Progress Notes 36104704

Disponible également en français

No. 129, July 1982

Population, reproductive success, and analysis of contaminants in Razorbills (*Alca torda*) in the estuary and Gulf of St. Lawrence, Quebec

by Gilles Chapdelaine[1] and Pierre Laporte[1]

Introduction

The seabird survey program in the sanctuaries on the North Shore of the Gulf of St Lawrence has enabled us to follow the fluctuations in population of several species from 1925 to 1977 (Chapdelaine 1980). *Alcidae* and *Laridae* are the principal families surveyed, representing 56% and 37% respectively of the total. Among the *Alcidae*, Razorbills (*Alca torda*) and Puffins (*Fratercula arctica*) in particular have decreased in numbers since 1965. In this project, we dealt with Razorbills because of their large numbers in the estuary and Gulf of St Lawrence. Bédard (1969) estimated the Razorbill population of Canada to be 42 200, with 50% occurring in the estuary and gulf. More recently, Nettleship (1977) estimated this population at 38 130 birds. On the basis of this revised figure and the most recent data (Table 1), the number of Razorbills in the estuary and gulf would represent no more than 18% of the total in the western Atlantic.

The purpose of this project is to update the information on the distribution and abundance of Razorbills in the estuary and Gulf of St Lawrence and to present some biological parameters on reproduction and the presence of contaminants in eggs. This approach will help to orient more specific studies, which could lead to identification of the reasons for the decline in the Razorbill population in the gulf.

Method

Distribution and abundance

Since the appearance of the Atlas of eastern Canadian seabirds (Brown *et al.* 1975), 8 colonies have been added to the list and 15 out of 17 colonies have been surveyed (Fig. 1, Table 1). Survey methods have varied according to the type of habitat and time available for counting. The various survey methods used were: (1) systematic counting of eggs and nests (the most accurate method); (2) selection of "monitored" colonies where the number of nests (Np) and the number of adults (Ni) are determined (the factor of K = Np/Ni enables us to estimate the number of couples in the colonies where we have observed only the number of adults present: the conversion-factor method); (3) counting of individuals (the least accurate method). Because of variations in the application of survey methods, their relative effectiveness (Lloyd 1975, Nettleship 1976, Cairns 1979) and the various people doing the counting, the survey of the Razorbill population in the estuary and Gulf of St Lawrence must be considered as approximate rather than definitive.

[1] CWS, Ste-Foy, Quebec G1V 4H5.

Biology of reproduction

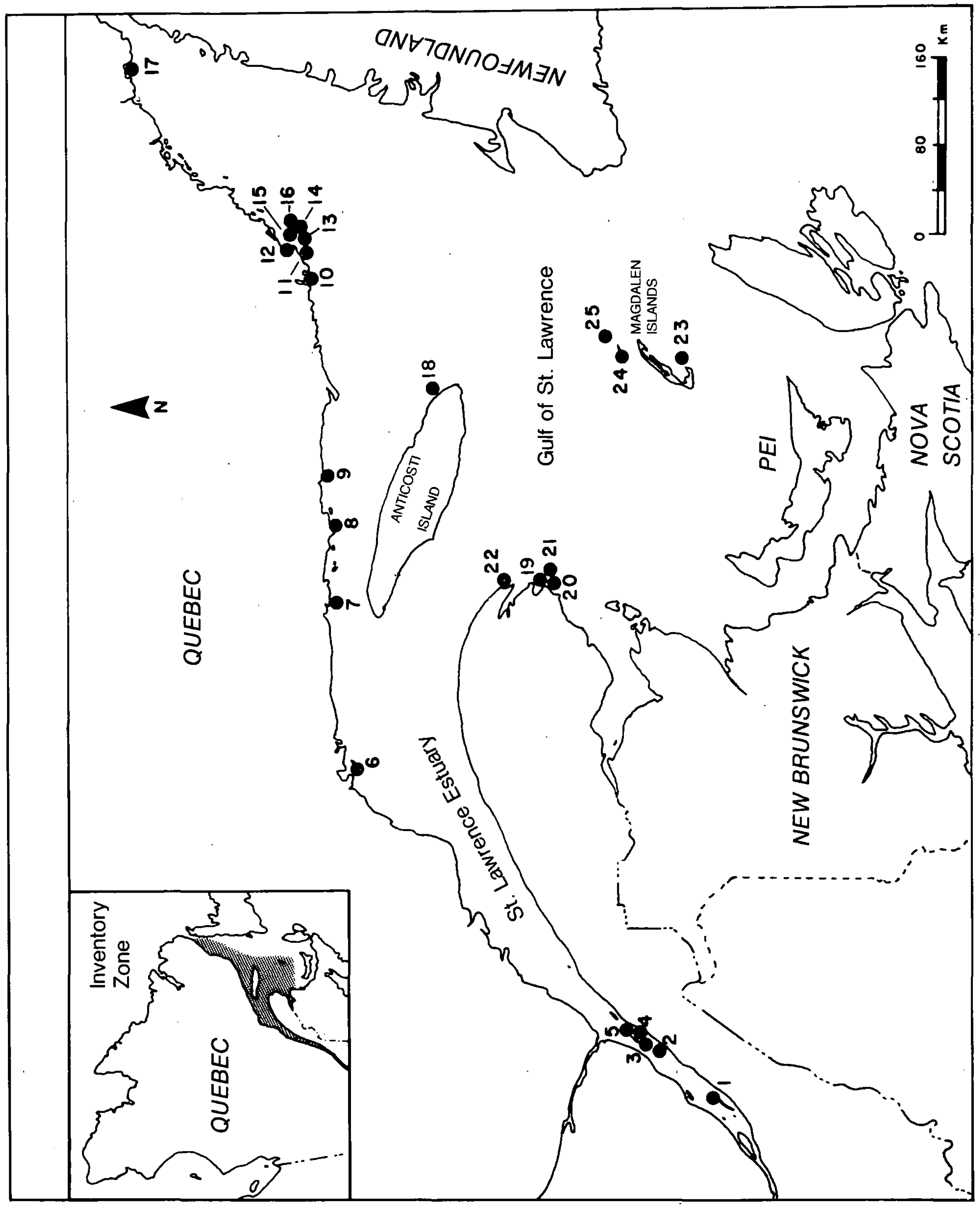
During the 1978 breeding season, we estimated the hatching and fledging success as well as the net productivity of Razorbills in the gulf by selecting 80 nests on the Sainte-Marie Islands (50°19′N, 59°39′W) and 27 on the Boat Islands (50°17′N, 59°43′W). For logistical reasons, we could calculate no more than the hatching success of 48 nests in the estuary colonies, that is, on the Pèlerins Islands (47°43′N, 69°45′W).

We identified each nest by a number written on the adjacent rock face. The nests located on the islands of the Lower North Shore were inspected three times during the breeding season, on 16 June, 13 July, and 24 July. In the estuary, the breeding season being almost 15 days ahead of the season on the North Shore, we made our visits on 29 May, 12 June, and 10 July. On each visit we recorded the status of the nest, that is, the absence or presence of an egg or chick.

Hatching success was calculated by determining the relationship between the number of nests containing a chick and the number of nests that had received an egg. This is a minimum estimate since, if the nest still had an egg at the third visit, it was considered unhatched although it could have been hatched later. Over a 2-year observation period, Bédard (1969) reported 30 July and 9 August as the latest hatching dates, with an incubation period varying from 36 to 39 days. The interval between our first and third visits was 38 days. The eggs that disappeared between the second and third visits were considered unhatched, but they could have been hatched and the chicks taken by predators. Consequently, we consider the hatching success presented here to be a minimum.

We estimated fledging success by determining the relationship between the number of nests containing a chick aged 12 days or older on the third visit and the number of nests containing a chick on the second visit. The complement of this value, the mortality rate, was applied to chicks less than 12 days old seen on the third visit. This mortality should be considered a maximum or probably overestimated value, since the chicks that were presumed dead or lost to predators may have

Figure 1
Distribution of Razorbill (*Alca torda*) colonies in the estuary and Gulf of St Lawrence



taken to the sea between the second and third visits, considering that the eggs were laid before 16 June. Bédard (1969) placed the laying period between 27 May and 30 June, and 18 days as the period before the young took to the sea.

We assessed net productivity by establishing the relationship between the number of fledglings and the number of nests that received an egg. We consider the estimate of the various parameters on reproduction presented here to be very conservative.

Analysis of contaminants

We gathered fresh and addled eggs on the Pèlerins Islands on 29 May. In the Sainte-Marie Islands archipelago, we gathered fresh eggs on 8 June and addled eggs on 24 July. Addled eggs are defined as those that have remained in place for more than 40 days and whose contents are rotten. The Ontario Research Foundation carried out analyses for residues of organochlorine compounds (Reynolds and Cooper 1975).

Results

Population distribution, abundance, and fluctuation

Figure 1 and Table 1 summarize the distribution and abundance of Razorbills in the St Lawrence system. We found 20% of the colonies in the estuary part and 80% in the gulf. The total population is estimated at 6740 individuals. Brown *et al.* (1975) put it at 7826 individuals. However, that revision is incomplete since it leaves out six colonies that are still active and contain 1860 individuals, which would raise the 1975 estimate to 9686. In a more exhaustive review, Bédard (1969) put the same population at 20 800 individuals. By comparing our estimate with Bédard's, there would be a 67% decrease. However, we should be careful in interpreting a decrease of this size in view of the inaccuracy of the counting methods for *Alcidae* (Lloyd 1975, Cramp *et al.* 1974, Cairns 1979) and the fact that all the colonies were not counted in the same year.

The largest concentration of Razorbills occurs on the Lower North Shore of the Gulf of St Lawrence. It is also in this area that the best data on fluctuations in seabird populations were gathered. Figure 2 shows the fluctuations in three sanctuaries on the Lower North Shore.

We note that the decrease first showed up on the Sainte-Marie Islands (1960–65) and then in the Betchouane and Baie des Loups sanctuaries (1965–72). Since these decreases took place, the population has continued to decline. We cannot document the fluctuations in populations elsewhere in the gulf and estuary for lack of earlier data.

Biology of reproduction

The figures for productivity of Razorbills in the sample colonies on the Sainte-Marie, Boat, and Pèlerins islands appear in Table 2. Since there were no significant differences between the hatching success, fledging success, and net productivity for the two islands on the Lower North Shore, we combined the data for those two locations. We estimate the hatching success at 70%, fledging success at 87%, and net productivity at 61%. For the colonies in the St Lawrence estuary, we estimate the hatching success at 69%, but did not measure fledging success and net productivity because our third visit was poorly timed in relation to the phenology of Razorbill reproduction in the estuary. In comparing parameters with the figures obtained in various places in the Razorbill distribution area in the north Atlantic subarctic zone (Table 3), we found in all cases that mortality was higher at the egg stage than at the chick stage.
chick stage.

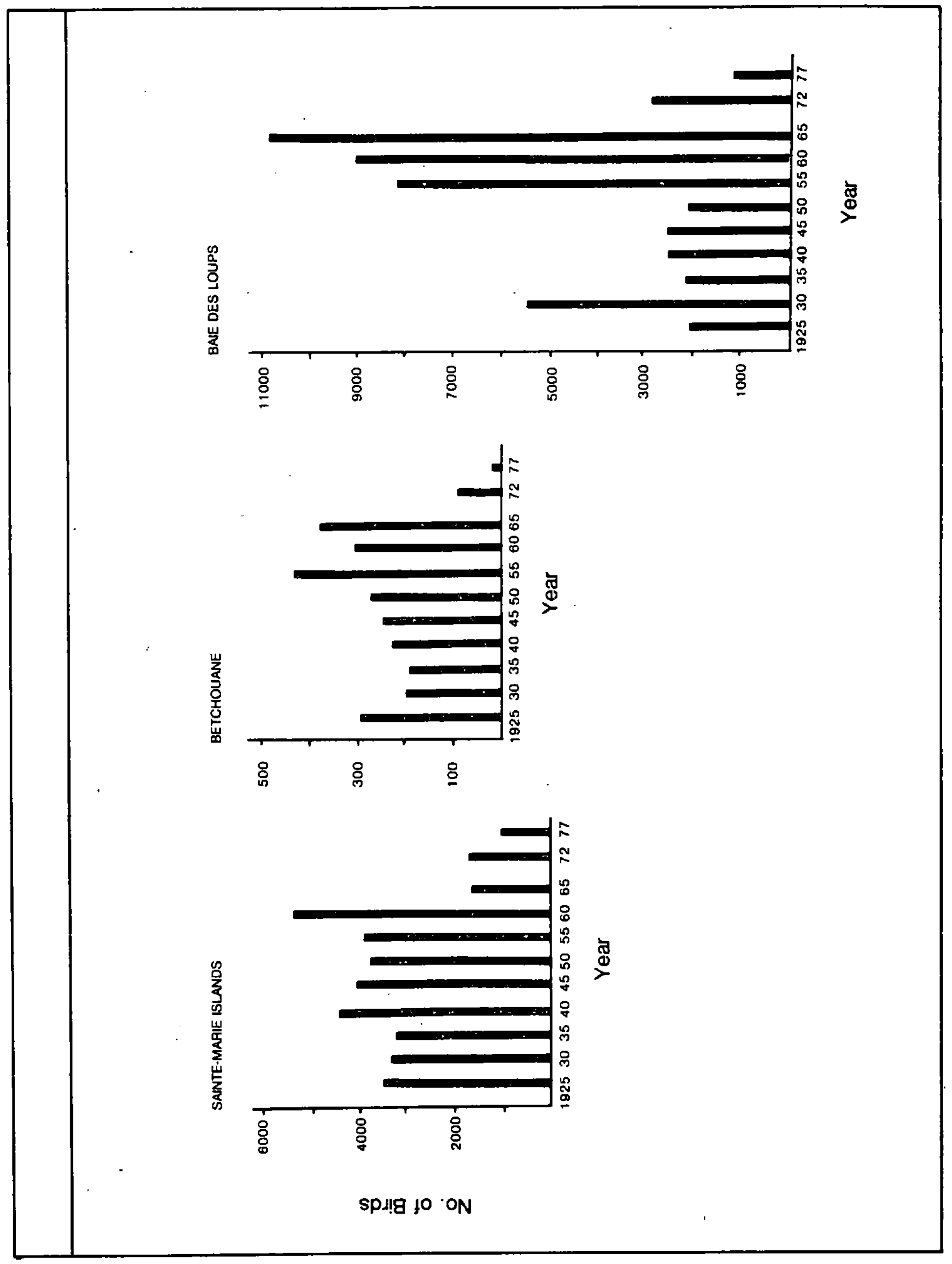
The results of analysis of organochlorine concentrations in the eggs appear in Table 4. In the case of the Sainte-Marie Islands archipelago, there appears to be no significant difference in concentrations between fresh and addled eggs (Wilcoxon test $P > 0.05$). In the estuary, the smallness of the sample and the condition of the addled eggs prevented any comparison; those addled eggs probably remained from the preceding breeding season (1977), unlike the ones gathered in the gulf.

According to residues found in the fresh eggs, it seemed that the concentrations of ΣDDT, α-chlordane, oxychlordane, and PCB would be higher in the estuary (Wilcoxon test $P \leq 0.05$). On the other hand, there was no significant difference between the levels for 1978 and 1972 reported by Pearce *et al.* 1979 (Wilcoxon test $P > 0.05$) (Table 5). The concentrations of ΣDDT and PCB found in the eggs in Quebec were much lower than those of the Baltic Sea in Sweden (Andersson *et al.* 1974). In addition, the PCB/ΣDDT ratio was close to 1 in Sweden, whereas it was nearly 4.8 in Canada. The thickness of the shell at the circumference of fresh and addled eggs was 0.477 mm ($n = 19$, $Sx = 0.006$) on the Sainte-Marie Islands and 0.473 mm ($n = 6$, $Sx = 0.016$) on the Pèlerins Islands. Like Andersson *et al.* (1974) and Pearce *et al.* (1979), we could not show any existing correlation between the thickness of the shell and the concentration of ΣDDT or DDE residues (ΣDDT: $r = 0.04$; DDE: $r = 0.25$, $n = 16$, $P > 0.05$).

Discussion

Chapdelaine (1980) gave three possible causes for the decrease in Razorbill populations on the Lower North Shore: (1) poaching and human disturbance, (2) water pollution from oil in wintering areas, and (3) the presence of toxic chemical products (PCB, ΣDDT) in appreciable quantities in Razorbill eggs, thus affecting

Figure 2
Fluctuation in the number of Razorbills in three representative colonies on the North Shore of the Gulf of St Lawrence



their productivity. Without being able to determine to what extent each of these factors helps to determine the decrease in Razorbills, the results of analyses of contaminants lead us to rule out the hypothesis that chemical products (PCB, ΣDDT) affected net productivity.

The lack of success with eggs on the Sainte-Marie Islands was not the result of the concentration of organochlorine residues. Furthermore, the thinning of shells related to DDE content, often associated with a decrease in productivity, was not evident among the Razorbills. The lower concentrations found in the gulf could only be a reflection of an overall dilution of concentrations in the marine ecosystem. This difference was not a factor in the hatching success of eggs since no difference appeared between the gulf and the estuary for this parameter. Although the amount of PCB and DDT (Table 4) seems high in fresh eggs on the North Shore, the figures for hatching success, fledging success, and net productivity are comparable, and even higher than those observed in Europe (Table 3), particularly in Sweden where the concentrations of organochlorine residues are much higher.

There is no information on the annual mortality of young birds (≤ 5 years) and adults (> 5 years). For the populations on the Lower North Shore of the St Lawrence, these basic data could enable us to determine whether the recruitment of young birds is sufficient to compensate for the annual mortality of adults. Lloyd (1977) has previously presented a survival table for the Razorbill population of Skokholm, England. The author estimates that 18% of the young birds produced annually reach the age of reproduction (5 years) and that between 8 and 10% of the adults die annually. If we apply these parameters to our results on net productivity, we note that the recruitment of young birds would not be enough to maintain the population on the Sainte-Marie Islands. Only 11 young birds per 100 couples (18% of 61) would reach the age of reproduction, whereas 16 to 20 adults (8 to 10% of 100 couples) would die. Application of these same parameters to all productivity figures in Table 3 shows that no colony could produce enough young to increase their numbers. However, Lloyd (1977) acknowledged that the parameters obtained on adult mortality could be distorted when he said:

> One of the main years for which adult survival was calculated was unusual in that the breeding season was late and there was some indication of higher than usual mortality among the adults before the breeding season.

Nevertheless, the loss of birds outside the nesting areas (on migratory routes and wintering grounds) does not need to be large to result in a decreased or unchanged colony.

The possibility that hunters on the North Shore confuse Razorbills with other wildfowl must be taken into consideration. Among the seizures of poached birds on the North Shore are many *Alcidae* (Common Murres, Razorbills, Black Guillemots). However, the lack of a banding program for *Alcidae* keeps us from knowing whether the poached birds are from the colonies of the Lower North Shore of the Gulf of St Lawrence or from those of the Labrador coast.

Conclusion

Lloyd (1976) estimated the world population of Razorbills at 208 000 couples. Of this number, only 10% nest in North America. The colonies of the estuary and Gulf of St Lawrence play an important part in the North American context. Estimates show that in 1963 these colonies represented more than 50% of the birds in the western Atlantic, whereas today they represent only 18%. Because of inaccuracies and the lack of standard survey methods, this decrease is perhaps not as large as it appears, but is still a real decrease. What does this recent decline in Razorbills mean for the future? Is the species in danger of disappearing from the North Shore? Can it regain its earlier numbers? With the scanty biological data that we have on Razorbill populations, we cannot venture to answer these questions.

In the years ahead we should improve our survey methods and co-ordinate the related surveys of Razorbill populations in the estuary and Gulf of St Lawrence. Young chicks and adults should be banded to gain a better understanding of migration routes and wintering grounds. We can also hope to obtain data from the beached bird surveys, which are not as popular in North America as in Europe, although some progress in this field has been made on the New England coast (Manomet Bird Observatory) and in the Great Lakes region (Long Point Bird Observatory).

References

Andersson, A.; Odsjö, T.; Olsson, M. 1974. Häckningsresultat hos tordmule i Stockholms Skärgård i relation till äggskalstjocklek och halter av DTT, PCB och kvicksilver i ägg. (Breeding success of Razorbills in the Archipelago of Stockholm in relation to eggshell thickness and levels of DDT, PCB, and mercury in eggs). Statens Naturvårdsverk. PM 483. 30 pp.

Bagg, A.M.; Emery, R.P. 1961. Regional reports. North-eastern Maritime Region. Audubon Field Notes 15(5):451.

Bédard, J, 1969, Histoire naturelle du Gode (*Alca torda*) dans le golfe Saint-Laurent, province de Québec, Canada, (Natural history of Razorbills (*Alca torda*) in the Gulf of St. Lawrence, Province of Quebec, Canada). Can. Wild. Serv. Rep. Ser. No. 7. 79 pp.

Braund, F.W.; McCullagh, E.P. 1940. The birds of Anticosti Island, Quebec. Wilson Bull. 52(2):96–123.

Brown, R.G.B.; Nettleship, D.N.; Germain, P.; Tull, C.E.; Davis, T. 1975. Atlas of eastern Canadian seabirds. Can. Wildl. Serv. Ottawa. 220 pp.

Brun, E. 1958. Notes on the fledging period of the Razorbill. Stockholm Bird Obs. Rep. 1958:23–26.

Cairns, D. 1979. Censusing hole-nesting auks by visual counts. Bird-banding 50(4):358–364.

Chapdelaine, G, 1980, Onzième inventaire et analyse des populations d'oiseaux marins dans les refuges de la Côte Nord du Golfe Saint-Laurent. (Eleventh census and analysis of seabird populations in the migratory bird sanctuaries of the North Shore of the Gulf of St. Lawrence) Can. Field-Nat. 94(1):34–42.

Cramp, S.; Bourne, W.R.P.; Saunders, D. 1974. The seabirds of Britain and Ireland. London.

Lloyd, C. 1975. Timing and frequency of census counts of cliff-nesting auks. Br. Birds 68:507–513.

Lloyd, C.S. 1976. An estimate of the world breeding population of the Razorbill. Br. Birds 69:298-304.

Lloyd, C.S. 1977. Survival and age at first breeding in the Razorbill (*Alca torda*). Bird-banding 48(3):239–252.

Lloyd, C.S. 1979. Factors affecting breeding of Razorbills (*Alca torda*) on Skokholm. Ibis 121:165–176.

Nettleship, D.N. 1976. Census techniques for seabirds of arctic and eastern Canada. Can. Wild. Serv. Occ. Pap. No. 25. 31 pp.

Nettleship, D.N. 1977. Seabird resources of eastern Canada: Status, problems, and prospects. Pages 96-108 *in* T.Mosquin and C. Suchal, eds. Proceedings of the symposium on Canada's threatened species and habitats, Ottawa, 1976. Can. Nat. Fed. Spec. Publ. No. 6.

Paludan, K. 1947. Alken. Copenhagen. Munksgaard.

Pearce, P.A.; Peakall, D.B.; Reynolds, L.M. 1979. Shell thinning and residues of organochlorines and mercury in seabird eggs, eastern Canada, 1970–76. Pestic. Monit. J. 13(2):61-68.

Plumb, W.J. 1965. Observations on the breeding biology of the Razorbill. Br. Birds 58:449–456.

Reynolds, L.M.; Cooper, T. 1975. Pages 196-205 *in* Analysis of organochlorine residues in fish, water quality parameters. Am. Soc. Test. Mat. STP. 573.

Table 1
Distribution and number of Razorbills (*Alca torda*) in the estuary and Gulf of St Lawrence

Location of colony*	Position	Census year	No. of couples(c) or individuals(i)	Census method†	Source and observers‡
Estuary					
Îlot du Pilier Nord (1)	47°12′N, 70°21′W	1979	3c	SCE	JD, RA, 1979 (CWS)
Grande Île (Kamouraska) (2)	47°37′N, 69°52′W	1979	1c	SCE	MC, 1974 (CWS)
Île Long Pèlerin (3)	47°43′N, 69°45′W	1978	321c	CF, SCE	GC, GT, PL, ML, 1978 (CWS)
Île Gros Pèlerin (4)	47°45′N, 69°42′W	1978	107c	CF, SCE	GC, GT, PL, ML, 1978 (CWS)
Îles du Pot-à-l'eau-de-vie (5)	47°52′N, 69°41′W	1976	57c	SCE	DC, 1977
Gulf					
Île Corossol (6)	50°05′N, 66°23′W	1977	40c	CF, SCE	Chapdelaine, 1980 (CWS)
Île de la Maison (7)	50°12′N, 64°12′W	1978	1c	SCE	GC, AB, GT, 1978, 1981
Île du Sanctuaire (Betchouane) (8)	50°12′N, 63°13′W	1978	3c	SCE	GC, AB, GT, 1978, 1981
Refuge de Watshishu (9)	50°16′N, 62°38′W	1977	4c	SCE, CI	Chapdelaine, 1980 (CWS)
Baie des Loups (10)	50°10′N, 60°17′W	1977	595c	SCE, CF	Chapdelaine, 1980 (CWS)
Île Ouapitagone (11)		1977	5i	CI	GC, GT, PD, 1977 (CWS)
Îles Innommées (12)		1976	1200i	CI	GC, JR, 1976 (CWS)
Îles Mariannes (13)		1976	44c	CF, SCE	GC, JR, 1977 (CWS)
Îles aux Perroquets (Boat Islands) (14)	50°17′N, 59°43′W	1977	268c	SCE	DC, 1977
Îles Galibois (15)	50°17′N, 59°47′W	1977	4c	SCE, CF	GC, JR, 1977 (CWS)
Îles Ste-Marie (16)	50°19′N, 59°39′W	1977	596c	SCE	GC, JR, 1977, 1980 (CWS)
Île aux Perroquets (17)	51°26′N, 57°15′W	1977	226c	CF	Chapdelaine, 1980 (CWS)
Île d'Anticosti (18)	49°20′N, 61°40′W	1940	--	?	Braund and McCullagh, 1940
Les Trois Sœurs (19)	48°32′N, 64°13′W	1979	2i	CI	GC, GT, 1979 (CWS)
Rocher Percé (20)	48°30′N, 64°12′W	1979	3i	CI	GC, GT, 1979 (CWS)
Île Bonaventure (21)	48°29′N, 64°07′W	1979	307c	SCE, CF	GC, GT, AB, 1979 (CWS)
Forillon (cap Bon Ami) (22)	48°57′N, 64°12′W	1979	14i	CI	GC, GT, 1979 (CWS)
Île d'Entrée (23)		1977	15i	CI	JB, 1977 (CREM)
Île Brion (24)	47°48′N, 61°29′W	1977	54i	CI	JB, 1977 (CREM)
Rocher aux Oiseaux (25)	47°51′N, 61°12′W	1961	300i	CI	Bagg, A.M.; Emery, R.P., 1961

* The numbers in parentheses correspond to nesting areas shown on the distribution map (Fig. 1).
† SCE = systematic counting of eggs or nests;
CI = counting of individuals;
CF = conversion factor (see Nettleship 1976: 19-20).

‡ RA: Rhéal Angers; AB: André Bourget, JB: Jean Burton; DC: David Cairns; GC: Gilles Chapdelaine; MC: Michel Cantin; JD: Jean Deshaies; PD: Pierre Dupuis; PL: Pierre Laporte; ML: Mario Laverdière; JR: Jacques Rosa; GT: Germain Tremblay.
Agencies involved: Canadian Wildlife Service (CWS); Centre de recherche écologique de Montréal (CREM).

Table 2
Comparison of hatching success, fledging success, and net productivity of Razorbills (*Alca torda*) in the Sainte-Marie, Boat, and Pèlerins islands, 1978

Colonies	Eggs laid	Hatching success		Fledging success		Net productivity	
Ste-Marie	53	68%*	(36)§	92%†	(33)	62%‡	(33)
Boat	27	74%*	(20)	100%†	(20)	74%‡	(20)
Total	80	70%	(56)	87%	(49)#	61%	(49)
Pèlerins	48	69%	(33)	—		—	

* $P>0.50$; $X^2 = 0.32$; df = 1.
† $P>0.25$; $X^2 = 0.65$; df = 1.
‡ $P>0.25$; $X^2 = 1.12$; df = 1.
§ The figures in parentheses show the number of chicks.
\# Correction based on an estimate of 13% mortality among chicks in the nest.

Table 3
Productivity of Razorbills (*Alca torda*) measured by different authors in various parts of the distribution area

Region	Study year	No. eggs	Hatching success (%)	Fledging success (%)	Net prod. (%)	Source
Canada	1962, 1963	96	76	88	67	Bédard (1969)
Canada	1978	80	70	87	61	This study
England	1958	31	65	95	61	Brun (1958)
England	1964	86	69	78	53	Plumb (1965)
England	1971, 1972 1973	735	71	94	67	Lloyd (1979)
Denmark	1946	15	53	87	46	Paludan (1947)
Sweden	1971, 1972	446	77	82	63	Andersson *et al.* (1974)

Table 4
Concentration of organochlorine residues in Razorbill (*Alca torda*) eggs taken from the Pèlerins Islands and the Sainte-Marie Islands, 1978. Concentration expressed in ppm on the basis of fresh weight (median, variance between parentheses)

Sampling date and location	N	% lipids	% H_2O	ΣDDT*	Dieldrin	Heptachlor epoxy	α-Chlordane	Oxy-chlordane	Benzene hexachloride	PCB (Aroclor 1260)
Estuary Pèlerins Islands archipelago										
— fresh eggs (29 May)	3	8.7 (8.3–9.8)	72.5 (72.2–73.8)	3.49 (3.05–3.55)	0.23 (0.16–0.25)	0.08 (0.07–0.09)	0.38 (0.33–0.52)	0.15 (0.14–0.16)	0.19 (0.19–0.24)	24.7 (23.2–28.3)
— addled eggs (29 May)	3	10.6 (7.9–10.6)	48.2 (36.2–56.0)	9.45 (8.28–47.15)	0.47 (0.40–0.94)	0.21 (0.15–0.27)	0.60 (0.46–1.18)	0.41 (0.37–0.69)	0.64 (0.54–0.73)	75.4 (63.1–132.0)
Gulf Ste-Marie Islands archipelago										
— fresh eggs (16 June)	5	11.2 (10.7–11.5)	71.3 (64.0–73.5)	1.95 (1.80–2.34)	0.19 (0.10–0.21)	0.07 (0.05–0.08)	0.14 (0.12–0.20)	0.10 (0.08–0.14)	0.20 (0.16–0.23)	10.9 (7.70–11.9)
— addled eggs (24 July)	5	12.8 (11.5–14.1)	68.0 (62.5–69.5)	3.27 (1.74–6.82)	0.17 (0.14–0.22)	0.08 (0.07–0.10)	0.23 (0.08–0.27)	0.12 (0.09–0.18)	0.22 (0.19–0.31)	16.6 (8.4–26.1)

* DDE + p,p'DDT + p,p'DDD

Table 5
Residues of organochlorine compounds in Razorbill (*Alca torda*) eggs expressed in parts per million (ppm) on the basis of fresh weight

Location	Year	Sample size	% Lipids†	% H_2O†	ΣDDT DDE + p,p'DDT + p,p'DDD	Dieldrin	PCB#	References
Canada								
Estuary								
Îles Pèlerins	1978	3	8.9 (±1.9)	72.8 (±2.1)	3.36 (2.73–4.13)‡	0.21 (0.12–0.38)‡	25.3 (19.7–32.6)‡	Current study
Gulf								
Île Ccrossol#	1972	5	14.4 (+1.5)	71.4 (±0.9)	4.55 (1.88–11.03)‡	0.15 (0.06–0.38)‡	21.7 (13.0–36.0)‡	Pearce *et al.* 1979
Île Brion#	1973	3	12.5 (±4.8)	72.0 (±5.4)	2.69 (1.72–4.20)‡	0.12 (0.07–0.21)‡	8.37 (4.77–14.7)‡	Pearce *et al.* 1979
Îles Ste-Marie#	1972	5	17.2 (±2.7)	72.4 (±1.1)	2.69 (1.81–3.99)‡	0.10 (0.07–0.16)‡	9.34 (6.30–13.9)‡	Pearce *et al.* 1979
Îles Ste-Marie	1978	5	11.2 (±0.4)	70.2 (±4.5)	2.01 (1.74–2.31)‡	0.16 (0.11–0.23)‡	10.3 (8.31–12.7)‡	Current study
Sweden								
Stora Karlsö	1970	3	13.7*	—	96	—	98	Andersson *et al.* 1974
Stockholm	1970	5	12.0*	—	71	—	70	Andersson *et al.* 1974
Stockholm	1971	10	10.0*	—	160	—	120	Andersson *et al.* 1974
Stockholm	1972	10	13.2*	—	94	—	83	Andersson *et al.* 1974

* Percentage calculated from the report of ΣDDT residues given on the basis of fresh weight and weight of lipids.
† Arithmetic mean (95% confidence interval).
‡ Geometric mean (95% confidence interval).
§ Concentrations of PCB are reported on the Aroclor 1260 base in order to make comparison with Pearce *et al.* (1979); the concentrations reported for Sweden are not given.
# Means and intervals recalculated from raw data (Pearce, pers. comm.).