Birds perching on oyster culture gear in eastern New Brunswick, Canada

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Abstract

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Following concerns raised by industry and regulatory agencies, a study was carried out to determine the abundance of birds perching on floating oyster gear along the eastern coast of New Brunswick, Canada. A total of 35,621 culture units (floating cages, floating Vexar bags, etc.) were examined at 15 aquaculture sites during the fall of 2005. Twenty-one bird species were identified and 3,337 individuals were counted. The most common species spotted on oyster gear, and particularly on floating cages, was the double-crested cormorants (*Phalacrocorax auritus*), which represented almost half (48%) of all counts during the study. Herring gulls (*Larus argentatus*) and common terns (*Sterna hirundo*) were also commonly seen (17% and 13% of all counts, respectively). Floating cages attracted significantly more birds compared to other floating gear types, with mean values being as follow: 15.3 birds per 100 cages, 5.4 birds per 100 standard bags, and 1.7 birds per 100 modified bags. Regarding geographical patterns, culture sites located in south-eastern New Brunswick had more birds per 100 culture units compared to those located in north-eastern New Brunswick (mean 11.2 versus 3.7 birds per 100 culture units).

Résumé

L.A. Comeau, R. Chiasson, A. Chiasson, F. Pernet, and T. Landry. 2006. Birds perching on oyster culture gear in eastern New Brunswick, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 2681.

Au cours de l'automne 2005, des observations ornithologiques ont été effectués le long de la côte Est du Nouveau-Brunswick afin de déterminer le nombre d'oiseaux perchés sur les structures d'élevages. Un total de 35,621 unités d'élevage d'huîtres (poche flottante, cage flottante, etc.) ont été examinés dans 15 baux aquacoles. Vingt-et-une espèces d'oiseaux ont été identifiées et 3,336 individus ont été comptés. L'espèce la plus commune (48% des comptes) au cours de l'étude était le cormoran à aigrettes (*Phalacrocorax auritus*). Le goéland argenté (*Larus argentatus*) et la sterne pierregarin (*Sterno hirundo*) ont aussi été remarqué à plusieurs reprises (17% et 13% des comptes, respectivement). Les données suggèrent que certaines structures attirèrent plus d'oiseaux. Par exemple, il y avait en moyenne 15,3 oiseaux par 100 cages flottantes comparativement à 1,7 oiseaux par 100 poches flottantes modifiées. Un patron géographique fut également noté : l'abondance moyenne d'oiseaux était significativement plus élevée dans le Sud-Est de la province (moyenne de 11,2 oiseaux par 100 unités de culture) que dans le Nord-Est de la province (3,7 oiseaux par 100 unités de cultures).

Introduction

American oysters (*Crassostrea virginica)* in New Brunswick (N.B.) are mainly cultivated using floating Vexar® bags (Figure 1) (GTA Consultants en Pêches, 2003). This technique was developed in the 1990s partly in an attempt to keep the filter-feeding oysters in relatively warm and phytoplankton-rich waters. However, it is now becoming apparent that these structures provide potential perching platforms for a number of coastal bird species. During routine sampling in September 2004, the Canadian Food Inspection Agency (CFIA) noticed the presence of bird faecal matter deposited on a number of floating bags containing market-size oysters, a situation that was deemed to be an unacceptable human health risk. Since some oyster samples were found to exceed the standard for fecal coliforms, both the CFIA and Environment Canada (EC) recommended that all oyster suspended culture sites situated in the waters of eastern N.B. be immediately closed to harvesting. The Department of Fisheries and Oceans (DFO) proceeded with a closure order, which resulted in the near total shut down of all oyster production and marketing activities involving some 150 aquaculture sites.

Presently, the use of suspended culture gear is authorized for growing seed oysters up to a market size (> 65 mm). However, suspended gear can no longer be used for the mandatory depuration procedure[1] prior to the marketing of oysters. This policy entails a new husbandry step which is quite labour intensive, i.e. that the two side-floaters be removed from the Vexar bags for a complete immersion of the bag at the depuration site. Thus the bulk of the industry is currently growing oysters using floating gear which must be converted into non-floating gear prior to the marketing of oysters.

The industry acknowledges that birds create a potential point source of fecal contamination and wishes to find a solution. Converting all floating gear into non-floating gear at the growout sites is not a feasible option from the industry's perspective. Such a conversion would mean a significant lost in capital investments and possibly lengthen the production cycle (by moving the oysters in near-bottom and less productive waters). This standpoint is understandable considering that the industry has been developing the floating gear techniques for the past decade. In keeping with this information, the industry has begun giving serious consideration to low-cost gear modifications which could effectively deter birds from using the gear without having to resort to bird scaring devices. For instance, following the 2004 closures, one grower suggested positioning the two side floaters onto the top of two oyster bags as shown in Figure 4. This minor change allows the bag to sink approximately one inch below the surface. While the two floaters remain a potential perching platform, they represent less than 20% of the total area currently offered to birds when compared with the standard design.

[1] Prior to their marketing, all shellfish grown in conditionally closed areas must undergo a depuration procedure which typically involves moving the animals from their growth site to an area open to shellfish harvesting, where they remain completely immerged for a period of either 14 days (with subsequent testing for *E. coli*) or 30 days (without testing).

In this document, we report ornithological observations made within oyster farms in N.B. We present detailed data on bird species and their respective abundance in relation to floating oyster gear.

Methods

Study sites
From September 2005 to October 2005, 15 commercial oyster growing sites were visited along the eastern coastline of N.B. (Figure 2). Weather and logistical considerations were the main factors that determined the bird observation schedule. Sites were visited on average four times (range 1 to 9) during the study period.

Gear types
Standard floating Vexar® bags (Figure 3, dimensions: 80 cm × 40 cm × 10 cm) were suspended by two cylindrical buoys, one attached at each side of each bag. This configuration allows a partial immersion of the Vexar bag. *Modified* floating bags (Figure 4, dimensions: 80 cm × 40 cm × 10 cm) were suspended by two cylindrical buoys placed on top, thereby allowing the entire bag to sink approximately 3 cm below surface. Floating *cages* (Figure 5a, dimensions: 147 cm × 91 cm × 33 cm) were held in the upper water column by two large rectangular buoys (dimensions: 147 cm × 28 cm × 20 cm). It is standard practice to temporarily flip the cages to control bio-fouling; visually, however, it was difficult to ascertain if cages were in flipped position or not. Therefore, during the bird counts, no distinction was made regarding cage orientation. At one site, the grower had modified a small number of cages; he installed a wire frame over the buoys to prevent birds from perching (Figure 5b). Finally, oyster growing *tables* (Figure 6, dimensions: 3 m × 1 m × 45 cm) were seen at a single site. These dimensions are substantially greater than those for the other gear types.

A total of 35,621 culture units were examined for the presence of birds. This number can be broken-down based on gear type: 22,600 standard bags, 7,800 modified bags, 4,609 cages, 600 tables, and 12 modified cages equipped with bird deterring wires. The geographical distribution of the different gear types examined as part of the study is shown in Figure 7.

Bird counts
Bird observations were carried out either from land (September) or from a kayak (October) using binoculars and a spotting scope. Only birds perching on oyster gear and any associated buoys were identified and counted. Bird counts reflect the maximum number of individuals seen at any one time during the count period (15 to 60 minutes). Let us consider the following example: 15 cormorants were seen on oyster gear early into the count period, and five additional cormorants arrived shortly thereafter, but two individuals departed the area in the final minute. In this example, the count would have been noted as 20 (15 + 5) individuals.

Shortly after the bird count was completed, the gear type was recorded along with an estimate of the number of culture units (bags, cages, etc…). To standardize observations, the total number of birds counted on standard and modified bags was divided by the number of bags present within the count area; the outcome was

multiplied by 100 to provide an estimate of the bird abundance per 100 bags. Bird counts for cages were standardized using the same calculations, consequently yielding the number of birds per 100 cages.

Results

A total of 3,337 individual birds were counted in oyster farms over the course of the survey. Birds were present on all types of oyster equipment except tables and cages equipped with deterring wires. They were seen perching, preening, as well as drying their wings. Black-bellied plovers (*Pluvialis squatarola*) and dunlins (*Caldris alpine*) were the only birds seen eating small invertebrates within American eelgrass (*Zostera marina*) trapped on top of the oyster gear. Common terns (*Sterna hirundo*) on the other hand used oyster equipment for staging purposes and feeding of their young.

In terms of diversity, 21 bird species were identified (Table 1). The most common species was the double-crested cormorants (*Phalacrocorax auritus*), representing almost half (48%) of all counts. It was most often seen perching on oyster cages in southern N.B. (Figure 8). Herring gulls (*Larus argentatus*) were also commonly (17% of all counts) spotted on oyster gear with no obvious geographical pattern. Common terns (*Sterna hirundo*) were particularly abundant in Néguac Bay.

There were significant differences amongst the investigated sites with regards to the density of birds on oyster gear ($P < 0.05$, Kruskal Wallis). Mean density values at the different sites ranged from 0.5 to 31.0 birds per 100 culture units (Table 2). Furthermore, a greater density was generally recorded at sites located in southern N.B. compared to those located in the northern part of the province (i.e., mean 11.2 versus 3.7 birds per 100 culture units, $P < 0.01$, Mann-Whitney U).

Statistical analyses suggest that the observed variability was driven by two factors. First, bird density on culture gear was inversely correlated with the quantity of culture units present in the count area (Figure 9, $r^2 = 0.72$, $P < 0.001$). Second, cages attracted significantly more birds compared to other floating gear types, with the following mean values: 15.3 birds per 100 cages, 5.4 birds per 100 standard bags, and 1.7 birds per 100 modified bags. These values were significantly different from one another ($P < 0.001$, Kruskal Wallis); however, if cormorants are excluded from the comparative analysis, the mean values become similar ($P = 0.07$, Kruskal Wallis). This finding led us to focus on cormorants. It is the only species which presented significant differences between gear types ($P < 0.001$, Kruskal Wallis): 13.0 cormorants per 100 cages, 2.3 cormorants per 100 standard bags, and 0.8 cormorants per 100 modified standard bags. While it is clear that cages attracted a greater number of birds, and more specifically cormorants, bird density did not significantly ($P = 0.07$, Mann-Whitney) differ between standard and modified bags.

Oyster growing tables and modified cages were excluded from statistical analyses due to low sample numbers.

Discussion

Culture sites located in south-eastern N.B. had more birds per 100 culture units compared to those located in north-eastern N.B. The exact reasons for this north-south geographical pattern are unclear. The finding may reflect a density-dependent behaviour linked to the number of culture units made available for perching. For instance, it is possible that floating oyster gear in an area becomes more crowded with birds when fewer gear units are made available to the population. This gear-density-dependent interpretation is supported by a significant relationship reported in the present study, i.e. an inverse relationship between the number of birds per 100 culture units and the total number of units made available to birds. The interpretation is also consistent with north-south differences in the number of culture units made available to birds in the different survey areas. A total of 26,100 culture units were made available to birds in the northern survey area compared to 8,909 in the southern area. This latitudinal difference aquaculture activity was also detected during an extensive aerial survey, which indicated a total of 108,685 culture units in the northern part of the province compared to 54,503 in southern part (Comeau *et al.*, in press). Therefore, it is possible that the elevated bird densities reported for southern N.B. were partly linked to fewer culture units being available for perching behaviour, a situation which in turn led to a greater aggregation of birds.

There were significant differences in bird counts amongst the various gear types. No birds were observed on tables and also on cages equipped with a rigid wire deterring system. For tables, the associated sampling effort was low (1 visit to a single site) and consequently the result is dubious. The wire device installed atop floating cages likely deterred birds. However, the potential for a broad application of such a device is limited: at the end of our study, growers indicated that the rigid wire system was challenging in terms of cage handling and consequently that it is no longer considered a feasible option by the industry.

Birds and particularly cormorants were seemingly more attracted to cages than any other gear types. The fact that cages offer a greater perching area compared to bags may explain this result. The industry is aware of this result and it has since reflected on a possible modification to the cage design (other than the rigid wire system discussed above). A promising idea is shown in Figure 10. The two deterring wires on top of the rectangular buoy can be lowered quickly by knocking down the two supporting wooden blocks, thereby facilitating cage manipulation. The efficiency of this wiring system will soon be tested on both cages and modified floating bags equipped with spacer blocs.

Other results suggested the presence of fewer birds on modified bags (mean = 1.7 birds per 100 bags) compared to standard bags (mean 15.3 birds per 100 bags). However, this difference was not statistically significant ($P = 0.07$, Mann-Whitney U). It is possible that the sampling effort was insufficient to detect a significant difference between the two gear types. Regardless, it is now suggested that a greater lowering of the bags into the water column may help reduce the presence of birds. For instance, the larger birds identified in the present study have tarsus lengths between 6 and 9 cm (Table 3). Having the floating bag modified further by inserting spacer blocs between the top floaters and the Vexar bag would lower the bag approximately 9 cm below surface, thus rendering it unsuitable for perching.

We caution that bird counts were carried out within farms and consequently that there were many other co-factors which may explain our results. For example, nearby nesting habitat and feeding areas are likely other explanatory factors for the reported differences in bird density. The most striking result in this respect was a very high number (> 1,000) of common terns seen on oyster gear in Néguac Bay. Historically, Néguac Bay has been home to several tern colonies and remains an ideal feeding ground for this species. Another noteworthy result is that on several occasions, there were more cormorants on nearby dunes than on oyster equipment. Together these observations suggest that the oyster gear was not the main factor attracting birds into a given area.

Finally, a controlled field experiment is warranted to validate our findings and also to investigate other possible gear modifications such as the ones described above (spacer blocks, flexible wires running over buoys). With respect to future work, we propose the following:

- that a robust experimental design be developed for the testing of two null hypotheses, i.e. H_{01} (when given a choice of different floating gear types, birds will indiscriminately select these platforms) and H_{02} (when offered a single deterring gear type, birds will show adaptation behaviour);
- that experimental sites be isolated (away from oyster farms) and present a high number of birds (neighbouring colonies);
- that the experiment be replicated across the province (at least three embayments);
- that the experimental gear be distributed randomly to avoid selection by birds based on orientation, currents, or other factors;
- that bird counts be conducted at a regular interval between early spring and late autumn;
- that counts be conducted at one site per day and that the observation period be fixed within day and extended to at least 2 hours;
- that the sum of all individuals having landed on the experimental gear be considered as the count statistics. The sum of individuals will reflect the potential extent of feces deposited more accurately than the maximum number of individuals at any one time. To obtain the sum, an accounting of birds leaving and arriving could perhaps be conducted using video monitoring technology. Subsequent image analyses may prove useful for developing a simple computer model with the output parameter being the quantity of feces released over gear over time.

Acknowledgements

This study was funded by the Department of Fisheries and Oceans under the Aquaculture Collaborative Research and Development Program. We are also grateful to the oyster farmers who provided helpful advice and assistance, namely Léon Lanteigne, Amédé Savoie, Maurice Daigle, as well as Armand King and Danny King. Two reviewers, Denise Méthé and Sophie Bastien-Daigle, improved an early draft of the document.

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Table 1. A list of bird species seen on oyster cultivation gear in 2005 and their respective abundance based on gear type.

				Average number per 100 culture units								
Latin name	Common name	Total number recorded during survey	Percent of total count	Cages	std	n[2]	Standard floating bags	std	n[3]	Modified floating bags	std	n[4]
Phalacrocorax auritus	Double-crested Cormorant	1588	47.6	13.0	16.4	32	2.3	2.5	21	0.8	1.4	7
Larus argentatus	Herring Gull	570	17.1	2.1	2.8	19	2.6	4.1	24	0.6	0.7	6
Sterna hirundo	Common Tern[5]	435	13.0	5.9	3.6	3				2.3	0.4	2
Pluvialis squatarola	Black-bellied Plover	160	4.8	1.1	1.5	3	1.4	1.5	7	0.4	0.5	6
Caldris alpina	Dunlin	146	4.4	2.2	2.6	2	2.6	4.9	4	0.1		1
Larus marinus	Greater Black-backed Gull	113	3.4	1.2	1.9	19	0.9	0.9	17	0.1	0.1	2
Larus spp.	Immature[6] Gull	70	2.1	1.4	0.7	4	1.0	0.9	10	0.1		1
Larus argentatus	Imm. Herring Gull	54	1.6	0.6	0.8	4	0.6	0.9	8	0.2		1
Larus philadelphia	Bonaparte's Gull	52	1.6	2.6	2.0	2						
Larus delawarensis	Ringed–billed Gull	50	1.5	0.4	0.6	7	0.6	0.8	7			
Caldris spp.	Shorebirds spp.	28	0.8	0.9	0.9	2	0.3	0.6	3	0.1		1
Mergus serrator	Red-breasted Merganser	23	0.7				0.3	0.4	2			
Anas rubripes	Black Duck	9	0.3				0.1		1	0.0		1
Tringa melanoleuca	Greater Yellowlegs	8	0.2				0.1	0.0	3			
Ardea herodias	Great Blue Heron	6	0.2	0.1	0.1	4				0.0		1
Charadrius semipalmatus	Semipalmated Plover	6	0.2				0.0	0.0	2			

[2] Dates and sites were pooled

[3] Dates and sites were pooled

[4] Dates and sites were pooled

[5] Values for common terns are underestimated. At one sampling date, an unusual high number (> 1,000) of common terns were seen on modified bags in the Néguac Bay. The average value shown does not take into consideration that atypical observation.

[6] Refers to an immature plumage

Table 1 (Continued)

Latin name	Common name	Total number recorded during survey	Percent of total count	Average number per 100 culture units								
				Cages	std	n[7]	Standard floating bags	std	n[8]	Modified floating bags	std	n[9]
Caldris cantlus	Red Knot	5	0.1							0.1		1
Larus marinus	Imm. Greater Black-backed Gull	4	0.1				0.1	0.1	4			
Arenaria interpres	Ruddy Turnstone	4	0.1				0.0	.	1	0.1	0.1	2
Calidris fusicollis	White-rumped Sandpiper	3	0.1							0.3		1
Larus delawarensis	Imm. Ring-billed Gull	2	0.1				0.7		1			
Tringa flavipes	Lesser Yellowlegs	1	0.0				0.1		1			

[7] Dates and sites were pooled

[8] Dates and sites were pooled

[9] Dates and sites were pooled

Table 2. The abundance of birds on oyster gear in relation to site location. Average numbers represent birds of all species and were standardized to 100 culture units (bags, cages, etc.).

Site	Area*	Mean number of birds per 100 culture units	Standard Deviation	Number of site visits
Baie de Pokemouche	N	2.8	4.0	2
Baie St. Simon	N	6.1	8.0	2
Chiasson Office	N	6.1	5.3	3
Havre de Richibucto	N	7.0	7.6	7
Neguac	N	0.7	0.7	7
Petit Lamèque	N	9.4		1
Tabusintac	N	0.5		1
Tracadie	N	13.0		1
Aldouane	S	7.7	10.4	9
Baie du Village	S	23.0	19.3	3
Bedec	S	6.5	2.5	6
Bouctouche	S	9.6	5.4	6
Dune de Richibucto	S	31.0	21.5	4
Ile de Cocagne	S	8.0		1
Indian Island	S	4.6	0.4	2

* Site located north (N) or south (S) of Miramichi River

Table 3. Tarsus length (in cm) of the larger birds seen on oyster equipment (data courtesy of Dr. Donald MacAlpine, the New Brunswick Museum).

Scientific Name	*Larus marinus*	*Larus argentatus*	*Phalacrocorax auritus*	*Larus delawarensis*
Common Name	Greater Black-backed Gull	Herring Gull	Double-crested Cormorants	Ring-billed Gull
	5.7	6.3	7.2	5.3
	7.5	5.7	7.0	6.2
	7.2	6.4	8.6	7.0
	9.7	6.3	7.4	6.5
	10.4	8.8	8.3	6.2
	9.5	8.8	8.0	6.6
	10.4	6.0		6.3
	9.5	7.4		6.7
	9.4	9.0		6.1
		6.8		6.1
Average (cm)	8.8	7.2	7.8	6.3

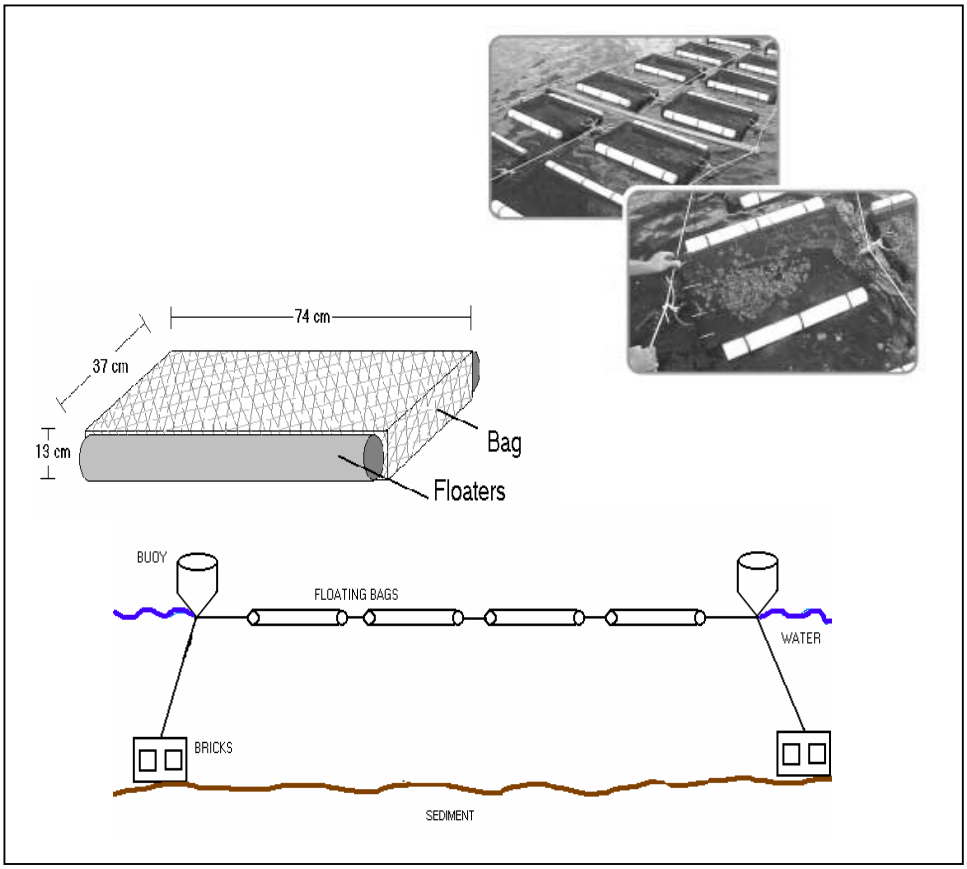

Figure 1. Floating Vexar® bag technique commonly used by the oyster industry in N.B. Drawing adapted from Sonier *et al*. (submitted) photos from www.maisonbeausoleil.ca

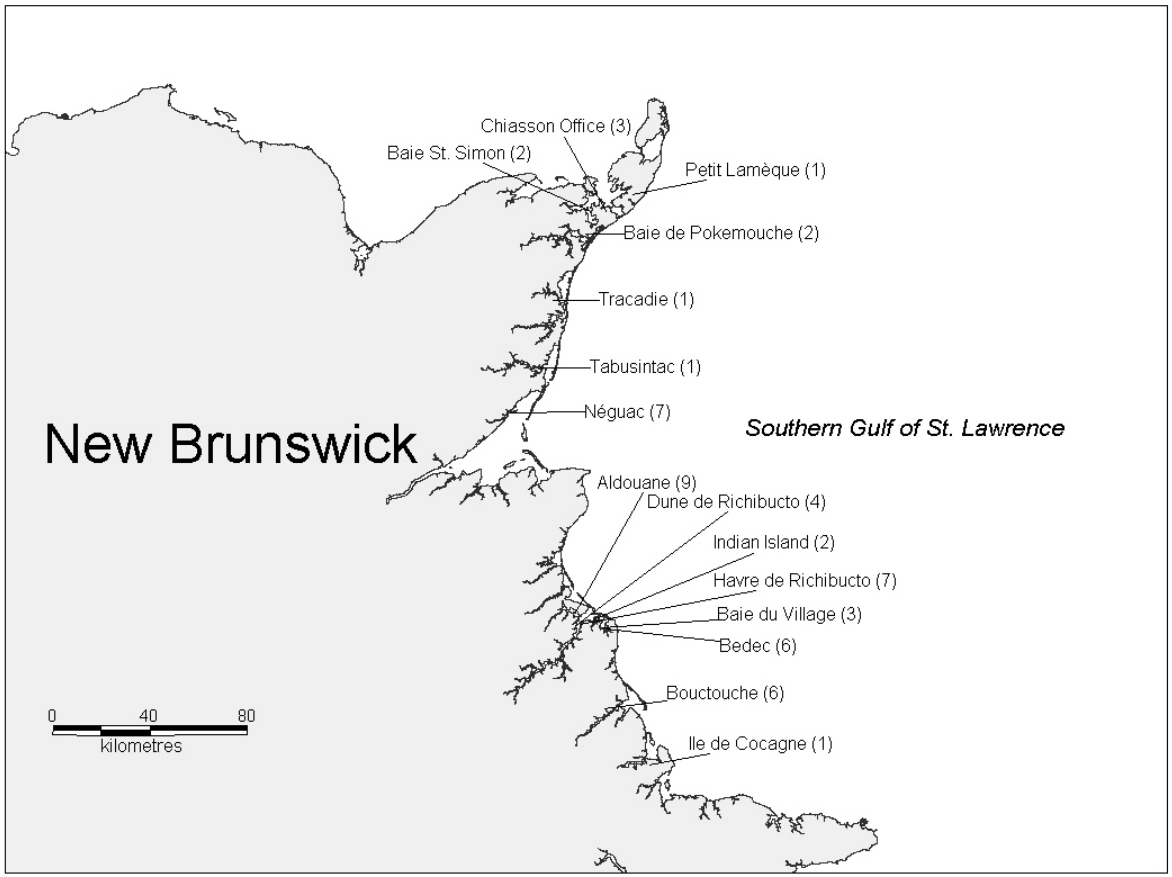

Figure 2. Map of eastern N.B. showing the approximate locations of bird observation sites in 2005. Number in parentheses show the number of site visits.

Figure 3. Standard floating Vexar bags.

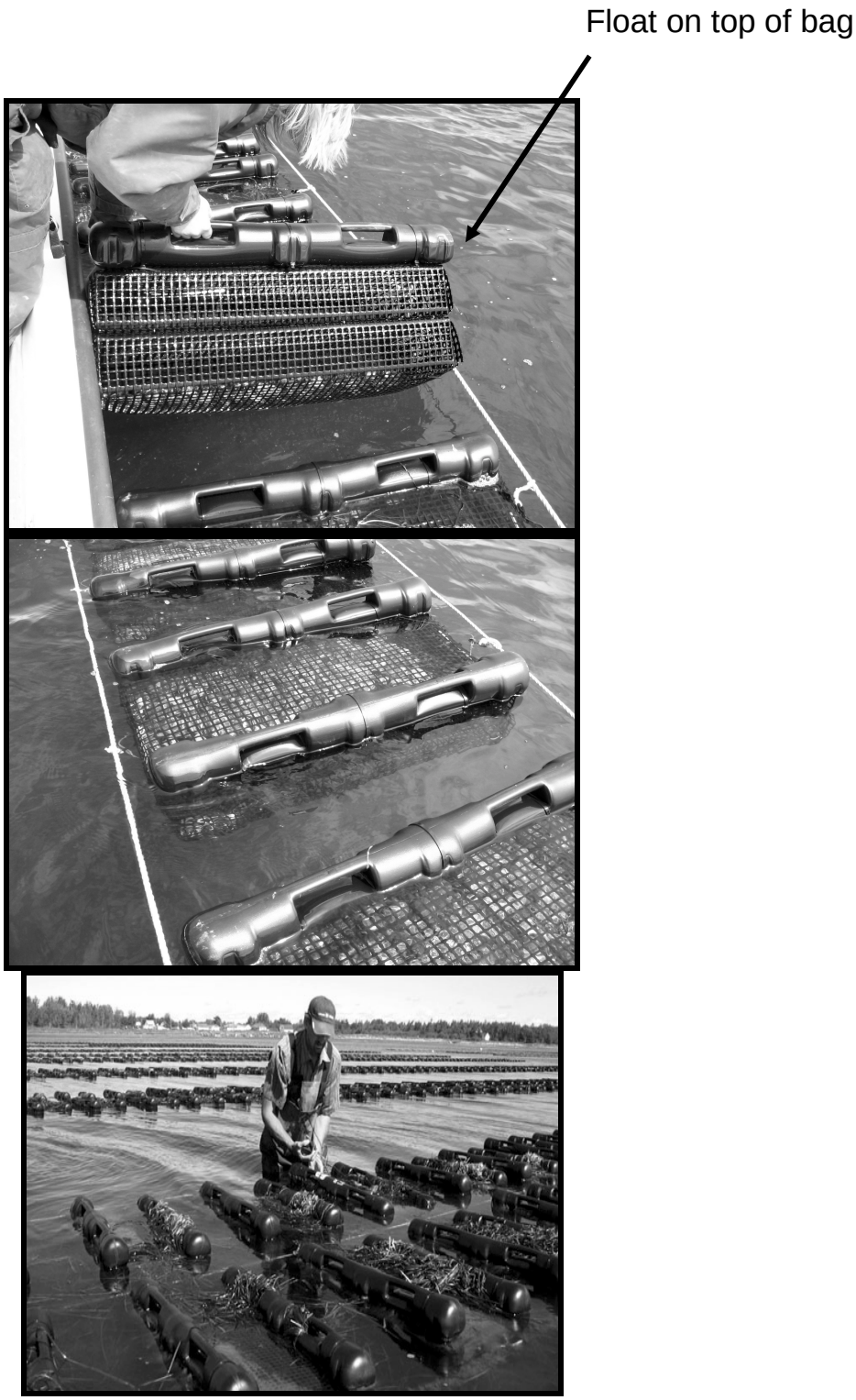

Figure 4. Modified floating bags. Photos, showing double-bags, were taken by Sylvio Doiron at the Ferme Marine Lanteigne.

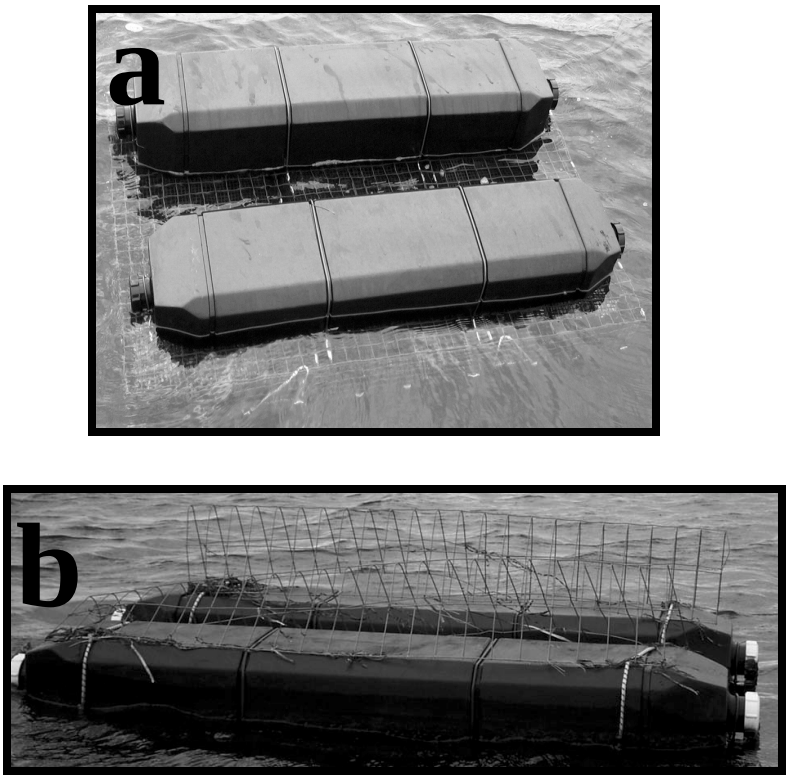

Figure 5. a) floating cage with large rectangular buoys; b) floating cage equipped with wire deterrent system.

Figure 6. Oyster growing tables. (photo courtesy of Sylvio Doiron)

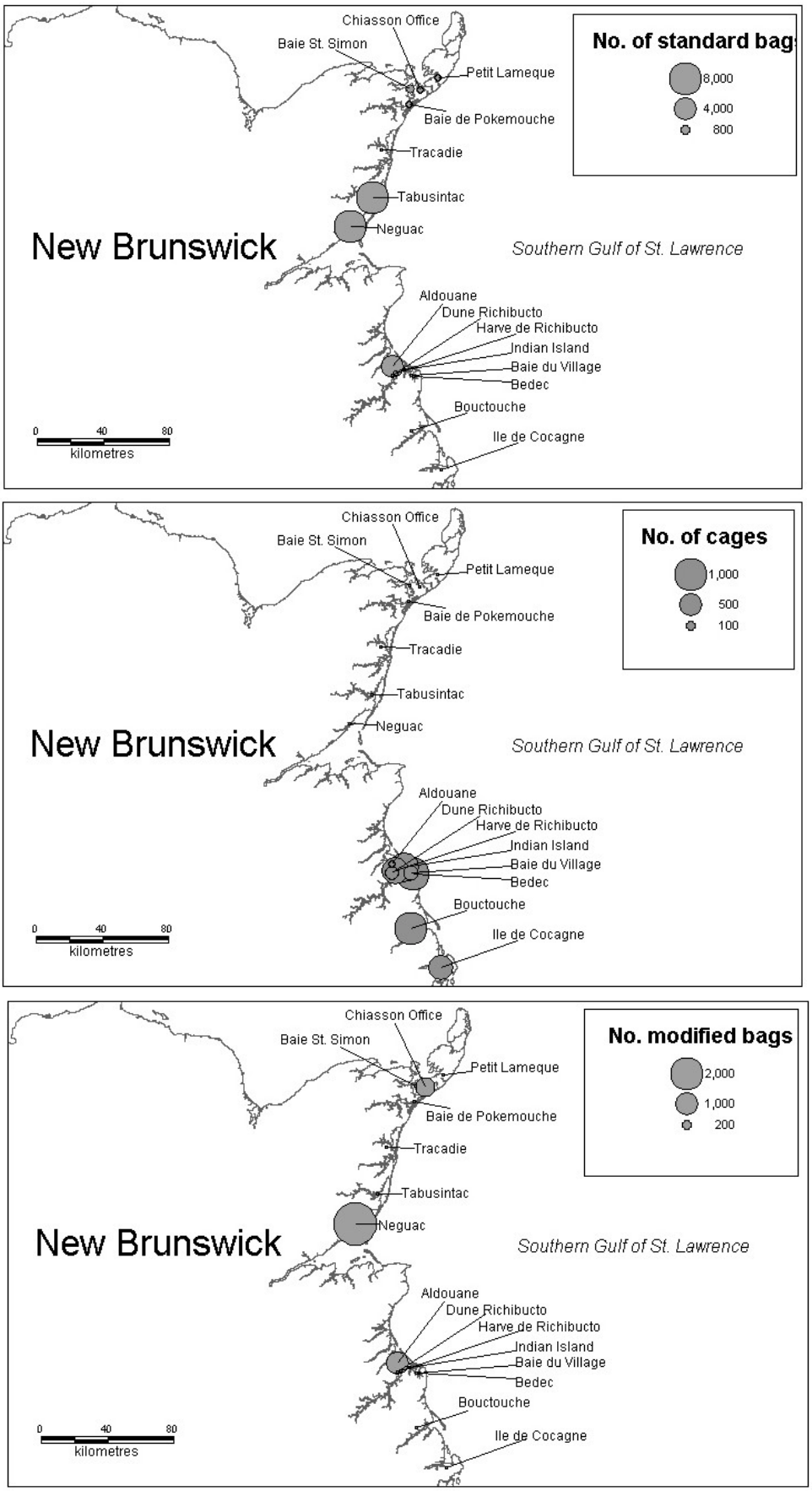

Figure 7. Geographical distribution of the different gear types along the coast.

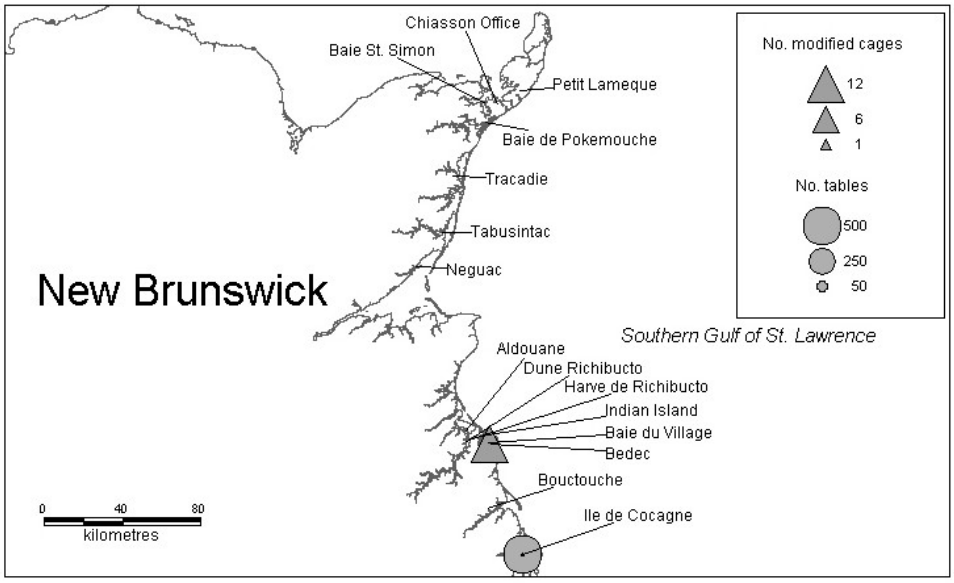

Figure 7 (continued).

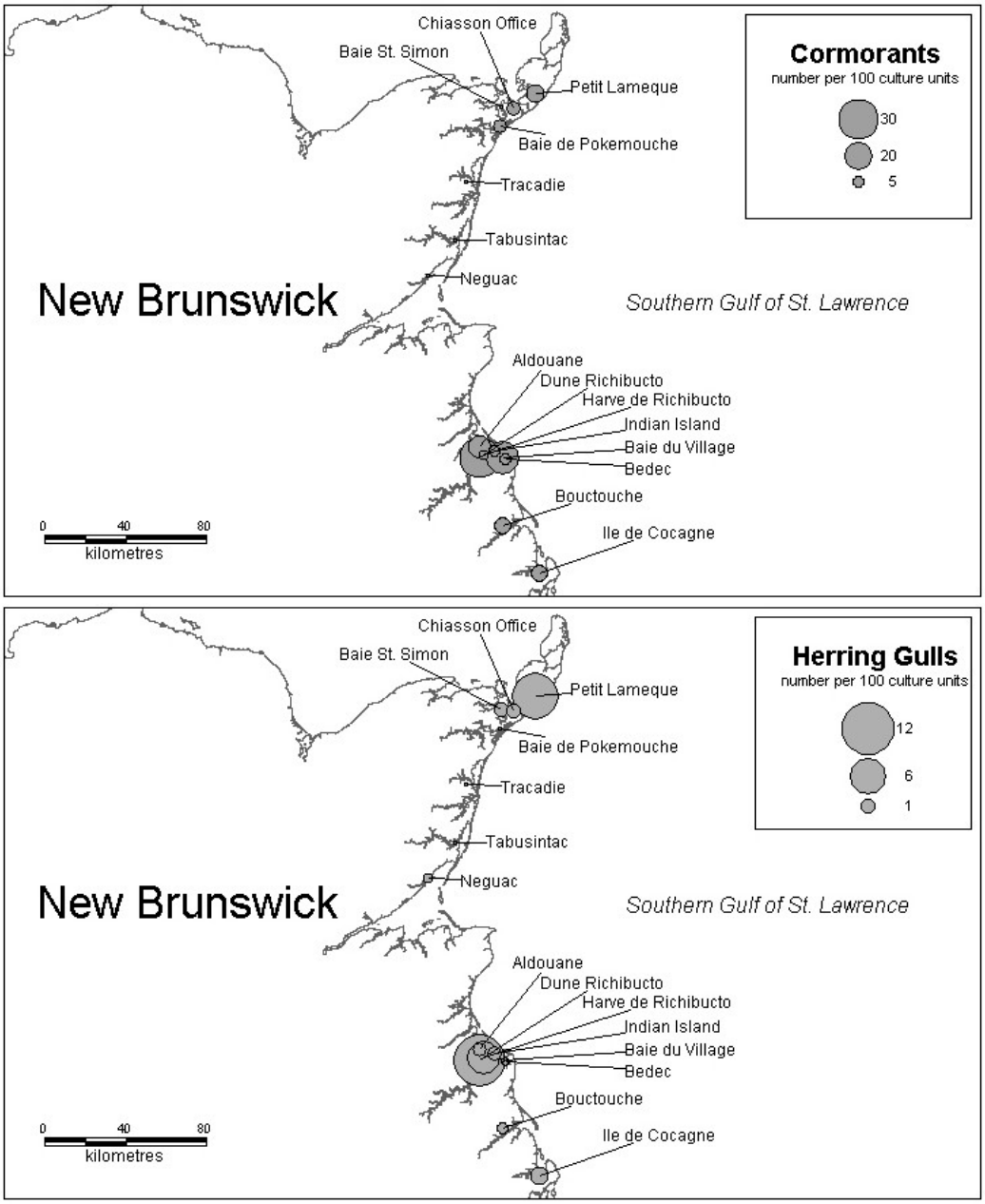

Figure 8. Maps showing the distribution of two most commonly observed birds, double-crested cormorants and herring gulls.

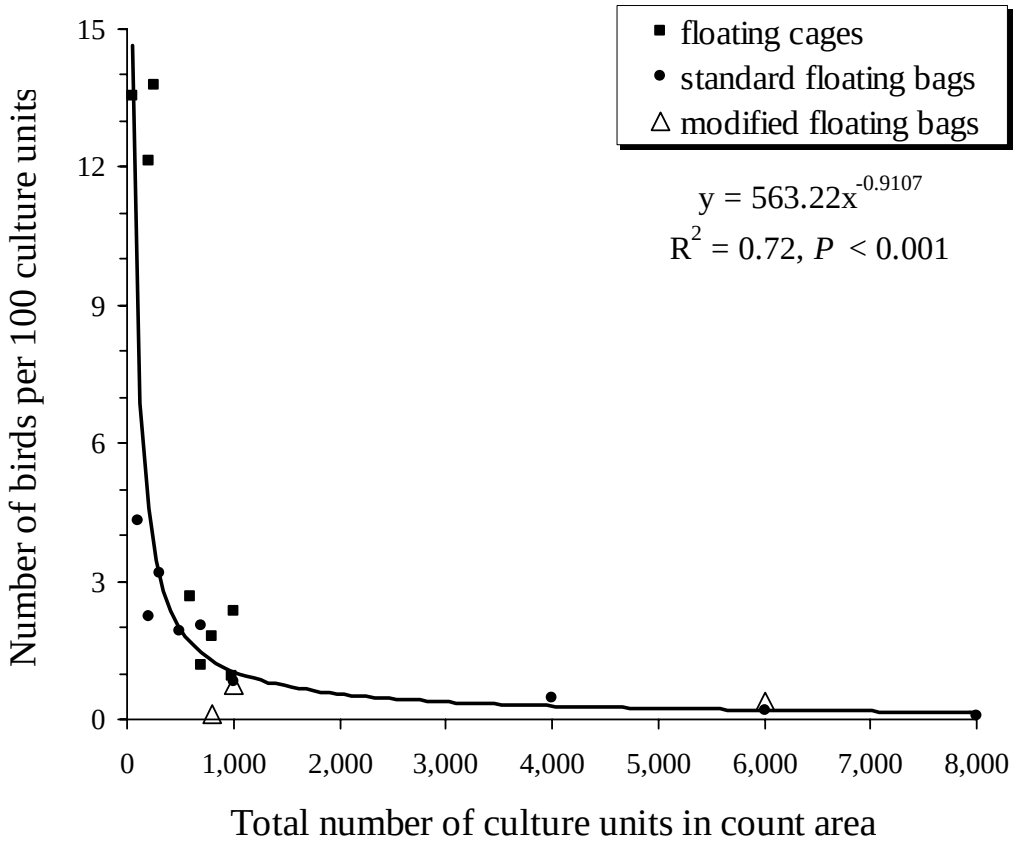

Figure 9. Relationship between the bird density on floating gear and the total number of gear units deployed in the count area. Data points represent mean values across several dates and sites.

Figure 10. Wires covering a buoy to prevent birds from perching, a modification proposed for 2006.