# A Recent Decline of Gannets, *Morus bassanus*, on Bonaventure Island, Quebec[1]

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**Abstract.** A comparison of the results of recent surveys of Gannets on Bonaventure Island shows that after increasing greatly over the previous 80 years, the breeding population decreased from 20 511 pairs in 1969 to 17 281 pairs in 1973, a 16% decline. Reduced fertility because of contamination by toxic chemicals (chlorinated hydrocarbons) and disturbance at the colony by tourist boats and visitors on land seem likely to be prime causes. Past population data are reviewed.

**Abstrait.** Une comparaison des résultats de relevés récents des fous de Bassan sur l'île Bonaventure démontre que cette population qui avait grandement augmentée depuis environ 80 années aurait diminuée de 20 511 paires en 1969 à 17 281 paires en 1973, un déclin de 16%. Leur fécondité aurait été réduite par la contamination de produits chimiques toxiques (hydrocarbons chlorurés) ainsi que par des dérangements à la colonie causés par les bateaux touristiques et les visiteurs sur l'île. Des données sur les populations passées sont revues.

## Introduction

The Gannet (*Morus bassanus*) population of Bonaventure Island, Gaspé Peninsula, Quebec (48°30′ N, 64°09′ W) has been known to exist since about 1860, and its history has been documented by ornithologists both in the past (e.g., Lucas 1890; Taverner 1918; Wynne-Edwards et al. 1936) and in recent times (e.g., Peakall 1962; Poulin 1968; Poulin, J.-M. and G. Moisan 1968[2]). The numbers of nesting Gannets at Bonaventure Island have increased very greatly during the last hundred years and reached a population high about 1966. Recent detailed studies of Bonaventure Island Gannets by Poulin (1968), however, show that hatching success (38%) and fledging success (78.3%) are much lower than in colonies elsewhere (e.g., Bass Rock, Scotland (Nelson 1966a, b), hatching success = 82%, fledging success = 92.3%), and that toxic chemical levels (DDE) in both breeding birds and their summer foods (chiefly mackerel, *Scomber scombrus*, and herring, *Clupea harengus*) are significantly higher than those at colonies along the Atlantic coast of Newfoundland (Keith 1969; Pearce et al. 1973). Moreover, egg-shell thinning was detected amongst Bonaventure Island birds in 1969 to an extent, about 17% thinner than pre-1915 eggs) that has been associated with reproductive failure in other birds (Keith and Gruchy 1972; Pearce et al. 1973).

These facts, combined with the knowledge that the Bonaventure Island colony represents about 53% of the total North American breeding population (Nettleship 1975), that it is situated where contamination is most concentrated, and that the island has recently been made a provincial park, have prompted the Canadian Wildlife Service to initiate accurate censusing of breeding pairs by standardized procedures to monitor population size, and to begin detailed studies of the species' reproductive ecology. The purpose of this paper is to reassemble and review past population data

[1]An investigation associated with the program "Studies on northern seabirds," Canadian Wildlife Service, Environment Canada (Report Number 28).

[2]The Gannets (*Sula bassana*) of Bonaventure Island, Quebec. Paper presented at the 1968 Northeast Fish and Wildlife Conference, Manchester, N.H., 14–17 January 1968. 17 pp.

and to report the results of surveys made in 1969 and 1973 in an attempt to provide an insight into current and possible future population performance and trends.

**Methods and Procedures Used in 1969 and 1973**

Procedures used to cenus Gannets at Bonaventure Island in the past have varied widely, ranging from simple visual impressions of bird numbers to ground counts of nests. This variation in census reliability and accuracy has made it impossible to make precise comparisons between population estimates made in different years. To avoid similar difficulties in the collection and interpretation of data in the future, a standardized census method is required to reduce individual observer bias to a minimum and to provide a permanent and precise record of the distribution and numbers of nesting birds. The technique of population analysis from aerial photography, similar to that pioneered by Acland and Salmon (1924) and used to count Gannets in Great Britain (e.g., Salmon and Lockley 1933; Barret and Harris 1965), provides the most effective solution.

The census method used in 1969 and 1973 was basically the same: a series of overlapping aerial photographs was taken on a single visit during the incubation period in early July from a single-engined fixed-wing aircraft. In 1969 a 35-mm camera with a 50-mm lens was used; in 1973 the photographs were taken with a 70-mm camera and 100-mm lens. In both years the film used was Kodak Plus-X black-and-white. The distance from the colony was about 1800 to 2000 feet (549–610 m). The disturbance of nesting birds appeared slight, and no unusual movement from nest territories was detected.

Nesting areas on the cliff-face and on flattish ground at the cliff-top were both easily delimited on the photographs (7 × 10-inch or 9 × 13-inch glossy enlargements) by the extremely regular spacing of white dots (see Figure 1). Occupied nests were systematically counted under a hand lens (8×) using a plastic grid overlay (1 × 1-cm quadrats), following procedures similar to those outlined by Barrett and Harris (1965). Photo quality not only allowed individual nests to be counted, but often made it possible to determine whether one or two birds were associated with each nest. The only sources of error in the colony analyses appear to be in the demarcation of nesting areas on the prints and in accurately counting nests back from the cliff-top on flattish ground towards the inland edge of the cliff-top nesting groups; both are estimated to be low, probably less than 2%. Since only attended nests were counted, and the status of each nest was unknown, this assessment of breeding population represents the number of 'nest-site holders' rather than the number of 'true breeders' (i.e., pairs that built a nest and laid one egg).

**Description of the Colony**

Bonaventure Island is approximately 1.7 miles (2.7 km) long and 1.6 miles (2.6 km) broad at its widest point and is roughly circular in shape with an area of about 1140 acres (460 hectares). The cliffs, made up of a conglomerate-red sandstone mixture, reach a height of 300 feet (91 m) on the southeastern coast where the Gannets nest (Figure 1). The nesting area can be divided topographically into five parts (Poulin 1968; Lafleur, Y. 1969[3]), which together occupy some 3600 feet (1097 m) of cliff. Nests are presently located on ledges on the cliff-face (cliff-ledge habitat) and on flattish ground at the top of the cliffs (cliff-top habitat), although this was not always the case (see next section). The eastern and southern cliffs were made a federal migratory bird sanctuary in 1919.

**Previous Estimates of Colony Size**

Estimates of the numbers of Gannets breeding at Bonaventure Island since its existence as a colony was established are given in Table 1 and Figure 2. Although it appears that the colony was present in 1860 and consisted of large numbers by 1881, it was not until 1887 that an attempt was made to estimate the number of breeding pairs. The methods of conducting the surveys varied considerably between years, making it difficult to identify real changes in the total nesting population. It

[3]Ile Bonaventure 1968. Canadian Wildlife Service Report, Ottawa. 102 pp.

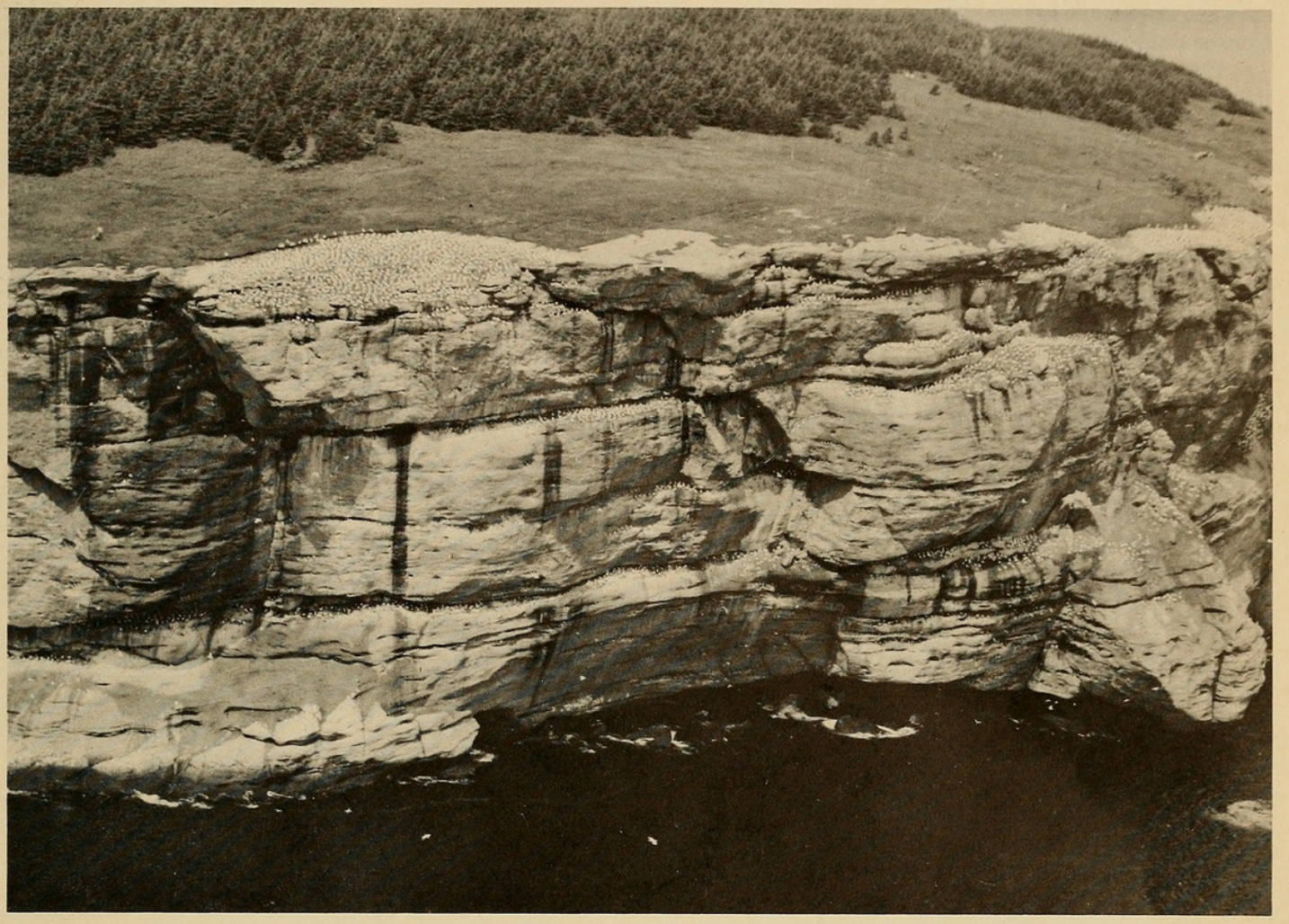

FIGURE 1. Aerial view of a portion of the Gannet colony on Bonaventure Island, 7 July 1973, showing the two principal nesting habitats: ledges on the cliff-face (cliff-ledge) and flattish ground at the top of the cliffs (cliff-top).

seems likely, however, that the colony increased substantially in size between 1887 and 1898, remained fairly stable to 1919, and then increased to about 6000 pairs by 1932, increasing only a little further by 1940.

The first record of a nest on the flat ground at the tops of the cliff was made in 1934 (Poulin and Moisan 1968[2]); by 1940 the numbers nesting on flat ground were substantial (Fisher and Vevers 1943). Figure 3 shows nesting Gannets on the flat ground.

No additional information on the breeding population was collected until 1961, when Peakall (1962) estimated it to be 13 250 pairs, of which 6800 were on cliff-ledges and 6450 were in groups at the top of the cliffs (cliff-top sites). A further increase in numbers occurred between 1961 and 1966, with a total in 1966 (Poulin 1968) of 21 215 pairs, comprising 8967 on cliff-ledges and 12 248 on the top. Both of these increases can be explained by an annual increment of less than 10%, which falls within the reproductive capacity of the colony during the periods of maximum increase (see Fisher and Venables 1938; Capildeo and Haldane 1954; Nelson 1966a).

### 1969 and 1973 Counts

The procedures and method of analysis used to census the breeding population in 1969 and 1973 were virtually identical. The results given in Table 1 show that the total number of breeding pairs has decreased by roughly 16% since 1969. Much of the decrease seems to have occurred amongst birds breeding on ledges on the cliffs: in 1969, the population comprised 11 854 cliff-ledge pairs and 8657 cliff-top pairs (total: 20 511 pairs), whereas in

TABLE 1 — Estimates and counts of Gannets nesting at Bonaventure Island

| Census date | Number of pairs[1] | Census method | Authority |
|---|---|---|---|
| *ca.* 1860 | breeding, no count | — | Fisher and Vevers (1943) |
| 1881 | 'large colony' | — | Brewster (1884) |
| 1887 | *ca.* 1500 | boat count | Lucas (1890) |
| July 1898 | 3500 | boat count | F. M. Chapman *in* Gurney (1913) |
| 1914, 1915 | 4000 | boat count | Taverner (1918) |
| 10, 18 July, 3 Aug. 1919 | 4000 | boat count | Townsend (1920) |
| 1923–1925 | 'numbers increasing' | boat count | Duval (1925), Bond (1926) |
| 1932 | 6000 | boat and ground count | H. F. Lewis *in* Wynne-Edwards (1935) |
| 1934 | *ca.* 6500 | boat and ground count | Wynne-Edwards et al. (1936) |
| Aug. 1938 | 7000 | boat and ground count | V. C. Wynne-Edwards *in* Fisher and Vevers (1940) |
| May, July 1939 | 6600–7000 | boat and ground count | W. Duval and L. I. Grinnell *in* Fisher and Vevers (1943) |
| May 1940 | *ca.* 6680 | boat and ground count | H. F. Lewis *in* Fisher and Vevers (1943) |
| 10–13 July 1961 | 13 250 | combined ground count and boat photography | Peakall (1962) |
| July 1966 | 21 215 | combined aerial photography, boat and ground count | Poulin (1968), Poulin and Moisan (1968[2]) |
| 13 July 1969 | 20 511 | aerial photography | this study |
| 7 July 1973 | 17 281 | aerial photography | this study |

[1] Represents the number of 'nest-site holders.'

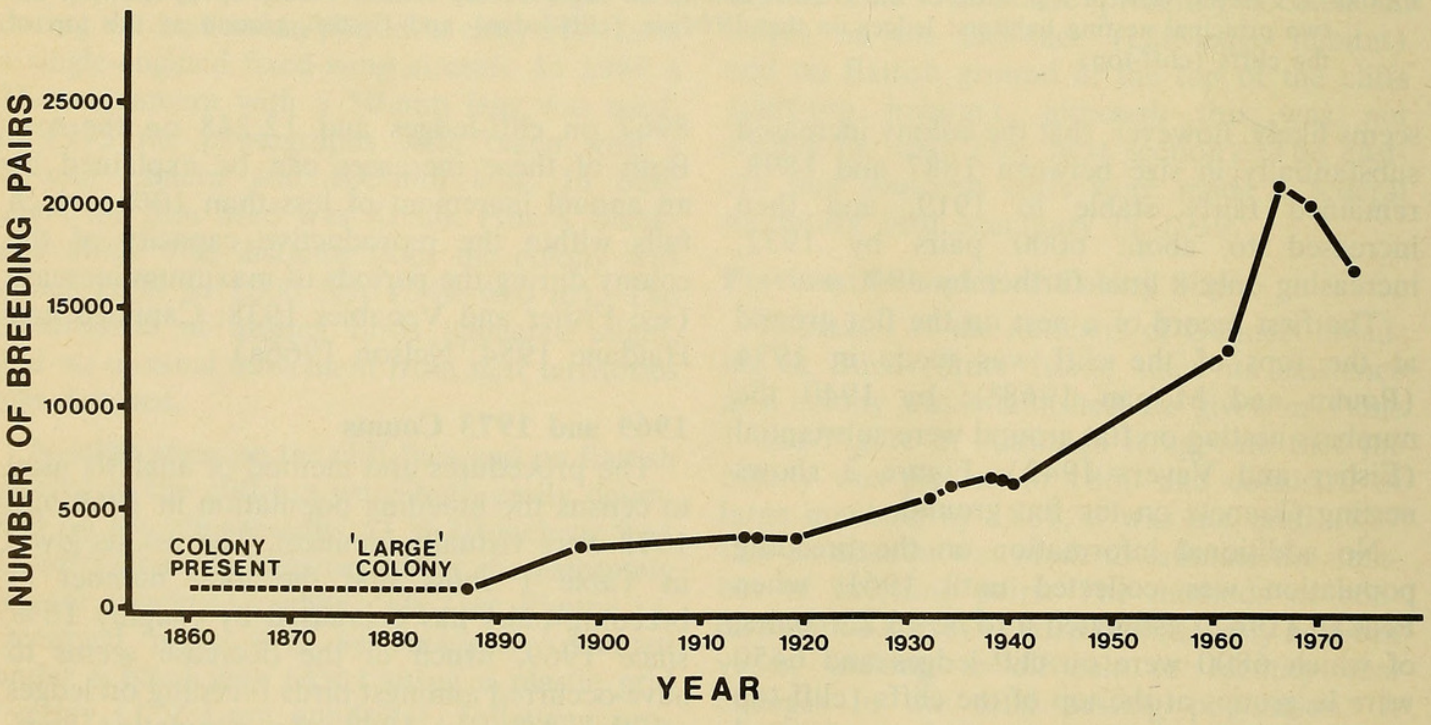


FIGURE 2. Pattern of population changes of Gannets at Bonaventure Island (based on data given in Table 1). Broken line indicates period of known breeding, but no precise counts were made.

FIGURE 3. Gannets nesting on Bonaventure Island, Quebec. Photograph by Philip S. Taylor taken on 29 July 1974.

1973 there were 9274 and 8007 pairs (total: 17 281 pairs), respectively. Thus there was a total loss of 3178 breeding pairs between the two breeding seasons, with 81% of the loss from cliff-ledge habitat and 19% from the top.

The difference between the 1969 and 1966 counts may be due to different methods of counting and estimating the colony, but it may simply indicate that numbers remained relatively unchanged during the period (see Discussion).

## Discussion

### *Population Changes*

The history of Gannets on Bonaventure Island is well known only from 1887, and quite unknown before 1860. The periods of steady (1919 to 1938) and rapid (1940 to 1961, 1961 to 1966) growth of the Bonaventure colony (see Table 1, Figure 2) coincide with the substantial increase in world Gannet numbers, which has been in progress over much of this century (see Nelson 1966b). But although Gannets appear to be still increasing in numbers in most parts of the North Atlantic (Nelson 1966b; Cramp et al. 1974; Nettleship 1975), a serious decrease has begun at Bonaventure Island.

Although there were differences in census procedures used in 1966 and 1969, both estimates of the size of the total breeding population are reliable and should be acceptable as an accurate representation of population events. This means that a maximum in the size of this population was reached in 1966 or within one or two years of that date (based on projections of population size using established potential annual increment rates (Fisher and Venables 1938)). It is, however, impossible to assess the differences, if any, in the distribution of birds on cliff-ledge and cliff-top nesting habitats. Even though a change in habitat utilization is suggested by the data, as measured by the number of pairs found nesting in the two habitats, it seems quite likely that the difference is an artifact of differing habitat delineations and classification made during the analyses rather than an actual change in the extent of use of the habitats themselves. Only an exact comparison of the nesting areas can resolve the question.

The most accurate and comparable surveys of the Gannet colony (1969 and 1973) show that about 16% of the population that was breeding in July 1969 was not present in the summer of 1973. No comparable large reduction is known to have occurred at any time in the preceding 80 years.

There is no obvious reason why the total number of breeding pairs has decreased so significantly, or why most of the loss appears to have occurred from birds nesting on cliff-ledge habitat. Because Gannets are still increasing in numbers in other parts of the North Atlantic (see first paragraph of Discussion), and historically were present in larger numbers in the Gulf of St. Lawrence than at present (Bent 1922; Brown, R. G. B. and D. N. Nettleship 1973[4]; Nettleship 1974), it seems unlikely that recent events at Bonaventure Island can be accounted for by any of the usual explanations associated with a decrease in a bird population or growth curve. Nor can the decline be explained by changes in the physical structure of the cliff-face (produced by erosion and other similar factors) making it less suitable for nesting; the physical features of all the nesting areas appear unchanged (based upon examination of aerial photographs and ground observations). There is also little evidence to indicate an increased emigration of Bonaventure-reared birds to other Gannet colonies in eastern Canada (see Moisan and Scherrer 1973) as has been suggested for the growth of certain colonies in east Newfoundland (Tuck 1960). Two main classes of factors seem possible to explain the decrease: either changes in certain properties at the colony, and/or changes in the food supply (quantity and/or quality) at sea.

### *Disturbance by Tourists*

The progressive increase in the number of tourists visiting the colony during the breeding season and the much higher volume of boat traffic viewing the colony from the sea at the

[4]Seabirds in the Gulf of St. Lawrence. Proceedings of the Canadian Society of Fisheries and Wildlife Biologists, Canadian Society of Zoologists Symposium: Renewable resource management of the Gulf of St. Lawrence, 5 January 1973, Halifax, Nova Scotia.

base of the cliffs might have had some effect. Precise figures are not available to allow a detailed assessment of the increase in human disturbance, but the increase is almost certainly at least 100% since 1965. In 1973, the Percé Boat Association transported about 71 000 people around the island from mid-June to the end of September to view the Gannet cliffs (L. Brochet, personal communication). Allowing 25 people per boat-trip, this means that at least 2800 trips were made. What influence this large volume of boat traffic has on the cliff-nesting Gannets is impossible to estimate at this time, but it is unlikely to be beneficial. But even if it does not influence the outcome of breeding attempts, observations made in 1974 indicate that it probably seriously disturbs non-breeding birds which are trying to establish sites on the cliff-face. A related factor, the exhaust fumes from the boats, might also have an adverse effect on Gannets. Both these factors either alone or together could conceivably lower annual production and reduce the rate of recruitment into the cliff-ledge sites.

There is also the disturbance factor created by people visiting the Gannet colony on foot on top of the cliffs. While the increase in visitation on land is poorly documented, it too appears to have increased dramatically since 1965. At least 18 000 visitors landed on Bonaventure Island in 1973 (C.W.S. Bonaventure files), most of whom visited the Gannet colony during the critical periods of incubation and early chick growth (mid-June to mid-August). Ground surveys at the colony in 1974 with J.-M. Poulin indicate that cliff-top areas which receive heavy visitation have receded (i.e., Gannets absent in areas where they nested in 1966 and 1967), whereas some areas with little or no visitation are expanding (i.e., Gannets now nesting in areas which were without nests in 1966 and 1967). All this refers to tourists on foot on the top of the cliffs. Moreover, 1974 data of the behavior of people visiting the colony indicate that up to 25% of visitors do cross the rope fences and by doing so disturb nesting birds (e.g., interrupt incubation, brooding and feeding of young, and cause the dispersion of chicks away from their nest-sites resulting in an increase in pre-fledgling mortality).

Combined, these factors alone could account for the observed decline in Gannet numbers and the differential loss in the two habitats. But there also remains the question of the importance of a changing food supply and other factors at sea.

*Food Supply and Toxic Chemicals*

Less obvious factors away from the colony which might explain the decrease include changes in the distribution and numbers of mackerel and herring (the main summer foods of Gannets at Bonaventure Island) due either to over-fishing by man or to man-made alterations to water characteristics in the Gulf of St. Lawrence (e.g., rate of water run-off (Neu 1970)). Our lack of knowledge makes it impossible to assess these parameters adequately, although the annual catch of mackerel is known to have decreased in recent years in the Gulf region.

A more immediate contributory cause of the Gannet population decline might be environmental contamination by toxic chemicals. If the relatively high DDE levels found in the eggs (Keith and Gruchy 1972), young (Keith and Gruchy 1972; Pearce et al. 1973), and brain tissue of adult Gannets (Pearce et al. 1973) and in their summer foods at Bonaventure Island (Pearce et al. 1973; Duffy and O'Connell 1968; Sprague and Duffy 1971) were responsible for the low breeding success recorded in 1966 and 1967 by Poulin (1968) and the egg-shell thinning, and annual production remained low in subsequent years, the population decrease might be explained by reduction in the number of young produced and a correspondingly low rate of annual recruitment insufficient to maintain population size. The difference in the extent of the losses in the two nesting habitats might then also be associated with the age structure of the population, especially if a fairly large number of breeding adults reaches maximum longevity at more or less the same time. In other words, if annual production and recruitment are insufficient to maintain population size, and a large proportion of the birds nesting on the cliff-face consists of older birds (as suggested by population events since the 1930s), it is conceivable that losses due to a lengthy low annual repro-

ductive rate in both habitats may first become evident on the cliff-face as older birds die from old age more or less simultaneously and are not replaced, whereas a disproportionate number of breeding birds on cliff-top habitat might be in a younger age class. The average life expectancy of a breeding adult Gannet is poorly known, but Nelson (1966a) gives 16.2 years for birds at a colony in Scotland, though individual Gannets are believed to have lived for as long as 40 years. If this is the case, we can expect a continuing low breeding success, especially hatching success, followed by further decreases in population size. Alternatively, if contamination levels become much lower and breeding success markedly improves, the population might recover and return to its former size.

## Conclusions

Much more, however, needs to be known about the factors mentioned above if causal relationships are to be elucidated. At present, it is only possible to conclude that the Gannet population decline at Bonaventure Island may be due partly to contamination by toxic chemicals at sea originating from the polluted St. Lawrence River, partly from an unmanaged visitation at the colony by people on foot and on the water by boat, and to one or more undetermined factors, possibly including changes in the availability of summer food. All this indicates that further studies are required and that any increase in tourism (especially now that the island has been made a provincial park) must be carefully designed and implemented to prevent further deterioration of this uniquely rich seabird area.

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