EASTERN LOWLANDS INITIATIVE

RESEARCH PROJECT

Progress report

Charles Maisonneuve[1], *Luc Bélanger*[2], *Jason Beaulieu*[3], *Daniel Bordage*[2], *Shane Gabor*[4], *Marcelle Grenier*[2], *Benoît Jobin*[2] *et Bernard Filion*[3]

[1]Société de la faune et des parcs du Québec
[2]Canadian Wildlife Service, Québec Region
[3]Ducks Unlimited Canada
[4]Institute for Wetland and Waterfowl Research

Ducks Unlimited Canada

IWWR

Environnement Canada
Service canadien de la faune

Environment Canada
Canadian Wildlife Service

Québec
Société de la faune et des parcs du Québec

1.

ABSTRACT

Although data on the population and distribution of waterfowl is relatively abundant for many regions of the province of Quebec, no systematic survey was ever carried out in the inland portion of the southern Quebec lowlands. Coverage of these lowlands became important to obtain essential baseline data for adequate planning of waterfowl habitat protection and restoration actions in areas of Quebec which are the most threatened by human influence.

During the spring of 1998 and 1999, aerial waterfowl surveys were carried out in 343 plots of 4 km^2 distributed in the lowlands of the St. Lawrence Valley and Lake Saint-Jean, as well as in agricultural areas of Abitibi. For the St. Lawrence Valley, five main landscapes were defined based on land use from LANDSAT-TM satellite images: cash crops, dairy farms, heterogeneous cultures, agroforested and forested areas. Highest densities of Indicated breeding Pairs (IBPs) were obtained in Abitibi with nearly 180 IBPs/100 km^2, the lowest densities (74 IBPs/100 km^2) being obtained in the western part of the St. Lawrence Valley where areas of cash crops are centred. The American black duck and the mallard are the dominant species in all regions covered, with nearly 70% of all pairs counted. The southern Quebec lowlands harbour nearly 10% of the Quebec black duck population which is estimated at around 200 000 IBPs. Within the St. Lawrence Valley, mallard densities were similar across all landscapes (26-39 IBPs/100 km^2). However, black duck densities in dairy farm and forested landscapes were higher (> 40 IBPs/100 km^2) than in cash or heterogeneous crops (9-12 IBPs/100 km^2). These results underline the importance of the dairy farm landscape for black ducks and indicate that the transition of this type of landscape towards a cash crop landscape represents a threat to an important portion of the Quebec, or even the continental, population of this species.

These preliminary results help identify target areas for future habitat protection and restoration actions. Continued analyses during 2001 will allow a more in-depth study. A waterfowl habitat model will be built, as well as a map of habitat potential for the lowlands of southern Quebec. These tools will be of great importance for the planning of future EHJV actions in these areas.

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1. INTRODUCTION

Under the ecological framework of Canada (Environment Canada 2000), the province of Quebec is divided into 7 ecozones covering a total area of 1 667 926 km^2. Each of these ecozones harbours habitats and wildlife communities which vary according to climatic, edaphic and topographical conditions. About 25 % of the Canadian population is in Quebec. More than half of the province population lives on less than 1% of its territory, and this essentially in the lowlands of the St. Lawrence Valley, of Lake Saint-Jean, and of Abitibi. Thus, the greatest development pressures exerted on wildlife habitats, mostly due to agriculture and forest exploitation, are concentrated in the lowlands of these three regions. These are among the Key Protection Areas of the Eastern Habitat Joint Venture (EHJV), where wetland conservation and restoration activities must eventually be planned in the Eastern Lowlands to favour waterfowl production and biodiversity. Planning of these operations must be done with baseline data on the species present and on their needs for maintaining their populations. Although survey programs initiated with the Black Duck Joint Venture (BDJV), the St. Lawrence Action Plan, and the Arctic Goose Joint Venture (AGJV) have allowed the gathering of such baseline data on waterfowl along the St. Lawrence, in the boreal forest and in northern Quebec, up until now in Quebec, no complete dataset existed on the abundance and distribution of waterfowl species during the breeding season in the St. Lawrence Valley outside of the river corridor. Moreover, regions within the boreal forest --which have been converted to agriculture, such as the Lake Saint-Jean Lowlands and certain areas of Abitibi-Témiscamingue--, are excluded from the BDJV surveys.

Thus, the Québec partners of the EHJV – Ducks Unlimited Canada (DUC), Canadian Wildlife Service (CWS), Société de la faune et des parcs (FAPAQ) – with the collaboration of the Institute for Wetland and Waterfowl Research (IWWR), initiated a detailed breeding waterfowl survey covering, for the first time, all of the lowlands of the St. Lawrence Valley, Lake Saint-Jean and Abitibi. The objectives of these surveys, carried out in the spring of 1998, 1999, and 2000 were 1) to estimate waterfowl populations using

these areas (densities and total numbers), 2) to document the distribution of the various species and variations in breeding pair densities, and 3) to establish and validate a predictive model making a relationship between breeding pair densities and multiple habitat variables obtained, among other things, through satellite imagery analysis. This model will help predict breeding pair densities in areas not covered by surveys, and, consequently, produce a waterfowl habitat potential map for the lowlands of southern Quebec. This map will become a major tool to identify priority areas for EHJV operations in these lowlands and be used as a Decision Support System tool for the planning and evaluation of actions through the EHJV.

2. METHODS

2.1. Study area

The study area, covering nearly 39 000 km^2, covers all lowlands in the St. Lawrence Valley and Lake Saint-Jean areas, as well as sectors of Abitibi where agriculture has been developed. Because previous surveys had covered the shores and islands of the St. Lawrence as well as its main tributaries (Bordage and LePage, unpubl. data), a 1 km wide strip was excluded along these shores. The St. Lawrence Valley was divided in two zones, the Maple-Hickory and Maple-Basswood zones, based on the lowland limits and the ecological regions of Quebec (Thibault 1985). Five main landscapes based on land use types were then delimited in the Valley, with the use of LANDSAT-TM satellite images bought in 1993-1994: cash crops (corn, cereals, soya) dairy farms (pastures, haylands), heterogeneous agriculture (mix of the two previous), agroforested landscape (mosaic of cultivated lands and forests) and forested landscape (dominance of forests, including peatlands) (figure 1). Methods leading to such landscape definition will be detailed in a distinct paper (in prep.).

The western portion of the St. Lawrence Valley, where most of the cash crops are located, has been affected by considerable perturbations through forest clearing and stream drainage and chanellization. The transition from traditional farming to intensive agriculture has greatly contributed to landscape alterations in that region (Bélanger et al. 1999, Bélanger and Grenier, in press), causing an increased fragmentation of residual forest habitats, a dominance by cash crops, a straightening of the streams and the drainage of wetlands, as well as an increased use of pesticides and of organic and chemical fertilisers.

2.2. Surveys

Waterfowl survey blocks were distributed on a 2 x 2 km grid, based on the Mercator system. Thus, 343 blocks were systematically established every 10 km. All surveys were carried out by helicopter and each of the blocks was covered only once between April 20th and May 11th by three experimented observers. Surveys were planned to target early nesting species, more specifically mallards and black ducks. This approach leads to

relatively reliable population estimates for these species, and may be justified by the fact that they are the most abundant species in the whole study area. Survey methodology was the same as the one used in the aerial surveys of the BDJV (Bordage and Plante 1997), and criteria used for determination of indicated breeding pairs (IBP) were those recently adopted by the BDJV for Eastern Canada (Appendix 1).

In the spring of 2000, eight 100 km^2 blocks (10 x 10 km) were also covered with the same methodology. Two blocks were chosen within each of the landscapes identified with the satellite images, with the exception of the forested landscape. Each block was covered twice between April 18th and April 28th, a period of one week separating each survey of a same block. The objective of these last surveys were to gather data which will be used, among other things, to validate the model of habitat potential built with the data from the 1998-1999 surveys. Results from these surveys will be presented in subsequent reports.

3. PRELIMINARY RESULTS

3.1. Total numbers

Results of the surveys led to an estimation of a total waterfowl population for the lowlands (St. Lawrence, Lake saint-Jean and Abitibi) of more than 38 000 IBPs (mean density of 98 IBPs/100 km^2), with the black duck (*Anas rubripes*) and the mallard (*Anas platyrhynchos*) as the most abundant species, at nearly 70% of total numbers (table 2). This estimate must be considered as a minimum considering the technique used for the surveys (helicopter) which does not permit the detection of all pairs present, especially with only one visit. Moreover, the timing of the surveys was planned to be optimal for early nesting species, more specifically the mallard and the black duck. Finally, we must underline the fact that surveys were purposely limited to the inland portion of the lowlands. All blocks in contact with the shores of the St. Lawrence and its main tributaries were excluded beforehand in order to obtain an accurate idea of inland densities. According to ground surveys carried out in 1992 for the St. Lawrence Action Plan and the BDJV, there is an additional 38 000 IBPs along the 3 564 km^2 of shores and islands bordering the lowlands of southern Quebec (Bordage and LePage, unpubl. data). Overall, the southern Quebec lowlands harbour around 76 000 IBPs.

3.2. Regional comparisons

The highest breeding pair densities were obtained in Abitibi (178 IBPs/100 km^2, table 3), whereas the western part of the St. Lawrence Valley, which is the maple-hickory zone where most of the cash crops are concentrated, harboured the lowest densities (74 IBPs/100 km^2). Comparisons of breeding pair densities obtained in the three regions (table 4) indicates that densities were significantly higher in Abitibi (Kruskal-Wallis test, $P = 0{,}0001$, multiple comparisons test, $\alpha < 0{,}05$). This also applies for mallard densities (Kruskal-Wallis test, $P = 0{,}0001$, multiple comparisons test, $\alpha < 0{,}05$). Significant regional differences in black duck densities were also obtained (Kruskal-Wallis test, $P = 0{,}02$), but multiple comparisons test failed to pinpoint which region(s) contributed to this difference.

3.3. Landscape comparisons

One of the most interesting results from this project is the fact that, in the St. Lawrence Valley where landscapes have been delimited, black duck densities were as high in the dairy farm landscape as in the forested landscape (table 5), these densities being significantly higher than in the cash crop or heterogeneous landscapes (Kruskal-Wallis test, $P = 0{,}001$, multiple comparisons test, $\alpha < 0{,}05$). The multiple comparisons test indicated that densities in the agroforested landscape overlapped with densities in the other preceding 4 landscapes. In the case of the mallard, breeding pair densities were not different from one landscape to the other (Kruskal-Wallis test, $P = 0{,}741$).

4. DISCUSSION

4.1. Dominant species : black ducks and mallards

The black duck breeds exclusively in north-eastern North America, and more than half of the world population breeds in Québec (Rusch et al. 1989). In 1998 and 1999, years when we carried out our surveys in the lowlands, black duck population estimates obtained for the boreal forest (503,800 km^2) from the BDJV surveys were of 108,000 and 155,000 IBPs respectively (Bordage 2000). However, areas covered in Abitibi during the present study (5,440 km^2) must be excluded because they were included in the 503,800 km^2 leading to these estimates, thus reducing these estimates to 106,500 and 153,500 respectively (table 6). Breeding pair densities indicated in various studies carried out in the taiga lead to a crude estimate of nearly 52,000 breeding pairs for this ecoregion located north of the territory covered by the BDJV surveys. Data from surveys carried out in the southern portion of the Appalachians, which is not covered by the BDJV surveys, give an estimation of 4,800 IBPs for this area (table 6). The black duck population estimate obtained from our surveys in the lowlands was 7,500 IBPs in 1998 and 14,700 IBPs in 1999. By adding 10,800 IBPs nesting along the shores of the St. Lawrence and of its main tributaries (Bordage and LePage, unpubl. data), the southern Quebec lowlands would harbour from around 18, 000 to 25,000 IBPs of black ducks. This represents nearly 10% of the Quebec population of this species estimated at around 200,000 breeding pairs. The same reasoning applied to the mallard indicates that around 50% of the population of this species is concentrated in the southern lowlands (table 6).

In the lowlands, black duck breeding pair densities were higher in dairy farm and forested landscapes with more than 40 IBPs/100 km^2 (this study). For comparison, mean densities of 9-27 IBPs/100 km^2 were obtained in the other St. Lawrence lowland landscapes, and a mean density (1998-1999) of 26 IBPs/100 km^2 was obtained for the boreal forest (Bordage 2000). The mallard is encountered in similar densities in all of the landscapes of the St. Lawrence lowlands (26-39 IBPs/100 km^2). For the same years, mean densities obtained in the boreal forest were much lower (5.5 IBPs/100 km^2, Bordage 2000), densities higher

than 15 IBPs/100 km^2 for this species seeming to exist only in the Abitibi region (Bordage and Plante 1997).

During the last few years, surveys carried out in the boreal forest seem to indicate population increases for black ducks and mallards (Bordage 2000). Unfortunately, this type of data is not available for the lowlands. But it seems that black duck numbers, particularly in areas of cash crops where survey results indicate very low black duck densities, are much lower than what they used to be. Numbers of black ducks banded in this part of the province have dropped drastically during recent decades (CWS, unpubl. data). Based on the results of the 1998 and 1999 surveys, it is possible to suspect that the transition of dairy farms into cash crops may have contributed to the low numbers of black ducks in the south-western part of the province. Agricultural practices in the cash crop areas have led to the elimination of habitats like woodlots, riparian strips, fallow lands and vegetation along fencerows which are used for nesting by black ducks (Bélanger et al. 1998, Maisonneuve et al. 2000a). The mallard, a more generalist and opportunistic species which invaded Quebec mainly through the St. Lawrence corridor, occupy all landscapes without discrimination.

Thus, habitat modifications in southern Quebec, probably as well as in southern Ontario, may have had a marked influence on the black duck population decline at the regional or even continental scale. This, however, has still to be tested (in prep.). Modifications of agricultural practices coupled with the creation of cultivars able to grow in harsher conditions represent a threat for the portion of the black duck population nesting in dairy farm landscapes as this type of landscape may evolve towards a cash crop landscape. Thus, the black duck could eventually represent an excellent indicator species in studies aiming to evaluate the environmental quality in dairy farm landscapes. The black duck could be used as an indicator for the wetland availability and quality as well as for the integrity of terrestrial landscapes comprising elements such as riparian strips and woodlots.

4.2. Migrating species

It has been shown recently that results from aerial surveys planned to target optimal periods for early nesting species, as was done in the present study, may not be reliable when it comes to species with a later nesting chronology (Naugle et al. 2000). This seems particularly true for divers which generally migrate at a later date. From our survey results, the common merganser and the ring-necked duck would seem to occupy the third and fourth rank in terms of abundance in the lowlands of southern Quebec (table 2). These two species also occupied the same ranks during aerial surveys carried out from 1992 to 1995 in the Boyer and Le Bras River watersheds located in dairy farm landscapes in the Quebec City region (Maisonneuve et al. 1998). However, no broods of either of these species were ever observed in these same watersheds during aerial brood surveys (Maisonneuve et al. 1998) or during the numerous hours of field work carried out on the ground in these watersheds (Maisonneuve, pers. obs.). Although these species are reported to nest in the St. Lawrence Valley (Alvo 1995, Lepage and Doyon 1995), they are not abundant. It is highly likely that the great majority of individuals of both of these species located in the St. Lawrence Valley were still migrating towards more northerly nesting grounds.

The same reasoning probably also applies to the green-winged teal. After mallards and black ducks, this species was the most abundant in our surveys (table 2), as well as in the multiple surveys carried out in the Boyer and Le Bras River watersheds (Maisonneuve et al. 1998). Only one brood of this species was ever observed within those watersheds, and it was located in a bog at the margin of an essentially agricultural area. Although nesting of the green-winged teal has been confirmed in some areas of the St. Lawrence Valley (Moisan 1995), the relative abundance of nesting instances seems much less than that of the breeding pairs obtained during aerial surveys. With the notable exception of the Abitibi region, where there are high densities of beaver ponds, which are good habitats for green-winged teals, the other lowland areas surveyed do not harbour much adequate

habitat for this species. The majority of green-winged teal pairs located during the surveys were probably still migrating at the time the surveys were carried out..

The fact that the majority of green-winged teals, common mergansers and ring-necked ducks observed during the surveys are considered as migratory reduces by a few thousand pairs the size of the waterfowl population estimate made above for southern Quebec lowlands. However, it emphasises the particular importance of the two most abundant species, the black duck and the mallard.

4.3. Resident Canada geese

If migrating species noted during the surveys are excluded, the Canada goose becomes the third most abundant species after the mallard and the black duck. Our surveys present the first opportunity to obtain an estimate of the number of resident Canada geese (*Branta canadensis maxima*) in Quebec. From our results, there would be nearly 1 000 IBPs in the inland portion of the lowlands of the St. Lawrence Valley, Lake Saint-Jean and Abitibi (table 2). By adding to this figure an estimate of another 700 pairs nesting along the shores of the St. Lawrence and its main tributaries (Bordage and LePage, unpubl. data), the total population may be estimated at about 1,700 pairs. This excludes the Appalachian region where nesting has also been confirmed (Cotter et al. 1995).

The resident population of Canada geese nesting in the mid United States has grown from a few thousands in 1965 (Hanson 1965) to more than a million in 1996 (Wood et al. 1996 cited in Smith et al. 1999). Such an explosion is not unique to North America, an annual increase of 8% having been observed in the Canada goose population in England between 1976 and 1991 (Allan et al. 1995). Resident Canada geese use urban parks, golf courses, etc. as nesting grounds. Combined to a high survival rate, the increasing number of these birds in those environments has caused increasing cases of conflicts with humans (Conover and Chasko 1985). Problems associated with these geese are multiple: accumulation of droppings, aggressive behaviour of the birds, health risks, depredation, beach contamination, etc. (Smith et al. 1999). The actual level of population and

distribution of this goose in Quebec should enable the planning of actions for the prevention of a demographic explosion and the control or reduction of ensuing problems.

5. CONCLUSION AND ACTIVITIES PLANNED FOR 2001

The numerous and extensive perturbations characterising the cash crop landscape probably explain the very low waterfowl breeding pair densities in this type of landscape. Because of this severe deterioration of wildlife habitats, particularly aquatic habitats, future interventions to improve the situation in such landscapes should be limited to education and sensibilization activities. Restoration efforts needed in such landscapes to noticeably improve aquatic habitats would be of such amplitude that it is highly probable they would be carried out to the detriment of other improvement efforts in less perturbed areas where habitats still have a good potential and are faced with growing development pressures.

Among the less degraded areas, dairy farms are the most likely to be modified in the next few years. These farms are characterised by numerous woodlots, hedgerows and riparian strips which are important wildlife habitats. The gradual expansion of cash crops and the development of cultivars which have the capacity of growing in more severe conditions bringing growing pressure for the modification of dairy farms in the next few years.

Among the two most abundant waterfowl species in southern Quebec, the mallard seems an opportunistic species which can occupy a variety of habitats. On the other hand, before the initiation of the ELI research project, it was not known that dairy farm landscapes could be particularly attractive for black ducks. Continued data analyses will lead to the production of a model and a map of habitat potential for black ducks that will become of great value for the orientation of activities to promote populations of this species. Factors limiting the production of black ducks in this type of landscape have already been identified (Maisonneuve et al 2000a and b). Future activities could eventually aim for the conservation (by influencing already existing habitats and agricultural practices) of a threatened section of the continental black duck population. The black duck is a species associated with forested habitats and it seems that some elements of these (forest cover, number of isolated woodlots, etc.) are still covering adequate areas of the dairy farm

landscapes, which does not seem to be the case in the cash crop and heterogeneous landscapes (Bélanger and Grenier, in press).

Considering the relatively low waterfowl densities obtained in the southern Quebec lowlands, it is clear that an extensive approach will have to be adopted in the next few years in order to favour waterfowl habitat conservation on that territory. Thus, it will be particularly important to target the adequate activities and priority species in order to avoid a dispersion and a dilution of future actions. Up until now, the data required to proceed with such an exercise was practically non-existent. In that sense, the aerial surveys and landscape definition in the southern Quebec lowlands prove to be indispensable tools. Finally, continued analyses of the data gathered since 1998 will point to other avenues of interventions and research needs for the southern Quebec lowlands, and this in the agricultural as well as in the forested landscapes.

There is no field work aimed at the acquisition of additional data planned for the year 2001. The main research activities of the EHJV will be related to the completion of the analyses of the survey data, and of the satellite images, and to the production of the waterfowl habitat model. These tasks and the publication of their results will allow a better understanding of wildlife habitats in the southern Quebec lowlands. They will help identify the additional baseline data needed for adequate orientation of conservation and management actions. Considering the particular importance of the black duck in Quebec and the continental importance of the Quebec population of this species, the relatively high abundance of this species in dairy farm landscapes, and the possibility of using the black duck as a global indicator of environmental quality in this type of landscape, emphasis will probably be put on black ducks in dairy farm landscapes in future work. Results from the spring 2000 surveys will be used to validate the habitat models developed through this project, and sectors presenting highest potential for black ducks will be clearly identified. It will be easier to pinpoint research needs for the definition of habitat characteristics which favour an abundance of black ducks in dairy farm

landscapes. Further surveys shall eventually help verify the hypothesis that the black duck population decline may be due, in part, to habitat modifications.

E*xpected products*

- Paper on southern Quebec lowlands landscape definition
- Paper on southern Quebec lowlands waterfowl population estimates
- Paper on the influence of landscape changes in the St. Lawrence Valley lowlands on the black duck population
- Waterfowl habitat model for southern Quebec lowlands
- Map of waterfowl habitat potential for southern Quebec lowlands

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Table 1 Sampling effort in the southern Quebec lowlands, 1998-1999

Region	Area (km^2)	Number of blocks (4 km^2) surveyed			% of area covered
		1998	1999	Total	
Abitibi-Témiscamingue	5 440	21	18	39	2.9
Lake Saint-Jean	5 448	23	26	49	3.6
Vallée du Saint-Laurent	28 122	129	129	258	3.7
Total	39 010	173	173	346	3.6

Table 2. Total and mean numbers of Indicated Breeding Pairs (IBPs) per block during the aerial surveys carried out in the southern Quebec lowlands, 1998-1999, and population estimates

Species	Total IBPs	Mean IBPs/block (4 km^2)	s.e.	Population estimate (39 010 km^2)	C.V.
Canada goose	34	0.10	0.02	975 ± 195	20.0
Wood duck	27	0.08	0.02	780 ± 195	25.0
Green-winged teal	174	0.50	0.08	4 876 ± 780	16.0
Mallard	548	1.58	0.10	15 409 ± 975	6.3
Black duck	394	1.14	0.12	11 118 ± 1 170	10.5
Northern pintail	12	0.04	0.01	390 ± 97	25.1
Blue-winged teal	12	0.04	0.01	390 ± 97	25.1
Northern shoveler	1	0.00	0.00	28 ± 28	100.0
Gadwall	3	0.01	0.01	97 ± 97	100.0
American wigeon	19	0.06	0.02	585 ± 187	33.3
Ring-necked duck	52	0.15	0.04	1 463 ± 390	26.7
Common goldeneye	3	0.01	0.01	97 ± 97	100.0
Hooded merganser	9	0.03	0.01	293 ± 97	33.5
Common merganser	66	0.19	0.05	1 853 ± 491	26.3
Total	1 354	3.91	0.26	38 132 ± 2 536	6.7

Table 3. Population estimates and densities of indicated breeding pairs (per 100 km2) from aerial surveys carried out in the southern Quebec lowlands. 1998-1999

Species	Abitibi		Lake Saint-Jean		St. Lawrence Valley			
					Maple-hickory		Maple-basswood	
	Population	Density	Population	Density	Population	Density	Population	Density
Canada goose	35	0.6	84	1.5	328	2.7	490	3.1
Wood duck	314	5.8	56	1.0	109	0.8	327	2.1
Green-winged teal	1 046	19.2	834	15.3	1 202	9.8	1 904	12.0
Mallard	2 249	41.3	1 737	31.9	1 352	11.1	5 917	37.2
Black duck	4 524	83.2	1 974	36.2	5 408	44.2	4 271	26.9
Northern pintail	0	0.0	56	1.0	137	1.1	136	0.9
Blue-winged teal	314	5.8	0	0.0	55	0.5	27	0.2
Northern shoveler	0	0.0	0	0.0	27	0.2	0	0.0
Gadwall	0	0.0	0	0.0	0	0.0	82	0.5
American wigeon	349	6.4	111	2.0	27	0.2	108	0.7
Ring-necked duck	697	12.8	361	6.6	164	1.3	354	2.2
Common goldeneye	0	0.0	56	1.0	0	0.0	27	0.2
Hooded merganser	105	1.9	56	1.0	55	0.5	54	0.3
Common merganser	70	1.3	250	4.6	137	1.1	1 360	8.6
Total	9 703	178.4	5 575	102.3	8 999	73.6	15 057	94.8

Table 4. Mean densities of indicated breeding pairs (IBPs/100 km2) for black ducks and mallards from aerial surveys carried out in the different regions of southern Quebec, 1998-1999

Region	***n***	**Density ± s.e.**		
		Black duck	Mallard	All species
St. Lawrence Valley	258	26 ± 3 A	34 ± 3 A	86 ± 7 A
Lake Saint-Jean	49	32 ± 6 A	36 ± 7 A	102 ± 14 A
Abitibi	39	41 ± 11 A	78 ± 10 B	173 ± 27 B
Kruskal-Wallis test		$P = 0.02$	$P = 0.0001$	$P = 0.0001$

Densities followed by identical letters are not significantly different (multiple comparisons test, $\alpha < 0.05$)

Table 5. Mean densities of indicated breeding pairs (IBPs/100 km2) for black ducks and mallards in the different landscapes identified in the lowlands of the St. Lawrence Valley, 1998-1999

Landscape	***n***	**Density ± s.e.**	
		Black duck	Mallard
Cash crops	52	12 ± 4 A	37 ± 6 A
Heterogeneous crops	44	9 ± 4 A	39 ± 7 A
Dairy farms	79	42 ± 8 B	26 ± 3 A
Agroforested	57	27 ± 8 AB	37 ± 6 A
Forested	14	43 ± 11 B	34 ± 17 A
Kruskal-Wallis test		$P = 0.0001$	$P = 0.74$

Densities followed by identical letters are not significantly different (multiple comparisons test, $\alpha < 0.05$)

Table 6. Population estimates (indicated breeding pairs) for black ducks and mallards in different regions of Quebec, south of the 51th parallel

Region	Source	Year	Black duck	Mallard
Taiga	Various sources (CWS, SEBJ, Hydro-Quebec)	??	52 000	5 000
Boreal shield	Bordage 2000	1998	106 500[a]	8 200[a]
		1999	153 5000[a]	19 400[a]
Appalachians	Bordage (unpubl. data) and EHJV (unpubl. results)	1992-1993 1998-1999	4 800[b]	5 100[b]
Lowlands	ELI project	1998	7 500	12 100
		1999	14 700	18 700
St. Lawrence (shores and islands)	Bordage and LePage (unpubl. data)	1993	10 800	6 000
Quebec population estimates		1998	181 600	36 400
		1999	235 800	54 200

[a] Estimates adapted by excluding areas covered in Abitibi during the ELI project
[b] Mean value calculated from the all blocks and years covered

Figure 1 - Landscapes of the Saint Lawrence lowlands

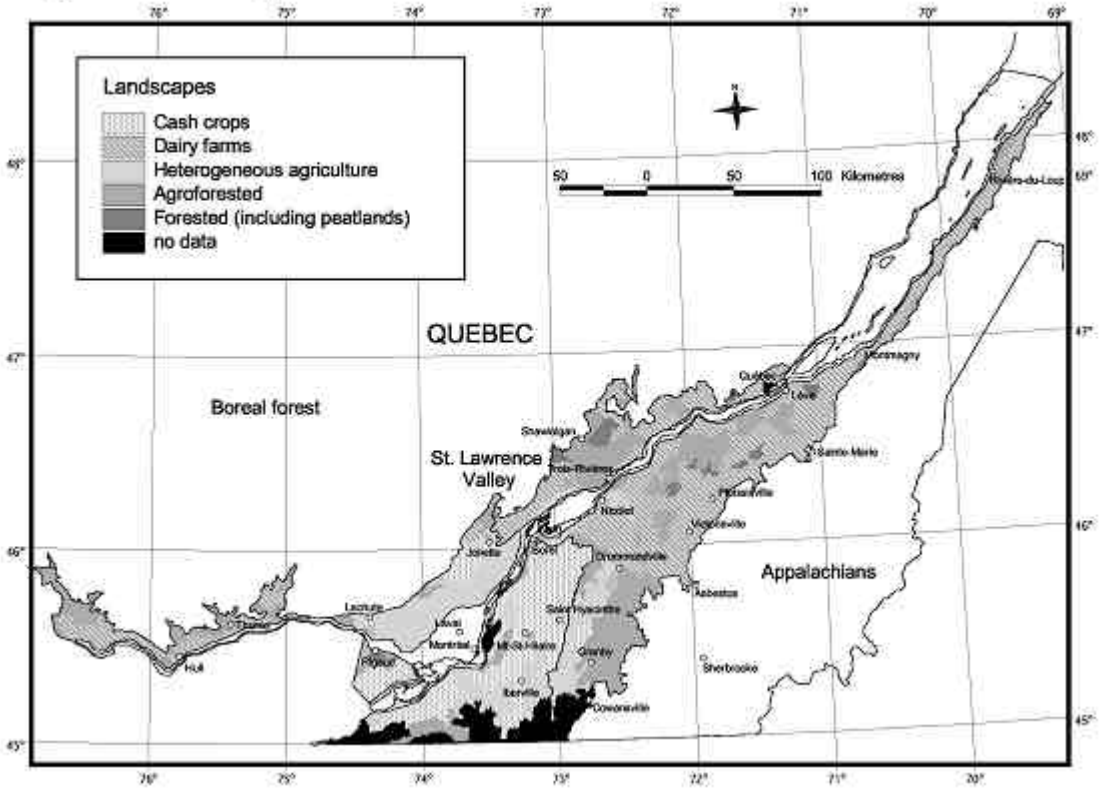


Figure 2 - Waterfowl surveys in the lowlands of southern Quebec, 1998-1999

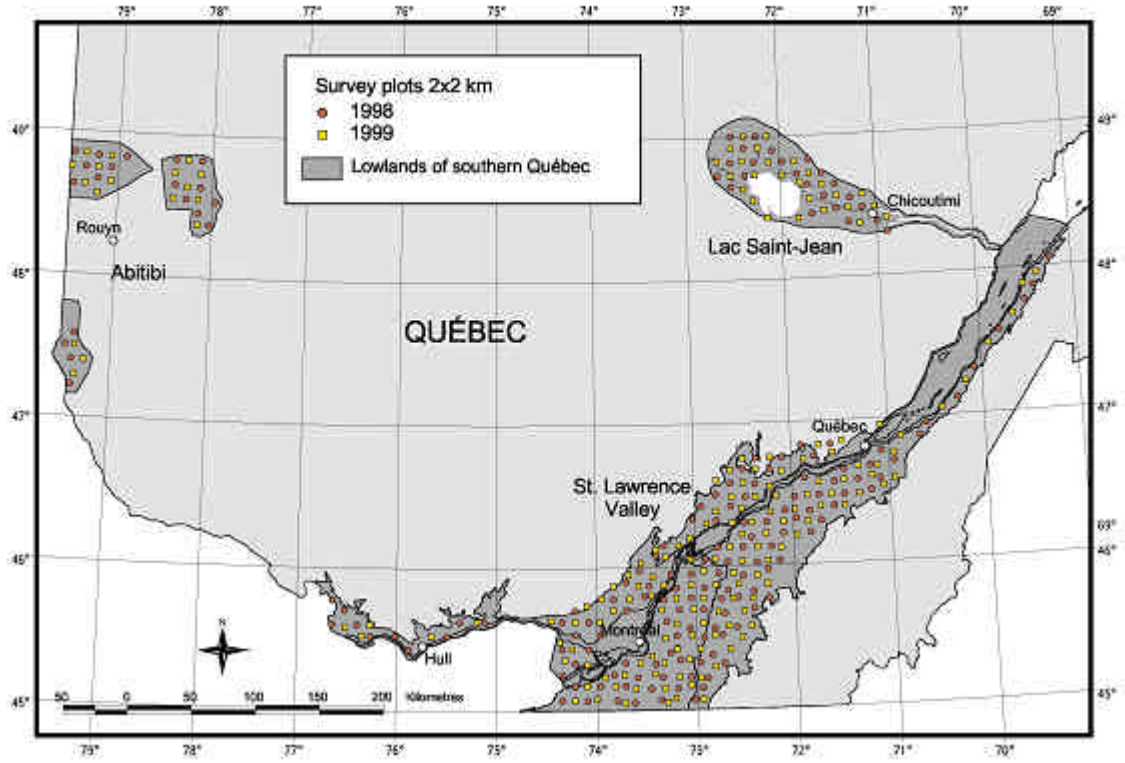
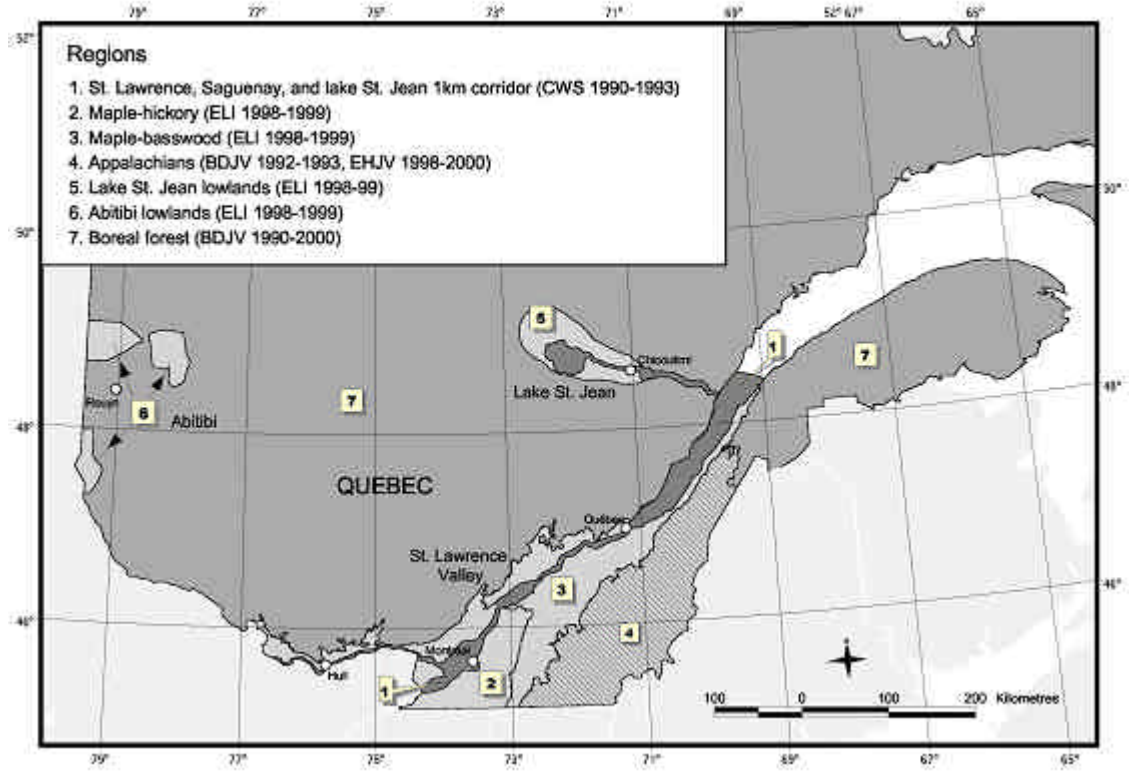


Figure 3 - Regions of southern Quebec covered by waterfowl surveys



Appendix 1. Standardized method of calculating indicated pair (IP) from Black Duck Joint Venture helicopter survey data in Eastern Canada, 1990-2000

Sighting combination[1]				Number of Indicated Pairs (IP)					
				Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
				Dabbler	**ABDU**	**Diver**	**RNDU**	**CAGO**	**COLO**
M	F	U	T	(except ABDU)		(except RNDU)			
1	0	0	1	1	1	1	1	1	1
0	1	0	1	0	1	0	0	1	1
0	0	1	1	0	1	0	0	1	1
2	0	0	2	2	1.5	2	2	1	1
1	1	0	2	1	1.5	1	1	1	1
1	0	1	2	1	1.5	1	1	1	1
0	2	0	2	0	1.5	0	0	1	1
0	1	1	2	0	1.5	0	0	1	1
0	0	2	2	0	1.5	0	0	1	1
3	0	0	3	3	3	3	3	1	0
2	1	0	3	2	3	2	2	1	0
2	0	1	3	2	3	2	2	1	0
1	2	0	3	1	3	1	1	1	0
1	1	1	3	1	3	1	1	1	0
1	0	2	3	1	3	1	1	1	0
0	3	0	3	0	3	0	0	1	0
0	2	1	3	0	3	0	0	1	0
0	1	2	3	0	3	0	0	1	0
0	0	3	3	0	3 (2)[2]	0	0	1	0
4	0	0	4	4	4	4	4	0	0
3	1	0	4	0	4	3	3	0	0
3	0	1	4	3	4	3	3	0	0
2	2	0	4	2	4	2	2	0	0
2	1	1	4	2	4	2	2	0	0
2	0	2	4	2	4	2	2	0	0
1	3	0	4	1	4	1	1	0	0
1	2	1	4	1	4	1	1	0	0
1	1	2	4	1	4	1	1	0	0
1	0	3	4	1	4	1	1	0	0
0	4	0	4	0	4	0	0	0	0
0	3	1	4	0	4	0	0	0	0
0	2	2	4	0	4	0	0	0	0
0	1	3	4	0	4	0	0	0	0
0	0	4	4	0	4	0	0	0	0
1	x	x	>4	0	0	0	1	0	0
2	x	x	>4	0	0	0	2	0	0
3	x	x	>4	0	0	0	3	0	0
4	x	x	>4	0	0	0	4	0	0
>4	x	x	>4	0	0	0	0	0	0

[1] M, male; F, female; U, sex unknown; T, total

[2] number in parenthesis is for Newfoundland data where different