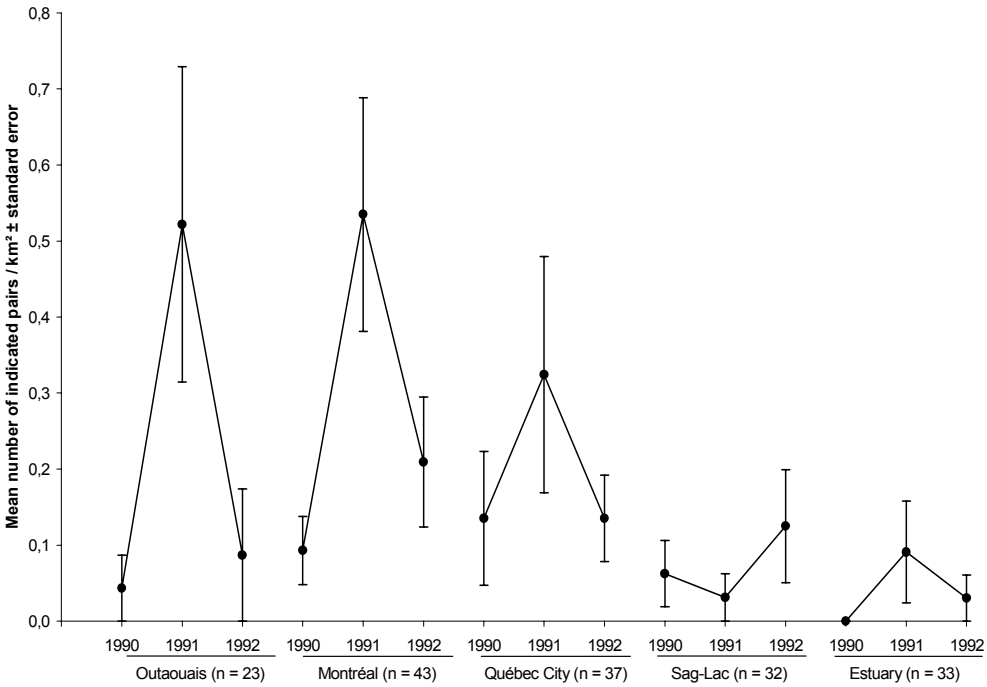


Figure 26. Mean number of Common Goldeneye indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

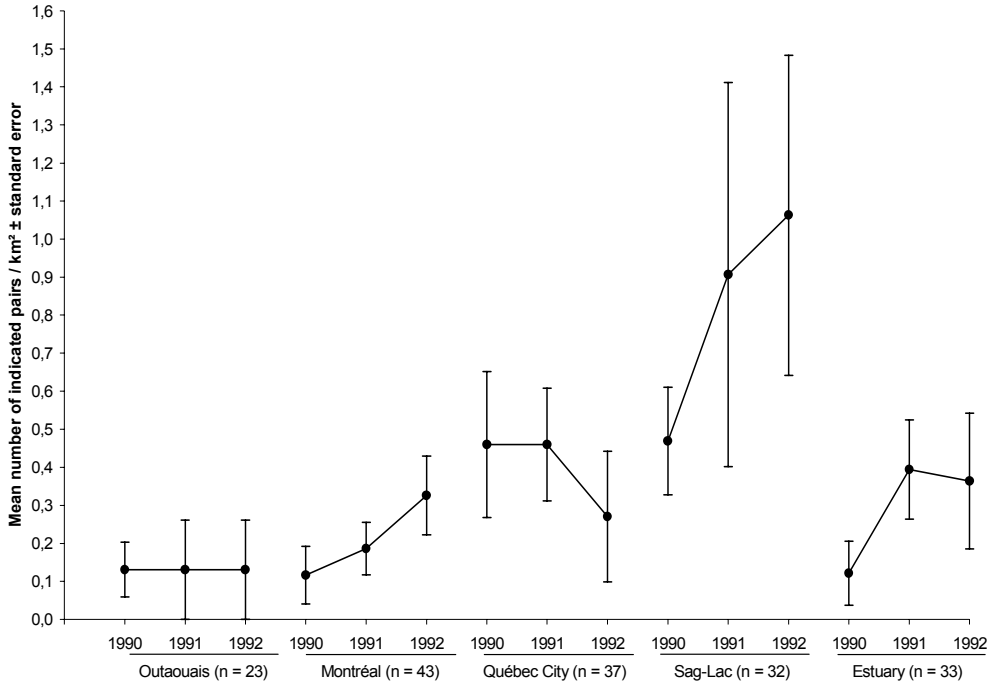


Figure 27. Mean number of Barrow's Goldeneye indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

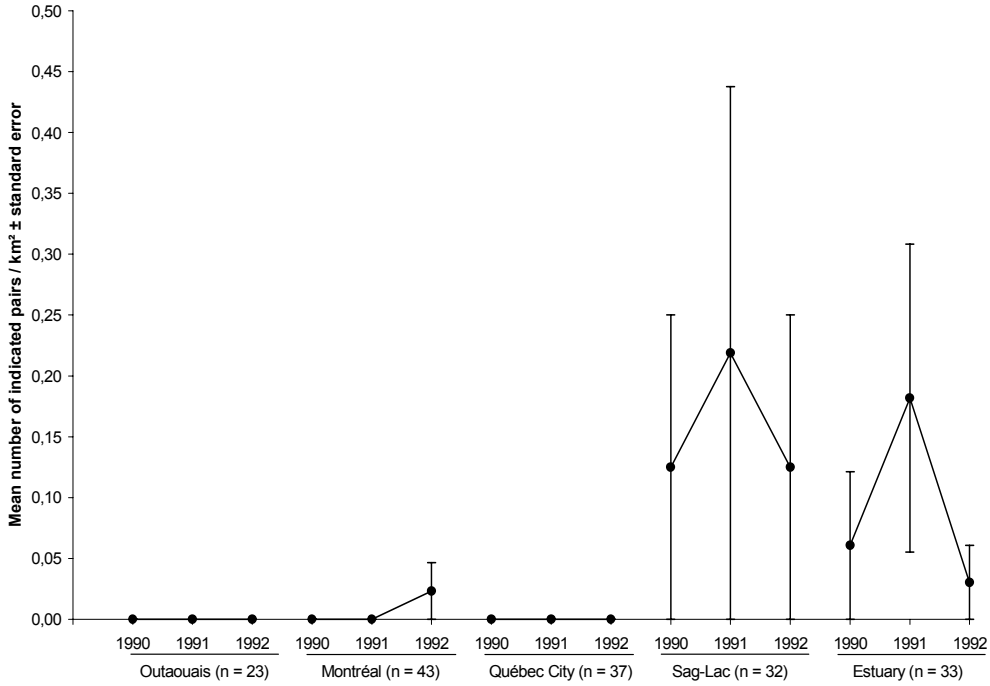


Figure 28. Mean number of Hooded Merganser indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

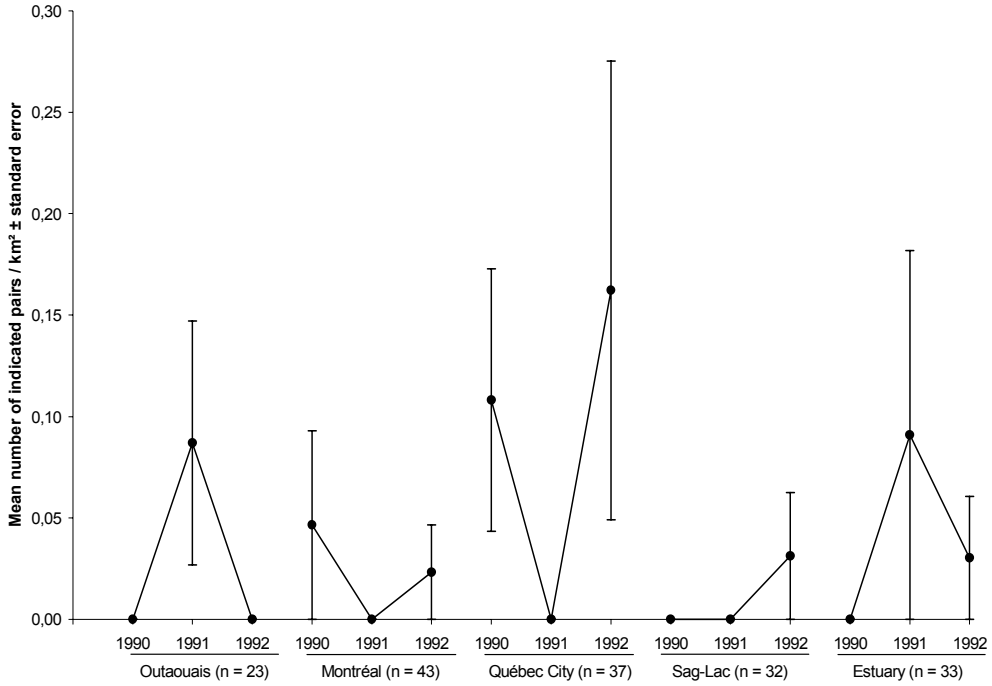


Figure 29. Mean number of Red-breasted Merganser indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

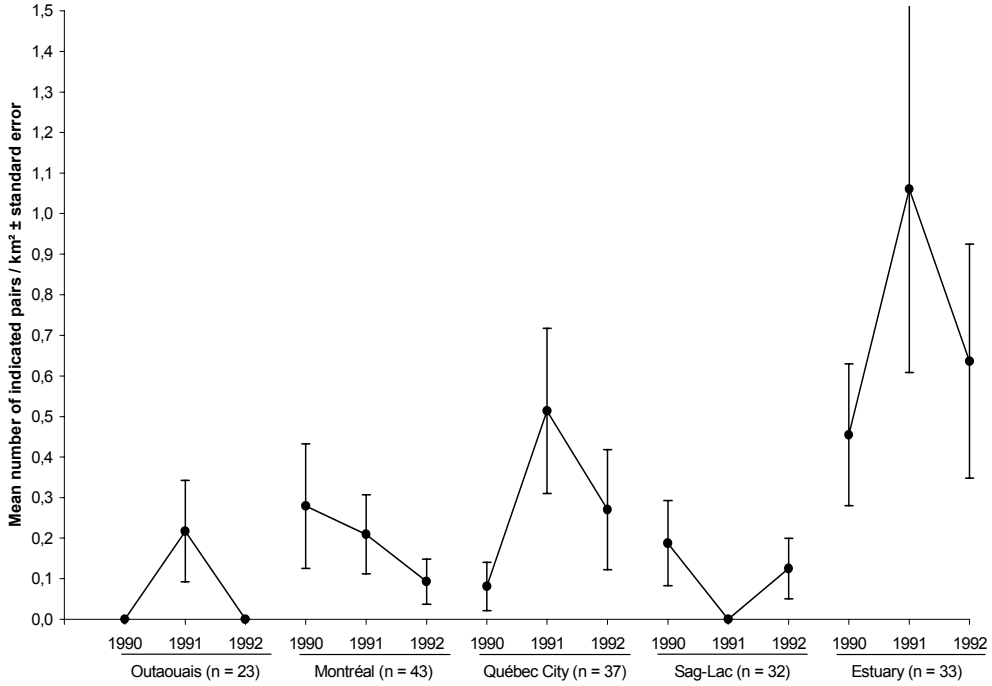


Figure 30. Mean number of Common Merganser indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

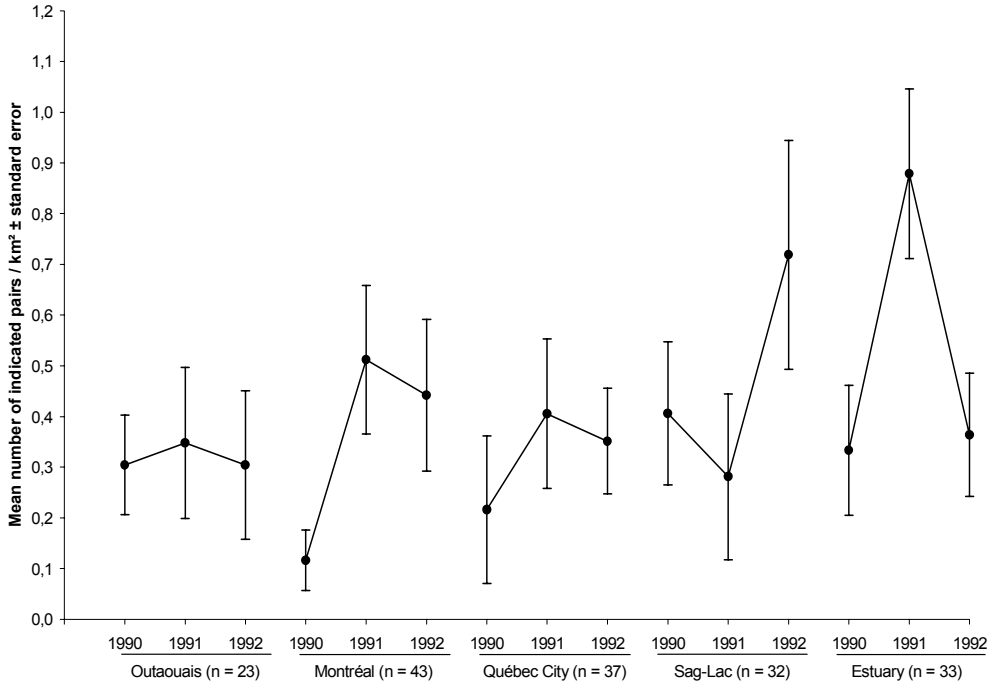


Figure 31. Mean number of Ruddy Duck indicated pairs per square kilometre (± standard error) for each region surveyed along the St. Lawrence River and its main tributaries in 1990-1992; regions are presented from west to east.

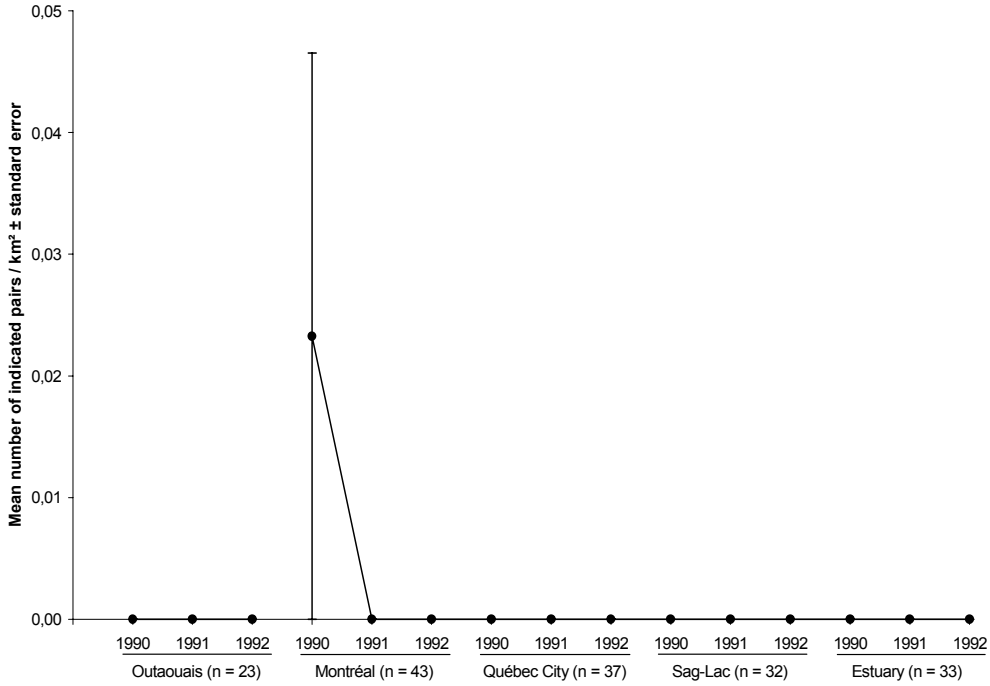


Figure 32. Breakdown (%) of breeding (indicated pair) or migrant status for each behaviour recorded; all species of waterfowl and all years combined, 1990-1992.

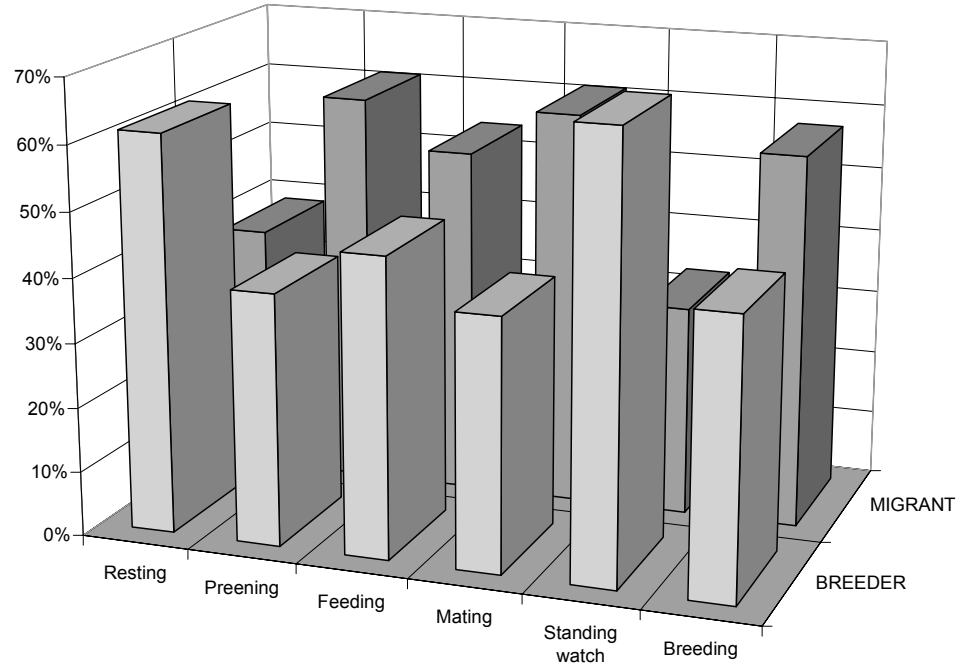


Figure 33. Breakdown (%) of behaviours noted for waterfowl, depending on whether the individuals are considered breeders (indicated pairs) or migrants; all species and all years combined, 1990-1992.

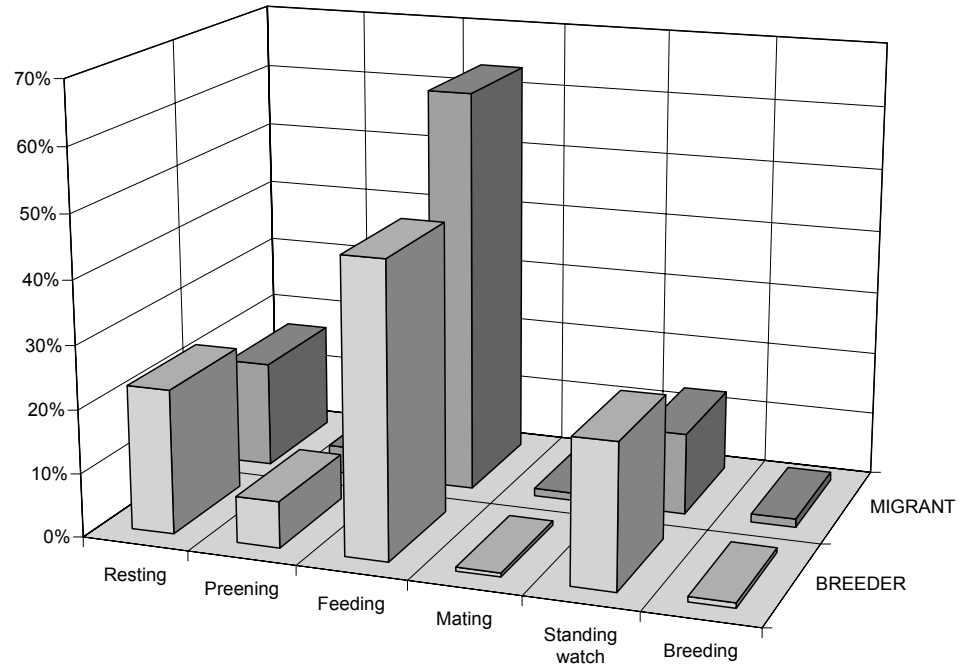


Figure 34. Breakdown (%) of behaviours noted for the American Black Duck, depending on whether the individuals are considered breeders (indicated pairs) or migrants; all years combined, 1990-1992.

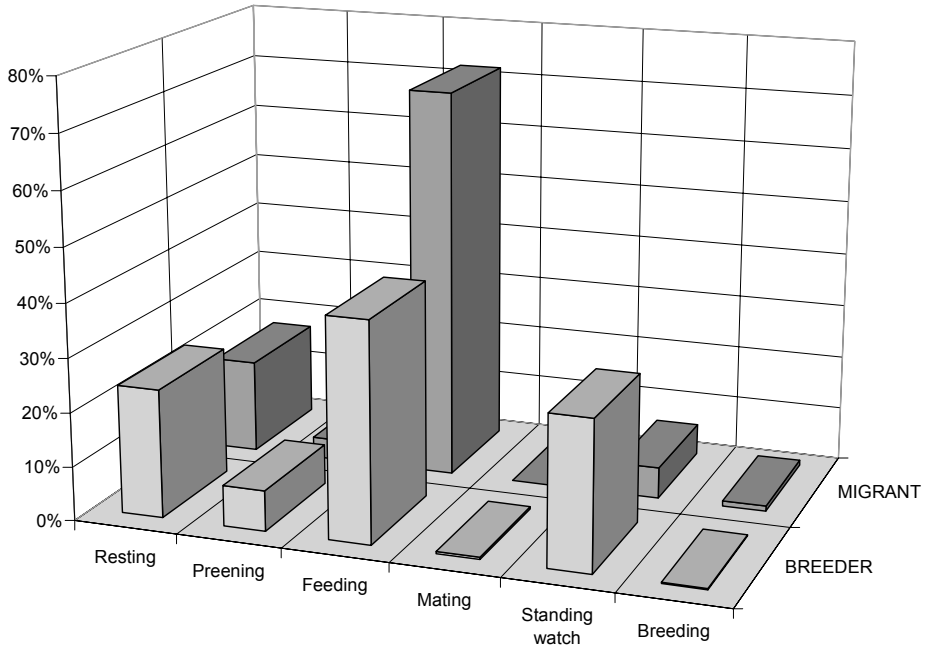


Figure 35. Breakdown (%) of behaviours noted for the Mallard, depending on whether the individuals are considered breeders (indicated pairs) or migrants; all years combined, 1990-1992.

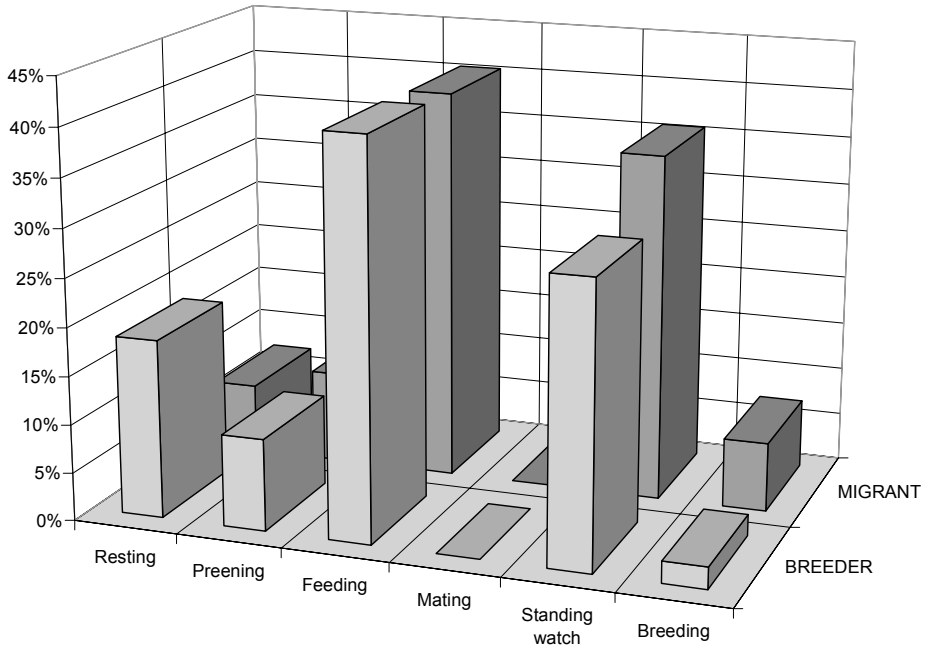


Table 1. Survey dates, survey duration by quadrat, number of quadrats surveyed in each of the three survey years 1990-1992 and total size of the study area in each region

Region	Year	Survey date (dd/mm)[a]	Survey duration (min)[b]	Number of quadrats (1 km^2)	Total area (km^2)
Outaouais	1990	26/04-03/05	57 (30-210)	23	1 103
	1991	23/04-03/05	54 (30-106)	23	1 103
	1992	29/04-13/05	144 (60-305)	23	1 103
Montréal	1990	26/04-01/05	104 (30-275)	43	1 456
	1991	23/04-30/04	86 (30-255)	43	1 456
	1992	26/04-04/05	81 (30-195)	43	1 456
Québec City	1990	25/04-04/05	98 (30-230)	37	919
	1991	23/04-06/05	86 (35-170)	37	919
	1992	03/05-12/05	61 (20-192)	37	919
Saguenay–Lac-Saint-Jean	1990	03/05-09/05	57 (23-133)	32	732
	1991	07/05-17/05	51 (28-149)	32	732
	1992	07/05-17/05	75 (8-165)	32	732
Estuary	1990	03/05-10/05	94 (30-170)	33	1 123
	1991	04/05-11/05	74 (30-130)	33	1 123
	1992	09/05-16/05	51 (22-120)	33	1 123
Total	**1990**	**25/04-10/05**	**85 (23-275)**	**168**	**5 333**
	1991	**23/04-17/05**	**73 (28-255)**	**168**	**5 333**
	1992	**29/04-17/05**	**78 (8-305)**	**168**	**5 333**

[a] Survey start date-Survey end date.

[b] Survey duration by quadrat (min): mean (minimum-maximum).

Table 2. Number of indicated pairs (± standard error) of each species observed along the shores of the St. Lawrence River and its main tributaries, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	105 (53)	0 (0)	133 (58)	79	-[a]
Canada Goose	851 (158)	717 (155)	1 272 (224)	947	14
Sub-total	**956**	**717**	**1 405**	**1 026**	
DABBLERS					
Wood Duck	446 (173)	866 (308)	1 259 (409)	857	16
Gadwall	589 (181)	718 (257)	1 946 (488)	1 084	13
American Wigeon	1 000 (242)	1 964 (377)	1 894 (381)	1 619	8
American Black Duck	14 090 (1 609)	15 650 (1 918)	16 264 (1 885)	15 335	1
Mallard	3 924 (505)	4 150 (478)	7 695 (890)	5 256	2
Blue-winged Teal	1 297 (287)	1 229 (327)	1 715 (387)	1 414	10
Northern Shoveler	1 301 (369)	996 (259)	1 313 (335)	1 203	12
Northern Pintail	3 036 (547)	2 768 (511)	3 276 (570)	3 027	3
Green-winged Teal	2 253 (378)	3 175 (516)	3 525 (607)	2 984	4
Sub-total	**27 935**	**31 516**	**38 887**	**32 779**	
DIVERS					
Redhead	206 (162)	205 (112)	57 (41)	156	21
Ring-necked Duck	1 798 (536)	2 389 (562)	1 894 (491)	2 027	6
Greater Scaup	102 (102)	1 881 (520)	120 (63)	701	17
Lesser Scaup	0 (0)	664 (202)	25 (25)	230	-[a]
Greater or Lesser Scaup	1 061 (273)	68 (48)	1 169 (322)	766	N/A[b]
Common Eider	1 191 (391)	544 (184)	2 008 (524)	1 248	11
Harlequin Duck	0 (0)	102 (76)	0 (0)	34	-[a]
Surf Scoter	201 (142)	467 (273)	510 (317)	393	18
Bufflehead	353 (119)	1 777 (359)	650 (177)	927	15
Common Goldeneye	1 215 (264)	1 943 (455)	2 052 (451)	1 737	7
Barrow's Goldeneye	160 (114)	364 (214)	159 (103)	228	19
Hooded Merganser	167 (90)	198 (122)	240 (117)	202	20
Red-breasted Merganser	1 129 (312)	2 208 (576)	1 190 (364)	1 509	9
Common Merganser	1 375 (262)	2 694 (375)	2 236 (359)	2 102	5
Ruddy Duck	34 (34)	0 (0)	0 (0)	11	-[a]
Sub-total	**8 992**	**15 505**	**12 312**	**12 269**	
Total (waterfowl)	**37 883**	**47 737**	**52 605**	**46 075**	

[a] The species was not observed every year.

[b] The rank was not attributed because the species was not identified.

Table 3. Number of indicated pairs (± standard error) of each species observed along the shores of the Ottawa River, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	0 (0)	0 (0)	0 (0)	0	0[a]
Canada Goose	0 (0)	0 (0)	144 (105)	48	-[b]
Sub-total	**0**	**0**	**144**	**48**	
DABBLERS					
Wood Duck	48 (48)	336 (234)	288 (142)	224	6
Gadwall	0 (0)	0 (0)	0 (0)	0	0[a]
American Wigeon	48 (48)	96 (66)	0 (0)	48	-[b]
American Black Duck	192 (107)	575 (267)	695 (356)	488	2
Mallard	575 (182)	240 (97)	719 (215)	512	1
Blue-winged Teal	192 (133)	144 (105)	0 (0)	112	-[b]
Northern Shoveler	0 (0)	0 (0)	48 (48)	16	-[b]
Northern Pintail	0 (0)	0 (0)	144 (105)	48	-[b]
Green-winged Teal	0 (0)	48 (48)	144 (144)	64	-[b]
Sub-total	**1 055**	**1 439**	**2 038**	**1 511**	
DIVERS					
Redhead	0 (0)	0 (0)	0 (0)	0	0[a]
Ring-necked Duck	288 (199)	336 (290)	192 (113)	272	4
Greater Scaup	0 (0)	240 (196)	0 (0)	80	-[b]
Lesser Scaup	0 (0)	48 (48)	0 (0)	16	-[b]
Greater or Lesser Scaup	48 (48)	0 (0)	0 (0)	16	N/A[c]
Common Eider	0 (0)	0 (0)	0 (0)	0	0[a]
Harlequin Duck	0 (0)	0 (0)	0 (0)	0	0[a]
Surf Scoter	0 (0)	0 (0)	0 (0)	0	0[a]
Bufflehead	48 (48)	575 (229)	96 (96)	240	5
Common Goldeneye	144 (79)	144 (144)	144 (144)	144	7
Barrow's Goldeneye	0 (0)	0 (0)	0 (0)	0	0[a]
Hooded Merganser	0 (0)	96 (66)	0 (0)	32	-[b]
Red-breasted Merganser	0 (0)	240 (138)	0 (0)	80	-[b]
Common Merganser	336 (108)	384 (164)	336 (162)	352	3
Ruddy Duck	0 (0)	0 (0)	0 (0)	0	0[a]
Sub-total	**863**	**2 062**	**767**	**1 231**	
Total (waterfowl)	**1 918**	**3 501**	**2 949**	**2 789**	

[a] The species was not observed.

[b] The species was not observed every year.

[c] The rank was not attributed because the species was not identified.

Table 4. Number of indicated pairs (± standard error) of each species observed along the shores of the St. Lawrence River and the Richelieu River in the Montréal region, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	0 (0)	0 (0)	34 (34)	11	-[a]
Canada Goose	169 (87)	102 (57)	339 (136)	203	15
Sub-total	**169**	**102**	**372**	**214**	
DABBLERS					
Wood Duck	102 (75)	406 (183)	779 (367)	429	11
Gadwall	440 (165)	643 (253)	1 896 (486)	993	4
American Wigeon	406 (177)	982 (313)	1 185 (333)	858	5
American Black Duck	2 489 (521)	2 015 (611)	3 301 (1 163)	2 602	2
Mallard	2 099 (412)	2 438 (410)	4 436 (751)	2 991	1
Blue-winged Teal	203 (142)	643 (284)	576 (257)	474	10
Northern Shoveler	677 (312)	677 (239)	745 (292)	700	7
Northern Pintail	1 321 (402)	542 (252)	1 558 (445)	1 140	3
Green-winged Teal	203 (104)	576 (233)	813 (311)	530	8
Sub-total	**7 940**	**8 922**	**15 288**	**10 717**	
DIVERS					
Redhead	0 (0)	68 (47)	34 (34)	34	-[a]
Ring-necked Duck	508 (199)	1 185 (442)	643 (267)	779	6
Greater Scaup	102 (102)	372 (228)	0 (0)	158	-[a]
Lesser Scaup	0 (0)	169 (111)	0 (0)	56	-[a]
Greater or Lesser Scaup	372 (212)	34 (34)	677 (249)	361	N/A[b]
Common Eider	0 (0)	0 (0)	0 (0)	0	0[c]
Harlequin Duck	0 (0)	34 (34)	0 (0)	11	-[a]
Surf Scoter	0 (0)	0 (0)	0 (0)	0	0[c]
Bufflehead	135 (65)	779 (224)	305 (124)	406	12
Common Goldeneye	169 (111)	271 (100)	474 (151)	305	13
Barrow's Goldeneye	0 (0)	0 (0)	34 (34)	11	-[a]
Hooded Merganser	68 (68)	0 (0)	34 (34)	34	-[a]
Red-breasted Merganser	406 (224)	305 (142)	135 (81)	282	14
Common Merganser	169 (87)	745 (213)	643 (218)	519	9
Ruddy Duck	34 (34)	0 (0)	0 (0)	11	-[a]
Sub-total	**1 964**	**3 962**	**2 980**	**2 968**	
Total (waterfowl)	**10 073**	**12 985**	**18 640**	**13 900**	

[a] The species was not observed every year.

[b] The rank was not attributed because the species was not identified.

[c] The species was not observed.

Table 5. Number of indicated pairs (± standard error) of each species observed along the shores of the St. Lawrence River in the Québec City region, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	25 (25)	0 (0)	99 (48)	41	-[a]
Canada Goose	248 (77)	149 (67)	447 (110)	281	10
Sub-total	**273**	**149**	**546**	**323**	
DABBLERS					
Wood Duck	273 (146)	124 (81)	124 (88)	174	14
Gadwall	149 (76)	75 (42)	50 (50)	91	15
American Wigeon	397 (136)	373 (104)	298 (95)	356	7
American Black Duck	2 819 (557)	4 458 (827)	5 601 (1 060)	4 293	1
Mallard	646 (174)	869 (159)	1 515 (311)	1 010	2
Blue-winged Teal	298 (95)	99 (48)	149 (76)	182	12,5
Northern Shoveler	373 (153)	273 (93)	224 (103)	290	9
Northern Pintail	795 (237)	1 068 (263)	745 (241)	869	3
Green-winged Teal	447 (177)	1 217 (247)	919 (276)	861	4
Sub-total	**6 197**	**8 557**	**9 625**	**8 126**	
DIVERS					
Redhead	0 (0)	0 (0)	0 (0)	0	0[b]
Ring-necked Duck	820 (442)	571 (144)	671 (364)	687	5
Greater Scaup	0 (0)	298 (95)	75 (55)	124	-[a]
Lesser Scaup	0 (0)	447 (162)	25 (25)	157	-[a]
Greater or Lesser Scaup	298 (95)	0 (0)	298 (163)	199	N/A[c]
Common Eider	0 (0)	0 (0)	0 (0)	0	0[b]
Harlequin Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Surf Scoter	99 (99)	25 (25)	0 (0)	41	-[a]
Bufflehead	124 (81)	298 (143)	124 (52)	182	12,5
Common Goldeneye	422 (177)	422 (136)	248 (158)	364	6
Barrow's Goldeneye	0 (0)	0 (0)	0 (0)	0	0[b]
Hooded Merganser	99 (59)	0 (0)	149 (104)	83	-[a]
Red-breasted Merganser	75 (55)	472 (187)	248 (136)	265	11
Common Merganser	199 (134)	373 (135)	323 (96)	298	8
Ruddy Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Sub-total	**2 136**	**2 906**	**2 161**	**2 401**	
Total (waterfowl)	**8 606**	**11 612**	**12 332**	**10 850**	

[a] The species was not observed every year.

[b] The species was not observed.

[c] The rank was not attributed because the species was not identified.

Table 6. Number of indicated pairs (± standard error) of each species observed along the shores of the Saguenay River and the Lake Saint-Jean, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	46 (32)	0 (0)	0 (0)	15	-[a]
Canada Goose	297 (86)	160 (79)	275 (79)	244	8,5
Sub-total	**343**	**160**	**275**	**259**	
DABBLERS					
Wood Duck	23 (23)	0 (0)	69 (69)	31	-[a]
Gadwall	0 (0)	0 (0)	0 (0)	0	0[b]
American Wigeon	46 (32)	343 (147)	343 (143)	244	8,5
American Black Duck	1 087 (325)	1 761 (643)	1 613 (389)	1 487	1
Mallard	229 (77)	229 (83)	480 (163)	313	6
Blue-winged Teal	366 (164)	206 (94)	412 (157)	328	5
Northern Shoveler	183 (104)	46 (32)	160 (85)	130	11
Northern Pintail	206 (88)	137 (61)	183 (87)	175	10
Green-winged Teal	412 (157)	892 (364)	595 (156)	633	2
Sub-total	**2 551**	**3 614**	**3 854**	**3 340**	
DIVERS					
Redhead	206 (162)	137 (101)	23 (23)	122	12
Ring-necked Duck	183 (114)	297 (127)	320 (139)	267	7
Greater Scaup	0 (0)	732 (375)	46 (32)	259	-[a]
Lesser Scaup	0 (0)	0 (0)	0 (0)	0	0[b]
Greater or Lesser Scaup	275 (117)	0 (0)	160 (117)	145	N/A[c]
Common Eider	0 (0)	0 (0)	0 (0)	0	0[b]
Harlequin Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Surf Scoter	0 (0)	0 (0)	0 (0)	0	0[b]
Bufflehead	46 (32)	23 (23)	92 (55)	53	14
Common Goldeneye	343 (104)	663 (369)	778 (308)	595	3
Barrow's Goldeneye	92 (92)	160 (160)	92 (92)	114	13
Hooded Merganser	0 (0)	0 (0)	23 (23)	8	-[a]
Red-breasted Merganser	137 (77)	0 (0)	92 (55)	76	-[a]
Common Merganser	297 (103)	206 (120)	526 (165)	343	4
Ruddy Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Sub-total	**1 578**	**2 219**	**2 150**	**1 983**	
Total (waterfowl)	**4 472**	**5 993**	**6 279**	**5 582**	

[a] The species was not observed every year.

[b] The species was not observed.

[c] The rank was not attributed because the species was not identified.

Table 7. Number of indicated pairs (± standard error) of each species observed along the shores of the St. Lawrence River in the Estuary region, 1990-1992

Species	Indicated pairs (standard error)			Mean	Rank
	1990	1991	1992	1990-1992	
GEESE					
Snow Goose	34 (34)	0 (0)	0 (0)	11	-[a]
Canada Goose	136 (65)	306 (101)	68 (47)	170	11
Sub-total	**170**	**306**	**68**	**181**	
DABBLERS					
Wood Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Gadwall	0 (0)	0 (0)	0 (0)	0	0[b]
American Wigeon	102 (75)	170 (86)	68 (68)	113	12
American Black Duck	7 504 (1 374)	6 840 (1 461)	5 054 (894)	6 466	1
Mallard	374 (126)	374 (135)	544 (245)	431	7
Blue-winged Teal	238 (95)	136 (65)	579 (230)	318	10
Northern Shoveler	68 (68)	0 (0)	136 (81)	68	-[a]
Northern Pintail	715 (271)	1 021 (354)	647 (224)	794	5
Green-winged Teal	1 191 (276)	442 (129)	1 055 (388)	896	3
Sub-total	**10 192**	**8 984**	**8 082**	**9 086**	
DIVERS					
Redhead	0 (0)	0 (0)	0 (0)	0	0[b]
Ring-necked Duck	0 (0)	0 (0)	68 (68)	23	-[a]
Greater Scaup	0 (0)	238 (175)	0 (0)	79	-[a]
Lesser Scaup	0 (0)	0 (0)	0 (0)	0	0[b]
Greater or Lesser Scaup	68 (68)	34 (34)	34 (34)	45	N/A[c]
Common Eider	1 191 (391)	544 (184)	2 008 (524)	1 248	2
Harlequin Duck	0 (0)	68 (68)	0 (0)	23	-[a]
Surf Scoter	102 (102)	442 (272)	510 (317)	352	8
Bufflehead	0 (0)	102 (75)	34 (34)	45	-[a]
Common Goldeneye	136 (95)	442 (146)	408 (200)	329	9
Barrow's Goldeneye	68 (68)	204 (142)	34 (34)	102	13
Hooded Merganser	0 (0)	102 (102)	34 (34)	45	-[a]
Red-breasted Merganser	510 (196)	1 191 (508)	715 (324)	805	4
Common Merganser	374 (144)	987 (188)	408 (137)	590	6
Ruddy Duck	0 (0)	0 (0)	0 (0)	0	0[b]
Sub-total	**2 450**	**4 356**	**4 254**	**3 687**	
Total (waterfowl)	**12 812**	**13 646**	**12 404**	**12 954**	

[a] The species was not observed every year.

[b] The species was not observed.

[c] The rank was not attributed because the species was not identified.

Table 8. Phenology indices for the duck species for which indicated pairs were observed every year along the shores of the St. Lawrence River and its main tributaries in 1990-1992

Species	Phenology indices		
	1990	1991	1992
DABBLERS			
Wood Duck	0,17	0,58	0,29
Gadwall	7,50	13,00	2,80
American Wigeon	1,42	3,73	2,43
American Black Duck	62,50	19,90	5,63
Mallard	0,96	0,84	0,49
Blue-winged Teal	2,00	0,86	1,67
Northern Shoveler	1,54	0,93	2,63
Northern Pintail	0,90	2,17	0,93
Green-winged Teal	2,06	1,54	1,25
DIVERS			
Redhead	-[a]	1,00	-[a]
Ring-necked Duck	0,69	0,86	1,00
Greater Scaup	-[a]	0,72	-[a]
Common Eider	1,08	1,75	0,22
Surf Scoter	0,50	0,14	0,00[b]
Bufflehead	4,00	2,36	3,25
Common Goldeneye	2,13	1,21	0,85
Barrow's Goldeneye	1,00	3,00	3,00
Hooded Merganser	0,00[b]	14,00	5,00
Red-breasted Merganser	0,80	0,95	2,44
Common Merganser	1,70	1,70	2,54

[a] No unpaired male was observed.

[b] Observation of at least one unpaired male, but no observation of paired male (pair).

Table 9. Behaviours observed per record, all species of waterfowl and all years combined, along the shores of the St. Lawrence River and its main tributaries in 1990-1992; in alphabetical order of behaviour code.

Code	Behaviour	Frequency	Proportion 1 (%)	Proportion 2[a] (%)
DA	Distracting attention	5	0,1	0,2
FE	Feeding	1381	25,4	52,1
FL	Flight	475	8,7	
PR	Preening	165	3,0	6,2
IN	Incubation	1	0,0	0,0
MA	Mating	22	0,4	0,8
NB	Nest building	3	0,1	0,1
NE	Bird in nest with eggs	2	0,0	0,1
NU	Bird in nest (content unknown)	1	0,0	0,0
PT	Protecting territory (fighting, pursuit)	14	0,3	0,5
RE	Resting	547	10,1	20,6
SW	Standing watch (territory)	251	4,6	9,5
WA	Waiting	257	4,7	9,7
	Sub-total	**3124**	**57,5**	**100,0**
Nil	Not noted	2311	42,5	
	Total	**5435**	**100,0**	

[a] Proportion of all the behaviours observed, excluding flight.

Table 10. Breakdown (%) of the status of individuals by behaviour; all species of waterfowl and all years combined, 1990-1992.

Status	Behaviour					
	MA	FE	SW[a]	BR[b]	RE	PR
Breeder	38,9	46,1	67,6	42,6	61,5	38,9
Migrant	61,1	53,9	32,4	57,4	38,5	61,1
Total	100,0	100,0	100,0	100,0	100,0	100,0

[a] Include WA (Table 9).
[b] Combine NB, IN, DA, NE, NU and PT (Table 9).

Table 11. Breakdown (%) of the behaviours (see Table 9 for codes) per record including breeders (indicated pairs) or migrants, all years combined, 1990-1992; only the species for which indicated pairs were observed every year are presented.

Species	Status[a]	MA (%)	FE (%)	SW (%)[b]	BR (%)[c]	RE (%)	PR (%)
Canada Goose	B	0,0	30,0	30,0	0,0	40,0	0,0
	M	0,0	72,3	14,9	0,0	10,9	2,0
Wood Duck	B	0,0	23,8	57,1	4,8	4,8	9,5
	M	0,0	25,0	50,0	0,0	0,0	25,0
Gadwall	B	0,0	51,1	23,4	2,1	12,8	10,6
	M	0,0	35,3	41,2	5,9	11,8	5,9
American Wigeon	B	0,0	59,8	21,7	2,2	12,0	4,3
	M	0,0	48,5	36,4	0,0	12,1	3,0
American Black Duck	B	0,4	40,5	27,5	0,2	23,8	7,5
	M	0,0	72,1	5,8	1,0	17,3	3,8
Mallard	B	0,0	40,8	29,1	2,2	18,4	9,5
	M	0,0	40,5	35,7	7,1	7,1	9,5
Blue-winged Teal	B	0,0	62,7	22,2	0,0	13,6	1,7
	M	6,3	56,3	25,0	0,0	6,3	6,3
Northern Shoveler	B	0,0	46,6	31,0	0,0	8,6	13,8
	M	8,3	58,3	0,0	0,0	33,3	0,0
Northern Pintail	B	0,0	53,7	23,6	1,6	13,0	8,1
	M	0,0	63,6	18,2	2,6	10,4	5,2
Green-winged Teal	B	0,7	47,9	17,4	0,0	25,0	9,0
	M	0,0	74,1	8,4	0,0	13,9	3,6
Redhead	B	0,0	0,0	0,0	0,0	40,0	60,0
	M	0,0	85,7	0,0	14,3	0,0	0,0
Ring-necked Duck	B	1,8	38,2	18,2	0,0	34,5	7,3
	M	0,0	33,3	16,7	2,8	33,3	13,9
Greater Scaup	B	0,0	51,7	0,0	0,0	44,8	3,4
	M	0,0	61,9	0,0	0,0	23,8	14,3
Common Eider	B	2,9	48,6	8,6	0,0	37,1	2,9
	M	1,9	76,9	0,0	0,0	19,2	1,9
Surf Scoter	B	0,0	77,8	0,0	0,0	11,1	11,1
	M	0,0	100,0	0,0	0,0	0,0	0,0
Bufflehead	B	0,0	39,6	16,7	2,1	37,5	4,2
	M	5,0	40,0	25,0	5,0	25,0	0,0
Common Goldeneye	B	2,9	58,0	8,7	0,0	24,6	5,8
	M	11,1	63,0	7,4	0,0	11,1	7,4
Barrow's Goldeneye	B	0,0	50,0	0,0	0,0	50,0	0,0
	M	0,0	50,0	25,0	0,0	25,0	0,0
Hooded Merganser	B	0,0	16,7	16,7	0,0	50,0	16,7
	M	0,0	50,0	50,0	0,0	0,0	0,0
Red-Breasted Merganser	B	5,8	48,1	19,2	1,9	19,1	5,8
	M	11,1	55,6	7,4	11,1	11,2	3,7
Common Merganser	B	1,3	49,3	14,7	0,0	29,3	5,3
	M	0,0	61,5	7,7	0,0	23,1	7,7
Total all species	B	0,6	46,0	22,6	0,8	22,7	7,3
	M	1,2	63,5	12,8	1,3	16,8	4,3

[a] B: Breeder (indicated pair); M: migrant.

[b] Include WA (Table 9).

[c] Combine NB, IN, DA, NE, NU and PT (Table 9).

Table 12. Habitats used (%) by waterfowl during the surveys along the shores of the St. Lawrence River and its main tributaries in 1990-1992, all species of waterfowl and all years combined; per record, depending on whether the individuals are considered breeders (indicated pairs; B) or migrants (M).

Code	Habitat	Outaouais		Montréal		Qué. City		Sag-Lac[a]		Estuary		Total	
		B	M	B	M	B	M	B	M	B	M	B	M
Water	Water	32,5	26,5	17,0	13,2	30,0	35,0	65,4	62,2	48,8	50,2	36,7	37,9
Sm	Submerged	15,9	12,6	24,9	21,8	5,7	3,1	17,2	25,8	1,1	2,1	12,4	10,6
Fl	Floating	3,8	15,2	3,5	2,2	0,0	0,0	0,0	0,0	0,0	0,0	1,2	1,6
E	Emergent	19,1	32,5	16,3	12,2	41,7	46,2	13,6	7,9	40,3	36,8	28,5	30,0
Roc	Rock or sand	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,4	6,4	1,0	1,9
H	Herbaceous	5,1	0,0	6,5	5,6	1,9	1,8	0,0	0,4	0,7	0,7	2,7	2,0
S	Shrub	3,8	9,9	1,8	0,7	9,4	2,3	1,0	0,4	0,4	0,4	3,5	1,8
Fo	Forest	12,1	2,0	8,4	8,6	1,5	1,4	1,0	1,1	0,8	0,2	3,7	2,6
I	Idle land	0,0	0,0	2,3	2,4	0,2	0,0	0,0	0,0	1,1	0,4	1,0	0,6
A	Agricultural	4,5	0,0	17,5	31,8	9,6	10,1	1,9	2,2	2,3	2,9	8,6	10,7
U	Urban	3,2	1,3	1,8	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,4
	Sub-total	90,2	87,8	93,2	90,3	95,1	89,4	96,0	93,7	96,8	95,7	94,8	91,8
	Not identified	9,8	12,2	6,8	9,7	4,9	10,6	4,0	6,3	3,2	4,3	5,2	8,2
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

[a] Saguenay–Lac-Saint-Jean.

Appendix 1. Species code and English, French and scientific names of the species surveyed on the shores of the St. Lawrence River and its main tributaries, 1990-1992

English code	English name	French code	French name	Scientific name
SNGO	Snow Goose	NEI	Oie des neiges	*Chen caerulescens*
CAGO	Canada Goose	BCN	Bernache du Canada	*Branta canadensis*
ATBR	Atlantic Brant	CRA	Bernache cravant	*Branta bernicla*
WODU	Wood Duck	CBR	Canard branchu	*Aix sponsa*
GADW	Gadwall	CHI	Canard chipeau	*Anas strepera*
AMWI	American Wigeon	CAD	Canard d'Amérique	*Anas americana*
ABDU	American Black Duck	CNO	Canard noir	*Anas rubripes*
MALL	Mallard	COL	Canard colvert	*Anas platyrhynchos*
BWTE	Blue-winged Teal	SAB	Sarcelle à ailes bleues	*Anas discors*
NSHO	Northern Shoveler	SOU	Canard souchet	*Anas clypeata*
NOPI	Northern Pintail	PIL	Canard pilet	*Anas acuta*
GWTE	Green-winged Teal	SAV	Sarcelle d'hiver	*Anas crecca*
REDH	Redhead	FUT	Fuligule à tête rouge	*Aythya americana*
RNDU	Ring-necked Duck	FUC	Fuligule à collier	*Aythya collaris*
GRSC	Greater Scaup	FUM	Fuligule milouinan	*Aythya marila*
LESC	Lesser Scaup	PFU	Petit Fuligule	*Aythya affinis*
KIEI	King Eider	GRI	Eider à tête grise	*Somateria spectabilis*
COEI	Common Eider	DUV	Eider à duvet	*Somateria mollissima*
HARD	Harlequin Duck	ARL	Arlequin plongeur	*Histrionicus histrionicus*
SUSC	Surf Scoter	MFB	Macreuse à front blanc	*Melanitta perspicillata*
WWSC	White-winged Scoter	MAB	Macreuse brune	*Melanitta fusca*
BLSC	Black Scoter	MAN	Macreuse noire	*Melanitta nigra*
LTDU	Long-tailed Duck	KAK	Harelde kakawi	*Clangula hyemalis*
BUFF	Bufflehead	PGA	Petit Garrot	*Bucephala albeola*
COGO	Common Goldeneye	GAO	Garrot à œil d'or	*Bucephala clangula*
BAGO	Barrow's Goldeneye	GAI	Garrot d'Islande	*Bucephala islandica*
HOME	Hooded Merganser	COU	Harle couronné	*Lophodytes cucullatus*
RBME	Red-breasted Merganser	HUP	Harle huppé	*Mergus serrator*
COME	Common Merganser	GHA	Grand Harle	*Mergus merganser*
RUDU	Ruddy Duck	ROU	Érismature rousse	*Oxyura jamaicensis*

Appendix 2. Location of the 168 1-km^2 quadrats surveyed each year from 1990 to 1992 along the shores of the St. Lawrence River and its main tributaries. The coordinates correspond to the centre of the quadrats according to the Universal Transverse Mercator grid (UTM; NAD27) and the quadrats are listed by region from west to east and from south to north.

QUADRAT[a]	ZONE	UTMEAST	UTMNORTH
Outaouais			
RO01	17	617500	5238500
RO03	17	620500	5227500
RO02	17	621500	5232500
RO04	17	634500	5191500
RO05	17	636500	5188500
RO06	17	708500	5126500
RO07	18	291500	5120500
RO09	18	332500	5087500
RO13	18	360500	5083500
RO16	18	370500	5049500
RO14	18	373500	5069500
RO20	18	402500	5037500
RO22	18	436500	5025500
RO23	18	446500	5034500
RO24	18	463500	5041500
AO02	18	465500	5041500
AO03	18	472500	5042500
AO05	18	483500	5048500
RO26	18	515500	5054500
RO27	18	526500	5054500
RO28	18	530500	5053500
RO29	18	553500	5042500
RO30	18	559500	5037500
Montréal			
AM01	18	542500	4988500
AM02	18	544500	4990500
RM02	18	544500	4991500
AM03	18	557500	5008500
RM03	18	558500	5002500
RM04	18	565500	5006500
PM03	18	574500	5034500
RM05	18	575500	5016500
RM06	18	576500	5030500
RM07	18	582500	5033500
RM09	18	587500	5018500
RM08	18	589500	5024500
RM11	18	589500	5047500
PM04	18	590500	5020500
RM10	18	596500	5026500
RM12	18	597500	5041500
RM13	18	605500	5060500
PM05	18	611500	5029500
PM06	18	616500	5036500
RM14	18	617500	5046500
RM16	18	618500	5062500
RM15	18	621500	5058500
RM30	18	629500	4986500
RM29	18	633500	4995500
RM28	18	633500	5035500
RM17	18	633500	5076500
PM08	18	635500	5078500
RM18	18	636500	5087500
PM11	18	637500	4998500
PM09	18	637500	5086500
RM27	18	639500	5055500
RM19	18	640500	5102500
AM05	18	641500	5102500
RM25	18	643500	5084500
RM26	18	644500	5077500
AM07	18	649500	5111500
RM20	18	652500	5113500
RM21	18	659500	5102500
RM22	18	662500	5107500
RM24	18	668500	5125500
RM23	18	673500	5113500
PM10	18	673500	5114500
AM09	18	677500	5113500
Québec City			
RQ01	18	682500	5125500
PQ01	18	682500	5128500
RQ02	18	689500	5131500
RQ03	18	696500	5138500
RQ04	18	702500	5141500
RQ06	18	709500	5147500
RQ05	18	711500	5144500
RQ07	18	711500	5155500
RQ08	18	716500	5160500
RQ09	18	724500	5162500
RQ10	18	726500	5160500
RQ11	19	278500	5169500
RQ12	19	279500	5174500
RQ13	19	296500	5167500
RQ14	19	297500	5173500
RQ15	19	304500	5175500

AQ01	19	306500	5176500
RQ16	19	315500	5178500
RQ17	19	317500	5175500
RQ19	19	338500	5193500
RQ18	19	339500	5188500
RQ20	19	344500	5200500
RQ26	19	352500	5208500
RQ21	19	353500	5196500
PQ03	19	357500	5194500
RQ22	19	363500	5196500
PQ05	19	364500	5214500
RQ23	19	377500	5204500
RQ27	19	383500	5243500
RQ28	19	387500	5254500
PQ04	19	388500	5209500
AQ02	19	388500	5221500
AQ03	19	391500	5223500
RQ29	19	392500	5247500
RQ24	19	393500	5217500
RQ30	19	396500	5256500
RQ25	19	405500	5231500
Saguenay–Lac-Saint-Jean			
RS21	18	694500	5396500
RS22	18	696500	5386500
RS20	18	697500	5400500
RS23	18	699500	5384500
RS19	18	705500	5402500
RS24	18	713500	5369500
RS25	18	716500	5370500
RS26	19	288500	5368500
PS02	19	288500	5395500
RS27	19	291500	5371500
RS18	19	292500	5392500
RS28	19	294500	5375500
RS17	19	294500	5389500
RS29	19	295500	5378500
RS30	19	296500	5382500
RS15	19	301500	5382500
RS16	19	301500	5386500
RS14	19	306500	5382500
RS13	19	312500	5379500
RS12	19	323500	5373500
RS11	19	330500	5369500
RS10	19	334500	5368500
RS09	19	338500	5369500
RS08	19	351500	5367500
RS07	19	358500	5367500
RS05	19	361500	5357500
RS06	19	371500	5364500
RS04	19	372500	5356500
RS03	19	383500	5360500
PS01	19	401500	5350500
RS02	19	410500	5344500
RS01	19	418500	5342500
Estuaire			
RE16	19	409500	5265500
RE01	19	421500	5249500
RE02	19	422500	5257500
RE17	19	428500	5289500
RE03	19	430500	5263500
RE04	19	439500	5272500
RE18	19	439500	5311500
RE05	19	444500	5279500
PE06	19	445500	5328500
RE06	19	447500	5283500
RE07	19	455500	5293500
RE08	19	459500	5302500
RE09	19	463500	5310500
AE01	19	470500	5317500
PE02	19	471500	5318500
RE20	19	473500	5358500
RE21	19	485500	5380500
RE10	19	486500	5330500
RE22	19	493500	5387500
RE23	19	495500	5401500
RE24	19	509500	5409500
PE04	19	516500	5356500
RE25	19	516500	5415500
RE11	19	531500	5365500
RE26	19	533500	5434500
PE05	19	539500	5372500
RE12	19	539500	5373500
RE27	19	544500	5439500
RE28	19	545500	5434500
RE13	19	562500	5387500
RE14	19	570500	5391500
RE29	19	599500	5463500
RE15	19	600500	5407500

[a] The first letter of the quadrat corresponds to the status (A = under management; P = protected; R = regular, without particular status). The second letter identifies the region (E = Estuary; M = Montréal; O = Outaouais; Q = Québec City; S = Saguenay–Lac-Saint-Jean).

Appendix 3. Method of calculating indicated pairs used for the survey of the shores of the St. Lawrence River and its main tributaries, 1990-1992 (according to the Black Duck Joint Venture helicopter survey in eastern Canada)

Observation[a]				Number of indicated pairs				
				Group 1	Group 2	Group 3	Group 4	Group 5
M	F	U	T	Dabbler (except American Black Duck)	American Black Duck	Diver (except Ring-necked Duck)	Ring-necked Duck	Canada Goose
1	0	0	1	1	1	1	1	1
0	1	0	1	0	1	0	0	1
0	0	1	1	0	1	0	0	1
2	0	0	2	2	1,5	2	2	1
1	1	0	2	1	1,5	1	1	1
1	0	1	2	1	1,5	1	1	1
0	2	0	2	0	1,5	0	0	1
0	1	1	2	0	1,5	0	0	1
0	0	2	2	0	1,5	0	0	1
3	0	0	3	3	3	3	3	1
2	1	0	3	2	3	2	2	1
2	0	1	3	2	3	2	2	1
1	2	0	3	1	3	1	1	1
1	1	1	3	1	3	1	1	1
1	0	2	3	1	3	1	1	1
0	3	0	3	0	3	0	0	1
0	2	1	3	0	3	0	0	1
0	1	2	3	0	3	0	0	1
0	0	3	3	0	3	0	0	1
4	0	0	4	4	4	4	4	0
3	1	0	4	0	4	3	3	0
3	0	1	4	3	4	3	3	0
2	2	0	4	2	4	2	2	0
2	1	1	4	2	4	2	2	0
2	0	2	4	2	4	2	2	0
1	3	0	4	1	4	1	1	0
1	2	1	4	1	4	1	1	0
1	1	2	4	1	4	1	1	0
1	0	3	4	1	4	1	1	0
0	4	0	4	0	4	0	0	0
0	3	1	4	0	4	0	0	0
0	2	2	4	0	4	0	0	0
0	1	3	4	0	4	0	0	0
0	0	4	4	0	4	0	0	0
1	x[b]	x[b]	>4	0	0	0	1	0
2	x[b]	x[b]	>4	0	0	0	2	0
3	x[b]	x[b]	>4	0	0	0	3	0
4	x[b]	x[b]	>4	0	0	0	4	0
>4	x[b]	x[b]	>4	0	0	0	0	0

[a] M: male; F: female; U: unknown sex; T: total.
[b] x: whatever the number is, unless the total (T) is > 4.

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