[redacted]

LASKEEK BAY RESEARCH

5

LASKEEK BAY CONSERVATION SOCIETY

ANNUAL SCIENTIFIC REPORT, 1994

March 1995

LASKEEK BAY RESEARCH

5

LASKEEK BAY CONSERVATION SOCIETY

ANNUAL SCIENTIFIC REPORT, 1994

Edited by

ANTHONY GASTON, JANET BROWN and KATHY HEISE

March 1995

Copyright: Laskeek Bay Conservation Society

Box 867, Queen Charlotte City, B.C. V0T 1S0, Canada

Suggested citation: Gaston, A.J., Brown, J. and Heise, K. 1995. Laskeek Bay Research 5. Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

LASKEEK BAY CONSERVATION SOCIETY

The Laskeek Bay Conservation Society is a volunteer group based in the Queen Charlotte Islands. The society is committed to increasing the appreciation and understanding of the natural environment through:

sensitive biological research that is not harmful to wildlife or its natural habitat

interpretation and educational opportunities for residents of and visitors to the Queen Charlotte Islands

Established in 1990, the society is committed to a long-term seabird research programme in the Ancient Murrelet colony at Limestone Island. For further information, contact:

Laskeek Bay Conservation Society
Box 867, Queen Charlotte City
British Columbia V0T 1S0
Phone (604) 559-4582

BACKGROUND

The goals and objectives of the Society are:

1. To undertake and support research and long term monitoring of wildlife populations, including nesting seabirds and other marine birds, forest birds, marine mammals and introduced species of the Laskeek Bay area (roughly coastal waters of Hecate Strait from Cumshewa Inlet to Lyell Island) of Haida Gwaii, the Queen Charlotte islands.

2. To provide information on all aspects of the biology of the Laskeek Bay area for residents of Haida Gwaii, the Queen Charlotte islands, and visitors to the area.

3. To encourage students and residents of the area to participate in field programs and to undertake and assist in presentations and other activities that promote better understanding and improved conservation of marine birds and forested and marine ecosystems throughout Haida Gwaii, the Queen Charlotte Islands.

The Laskeek Bay Conservation Society organizes a volunteer programme each summer to carry out educational activities based on biological monitoring and research. During the past five years, a camp at East Limestone Island has been operated during the spring and early summer. In 1994 it was run from early April to mid-July. In this report we present observations from 1994, as well as a five-year summary of results to date, emphasizing what we have learned about inter-year variation and the directions that our programmes might take in future.

The scientific work of the Society continues and extends a programme that was initiated by the Canadian Wildlife Service in 1984. The aim of the work is to provide long term information on the biology and ecology of marine birds. Because they are top predators in marine food webs, marine birds are very sensitive indicators of environmental change. Things like the abundance of zooplankton, that may be difficult and expensive to measure directly over large areas, are reflected in changes to the behaviour and abundance of marine birds. By tracking a variety of species, with different habitat and diet needs, we can obtain an overall measure of the health of the marine ecosystem locally. Because marine waters may be subject to cyclical or directional changes operating at the scale of decades, such observations become most valuable when they are tracked consistently over many years.

During the last year, the Society contributed information to the Pacific Seabird Group's "North Pacific Seabird Monitoring Database". This programme is designed to integrate information from seabird monitoring studies around the entire North Pacific, involving researchers from Mexico, the U.S.A., Canada, Russia, Japan, Korea and China. The L.B.C.S. is making a major part of the Canadian contribution to this Database, which should provide information that will allow tracking of major oceanographic and climatic events that affect seabirds over large parts of their range.

In addition to the marine bird work, the Society is undertaking several other studies aimed at better understanding of the marine and terrestrial ecosystems of the Laskeek Bay area. These studies include maintaining records of all marine mammal activities in the area, and monitoring the sea lion haul-outs, gull colonies and Peregrine Falcon eyries. Studies of forest bird populations, including songbirds and woodpeckers, were begun in 1992. Documentation and study of rare plants and introduced mammal species on Limestone Island have also been initiated.

The seabirds programme concentrates on the biology of the Ancient Murrelet, a small diving bird more common in Haida Gwaii than anywhere else in the world. Its population has decreased

substantially over most of its range across the North Pacific, mainly because of predators introduced either deliberately (foxes, raccoons), or accidentally (rats), by people. Knowledge about what is happening to Ancient Murrelet populations is important for the conservation of the species, both in Canada, and worldwide. In 1993, at the suggestion of the Laskeek Bay Conservation Society, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) commissioned a report on the status of the Ancient Murrelet. As a result it has been declared vulnerable in Canada. The surveys being conducted by the Society constitute the only long term study of Ancient Murrelets ongoing anywhere in the world.

The Society also carries out surveys of Marbled Murrelets, which nest mainly in old-growth forest. The species' breeding habitat has been much reduced by logging activities in British Columbia and further south in the U.S.A.. COSEWIC has declared it to be threatened in Canada. In 1989 the Canadian Wildlife Service carried out boat surveys to determine the numbers of Marbled Murrelets feeding at sea around Louise Island, especially along those stretches of coast where the old growth forest is slated to be felled over the next few years. The Laskeek Bay Conservation Society is continuing these surveys on an annual basis to provide an indication of the effects of logging on the Marbled Murrelet population. The sequence of boat surveys carried out to date is the longest run of replicated Marbled Murrelet surveys in Canada.

A note on this report. As in previous years, the format of many of the tables and figures presented are identical to those shown in earlier reports, with the addition of the 1994 data. We have done this deliberately to emphasize the continuity of the research from year to year.

BRIEF SUMMARY OF SCIENTIFIC ACHIEVEMENTS 1990-94

- Measured population changes, breeding success and adult survival of Ancient Murrelets at East Limestone Island, and factors affecting the survival of chicks up to their return to the colony.

- Monitored the level of raccoon predation at East Limestone Island to estimate its effects on the Ancient Murrelet and Cassin's Auklet population.

- Carried out regular transect surveys of northern Laskeek Bay throughout April-July to estimate numbers of Marbled Murrelets and other seabirds using the area.

- Censused Glaucous-winged Gull colonies and Black Oystercatcher territories in Laskeek Bay and recorded breeding success and food fed to chicks of Black Oystercatchers (from 1992).

- Kept records of marine mammal sightings in Laskeek Bay, including regular counts of sea lion haul-outs.

- Censused and mapped Red-bellied Sapsucker nests on East Limestone Island annually from 1991.

- Assisted with research on the impact of introduced red squirrels on breeding songbirds and the effects of introduced Sitka black-tailed deer on the structure and composition of island vegetation.

ACKNOWLEDGEMENTS

The Laskeek Bay Conservation Society is non-profit volunteer-run organization, and could not operate without the generous support from a wide variety of groups and individuals. We gratefully acknowledge the contributions of all our supporters and apologize to any we may have inadvertently omitted from this list:

•The National Wildlife Research Centre of the Canadian Wildlife Service, for financial support and equipment loans;

• The Canadian Wildlife Service, Pacific and Yukon Region, and especially Gary Kaiser, for financial support and equipment loans;

• The Canadian Parks Service, for financial support, and the loan of night-viewing glasses;

• The Ministry of Environment, Lands, and Parks, Wildlife Branch, for permission to conduct our programs in the Skedans, Limestone, and Reef Islands Wildlife Management Area;

• The Gwaii Haanas Archipelago Management Board for permission to conduct surveys in the southern Laskeek Bay area;

• Dr. Cort Mackenzie for his exceptionally generous donation;

• Penny Richardson, Maggie Stronge, Oakley Dyer and Betsy Williams, Michael and Sandra Thomson, Ian Kwantes, Scott Whittemore for donations of money to support the camp;

• Queen Charlotte Adventures, with the vessels Anvil Cove and Spruce Cove, Keith and Barbara Rowsell and Mary Kellie for providing boat transport of people and gear for start-up in April and close-down in July;

• Marvin Boyd and Dan Pick at South Moresby Air Charters, for safe and efficient weekly transport of volunteers, gear, and groceries;

• Keith Rowsell, for building us a fine wood stove;

• Terry Husband on Kingii for bringing mail and supplies during trips to drop off and pick up school groups at Vertical Point

• Blue Water Adventures, for transporting the inflatable from Queen Charlotte safely to our boat shed;

• Nathalie Macfarlane and the Queen Charlotte Islands Museum Society, for continuing to provide us with meeting space and storage space for all our gear;

• All of the in-town support people who bought groceries, met volunteers, and picked up the garbage;

• The many people who gave donations or bought LBCS t-shirts at Limestone Island;

• And finally an enormous appreciation of each volunteer who came to East Limestone Island to discover and to help. We hope to see you again!

CONTENTS

ACTIVITIES IN 1994, OVERVIEW

Observers were present at Limestone Island from 5 April to 15 July in 1994. A total of 337 person-days of work was performed over the 14 week period. Of these, 275 days were contributed by 27 volunteers who stayed on Limestone for periods of one to five weeks. Nineteen of these volunteers were Queen Charlotte Island residents, of which five had returned from previous years. An additional 15 days were contributed by 3 volunteers who stayed for less than a week.

The first half of April was characterised by rather stormy weather, with rain almost daily, culminating in a virtual hurricane on 14 April that brought down several mature trees in the area at the head of Spring Valley and also blew the top off a large cedar beside the Boat Cove. Thereafter, conditions were generally moderate, but wet until 23 April, after which there was rain on only three dates in the following month. Heavy rain on 23 May heralded another stormy period that lasted until 3 June.

Trapping of Ancient Murrelet chicks. The chick trapping funnels were operated from 7 May to 11 June. Funnels were operated from darkness to at least 1 a.m., if no chicks were seen, or to 1 h after the last chick was recorded. Altogether, 618 chicks were caught in the funnels, of which all but 1 were banded. A further 40 were banded in burrows, and 17 outside funnels, for a grand total of 674 banded. The number trapped in the funnels was slightly lower than in 1993.

The highest recorded number of chicks caught in a night was 52, on 22 May. By 21/22 May, 50% of the chicks had passed through the funnels.

Trapping adult murrelets. Trapping of adults was carried out from 7-14 April and again from 14 May onwards. During April, trapping was not begun until about 1 h after the birds had begun to arrive, to reduce the possibility of trapping females arriving to lay eggs. In fact, no females with eggs were caught. Trapping was terminated when pairs began to incubate. Adult birds were banded, measured, weighed, and inspected for brood patches, and damage to feet and webs. We captured 173 adult birds, of which 44 had been banded in previous years. Ten of the 1994 retraps were banded as chicks on Limestone Island, two in 1990, five in 1991 and three in 1992.

Ancient Murrelet breeding biology. Beginning on 7 April, we inspected 83 study burrows daily for eggs. After 30 April, 22 burrows where no entries (tags knocked down) had been recorded were dropped from the inspections. At burrows where laying occurred, we measured the

first egg laid, using callipers for the length and maximum diameter, and a digital electronic balance for the weight. Once the first egg was laid, the burrow was fitted with a temperature probe which was used to observe the progress of incubation (for details of methods, see Report #2). After the clutch had been incubated for 30 days, the burrow was inspected, and if hatching had occurred, the chicks and adults were removed for weighing and banding and then replaced.

Eggs were laid in 27 burrows, of which 22 were also occupied in 1993. Incubation was successful in 22; 3 were deserted, one possibly as a result of our activities, one was dug up by a predator, and the result of one could not be determined. We caught 33 adults in burrows for banding, of which 15 were retraps from previous years.

Raccoons. Regular searches for raccoon sign were conducted in 1994. One raccoon was seen on East Limestone Island on 1 June. Fresh scat was found regularly, especially along shoreline areas and on West Limestone Island, where Ancient Murrelets also nest. In early June, B.C. Ministry of Environment and Parks staff killed four raccoons near Vertical Point. However, at least one raccoon continued to survive on East Limestone Island after June 10.

As in earlier years, we estimated predation rates by counting the number of Ancient Murrelets killed along seven 20m wide transects, which cover 17% of the colony area. Methods used were described in Report #2 (Gaston et al. 1992). The predation rate estimated for 1994 was similar to that seen in other years when raccoons were present, and higher than in 1992, when raccoons had been eradicated before the start of the season.

Boat surveys. Boat transects to estimate numbers of seabirds in the near shore and offshore waters of Laskeek Bay were conducted from a 4.5 m inflatable boat run at a constant speed. Sightings were recorded on a hand-held tape recorder. Those birds that were sitting on the water, or which flew up at the approach of the boat, were recorded as on the water. A note was made when birds were estimated to be more than 200 m from the boat's course and interesting observations of birds in flight were also recorded.

A total of 58 km of transects was traversed bi-weekly between 9 April and 10 July. Additional surveys were carried out in the waters east of Reef and the Skedans Islands, and three surveys in the area between Haswell Island and Lyell Island.

Seven surveys of each transect line were conducted. High numbers of Marbled Murrelets and Rhinoceros Auklets were recorded, but not as

high as those seen in 1993. The distribution of major concentrations was very unpredictable from survey to survey, although, as in previous years, maximum numbers were frequently seen between Limestone and Haswell islands. Surveys from Haswell Island south to Lyell Island produced large concentrations of Marbled Murrelets, as in 1992.

Numbers of Sooty Shearwaters were generally small and Black-legged Kittiwakes were much less common than in 1993, maintaining the record of even years having few kittiwakes. Pacific Loons, Cassin's Auklets, Ancient Murrelets, Common Murres, Pelagic Cormorants and Glaucous- Winged Gulls were also seen regularly.

Observations from shore. A regular log was kept of casual observations of birds and mammals throughout the area. From 7 April to 11 June a ten minute count of Ancient Murrelets flying over the gathering ground, to the east of Cabin Cove, was carried out nightly (see Report #4 for methods). This count provides an index of the numbers of Ancient Murrelets waiting to visit the colony that night, and hence an indication of how much activity to expect on the colony. The highest number of birds counted was 220, on 13 April. Counts were similar to previous years.

Black Oystercatchers. Oystercatchers are a very prominent bird of the Laskeek Bay area, breeding on most of the smaller islands. A programme to study their dispersal and breeding was initiated in 1992. This year, 30 Black Oystercatcher nests, of which 28 were active, were surveyed in Laskeek Bay. The first eggs were noted May 25 and the first chicks were found June 18. Twenty-three chicks were weighed and given yellow colour bands. Food materials were also collected in the vicinity of nest sites to study chick diets. The highest number of nests found were in the Reef Island area (8 nests), in the Skedans Islands (7 nests) and on South Low Island (5 nests).

Glaucous-winged Gulls. Our counts of nests, eggs and chicks at colonies in the Laskeek Bay area are intended to determine whether local populations are increasing, as they are in the Straits of Georgia. We counted 352 Glaucous-Winged Gull nests in Laskeek Bay, of which 63% were on the Lost Islands (221 nests) and a further 27% on Kingsway Rock (95 nests). Overall, we counted 44% more nests than in 1993, but this included 19 nests at Cumshewa Island that was not visited last year.

Cassin's Auklets. This year saw the first successful breeding in one of the nest boxes placed on Cassin's Tower in March 1992. One chick was successfully fledged. This was the first case of nest-box use by a Cassin's Auklet in Canada. Further trapping of adult Cassin's Auklets was carried out at Reef Island and a revised estimate of annual adult survival rate calculated.

Sapsucker studies. Red-breasted Sapsucker surveys were expanded this year by describing the location and condition of nest trees according to established classification procedures. The sample of nest trees increased to 28, of which 15 were active in 1994. At least 4 pairs of Hairy Woodpeckers were observed on East Limestone Island, but no Flickers were known to have nested.

Other bird studies. Songbird point counts were conducted occasionally on East Limestone Island to increase our songbird identification skills. Through the season, we also identified a total of 66 bird species, from loons to grosbeaks.

The Peregrine Falcon eyrie was active again in 1994, with 2 fledglings successfully reared. The pair have reared young in four out of the last five years. A family of Common Ravens (2 adults, 2 young) used a nest tree near the Boat Cove. Two Bald Eagle nests were active in Crow Valley for the first time in our records, both with almost-fledging chicks when we left on 15 July.

Botany. Plant diversity and development were noted as in previous years.

Intertidal surveys. Three intertidal plots (0.5 square metres each) were established in May at Cabin Cove, each at a different stage of the tide. The plots were visited 25 May, 23 June, and 12 July at the lowest low tides to record all plants and animals present. The diversity of organisms was inspiring, with 21 species of plants and 27 species of animals.

Marine Mammal Surveys. Eleven species of marine mammals, including four seals and seven whales, were observed in Laskeek Bay.

Steller Sea Lion numbers and seasonal trends on the Skedans Islands and the Reef Island Rocks, were fairly similar to 1993. California Sea Lions were recorded twice on Reef Island Rocks, after last year's first record for Haida Gwaii: the species is expanding rapidly in southern B.C. A mature male Northern Elephant Seal was seen several times.

Counts of Harbour Seals at intertidal haul-outs were recorded on Cumshewa, Skedans, Low, South Low, Reef, and Lost Islands. The largest group, 80 animals, was seen on the Cumshewa Rocks on 15 June and

the first pup was seen on 9 June at West Limestone Island.

Orcas were seen five times; once in April, and 4 times in July. Dozens of photos were taken, allowing the identification of individuals. Two females with calves, part of a large pod seen in July, were also reported from the mainland coast. Two Grey Whales and 2 other whales (possibly Sei Whales) were sighted in April; 3 Humpback Whales were seen in June, and Minke Whale were seen in May and June. Harbour Porpoises were sighted individually and in groups of 2 or 4, on eight occasions. Pacific White-sided Dolphins, in groups of 4 to 200 individuals, were sighted 11 times.

Impact of Introduced Predators. Dr. Jean-Louis Martin of the Centre National de Recherche Scientifique in Montpellier France returned for a brief visit to Limestone Island in late June and equipped his dummy nests with automatic cameras to record the identity of predators. This provided conclusive evidence that the most common nest predator on small land birds at Limestone Island is the Red Squirrel.

ANCIENT MURRELET CHICK TRAPPING

Background

Chicks usually leave their natal burrow on the second night after hatching and make their way to the sea, either with their parents, or on their own, after their parents have flown to the sea (Gaston 1992a). We catch them by means of plastic fences ("funnels", because of their V-shape) that guide them to trapping stations near the beach. They are weighed and banded before being taken to the sea and released. This procedure does not appear to affect their ability to rendezvous with their parents and make a successful transition to life at sea. For information on the aims and rationale for chick trapping, see Report #4.

Six funnels have been used each year since 1990, four on the north-east coast (N1-N4), one at the Cabin (C5) and one in Spring Valley (S6). They are kept in exactly the same place from year to year, to ensure that numbers trapped are comparable.

Results in 1994

In 1994, the first Ancient Murrelet chicks were captured on the night of 7 May and the last on 8 June. In the trapping funnels, we captured 618 chicks, a reduction of 5.2% over the number trapped in 1993. The highest total caught in one night was 52, on 22/23 May; 80% were trapped between 13-24 May and 90% between 13-29 May.

The median date (date by which 50% of chicks had left) for all captures was 21/22 May; two days later than in 1993 (Appendix 1, Figure 1). Unlike previous years, the mean date of departures was very close to the median, indicating that there was no "tail" of late chicks at the end of the season. Consequently, the mean date of departure was slightly earlier than in 1993, when the peak of departures occurred substantially before the mean (Report #4). Assuming an incubation period of 32 days, and two days between hatching and departure, the median date of clutch completion in 1994 was 17 April. As the two eggs are laid 8 days apart, the median date of laying for first eggs was 9 April.

Although the date of capture of chicks in the different funnels has been very similar in all years, there seems to be a tendency for chicks to be captured slightly earlier in the season in funnel #1, where the median departure date has been the earliest of the six funnels in four out of the

five years for which we have data (Figure 2).

Most chicks were trapped in the funnels between midnight and 01.30 h (68%, N=638). Chicks departing before 23 May left approximately half an hour earlier, on average, than those departing later in the season, presumably because of the change in the timing of sunset (Figure 3).

FIGURE 1

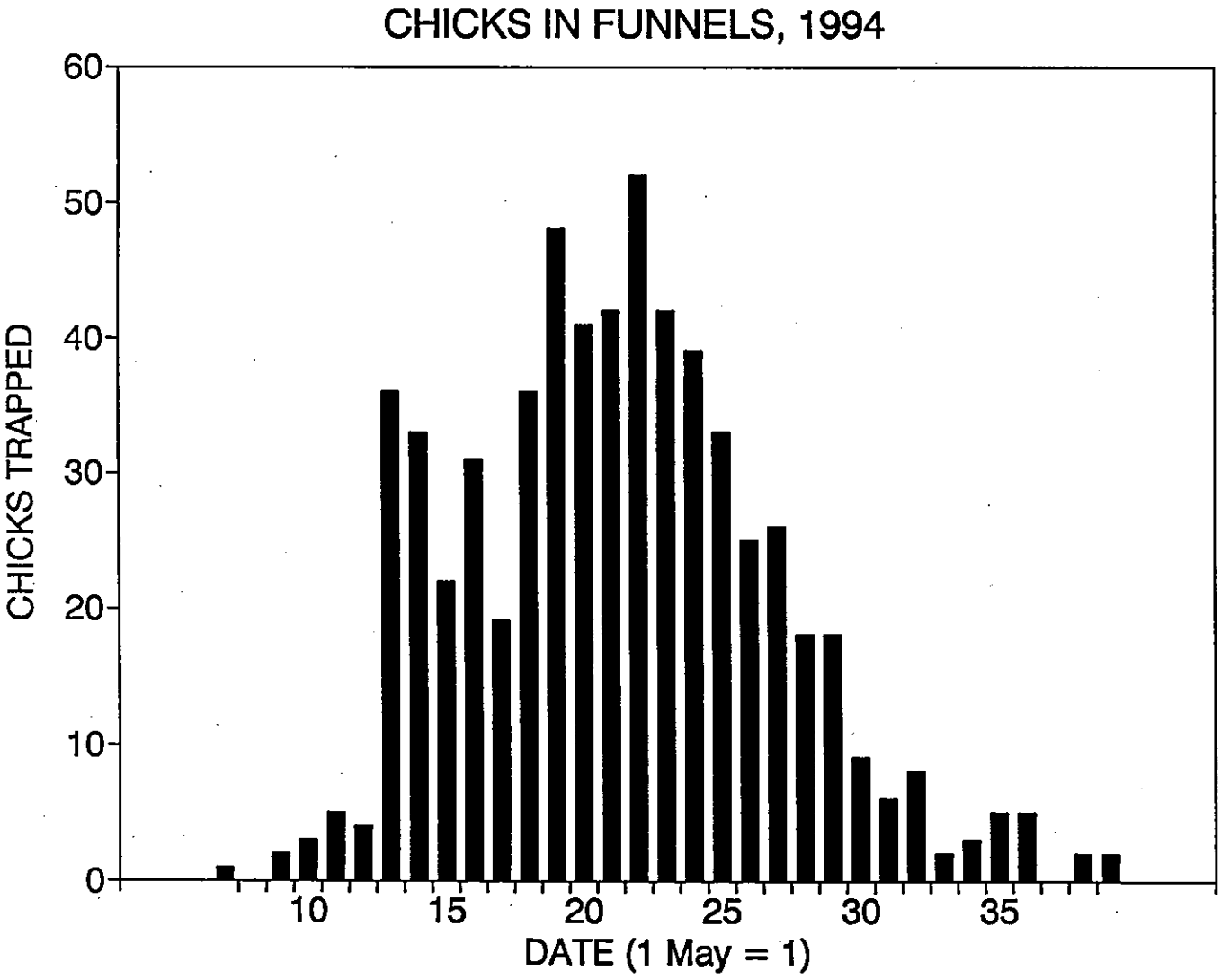


FIGURE 2

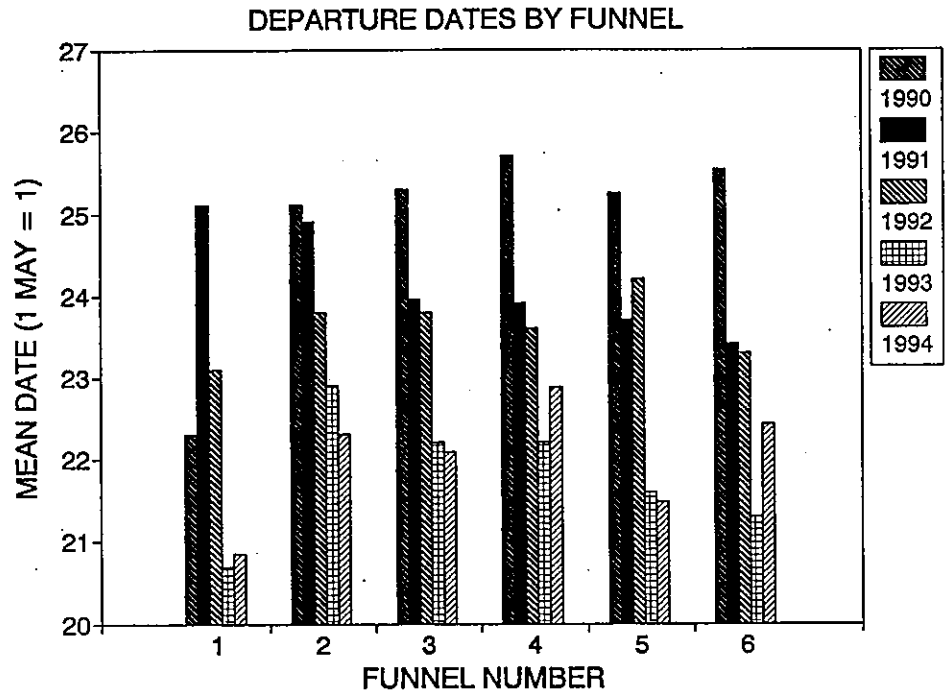
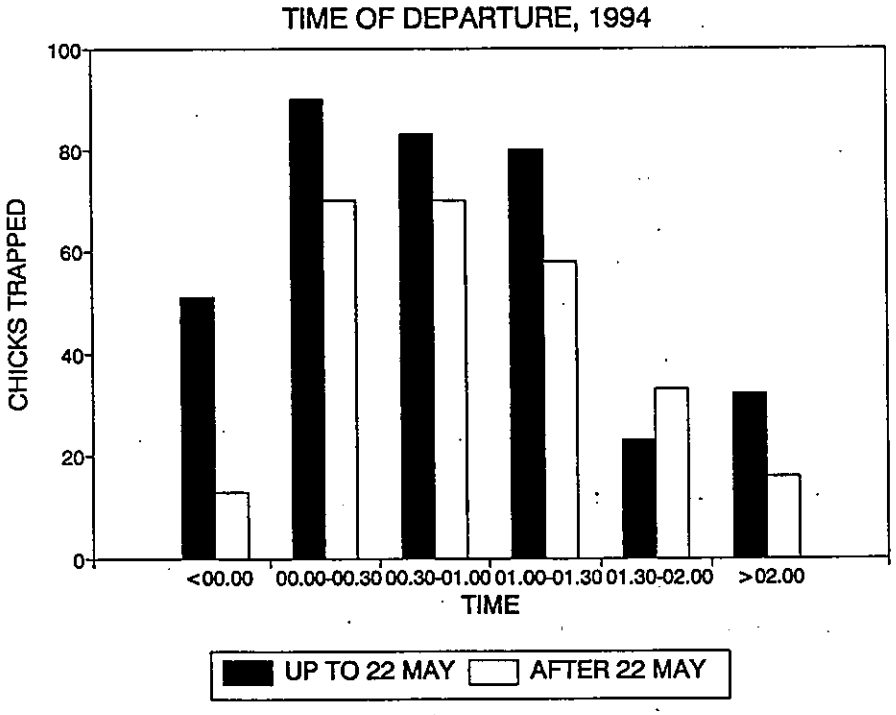


FIGURE 3



Chick weights

The mean weight of all chicks trapped in funnels was 27.3 ± 2.1 g (N=607, Figure 4). There was no difference in the mean weight of chicks trapped at the different funnels. There was no trend in weight over most of the season, but chicks trapped after 29 May tended to be lighter than those trapped earlier (Figure 5). Although peak weights occurred in the period 21-23 May, around the median date of departures, there was no significant difference in weight among three day periods up to 1 June. This pattern is not much different from earlier years, although a general decrease in weight throughout the season occurred in 1990.

Inter-year comparisons

Since 1990, 3381 chicks have passed through the funnels, most of which have been banded and weighed. Overall, the Spring Valley funnel has caught the most chicks (24%), followed by #3 on the NE shore. Changes in numbers from year to year appear fairly consistent at different funnels. All showed a decrease between 1990 and 1991, most showed a slight increase from 1991 to 1992 and similar numbers were caught in 1992, 1993 and 1994, although there has been a slight downward trend (Figure 6). Although the general trend of numbers captured since 1990 appears to be downward, there seems to be a small but steady increase occurring at funnel #1 (Figure 7).

The mean date of capture of chicks in the funnels was the earliest yet recorded and the past five years has seen a continuous trend towards earlier breeding at Limestone Island (based on mean dates, Table 1).

Table 1. Mean and median dates of chicks captured in the funnels at East Limestone Island, 1990-94

YEAR	MEAN	S.D.	MEDIAN	N
1990	25.2	6.7	23	865
1991	23.9	5.6	23	579
1992	23.6	4.4	22	671
1993	21.8	6.1	19	643
1994	21.3	5.6	21	618

FIGURE 4

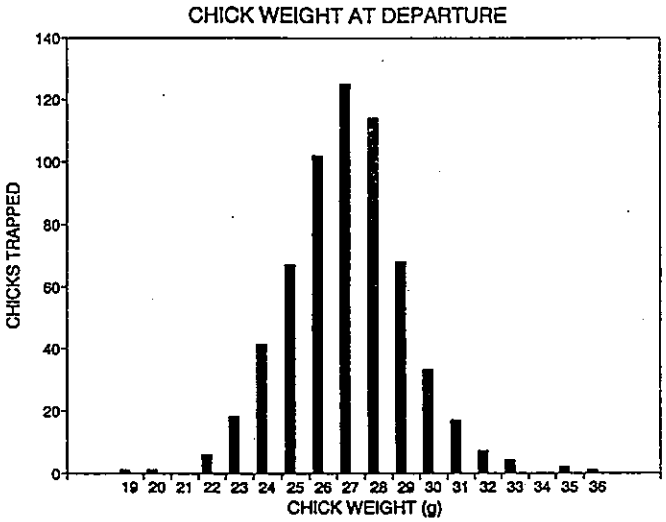


FIGURE 5

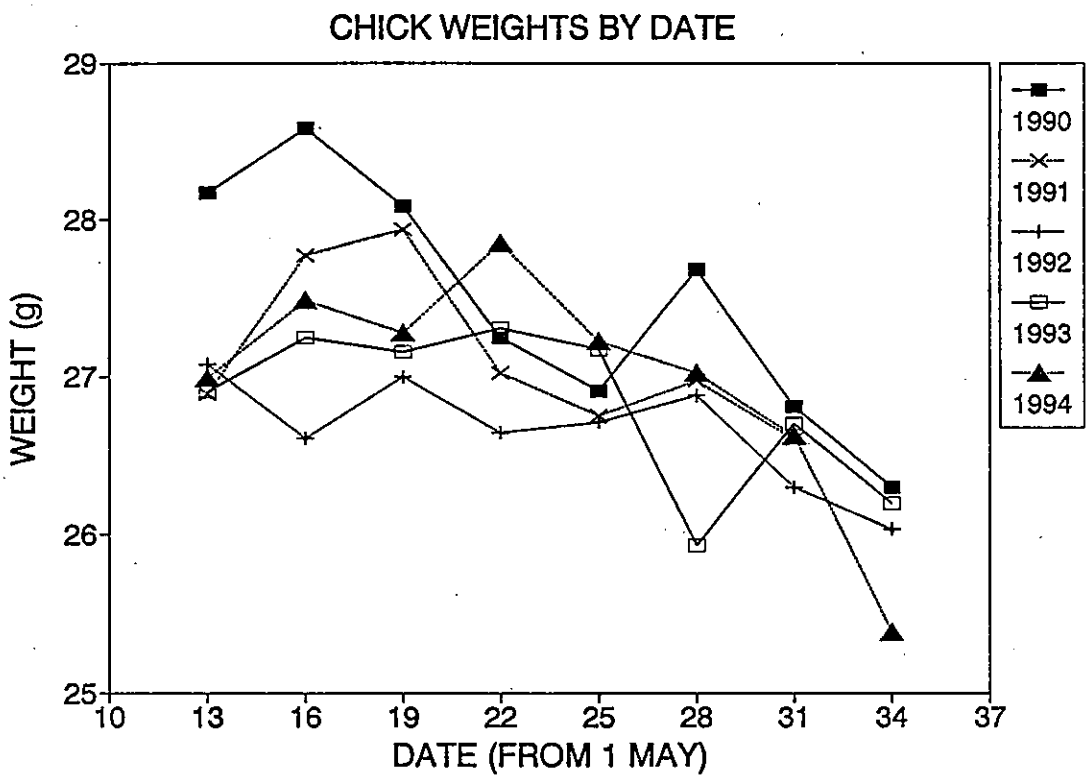


FIGURE 6

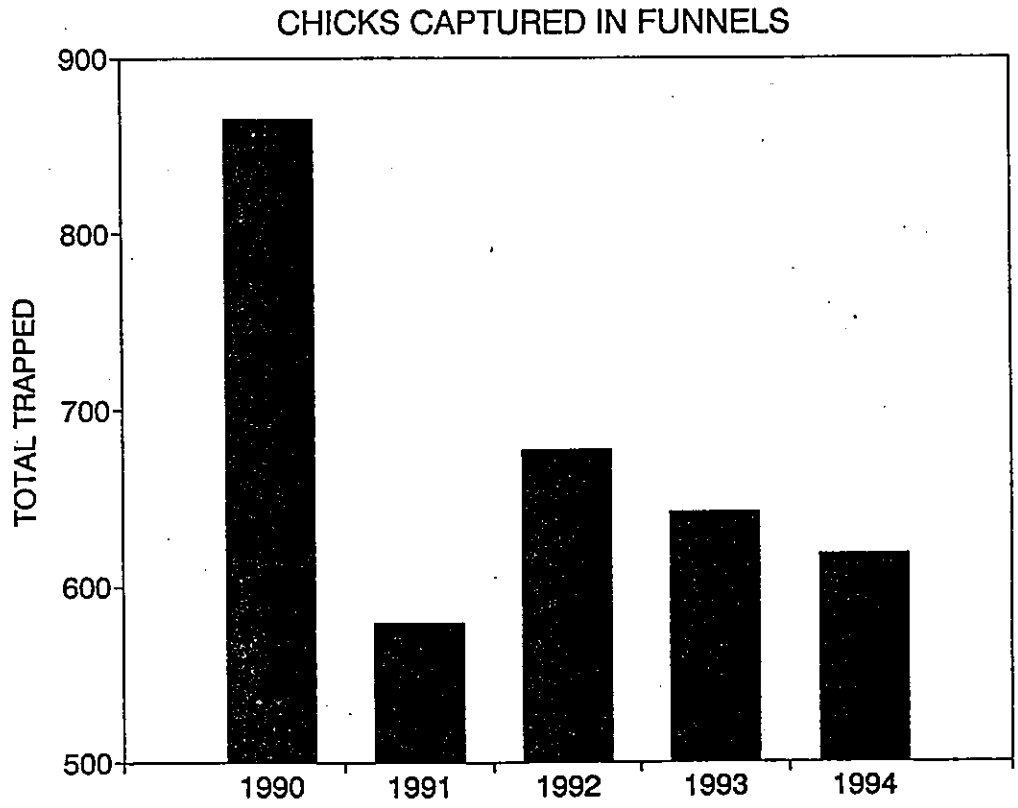
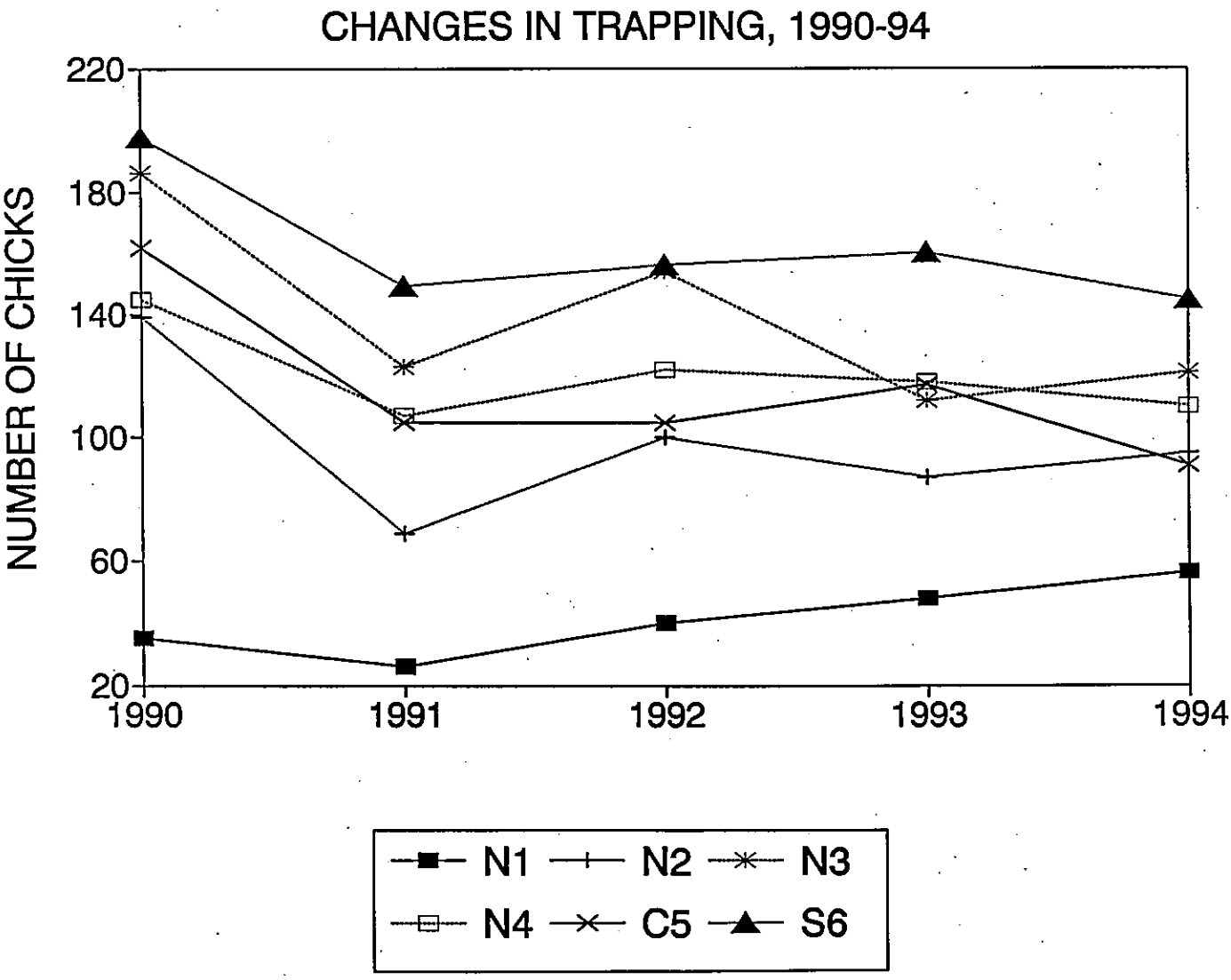


Table 2. Chick weights by year

YEAR	MEAN	S.D.	N
1990	27.7	2.5	865
1991	27.1	2.0	579
1992	26.7	2.1	671
1993	27.0	2.4	643
1994	27.3	2.1	607
Combined	27.2	2.2	3365

FIGURE 7



TRAPPING ADULT ANCIENT MURRELET IN 1994

Numbers trapped and retrapped

During the first half of April, we caught 42 adult Ancient Murrelets, of which 14 were retraps from earlier years. Most were caught at the North Cove and near the Junction. We left the area behind the cabin and around the Spring Valley burrow plot undisturbed. After the beginning of the chick departure period, a further 131 adults were caught on the surface, including 30 banded as adults in earlier years. This trapping was spread throughout the colony. Breeding status was judged on the basis of the size of the brood patches (>19 mm across = breeder).

Thirty adults were removed from burrows after hatching, of which 15 had been banded in previous years. Eleven of them had been banded in the same burrow in earlier years, and one had been banded in 1991 in a different burrow. Three pairs captured in the same burrow had also been paired together in earlier years. The other three retraps had been banded after being caught on the surface in previous years, two as breeders (in 1990 and 1991) and one as a non-breeder (1991).

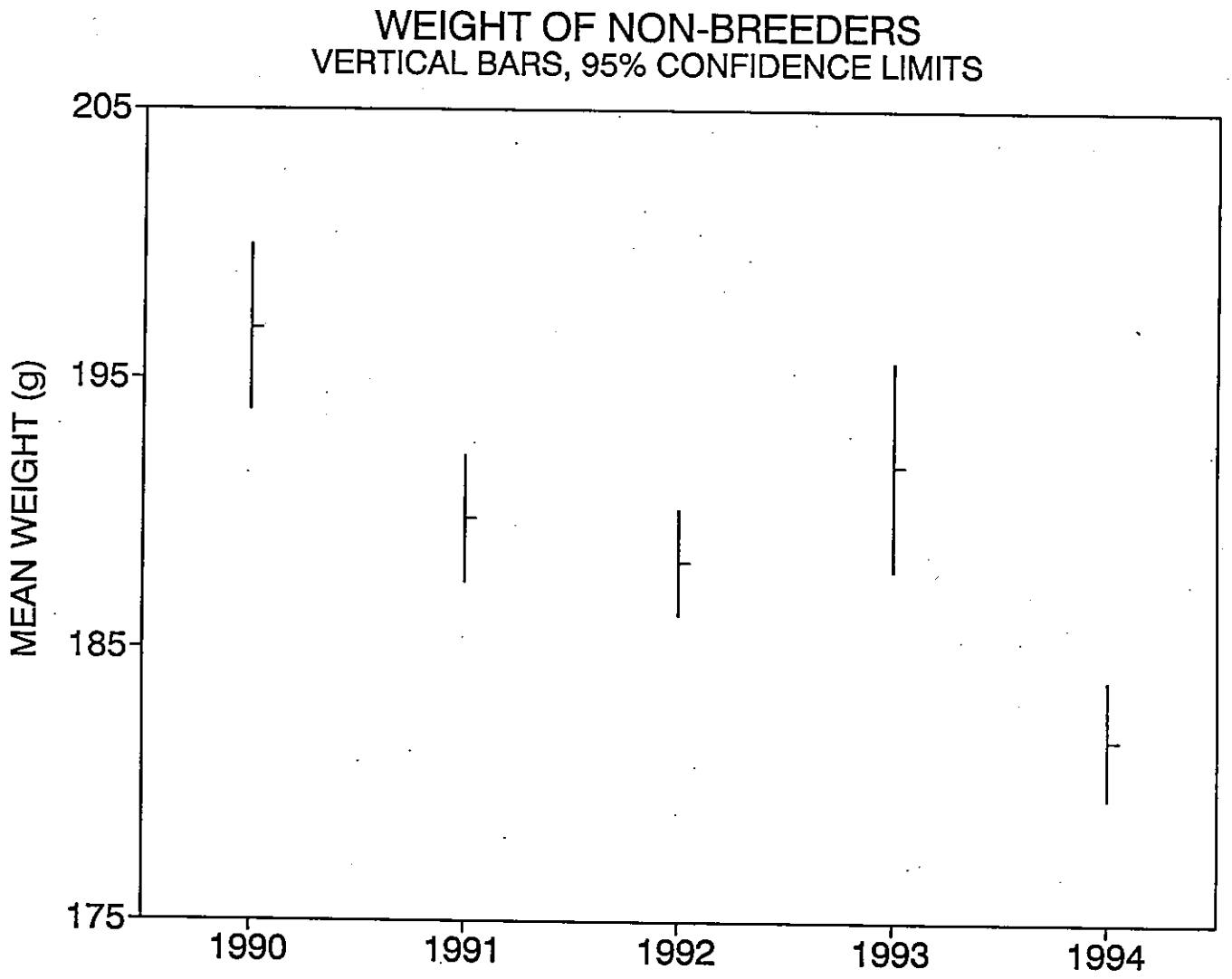
Of the 131 birds caught on the surface after the beginning of May, 71% had no brood patch, and were therefore non-breeding prospectors and another 21% had a full brood patch, and hence were presumably breeding. The other birds (8%) had incomplete brood patches and were probably non-breeders or failed breeders.

Adult weights

The mean weight of birds trapped as non-breeders (brood patch small or absent) was 181.7 g (s.d. 10.9, N=102). Breeders taken from burrows at the time of hatching averaged 206.6 g (s.d. 12.4, N=29); significantly heavier. The mean weight of the the five two-year-olds trapped was 174.5 g (s.d. 7.0), significantly lighter than the weight of all non-breeders. The weight of all two-year-olds captured to date averages 181.8 $\pm$ 2.4 g (N=12), lower than the average for all non-breeders (189.7 $\pm$ 15.5 g, N=724).

Comparing the data on weights obtained over the past five years, we find that the weight of non-breeders has fluctuated considerably, being highest in 1990 and 1993 and lowest in 1994 (Figure 8).

FIGURE 8



However, there has been no relationship between the weights of non-breeders and those of breeders removed from burrows at the time of hatching.

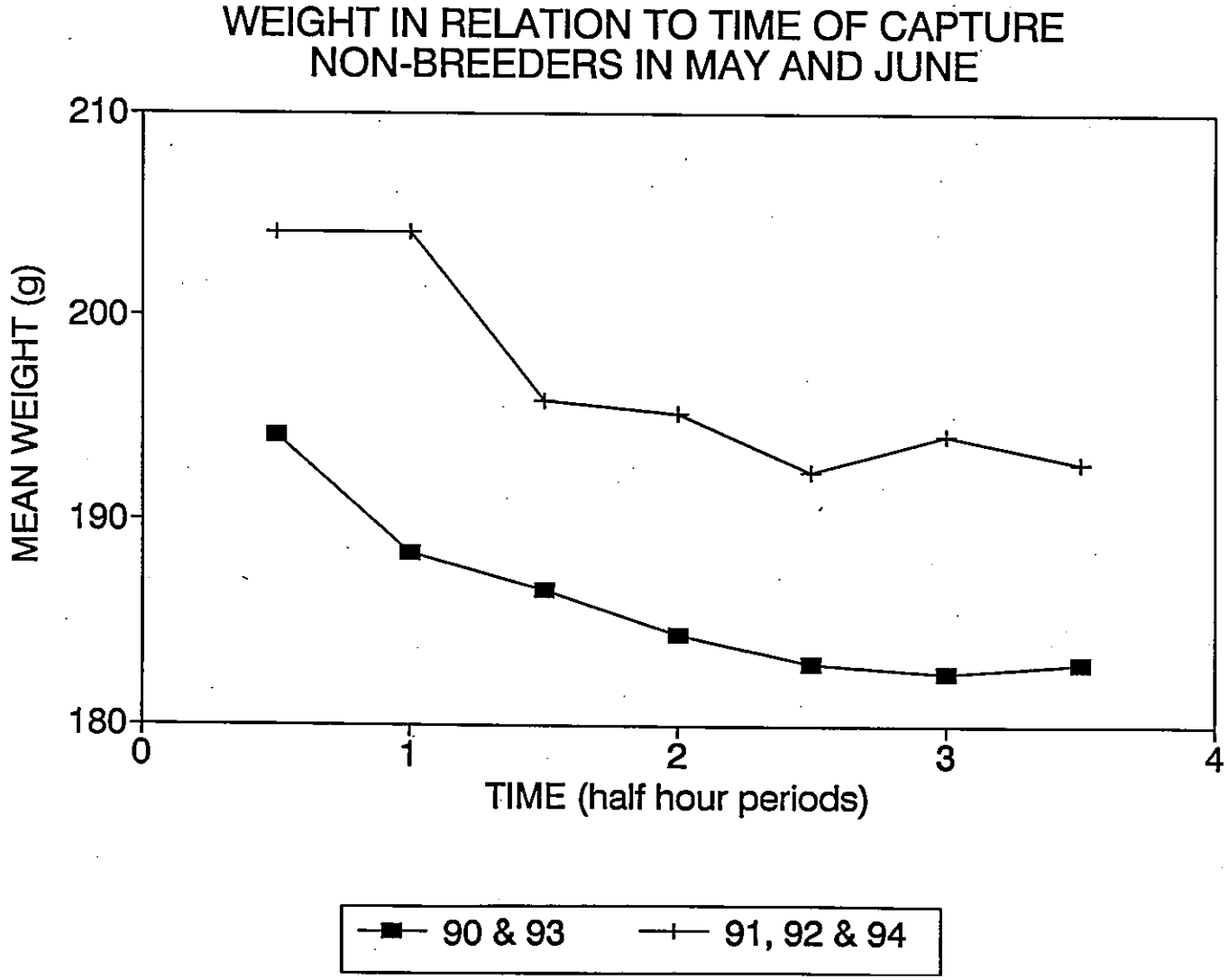
The average weight of two-year-olds recorded at Limestone Island (182 g) is very similar to the weights of birds at the same age captured at Reef Island (180 ± 7.4 g, N=20). However, the weights of all non-breeders recorded at Limestone Island, which averaged 189.5 g, were significantly heavier than those recorded at Reef Island, where the average over six years was 184.6 g (s.d. 11.6, N=924).

Although the time of year over which trapping was carried out at the two colonies was very similar, there was no standardization for time of night. An analysis of weights recorded at Limestone Island in May and June for birds with brood patches

less than 15 mm across shows that birds trapped early in the night tended to be much heavier than those trapped later. Data from Reef Island shows a similar pattern, with weights being similar to those observed at Limestone Island in 1991, 92 and 94 (Figure 9). The effect of time of trapping accounts for much of the difference in mean weights observed between 1991 and 1992, and 1994. When birds trapped before 01.30 h are omitted from the calculation, there is no significant difference between these three years, and all have significantly higher mean weights than those recorded in 1990 and 1993.

The finding that non-breeders arriving at different times during the night tend to differ in weight means that we can only make comparisons between years and colonies by standardizing the time of capture. The suggestion, made in last year's report, that the proportion of different age classes among prospectors at Limestone Island may differ from that at Reef Island, needs to be reassessed in the light of this information.

FIGURE 9



RESULTS OF ADULT TRAPPING, 1989-94

Numbers of adult birds trapped on the surface were generally higher in 1989-91 than in subsequent years (Figure 10). This was because, in the earlier years, more trapping was conducted before egg-laying began and trapping efforts in the latter part of the season began earlier in the night, as birds were arriving. An analysis of the time of trapping shows that more trapping was carried out before 01.00 during 1989-91 than in the later years (Figure 11). The reduction in pre-season banding has been necessitated by the difficulty of sustaining the camp through to mid-July, while the decrease in banding as birds are arriving has been brought about by a shortage of trained banders during the chick departure period, so that adult banding can be conducted only after most chicks have passed through the funnels.

The proportions of breeders (brood patch >19 mm) among adults trapped on the surface varied between 25-50% in 1989-91. In more recent years (1992-94), they have not exceeded 20% of those caught. During 1992-94 the proportions of all brood patch classes have been fairly constant among birds caught for the first time (Figures 12, and 13, Appendix 2).

FIGURE 10

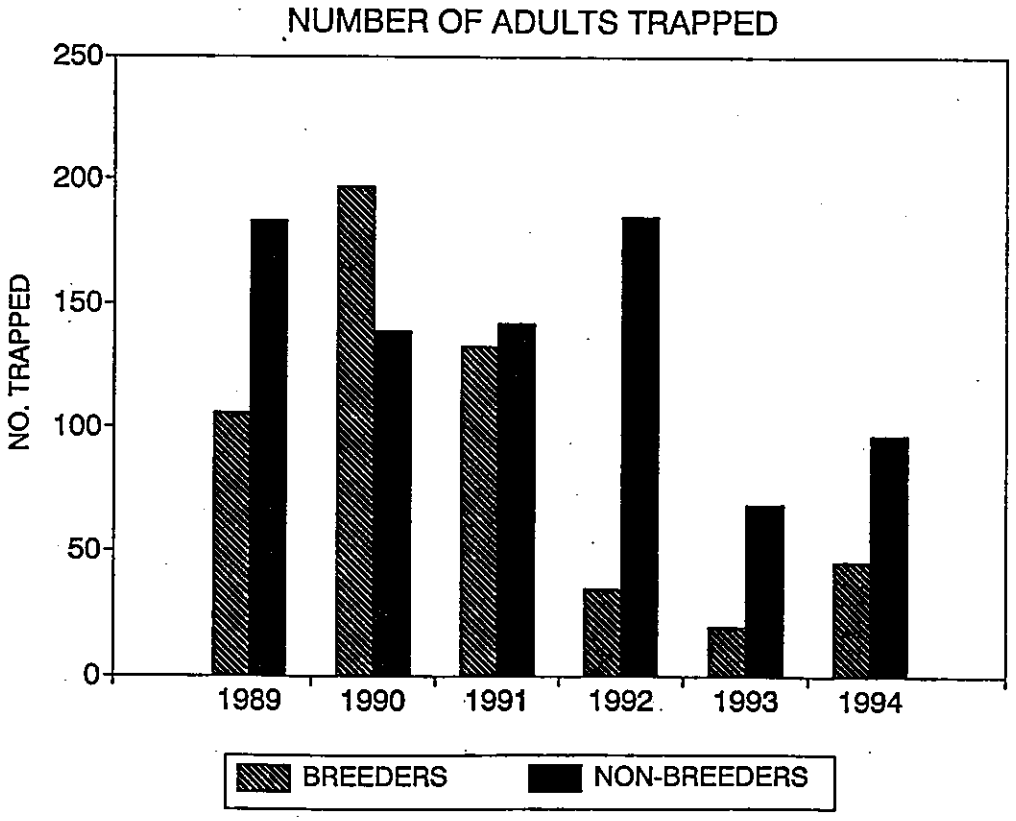


FIGURE 11

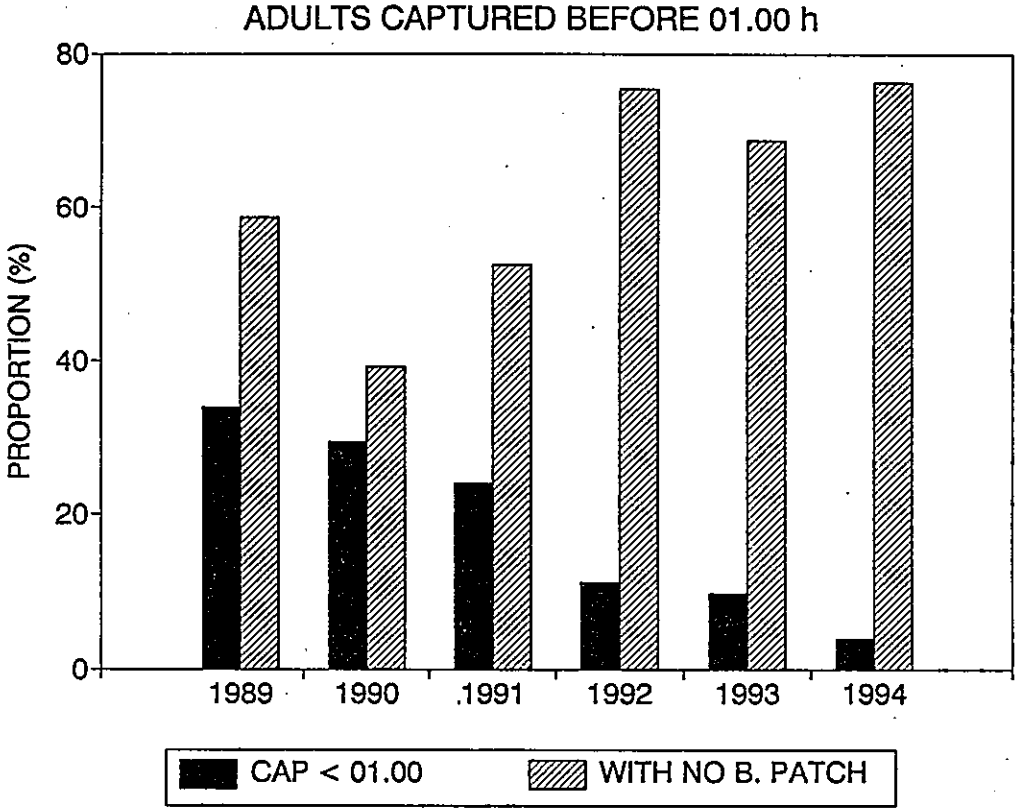


FIGURE 12

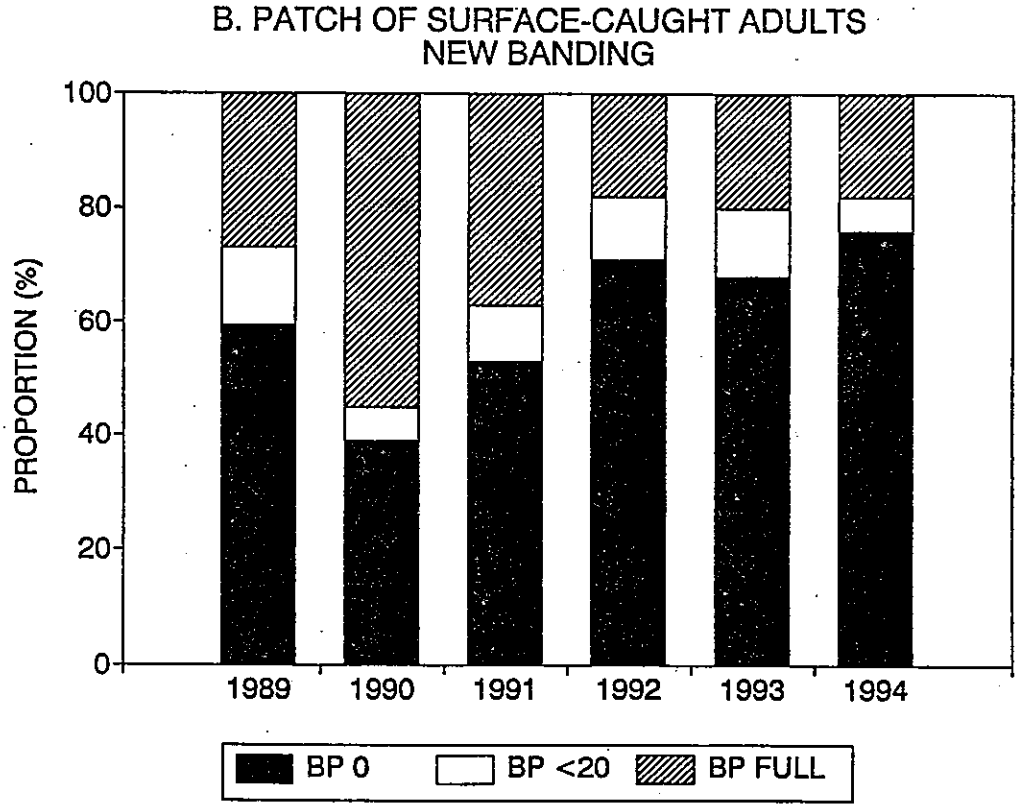
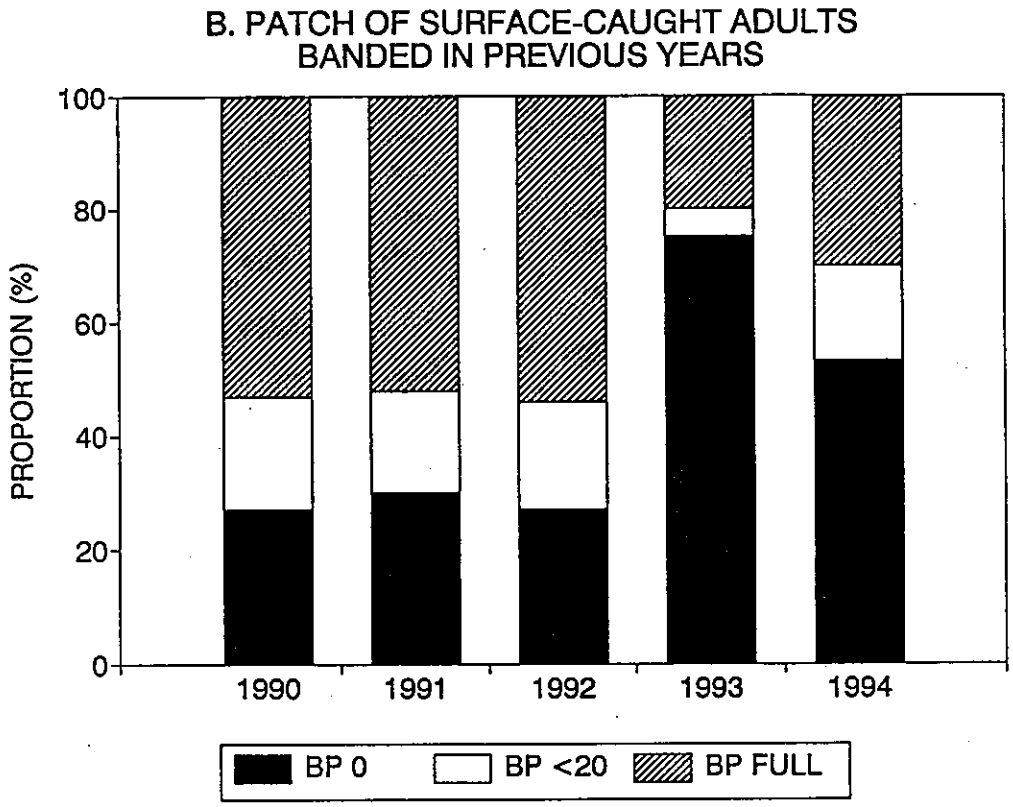


FIGURE 13



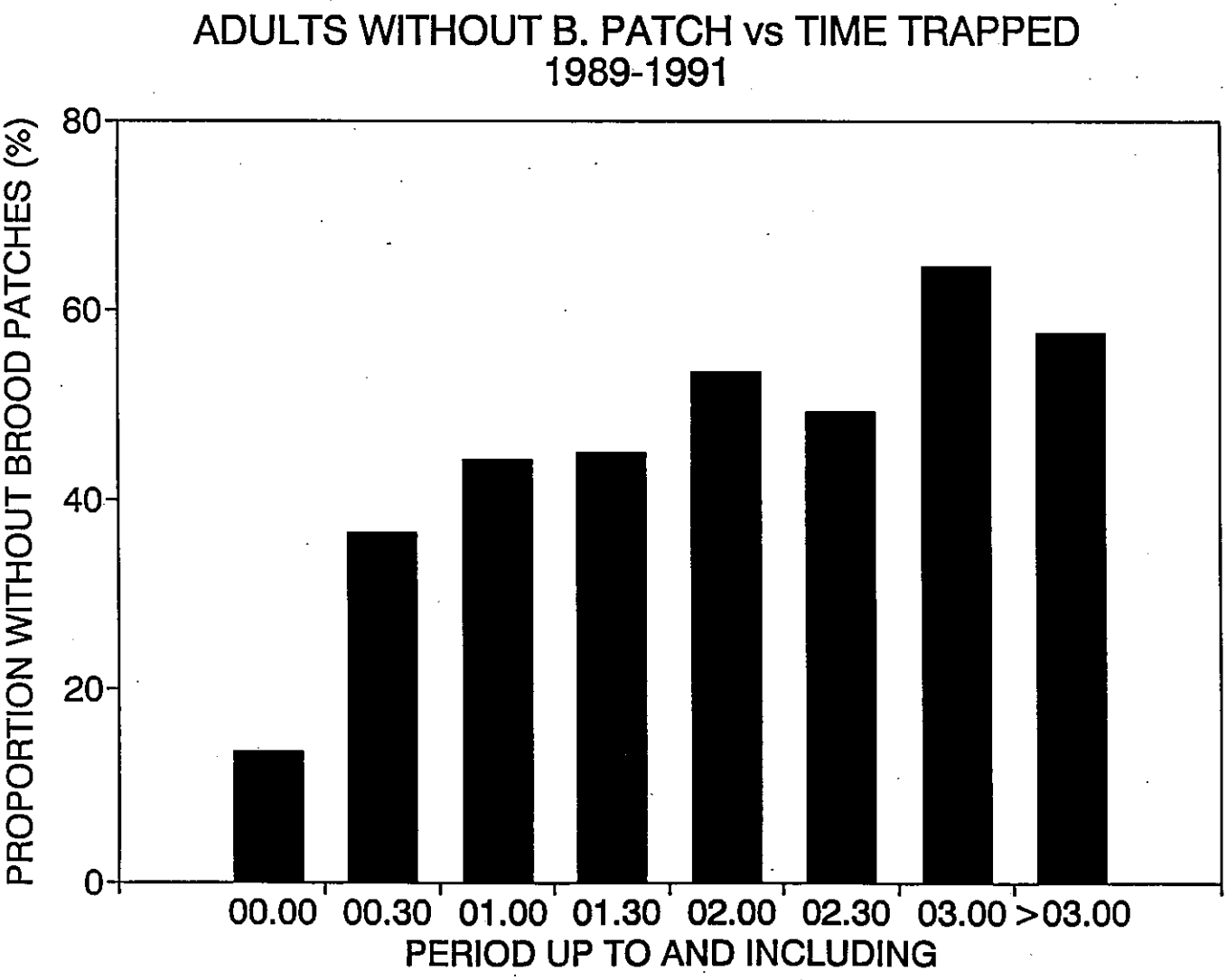
Among birds retrapped, the proportion of birds without brood patches has increased in 1993-94 over earlier years, as the number of birds banded as chicks has increased, reaching a maximum of 10 in 1994, 8 of which were without brood patches.

The change in the timing of banding effort may have been responsible for the change in the proportions of breeders and non-breeders trapped annually. The preponderance of birds without brood patches is presumably due to the bulk of trapping being carried out at the end of the season and late in the night, by which time most breeders had departed. Analyzing only the first three years, when many birds were caught before 01.00 h, the proportion of birds without brood patches was low among those captured before midnight (12%), but increased thereafter up to 02.00 h, after which it remained stable at about 50-70% of birds caught (Figure 14). Surprisingly, the proportion of birds banded in one year that were retrapped the next year has not changed a lot, perhaps because different individuals tend to have a similar schedule from year to year.

The switch towards catching birds later in the night during May and June increases the need to capture some breeders at the start of

the season, before incubation has begun, to provide an adequate sample of breeders to estimate their survival rate.

FIGURE 14



Rates of retrapping and the duration of prospecting

The proportion of birds banded as adults that were retrapped at East Limestone Island varied from 3.6% in 1993 to 11.6% in 1991, depending on the amount of effort expended. Combining all years, the rate of retrapping of birds banded as breeders was 12.8% (N=491), about three times that of birds banded as prospectors (4.5%, N=718). Among those banded as prospectors, 24% (N=29) were breeding when retrapped one year later, 50% (N=14) were breeding two years later and 81% (N=11) after three years. All those banded as prospectors four years earlier (N=4) were breeding. Because our trapping tends to select for prospecting birds, we should not assume that these are the true proportions in the total population, but the results indicate that most birds are breeding within two years of being trapped as a prospector. The suggestion made in Report #4, that age at first breeding may be older at Limestone Island than at Reef Island, may be an artifact of differences in the timing of our capture efforts.

Estimates of survival

A major objective of trapping adult murrelets is to estimate their survival rate. Because some banding was carried out by the C.W.S. in 1989, we have five years of retrap data available. This provides a suitable sample for preliminary analysis and can be compared with the six consecutive years of data obtained earlier at Reef Island (Gaston 1990). The data on numbers banded and retrapped are given in Appendix 3.

As in Report #4, the capture-recapture programme SURGE (Lebreton and Clobert 1986) was used to estimate survival rates based on the recapture of banded birds at Limestone Island. For this analysis, data from birds banded in burrows and those caught on the surface was combined, but breeders and non-breeders were treated separately. The resulting estimates suggest that, on average, 52% of breeders at Limestone Island survive from one year to the next (95% confidence interval 43-61%). If we calculate the survival rate separately for data excluding the first year after capture (when it is typically lower because a certain number of birds caught are merely visiting and never return to the catching area), the estimate is 56% (95% confidence interval 43-69%). The confidence limits on these estimates are very large, but they are much lower than the equivalent estimates for birds trapped at Reef Island between 1984-89, an estimate based on exactly the same type of data. Mean values for both estimates fall outside the confidence limits for the other, suggesting that the difference is probably significant (Table 4).

Given the very high level of predation by raccoons found at Limestone Island throughout the period of the study (except for 1992), the lower survival rate of breeders at that colony is not surprising. No raccoons were present at Reef Island during the work there. Raccoons take both breeders and non-breeders, especially the latter, so the difference between the two groups is probably not explained by predation. However, the 95% confidence limit on the estimate for non-breeders is very large and consequently this estimate is of little value. The true survival rate could be considerably lower than the mean value estimated.

Table 4. Annual survival rates estimated by SURGE

	Mean	95% conf. interval Minimum	Maximum
East Limestone			
Breeders	52%	43%	61%
Breeders (exc. 1st yr)	56%	43%	69%
Non-breeders	64%	48%	77%
Non-br. (exc. 1st yr)	89%	27%	99%
Reef I.			
Breeders	69%	65%	78%
Breeders (exc. 1st yr)	77%	67%	84%

Summary of data from adult trapping

Catching adult murrelets in the forest at night causes undeniable disturbance to the birds involved and hence requires substantial justification. The following information has been obtained from this technique thus far:-

(1) Survival rates of birds breeding at Limestone Island are lower than those reported from Reef Island during 1984-89;

(2) Survival rates of breeders may be lower than those of non-breeders;

(3) The weight of non-breeders trapped at Limestone Island declined during the night, so that birds caught after 3 a.m. weighed 10% less than those caught before 1 a.m. This probably indicates that older birds arrive earlier. The majority of birds caught after 3 a.m. are probably in their second year;

(4) After taking variation in the time of capture into account, the weight of non-breeders varies from year to year and is unrelated to variation in the weight of breeding birds. This could be related to the size of different year classes of recruits;

In addition, the following information obtained previously at Reef Island has been confirmed:

(5) Most prospecting birds are second years;

(6) Second year non-breeders weigh about 10% less than breeders.

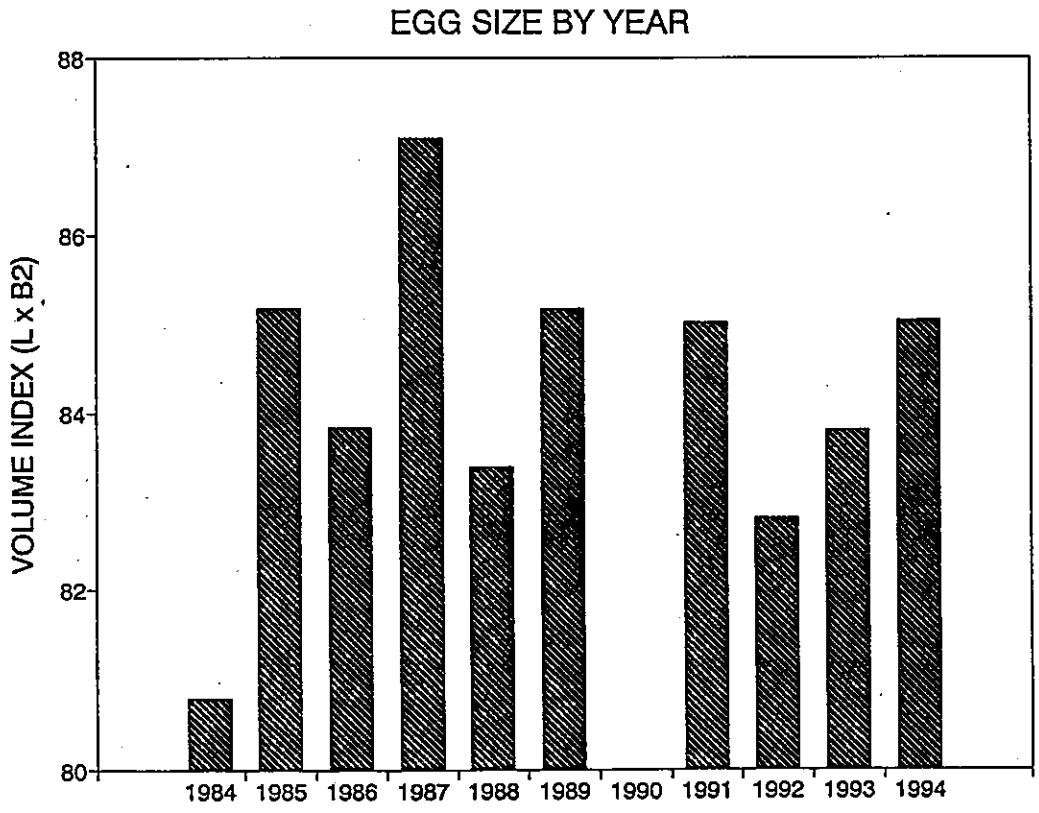
Eggs

The size of eggs laid by Ancient Murrelets at East Limestone Island has varied very little from year to year (Figure 15, Appendix 4); apparently a characteristic of the species. There is a tendency for egg size to decrease as the season progresses, but in 1994 this effect was insignificant. It was much more marked in 1991-93 (Appendix 5). The correlation, observed in previous years, between the size of eggs and the numbers of Black-legged Kittiwakes in the area, appears to have broken down to some extent in 1994. In other years, large eggs were associated with good numbers of kittiwakes, but in 1994, although eggs were larger than average, very few kittiwakes were present in the area.

Breeding success and incubation

Breeding by Ancient Murrelets was attempted in 27 of the study burrows at East Limestone Island in 1994, of which 22 succeeded in producing chicks. Three clutches were deserted, one possibly because of our disturbance, one burrow was dug up, presumably by a raccoon and the outcome at the remaining burrow could not be determined. A total of 40 chicks were reared for an average productivity of 1.54 chicks per pair. [It may be significant that 2 of the three eggs never incubated were the smallest laid in 1994, perhaps laid by young females.]

FIGURE 15



Eggs were present in 5 burrows when first inspected on 6-8 April and no burrows contained incubating birds. All but one pairs had begun incubation by the end of April. The median departure date for the study burrows was 21 May, exactly the same as for the chicks trapped in funnels.

The length of time between laying of the first egg and the beginning of incubation was recorded at 22 nests and averaged 8.8 days (Figure 16). Incubation was interrupted for 1-3 days at 12 nests, mostly within 3 days of the start of incubation. The duration of the combined incubation and brooding period (from the start of incubation to departure) averaged 32.9 days, with practically all periods between 31-34 days (Figure 17). The outlier at 38 days was a burrow where the eggs were neglected for three days early in incubation.

FIGURE 16

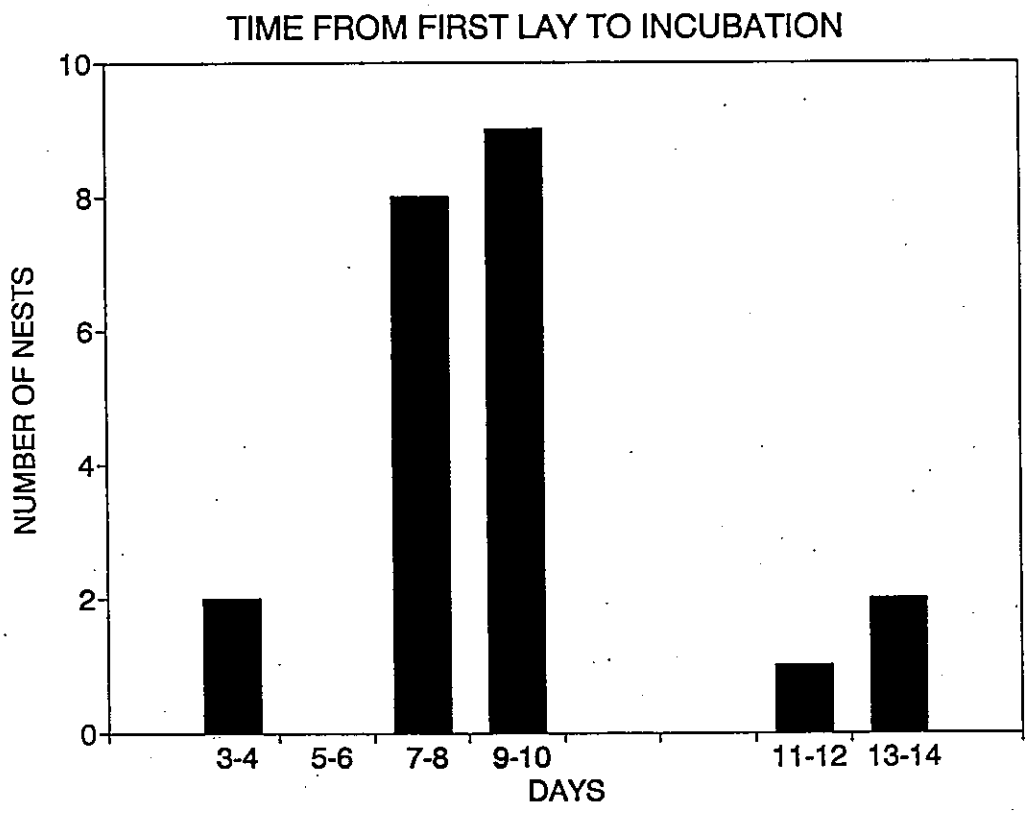
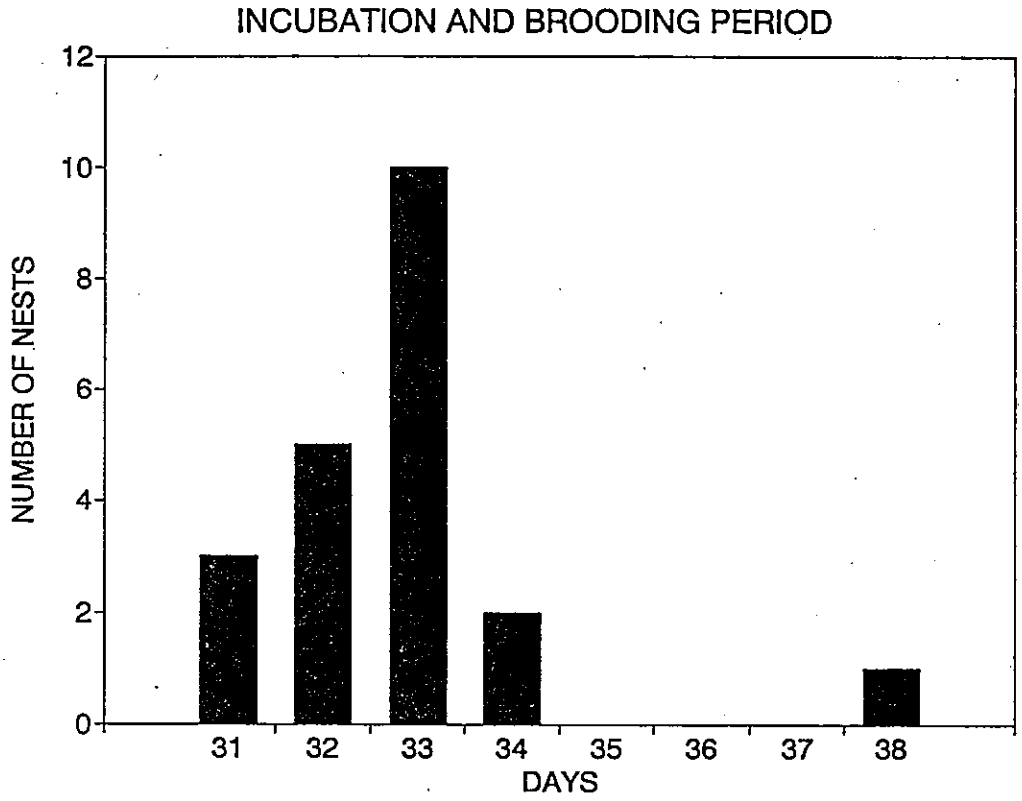


FIGURE 17



Out of 44 burrows that have been monitored in all five years at Limestone Island, only two have failed to produce a chick in any year; both have been occupied only once. Eleven burrows were occupied in all five years, of which seven succeeded in rearing chicks every time. Another eight did so in four out of the five years. The largest year on year change occurred between 1990 and 1991, when 13/36 (36%) successful burrows were not occupied the next year. The corresponding proportions for 1992, 1993 and 1994 were 20% (N=25), 23% (N=22) and 21% (N=29). In 1990, none of the burrows was inspected until after the chicks had departed, so disturbance could not have been involved in the amount of abandonment. The rate of turn-over of burrows is similar to that seen at Reef Island in 1987-89, when similar methods were used and suggests that it is normal to have approximately 20% of burrows occupied in one year unoccupied the next. With a relatively high annula mortality, such abandonments are to be expected. Some birds, including surviving pairs, will move burrows, even after breeding successfully, as we have had cases at both Reef and Limestone islands of the same pair breeding in a different burrow.

For a detailed description of raccoon predation activities and signs at East Limestone Island, see Report #3 (Gaston and Lawrence 1993). In 1994, as in the previous year, there was no evidence of raccoons on East Limestone Island at the start of the season. Scat surveys were carried out during 6-14 April covering most of the coast and none was found. However, a scat was found 85 m from the shore on 30 April, containing limpet shells and another was found near the shore on 2 May. Digging of burrows and headless carcasses, both usually associated with raccoon predation, were found from 5 May and some of the excavations seemed too large to be the work of otters. Raccoon hairs were found in one excavation. A raccoon scat was also found on West Limestone Island, where two excavated burrows were located.

We repeated the strip transects surveyed in previous years, searching them for predation remains at six day intervals throughout the season. Signs of predations were classified as:
(1) Feather piles. These consisted of large numbers of contour feathers (breast, back, scapulars) scattered over an area up to 5 m in diameter, but normally concentrated in a clump. Complete single or paired wings were sometimes associated with these piles, and occasionally feet. Wings found without associated contour feathers, either single, or attached in pairs to the pectoral girdle, were also included in this category.
(2) Burrow digging. Some burrows were enlarged through the entrance tunnel, while in other cases the predator dug down from above. Several holes within a radius of 5 m were treated as a single predation event, unless other evidence suggested that more than one occupied burrow had been entered.
(3) Carcasses or inverted skins. Carcasses found in previous years were sometimes practically intact, often with the head severed from the body. This appears to be characteristic of raccoon predation. At the other extreme, some whole skins were everted and completely cleaned inside.

In 1994, we found 58 predations within our transects, of which 51 were feather piles (Table 6). As in 1993, the small number of carcasses probably relates to the fact that most transect inspections were made several hours after dawn, by which time raccoon kills could have been scavenged by crows or ravens. However, the scarcity of burrow excavations until June suggests that the raccoon present in 1994 did less digging than animals present in earlier years.

Comparing the period up to 13 June for the 5 years for which we have comparable data, shows that the total predation remains found has ranged from 58-88, except in 1992,

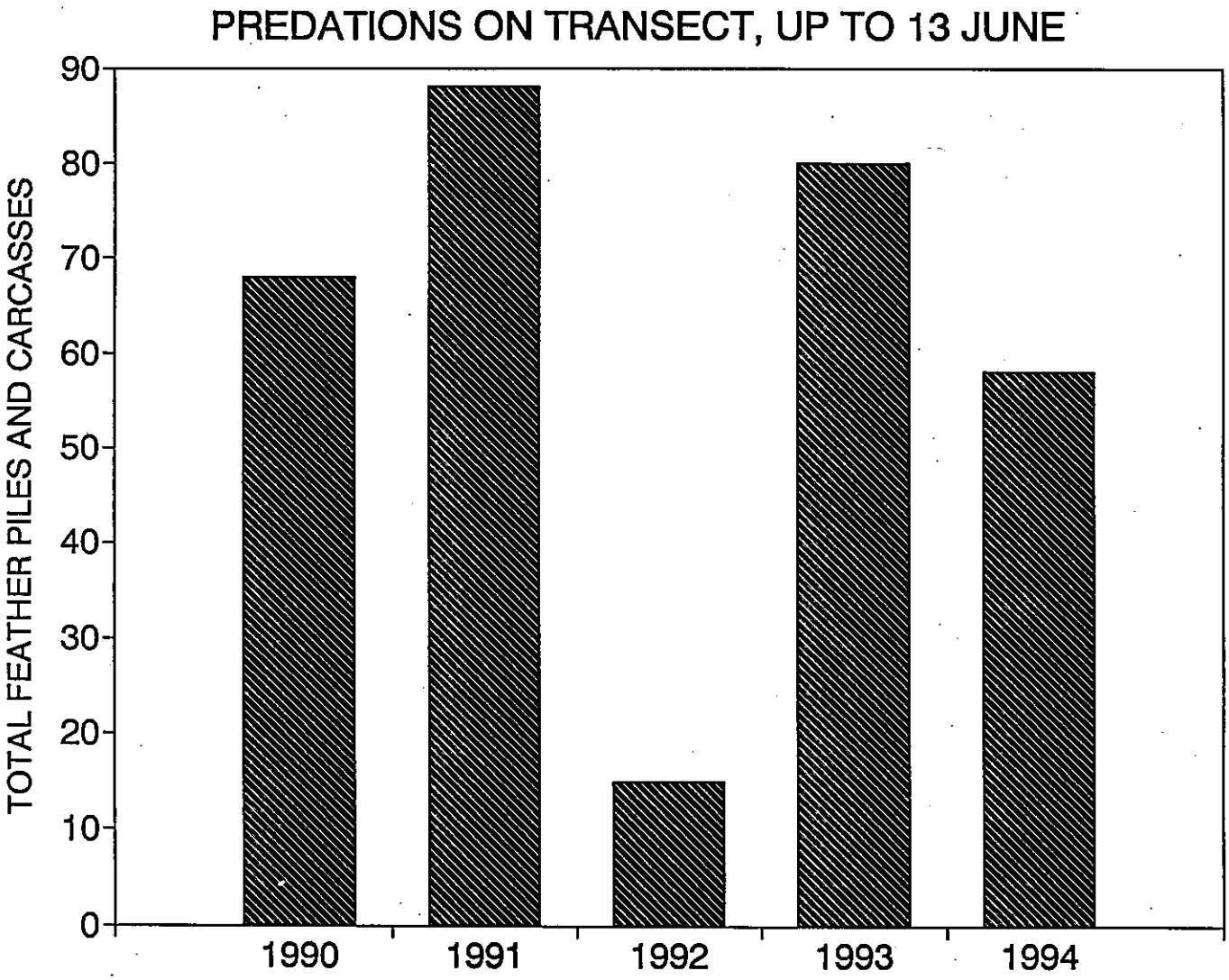
when we believe that no raccoon was present (Figure 18). This result strengthens the already considerable evidence that raccoons are a principal cause of the high predation observed at Limestone Island.

The mean length of wings found among predation remains up to 15 May was 139.6 mm (sd 3.7, N=43), and of those found between 15 May and 17 June 137.7 mm (sd 2.5, N=9). These measurements are substantially smaller than those taken in 1993, probably reflecting differences in measuring techniques between observers. However, in both years the reduction in wing length of about 2 mm between the early and late periods suggests that the majority of birds killed after mid-May are two-year-old prospectors. Studies at Reef Island showed that the young birds have wings averaging approximately 2 mm shorter than those of breeders.

Table 6. Predation remains found on transects in 1994

DATE	FEATHER PILES	BURROW DIGGING	CARCASSES
10 - 30 Apr	15	0	1
1 - 15 May	13	0	2
16 - 30 May	11	0	0
> 30 May	12	3	1
Totals	51	3	4

FIGURE 18


PREDATIONS ON TRANSECT, UP TO 13 JUNE
TOTAL FEATHER PILES AND CARCASSES
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994

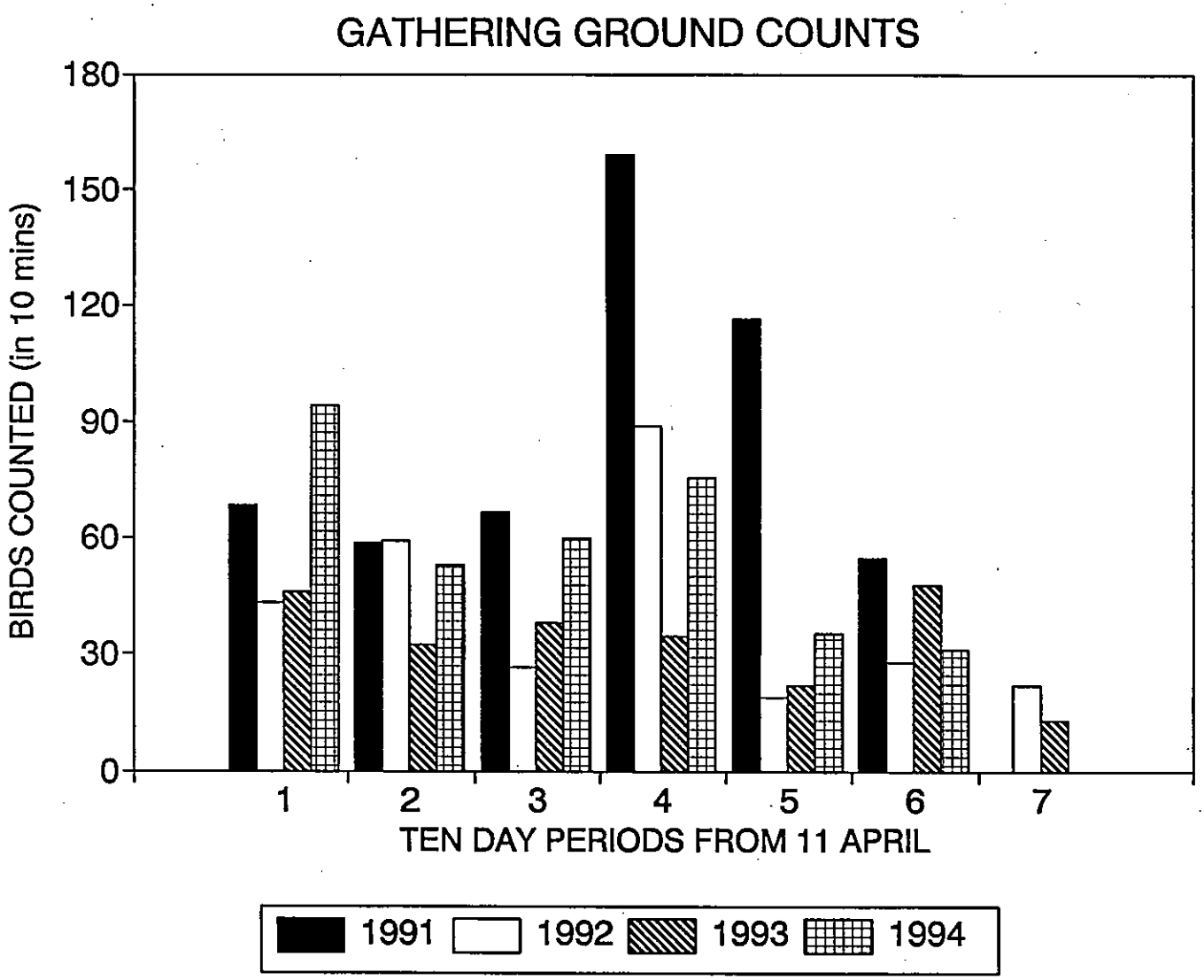
COUNTS OF ANCIENT MURRELETS ON THE GATHERING GROUND

Counts of birds flying over the gathering ground between the cabin and Low Island were made during a 10-minute watch from the cabin between 19.00-20.30 h from 7 April - 11 June. The same method was used as in previous years (see Report #4). Numbers were highest in April and declined steadily thereafter (Figure 19). The maximum count, of 220, was on 13 April and all the four highest counts occurred in April. No counts of over 100 occurred after 20 May. The pattern of a gradual decline from a peak in mid-April is quite different from that seen in earlier years, when peak numbers usually occurred in May, coincident with maximum numbers of non-breeding prospectors visiting the colony.

In comparison with earlier years, numbers of birds seen on the gathering ground were generally low, although slightly higher than in 1993. However the comparison is complicated by the difference in the seasonal pattern. If we compare only the period from 15 May onwards, in 1990 there were five counts of more than 100 birds. In 1991, there were eleven, including five of more than 200. In 1992, there were four counts above 100, including one over 200. In both 1993 and 1994 no counts exceeded 200 and only 3 reached 100 during the same period. The mean counts for the period 16 May - 15 June were 55, 131, 53, 29 and 42, respectively.

Differences in numbers recorded from year to year do not seem to be related to weather conditions, as wind speeds during the period 15 May - 15 June have averaged 8-9 km/h in all years. However, in 1994, there were only 6 days of calm (sea state <2), less than in 1993. Observations of birds on the gathering grounds tend to suggest that numbers of prospectors at East Limestone Island are declining, but the trend is still not very clear. The cause of the high numbers in April is especially puzzling because high winds and rough seas were prevalent during 11-18 April when peak numbers were recorded. These results emphasize that we still understand relatively little about what determines the presence or absence of murrelets on a given night.

FIGURE 19


GATHERING GROUND COUNTS
BIRDS COUNTED (in 10 mins)
180
150
120
90
60
30
0
1
2
3
4
5
6
7
TEN DAY PERIODS FROM 11 APRIL
1991
1992
1993
1994

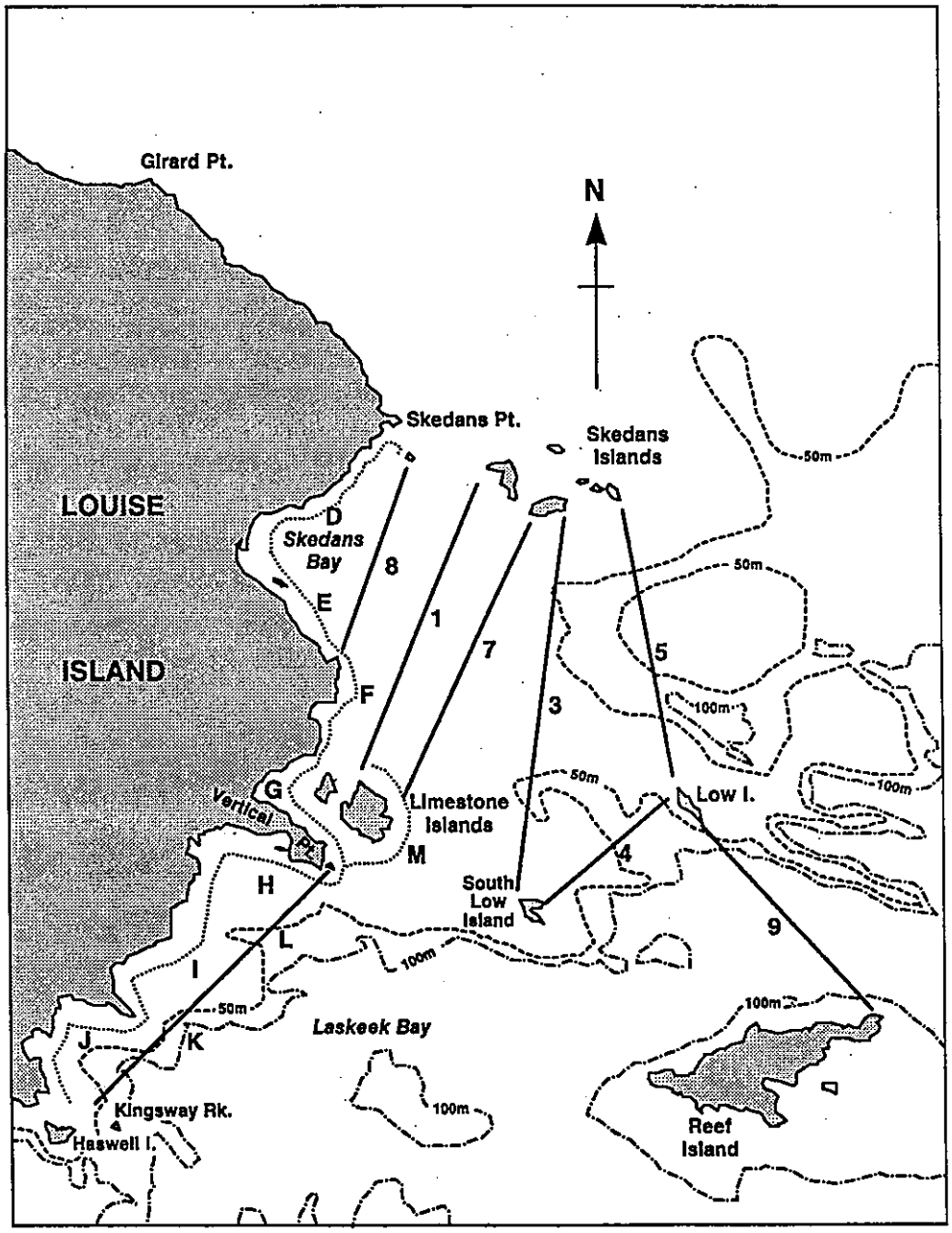
SURVEYS AT SEA

Methods

In 1994, boat surveys to census seabirds were conducted in Laskeek Bay between 9 April and 10 July. Figure 20 shows the location of the most commonly surveyed transect lines. Seven complete *coastal* and *offshore* surveys were conducted during the 14 week season. In addition, five surveys of waters in Hecate Strait, to the east of Reef Island, were carried out between 26 April - 9 July, and two sets of transects from Haswell Island south to Lyell Island were undertaken on 14 June, and 4 July. In 1992 this area provided high counts of Marbled Murrelets.

Surveys were carried out with a 4.5 m inflatable boat powered by a 25 hp outboard. Most surveys were done in the morning when sea conditions were calmest, with two observers and one boat driver. The species and number of all birds seen on the water within 200 m of either side of the boat were recorded. Because of changes in sea conditions, it was not always possible to complete surveys within a 1-2 day period. No surveys were done with sea conditions greater than Beaufort 2 (small wavelets).

FIGURE 20


Girard Pt.
N
Skedans Pt.
Skedans Islands
LOUISE
ISLAND
D
Skedans Bay
E
F
G
Vertical Pt.
M
H
I
L
J
K
Kingsway Rk.
Haswell I.
Laskeek Bay
Limestone Islands
South Low Island
Low I.
Reef Island
1
2
3
4
5
7
8
9
50m
100m

Marbled Murrelets

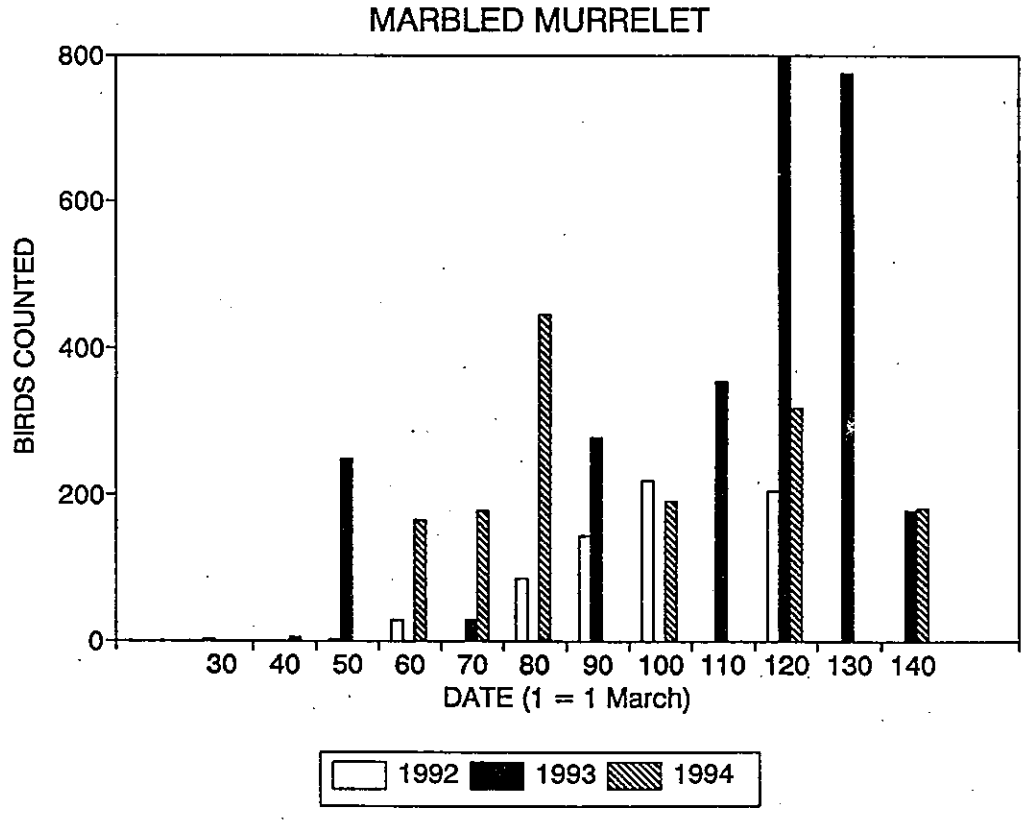
As in previous years, few Marbled Murrelets were seen in Laskeek Bay on surveys in the first half of April, but thereafter counts for complete transect sets varied from 166-445 birds (Table 7). These counts were comparable with earlier years, although there was nothing similar to the dramatic numbers seen on 21 June in 1993 (Figure 21).

Surveys of the southern part of Laskeek Bay, south of Kingsway Rock and Reef Island, produced few species, but larger numbers of Marbled Murrelets were seen than in previous years; 537 on 14 June and 635 on 3 July. Most of these were recorded on sections O (off Heming Head) and X . On 14 June, 200 Marbled Murrelets were also counted between Vertical Point and Kingsway Rock (transects K and L).

Table 7. Results of line transect surveys for marbled murrelets within Laskeek Bay during 1994.

Date	Transect		Total
	Coastal	Offshore	
9 April	2	6	8
23 April	65	101	166
4-7 May	19	158	177
16 May	229	216	445
7, 9 Jun	95	97	192
20 Jun	50	268	318
8 Jul	67	114	181
Totals	527	960	1487

FIGURE 21



Other seabirds

Besides Marbled Murrelets, the commonest birds seen on inshore transects (within 400 m of shore) were Pelagic Cormorants, Glaucous-winged Gulls and Pigeon Guillemots (Table 8), and on offshore transects Ancient Murrelets, Rhinoceros Auklets and Pigeon Guillemots (Table 9).

Species diversity was highest on both inshore and offshore transects in April, when a variety of ducks and grebes were recorded.

Rhinoceros Auklets and Ancient Murrelets were hardly recorded on inshore transects. Peak numbers of both occurred in mid-May and high numbers of Rhinoceros Auklets were still present in July (Figures 22 and 23). Pelagic and Double-crested Cormorants were commonest in April, after which Double-crested Cormorants virtually disappeared; the normal pattern in Laskeek Bay, presumably reflecting a movement to breeding sites elsewhere (Figure 24). Pacific Loons were recorded in relatively high numbers, mainly from mid-May to mid-June, with an additional 80 seen south of Kingsway Rock on 14 June.

FIGURE 22

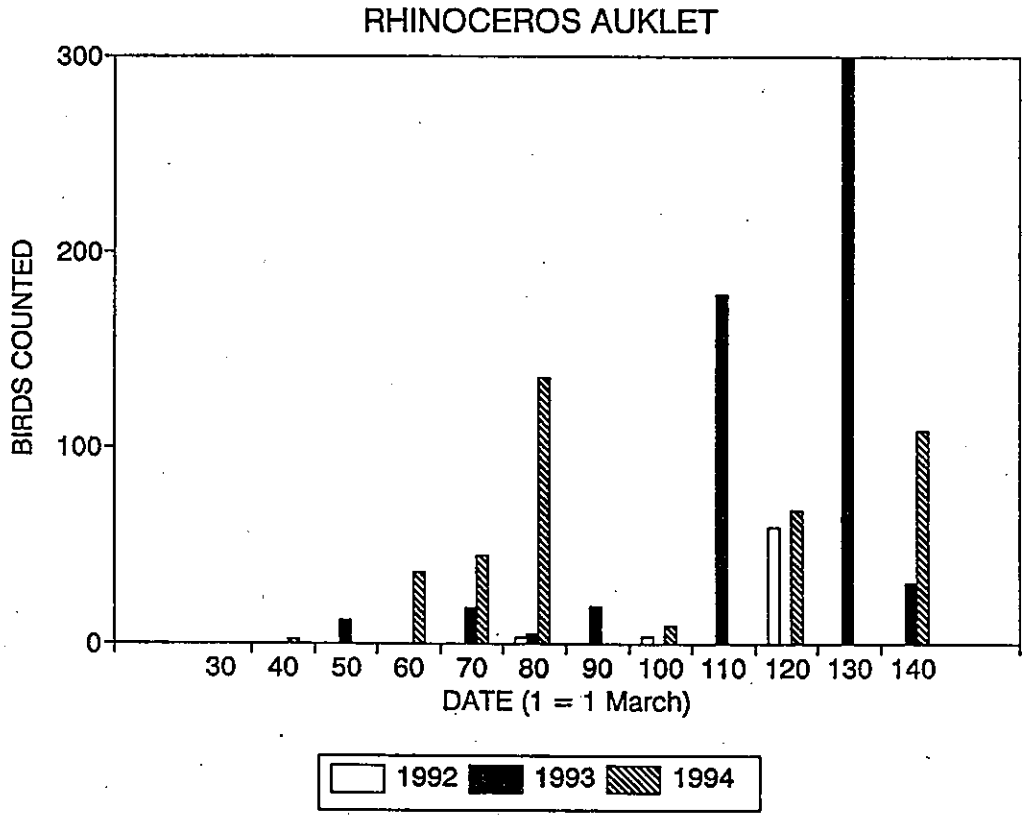


Table 8. Birds seen on inshore transects in the Laskeek Bay area in 1994.

Species	Survey Dates							Totals
	April		May		June		July	
	9	23	4-7	16	7-9	20	10	
Common Loon	0	1	0	3	1	0	0	5
Pacific Loon	0	0	6	26	15	1	4	52
Red-necked Grebe	3	0	0	2	0	0	0	5
Pelagic Cormorant	45	176	3	0	2	1	0	227
Double-crested Cormorant	16	10	0	0	0	0	0	26
Brandt's Cormorant	4	0	0	0	0	0	0	4
Goldeneye	0	0	3	0	0	0	0	3
Bufflehead	27	0	0	0	0	0	0	27
Harlequin Duck	4	4	0	2	0	0	0	10
White-winged Scoter	11	5	0	0	0	0	0	16
Black Scoter	0	0	0	4	0	0	0	4
Oldsquaw	2	0	0	2	0	0	0	4
Common Merganser	0	0	28	14	0	0	0	42
Glaucous-winged Gull	0	2	89	0	0	10	0	101
Pigeon Guillemot	19	27	25	8	9	11	9	108
Marbled Murrelet	2	65	19	229	95	50	67	528
Rhinoceros Auklet	0	0	1	10	0	0	0	11
Species Recorded	9	7	4	2	3	5	3	11

FIGURE 23

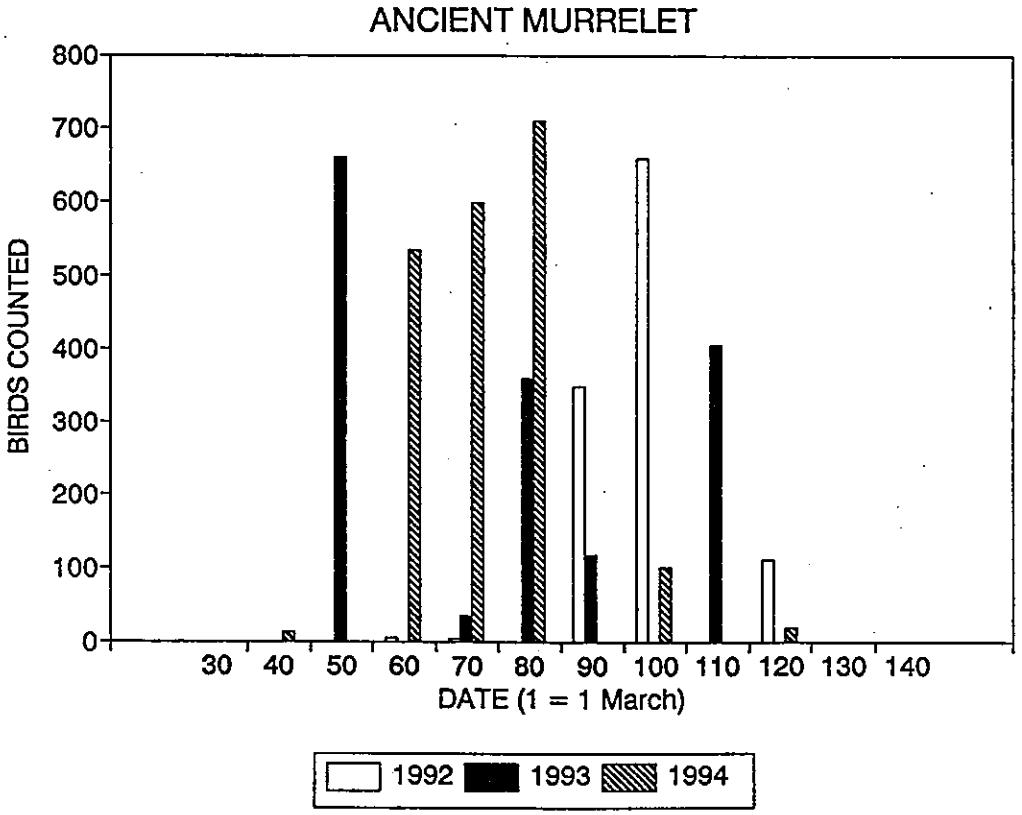
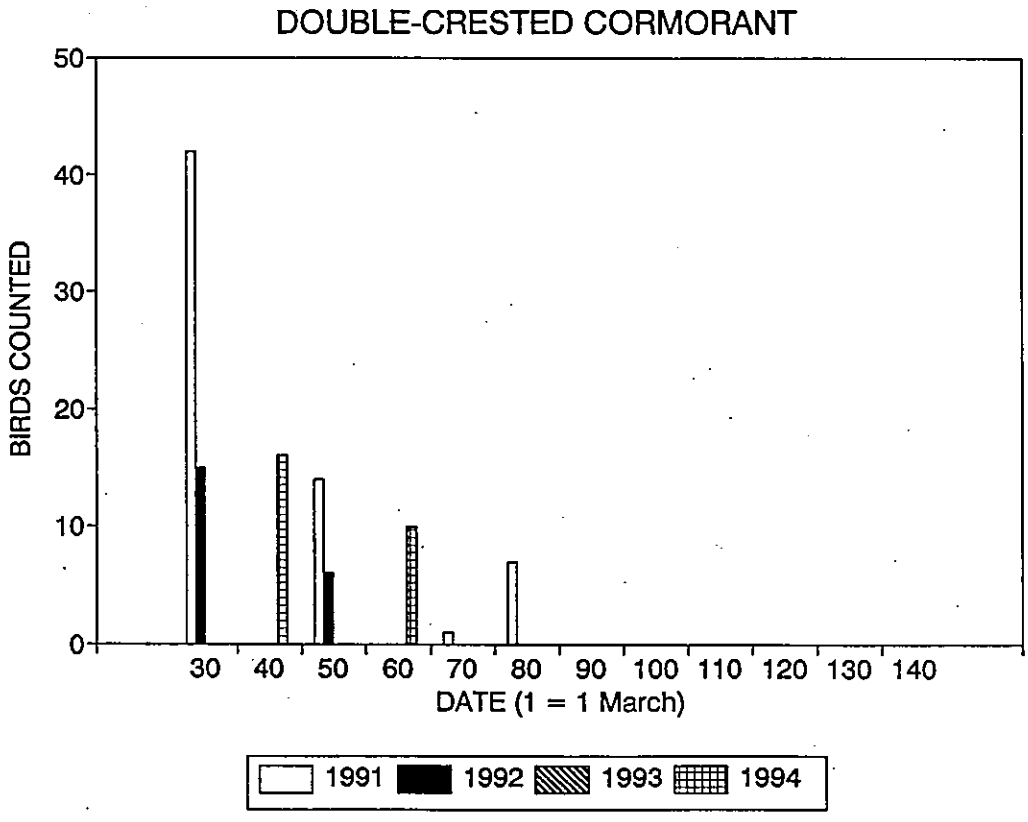


Table 9. Birds seen on offshore transects in the Laskeek Bay area in 1994.

Species	Survey Dates							Totals
	April		May		June		July	
	9	23	4-7	16	7-9	20	10	
Pacific Loon	0	1	34	42	0	0	0	77
Pelagic Cormorant	10	20	3	1	3	1	0	38
Double-crested Cormorant	0	5	0	0	0	0	0	5
Brandt's Cormorant	1	0	0	0	0	0	0	1
White-winged Scoter	0	52	0	0	0	0	0	52
Glaucous-winged Gull	12	27	1	2	0	1	11	54
Pigeon Guillemot	30	17	37	9	30	21	49	193
Marbled Murrelet	4	101	158	216	97	268	114	958
Common Murre	0	0	0	8	0	0	0	8
Ancient Murrelet	13	534	598	708	101	20	0	1974
Cassin's Auklet	0	0	0	0	0	1	0	1
Rhinoceros Auklet	2	36	44	126	9	68	109	396
Species Recorded	7	9	7	8	5	7	4	12

FIGURE 24



The first three surveys into Hecate Strait, east of Reef Island, recorded a good variety of birds, including Sooty Shearwaters, Cassin's Auklets, Ancient Murrelets, and Rhinoceros Auklets in moderate numbers (Table 10). However, very few birds were seen on 20 June and 9 July, illustrating the fact that migrants and winter visitors make up the bulk of birds using the strait in spring and early summer.

No Black-legged Kittiwakes were recorded at all on these surveys and there were only three sightings of the species in the Laskeek Bay area this year. This extends to eleven the run of years in which kittiwakes have been rare in even years and common in odd years. There is no obvious explanation for this phenomenon.

Table 10. Summary of birds seen on transects running east of the east tip of Reef Island in 1994.

Date	Time	Distance (km)	PALO	SOSH	BLKI	ANMU	RHAU	CAAU	COMU	GWGU	HEGU
26 April	0750	18.8	0	4	0	70	10	1	3	1	0
5 May	0830	11.4	5	45	0	62	13	2	12	2	60
6 June	1200	11.5	0	6	0	904	72	30	0	0	0
20 June	0900	19.7	0	1	0	0	0	0	1	0	0
9 July	0719	10	0	0	0	0	3	0	0	0	0
Totals		71.4	0	56	0	1036	98	33	16	3	60

GLAUCOUS-WINGED GULLS

Counts of nests and clutch sizes were undertaken on five breeding sites in Laskeek Bay between 26 June and 4 July 1994; the third annual census of breeding gulls in the area by the Society. Three hundred and sixty nests were counted on six islands: Skedans (16); Low (8 nests); Lost (221); Kingsway (95); Cumshewa (19) and Reef (1). Table 11 shows the number of nests censused each year, and the percent change in numbers of nests from one year to the next.

In 1994, there was a substantial (47%) increase over 1993. Most of the increase occurred at the Lost Islands, where the number of nests jumped from 140 to 221 (+57%). Rodway (1988) documented a 30% increase in numbers of Glaucous-winged Gulls in Haida Gwaii between 1977 and 1986. In Laskeek Bay, we have now seen an additional increase of 40% since 1986. The trend appears to be fairly constant (Figure 25). It also involves an increasing concentration of nests at Lost Islands, with that colony increasing from 30% of all Laskeek Bay nests in 1986 to 61% in 1994.

Just over half of the nests with eggs or chicks contained clutches or broods of three and no clutches of 4 were recorded (Table 12). The mean clutch/brood size was smaller than in 1993, but this may relate to the timing of the surveys and the fact that many eggs had hatched when surveys took place.

At Lost Islands, on 27 June, 61 nests contained eggs, 42 contained chicks and 15 contained both. On 2 July, only 17% (N=47) of clutches examined on another part of the Lost Islands had no eggs hatched. Based on these samples, we can assume that median hatching of first chicks was close to 28 June. This date is the same as that estimated on the basis of similar data for 1993. Hatching in both years was about 10 days later than in 1992 (Report #3).

Table 12. Counts of Glaucous-winged gull nests in the Laskeek Bay area in 1986, 1992, 1993 and 1994. Figures in brackets give % change on previous survey.

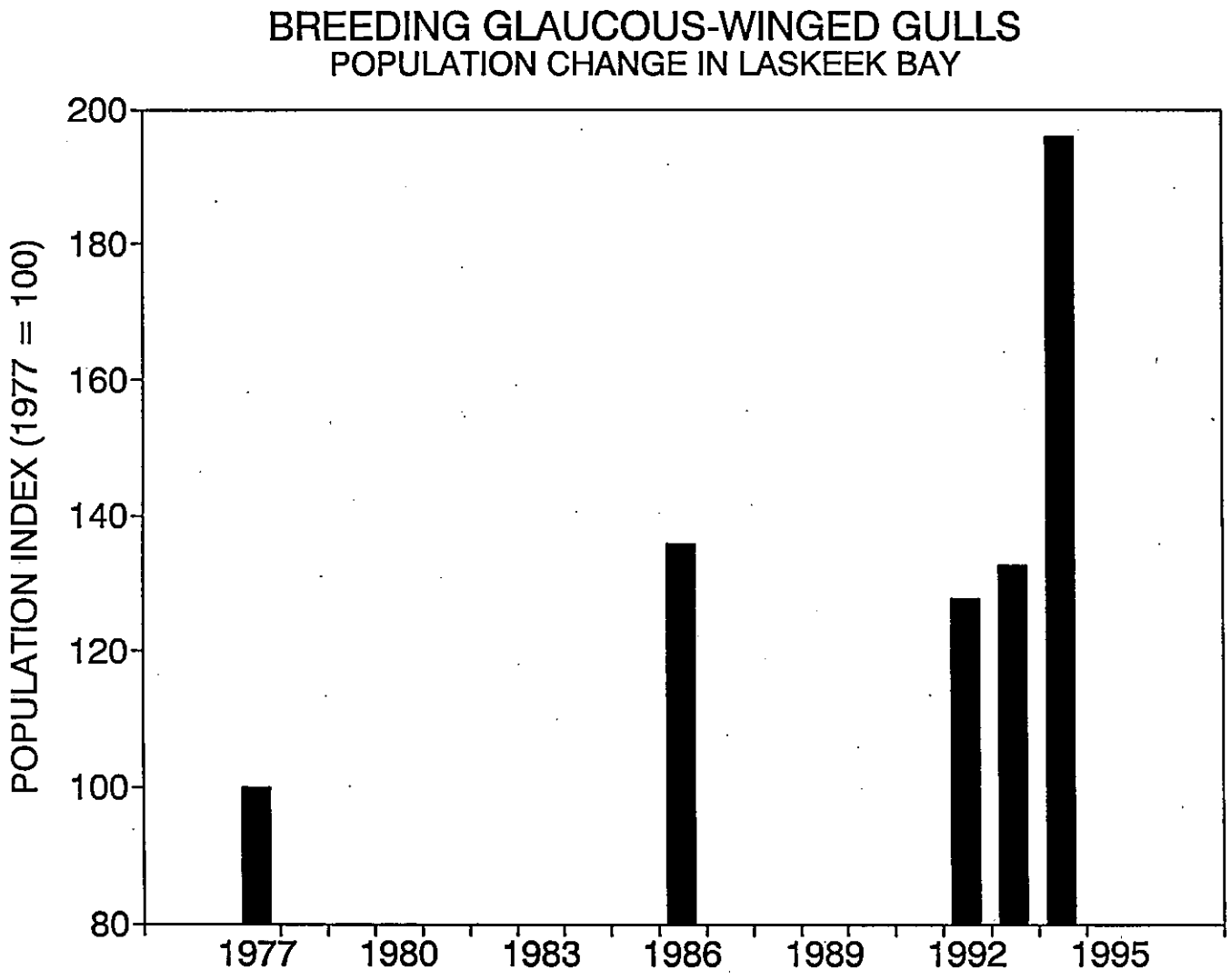
Location	1986	1992	1993	1994
Kingsway Rock	43	94 (+119%)	79 (-16%)	95 (+20%)
Lost Islands	75	120 (+60%)	140 (+17%)	221 (+57%)
Skedans Island	49	18 (-63%)	20 (+11%)	16 (-20%)
Low Island	39	1 (-97%)	4 (+300%)	8
Reef Island	7	2[1]	1	1
Cumshewa Island	37	?	?	19
Total	250	235 (+10%)	244 (+3.8%)	360 (+47%)

[1] Reef Island, 1992 2 pairs present but nests not inspected. In 1993, there were 2 pairs of gulls present, but only one pair defended an active nest, which contained 2 chicks. Source: 1986 data–Rodway 1988; LBCS reports 3 and 4

Table 13. Contents of Glaucous-winged gull nests in the Laskeek Bay area in 1994 (E = egg, C = chick)

Location	Date	Contents				
		0	1E/C	2E/C	3E/C	TOTAL
Kingsway Rk	Jun 27	30	11	19	35	95
Lost Island	Jun 27, Jul 2	56	36	51	78	221
Skedans Islands	Jun 26	5	0	0	11	16
Low Island	Jun 26	6	0	2	0	8
Reef Island	Jul 4	0	0	1	0	1
Cumshewa Island	Jun 26	12	0	2	5	19
Total		109	47	75	129	360

FIGURE 25


BREEDING GLAUCOUS-WINGED GULLS
POPULATION CHANGE IN LASKEEK BAY
POPULATION INDEX (1977 = 100)
200
180
160
140
120
100
80
1977
1980
1983
1986
1989
1992
1995

BLACK OYSTERCATCHERS

Surveys of Black Oystercatchers breeding in the Laskeek Bay area were carried out from early June to mid July in 1994. Thirty-six active nests were found and additional evidence of breeding (eggshell, food remains, distraction displays) was recorded at another seven sites. Twenty-six pairs bred in the "core" area (Skedans, Low and South Low, and Reef islands, the Limestones and Kingsway Rock); the same number as in 1993.

Clutch or brood sizes when first found were as follows: 10 of 1 egg, 22 of 2 eggs and 4 of 3 eggs (mean 1.83, Table 14). Complete clutch or brood loss was observed at 15 sites (42%), and partial loss occurred at a further 7 (19%). A raccoon scat was found close to a predated nest on the Skedans Islands. Brood sizes in the first half of July averaged 1.4 chicks. Chicks were present at the last visit at 20 out of 27 sites visited in July.

The approximate date of hatching could be estimated for 17 nests, and ranged from 2 June to 11 July, with a median of 17 June. This is similar to 1992 and 1993, although timing in earlier years was not measured as accurately as in 1994.

Many non-breeding birds were present in the Laskeek Bay area. A count of all apparently non-breeding groups totalled 90 birds, but this number may have included failed or off-duty breeders and some double counting. Two sightings were made of a bird with a light green colour bands (banded as chick in 1992), one at Skedans, the other on East Limestone Island. It is not known whether one or two birds were involved. A further 59 adult oystercatchers were observed in Skidegate Inlet on 19 July, but none carried a colour band. Sixteen Black Oystercatcher chicks were banded in 1994, using a single white plastic band above the metal band on the right leg and another white band on the left leg. The white band above the metal signifies a chick banded in 1994 (1992 = light green, 1993 = yellow), while the white band on the left signifies the Laskeek Bay area. Banders working in other parts of Haida Gwaii will be using a different area colour.

Table 14. Black Oystercatcher breeding activity in Laskeek Bay, 1994

SITE		VISITS			HATCH	CLUTCH (Date)	FINAL BROOD
		FIRST	LAST	NUMBER			
E. Limestone	I	22/5	15/7	21	10/6	2 (22/5)	2 (15/7)
	II	23/5	15/7	19	18/6	2 (23/5)	1 (15/7)
	III	23/5	14/7	15	16/6	2 (23/5)	0 (3/7)
W. Limestone	I	9/6	8/7	9	-	3 (9/6)	0 (18/6)
Kingsway Rk.	I	9/6	10/7	6	15/6	2 (9/6)	1 (10/7)
	II	20/6	10/7	4	-	1 (20/6)	1 (10/7)
	III	27/6	10/7	3	-	2 (27/6)	2 (10/7)
Large Dog	I	14/6	3/7	2	19/6	3 (14/6)	1 (3/7)
	II	14/6	3/7	2	-	1 (14/6)	0 (3/7)
Otter Islet	I	14/6	3/7	2	-	2 (14/6)	2 (3/7)
Cumshewa	I	15/6	2/7	3	-	2 (15/6)	0 (26/6)
	II	26/6	8/7	3	-	1 (26/6)	1 (8/7)
	III	26/6	8/7	3	2/7	2 (26/6)	2 (8/7)
Skedans	I	26/6	8/7	3	-	1 (2/7)	1 (8/7)
	II	15/6	2/7	3	-	2 (15/6)	0 (26/6)
	III	15/6	8/7	4	25/6	3 (15/6)	0 (8/7)
	IV	2/7	8/7	2	-	1 (2/7)	1 (8/7)
	V	18/6	8/7	4	-	2 (18/6)	1 (8/7)
Low Rocks	I	18/6	29/6	3	-	2 (18/6)	0 (29/6)
Skedans Vill	I	20/6	8/7	4	-	2 (20/6)	0 (8/7)
Reef	I	18/6	11/7	5	17/6	2 (22/6)	2 (11/7)
	II	18/6	11/7	5	17/6	2 (18/6)	0 (29/6)
	III	18/6	11/7	5	22/6	2 (18/6)	0 (5/7)
	IV	18/6	11/7	5	2/6	1 (18/6)	1 (11/7)
	V	18/6	11/7	5	17/6	1 (18/6)	?
	VI	18/6	11/7	5	11/7	3 (18/6)	1 (11/7)
	VII	18/6	11/7	5	9/7	2 (18/6)	2 (11/7)
South Low	I	18/6	26/6	2	-	1 (18/6)	0 (26/6)
	II	18/6	26/6	2	-	2 (18/6)	0 (26/6)
	III	18/6	10/7	4	26/6	2 (18/6)	0 (10/7)
	IV	18/6	26/6	2	-	2 (18/6)	0 (26/6)
Lost	I	27/6	10/7	3	-	2 (27/6)	2 (10/7)
	II	27/6	10/7	3	12/6	2 (27/6)	1 (10/7)
	III	27/6	10/7	3	-	2 (27/6)	2 (10/7)
	IV	2/7	10/7	2	-	1 (2/7)	0 (10/7)

East Limestone Island

Much activity was noted this year at Cassin's Tower, where many burrows were dug up by a raccoon in early 1991 and nest boxes were installed in 1992. A chick was found in box 1 when it was first inspected on 13 June. It weighed 98 g. When last seen, on 11 July, the chick was fully feathered, without signs of down. One other box was entered regularly (#4), but no chick was found. In addition, seven natural burrows on the tower showed signs of entry at every inspection.

A small study plot was established north of Cabin Cove and five natural burrows were tagged, as well as two boxes. Two of the natural burrows showed signs of entry frequently and calling was heard coming from the area on several nights. However, no definite evidence of breeding was obtained from that area.

Reef Island

Trapping of adult Cassin's Auklets was carried out at Cassin's Castle on Reef Island on 6 June 1994. Twenty Cassin's Auklets were trapped, of which eight had been banded in previous years: 1 in 1985, 3 in 1987, and 1 each in 1988, 1989, 1990 and 1992. Capture-recapture analysis of the data so far obtained at Cassin's Castle gave a new estimate of adult survival, updating the one published previously (Gaston 1992b). The new estimate suggests that annual adult survival is approximately 80%, with 95% confidence intervals between 72-87% ("Subsequent years", 1985-94, Table 15). This is only slightly higher than the estimate of adult survival for Ancient Murrelets breeding at the same colony (see above). The estimate for the first year is generally much lower than for subsequent years, because a certain proportion of birds trapped for the first time are probably prospectors that have a small chance of being retrapped again. This estimate is therefore ignored.

Table 15. Capture-recapture estimates for adult annual survival of Cassin's Auklets at Reef Island based on data up to 1991 and up to 1994.

YEARS	1985-91			1985-94		
	SURVIVAL	MINIMUM	MAXIMUM	SURVIVAL	MINIMUM	MAXIMUM
FIRST	.495	.369	.622	.593	.464	.711
SUBSEQUENT	.881	.726	.954	.805	.719	.869

SAPSUCKER STUDIES

Red-breasted Sapsucker nests have been located each year since 1991. The fourteen found in 1994 is the highest total so far and may indicate that not all were found in earlier years (Table 16). The apparent clustering of nests along frequently-used trails, especially the main trail from the Boat Cove to the Cabin, also seems to confirm that not all nests have been found each year.

Breeding sites found to date at East Limestone Island have all been in dead snags, with the exception of one in a partially dead tree. Many of the snags had lost some or most of their bark. Heights above the ground were estimated to be from 15-50 m (median 30 m, N=25). Two Hairy Woodpecker sites were in similar situations.

Observations of sapsuckers at East Limestone Island to date suggest that the species' ecology in Haida Gwaii differs substantially from that reported from other parts of the province. Campbell et al. (1990) report 78% of nests in live trees and 67% between 3.4-9.1 m up.

A sapsucker with a red band, marked in 1991 in Spring Valley, bred at site 21. A white-banded Hairy Woodpecker, also banded in 1991 was observed several times. Probably four pairs were present on the island, but only one nest was found.

Table 16. Red-breasted Sapsucker nesting trees occupied in 1991-94

SITE	1991	1992	1993	1994
1	*	FLIC	*	-
2	*	blown down		
3	*	blown down		
4	*	*	-	HAWO
5	*	*	-	-
6	*	*	not loc.	subs.
7	*	-	-	*
8	*	-	CBCH	-
9		*	*	*
10		*	-	-
11		*	*	*
12		*	*	-
13		*	*	*
14		*	-	-
15		*	*	?
16			*	-
17			*	*
18			*	-
19			*	-
20				*
21				*
22				*
23				*
24				*
25				*
26				*
27				*
28				*
TOTAL	8	10	10	14

BIRD RECORDS, 1994

BIRD SPECIES	FREQUENCY &/OR DATES SEEN, COMMENTS
Pacific Loon	Seen regularly from 22 April - 22 June. A dense flock of 4 was present just east of Cabin Cove on 26 May
Common Loon	Recorded periodically through the season.
Horned Grebe	One on 6 April.
Red-necked Grebe	One on 6 & 9 April, two on the 12th.
Western Grebe	One on 27 April.
Sooty Shearwater	Seen periodically throughout the season, twice in flocks of more than 100.
Fork-Tailed Storm-Petrel	Both seen and heard in flight and in burrows at East Limestone Island.
Double Crested Cormorant	Seen periodically through the season, but commonest in April.
Brandt's Cormorant	Four records in April, and one in May.
Pelagic Cormorant	Seen daily, usually flying North past Cabin Cove in the morning, south to roost in the evening.
Brant	Seen 10 times in April , once a flock of 100, once 200.
Canada Goose	Seen periodically until early May, including one flock of approximately 600 birds.
Green Winged Teal	Four on 7 May.
Northern Shoveler	Six seen on 5 May.
Harlequin Duck	Seen regularly until mid-May and sporadically thereafter.
Oldsquaw	One seen on 16 May.
Black Scoter	Seen on 25 April & 3 June.
Surf Scoter	Seen four times in early May, mostly on boat surveys.
White Winged Scoter	Seen regularly until mid-May.
Common Merganser	Seen periodically until mid-May.
Bald Eagle	Two nests were active, the usual one and one lower in Crow Valley. Both had young ready to fly when camp was closed on 15 July.

BIRD SPECIES	FREQUENCY &/OR DATES SEEN, COMMENTS
Red Tailed Hawk	One seen on 19 & 27 May.
Peregrine Falcon	Heard and seen regularly from 11 April. Two chicks fledged by 28 June. The eyrie has been active in four out of the five years since 1990.
Sharp-Shinned Hawk	One seen on 6, 24 & 25 May.
Blue Grouse	Heard occasionally from late April through early May.
Sandhill Crane	Seen on 6 April.
Black Oystercatcher	Seen daily. Three pairs nested on East Limestone Island.
Whimbrel	Seen on 9 May (85 going N) and 18 May (17 in Breaker Bay).
Surfbird	Seen on 2,5,8, & 9 July.
Western Sandpiper	Seen 10 July from boat.
American Dipper	Seen on 15 July.
Black Turnstone	Seen 6 times, usually from the boat.
Herring Gull	Seen periodically through mid-May, once on 2 July.
Glaucous-winged Gull	Recorded daily.
Black-legged Kittiwake	Recorded on 25 April, 1 May, and 16 and 26 June.
Common Murre	Recorded on 1-5 May; 3, 7, & 22 June
Pigeon Guillemot	Seen regularly through the season.
Marbled Murrelet	Seen and heard frequently through the season (see boat surveys).
Ancient Murrelet	Recorded daily until late June.
Cassin's Auklet	Seen and heard throughout the season. One chick was reared in a nest box on Cassin's Tower.
Rhinocerous Auklet	Seen regularly through the season (see boat surveys).
Tufted Puffin	Seen on boat surveys 3 & 16 May, 8 & 9 June.
Northern Saw-Whet Owl	Heard in mid-May & early June. Once one was seen on ground near an Ancient Murrelet chick.
Rufous Hummingbird	Seen regularly through the season. Several young fed at feeder by Cabin.
Belted Kingfisher	Seen regularly through the season.

BIRD SPECIES	FREQUENCY &/OR DATES SEEN, COMMENTS
Red Breasted Sapsucker	Seen regularly through the season. Fourteen nests were active.
Hairy Woodpecker	At least 4 pairs were seen and heard. One pair had a chick in July.
Northern Flicker	Seen and heard periodically through May.
Western Flycatcher	Seen and heard from 12 April.
North-Western Crow	Seen daily. Nested in Crow Valley and along the southern cliffs.
Common Raven	A pair had a nest behind the Boat Cove, and raised 3 young, which fledged on 28 May.
Chestnut-Backed Chickadee	Frequently seen and heard.
Red-Breasted Nuthatch	Seen and heard sporadically through the season.
Brown Creeper	Noted throughout the season, with almost daily sightings in the last two weeks of May.
Winter Wren	First families seen on 23 May and several family parties recorded in the next few days.
Golden-Crowned Kinglet	Seen and heard regularly until the end of June. Recently fledged chicks seen by 'S' plot in early June
Swainson's Thrush	Recorded from 16 June onwards
Hermit Thrush	Seen and heard through the season. One fledgling seen on 29 June.
American Robin	One seen and/or heard 6 times between 15 April and 2 May.
Varied Thrush	Seen and heard most days.
Orange-Crowned Warbler	Noted regularly starting on 24 April. One fledgling seen on 21 June.
Townsend's Warbler	Noted regularly starting 12 April. Young birds seen frequently in Spring Valley after 19 June.
Fox Sparrow	Seen on 8, 11, 12, 24 & 27 April and on 2 and 23 May.
Song Sparrow	Observed sporadically. A nest with two newly-hatched chicks was found on 11 June in a small spruce.

BIRD SPECIES	FREQUENCY &/OR DATES SEEN, COMMENTS
Dark-Eyed Junco	Seen regularly. At least two adults were banded. Chicks appeared on 30 May.
Red Crossbill	Foraging flocks often observed in forest canopy over Spring Valley and the Boat Cove.
Pine Siskin	Flocks seen periodically in Spring Valley.

TOTAL SPECIES: 68

MARINE MAMMALS

Seventeen species of whales, dolphins and porpoises (cetaceans) and five species of seals and sea lions (pinnipeds) have been recorded in the waters of Haida Gwaii, but many of these, such as the beaked whales and pilot whales, are only seen infrequently (Olesiuk & Bigg 1988, Ford *et al.* 1994). In 1994, six species of cetaceans and four species of pinnipeds were seen in the Laskeek Bay area. The only pinniped species not seen in 1994 in Laskeek Bay was the northern fur seal.

PINNIPED RECORDS

Steller Sea Lion. -- Steller sea lions are the largest of the eared seals (Otariidae) and are often seen from the shore of Limestone Island. Table 17 lists the counts of sea lions on the two principle haul-out sites within the Laskeek Bay area, the Skedans and Reef Islands. Sea lions do not breed on these sites, but use them as year-round haulouts. During the breeding season (May-July), many animals leave these haulouts and travel to rookeries, such as Cape St. James.

California Sea Lion. -- California sea lions were first observed in Laskeek Bay in 1993, and this was also a first record for Haida Gwaii. It appears that the number of California sea lions in British Columbia is increasing each year (P. Olesiuk, Pacific Biological Station, Nanaimo, Pers. Comm.). In 1994, seven California sea lions were recorded on the Reef Island rocks on 25 April and one was seen on 29 June.

Northern Elephant Seal.-- Northern elephant seals are the largest of the pinnipeds found in British Columbia, but they do not breed here. Breeding occurs on islands off California and Mexico during the winter months. Juveniles and adult males are usually solitary and may travel to British Columbia and Alaska during the summer. In Laskeek Bay in 1994, elephant seals were observed on three occasions: on 27 April 2.5 km northeast of East Limestone Island; on 2 May between Low Island and South Low Island; and on 5 of May at 52o 54.501 N, 131o 26.031 W in Hecate Strait.

Harbour Seal.-- Harbour seals are the most abundant pinniped in British Columbia. Their population has likely returned to historic levels since they received protection from hunting in 1970 (Olesiuk & Bigg 1988). Harbour seals are commonly seen hauled out on shorelines in the Laskeek Bay area, and are often seen swimming and feeding in Cabin Cove on Limestone Island. Table 18 lists counts of harbour seals made at some of the haul-outs in the area.

Table 17. Steller sea lion counts on Skedans and Reef Islands in 1994.

Location	Date	Count	Location	Date	Count
Skedans Isl.	Apr 9	60	Reef Is.	Apr 9	475
	May 4	94		Apr 25	497
	May 16	55*		May 5	353
				May 16	479
				June 6	471
				July 9	269

* including 20+ animals in water

Table 18. Harbour seal counts in Laskeek Bay in 1993.

Location	Date	No.
Skedans Is.	15 Jun	43
	26 Jun	10
Cumshewa I	15 Jun	16
	26 Jun	29
Cumshewa Rcks	15 Jun	80
Low I	9 Apr	17
	25 Apr	13
	4 May	28
	18 Jun	12
S Low Island	25 Apr	25
	18 Jun	24
Reef Island	16 May	22
	6 Jun	7

CETACEAN RECORDS

Baleen whales. Baleen whales are relatively common in the Queen Charlotte Islands, as shown by the fact that over 5200 baleen whales were commercially harvested from the area between 1910 and 1967 by commercial whalers (Nichol & Heise 1992). Fin and sei whales comprised the largest portion of the catch, but blue and humpback whales were also frequently taken. During this same period, there was no commercial whaling for grey whales. This was because grey whale numbers were severely depleted by whalers during the nineteenth century, and in 1937 grey whales were officially protected from commercial whaling. In British Columbia, commercial whaling for all species ended in 1967. In more recent times, the most commonly reported species of baleen whales in Haida Gwaii are humpback, grey and minke whales (Ford *et al.* 1994). In 1994, these three species of baleen whales were seen in Laskeek Bay. The overall number of sightings in 1994 was six, compared to 22 in 1993.

Humpback Whale.-- Humpback whales are the most frequently reported baleen whale in Haida Gwaii (Ford *et al.* 1994). They are most commonly reported around Langara Island,

however, they were seen on one occasion in Laskeek Bay in 1994 (Table 3).

Minke Whale.-- Minke whales are the smallest of the baleen whales, and are most commonly seen alone or in small groups along the east coast of south Moresby Island (Ford et al. 1994). Minke whales were seen on 3 occasions in Laskeek Bay in 1994 (Table 19).

Grey Whale.-- In the eastern north Pacific there are approximately 21,000 grey whales which migrate seasonally between winter breeding lagoons in Baja California and summer feeding grounds in Alaska (Breiwick et al. 1988). The majority of these animals travel off the west coast of Haida Gwaii, but some animals move along the east coast and may even feed along the eastern shore of Moresby and Graham Islands (Ford et al. 1994). Grey whales were seen on 2 occasions in Laskeek Bay in 1994 (Table 3).

Table 19. Baleen whale sightings in Laskeek Bay in 1994.

Date	No. and Species.	Location
10 April	2 grey whales	Cabin Cove, E. Limestone
10 April	1 grey whale	Cabin Cove, E. Limestone
2 May	1 minke whale	1/4 mi SE of SE tip of E. Limestone
6 June	1 humpback whale	East of Reef Island
15 June	1 minke whale	Skedans Passage
25 June	1 minke whale	near Low Island

Toothed Whales.

Killer whales are the most commonly reported species of toothed whale in the waters of Haida Gwaii, although this should not be interpreted to mean that they are the most common species in the area (Ford et al. 1994). They are easily recognized and are relatively large, so are more likely to be reported than smaller species. Pacific white-sided dolphins, Dall's porpoises and harbour porpoises are also frequently seen, and have been recorded in Laskeek Bay in previous years (Gaston & Heise 1994). Interestingly, no Dall's porpoises were seen in 1994. However, the overall number of sightings of all toothed whales was lower in 1994 compared to 1993 (24 sightings vs. 29 in 1993).

Harbour Porpoise.-- Harbour porpoise are small, reaching a maximum length of about 1.8 m, and weight of about 90 kg (Leatherwood et al. 1982). Their small size, dark grey or brown colour, and tendency to travel alone, or in small groups, often makes them difficult to observe. Despite this, harbour porpoises were seen on 9 occasions in Laskeek Bay in 1994 (Table 20). The largest group was seven, and most sightings were of one or two animals.

Table 20. Harbour porpoise sightings in Laskeek Bay in 1994.

Date	No. Seen	Location
6 June	4	Cabin Cove
7 June	7	Low Island
25 June	1	Cabin Cove
8 July	2	midway between E. Limestone & Skedans Is.
8 July	2	between Low & S. Low
9 July	1	East of Reef Island
11 July	1	East Limestone
12 July	2	East Limestone
13 July	2	Cabin Cove

Pacific White-sided Dolphin.-- Pacific white-sided dolphins are one of the most abundant and widely distributed small cetaceans in the North Pacific. They can reach a length of 2.5 m and weigh up to 180 kg (Leatherwood *et al.* 1982). They often exhibit a wide variety of aerial behaviours and can be found in groups of over 1000 animals. They were fist reported in Laskeek Bay in 1993, and were seen and/or heard on 10 occasions in 1994 (Table 21).

Table 21. Pacific White-sided dolphin sightings in Laskeek Bay in 1993.

Date	No. Seen	Location
26 April	4	52o 51.438 N, 131o 21.928 W
28 April	4	between Low and South Low
3 May	200	52o 51.878 N, 131o 25.916 W
5 May	25	52o 53.758 N, 131o 21.916 W
6 May	4	0.8 km S of Vertical Point
7 May	4	0.8 km E of Kingsway Rock
9 May	50-60	entrance to Selwyn Inlet
17 May	25	entrance to Selwyn Inlet
7 June	Many	east of Cabin Cove
1 July	10-20	between East Limestone and Low Island

Killer Whale.-- As reported above, killer whales are the most frequently reported toothed whale in Haida Gwaii. There are two known forms of killer whale in BC waters. "Transients" which are most often found in small groups of 1 to 5 and prey on marine mammals, are the most common form found in Haida Gwaii. "Residents" which live in large groups and prey on fish, have been recorded in Haida Gwaii on only two occasions (Heise et al. 1993). A new population of killer whales, known as "offshore" type have been documented along the BC coast, and the majority of sightings have been in the waters of Haida Gwaii (Ford et al. 1994). Offshores appear to resemble resident whales in that they travel in large groups and eat fish. However, relatively little is known about their life history and ecology. In Laskeek Bay, the majority of encounters with killer whales have been with transient killer whales (Heise et al. 1993). Killer whales were seen on 5 occasions in 1994 in Laskeek Bay (Table 22). Several individuals were identified from photographs.

Table 22. Killer whale sightings in Laskeek Bay in 1994.

Date	No. Seen	Location
22 April	7	Cabin Cove
8 July	8	Skedans to Vertical Point
10 July	6	Lost Islands
14 July	4	Lost Islands
15 July	12	East of Low Island

Terrestrial Mammals

Seven species of terrestrial mammals were observed, including five species seen regularly at East Limestone Island. They were the river otter, small brown bat, deer mouse, red squirrel, and Sitka black-tailed deer.

A Pine Marten was seen on Louise Island and although there were no sightings, the presence of fresh scats and an identified hair attested the presence of a raccoon on East Limestone Island.

REFERENCES

Breiwick, J.M., Rugh, D.J., Withrow,D.E., Dahlheim, M.E. & Buckland, S.T. 1988. Preliminary population estimate of grey whales during the 1987/88 southward migration. Unpubl. Rep., Int. Whal. Commn.

Ford, J.K.B., Heise, K., Barrett-Lennard, L.G., & Ellis, G.M. 1994. Killer whales and other cetaceans of the Queen Charlotte Islands/ Haida Gwaii. Unpubl. rep., Gwaii Haanas National Park Reserve, Parks Canada.

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. Condor 92: 998-1011.

Gaston, A.J. 1992a. The Ancient Murrelet. T. and A.D. Poyser, London.

Gaston, A.J. 1992b. Annual survival of breeding adult Cassin's Auklets in the Queen Charlotte Islands, British Columbia. Condor 94: 1019-1021.

Gaston, A.J. & Heise, K.H. 1994. Laskeek Bay Conservation Society, Annual Scientific Report 1993. Laskeek Bay Conservation Society, Queen Charlotte City.

Gaston, A.J., and Lawrence, A. 1993. Laskeek Bay Conservation Society, Report on scientific activities in 1992. Laskeek Bay Conservation Soc., Queen Charlotte City.

Gaston, A.J., Lawrence, A., and French, C. 1992. Laskeek Bay Conservation Society, Report on scientific activities in 1991. Laskeek Bay Conservation Soc., Queen Charlotte City.

Heise, K., Barrett-Lennard, L.G., Ford, J.K.B. & Ellis, G. 1993. Killer whales of the Queen Charlotte Islands: results of research on the abundance, distribution and population identity of Orcinus orca in the waters of Haida Gwaii in 1992. Unpubl. Rep., Gwaii Haanas National Park Reserve, Parks Canada.

Leatherwood, S., Reeves, R.R., Perrin, W.F. & Evans, W.E. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters. NOAA Tech Rep. NMFS Circular 444. U.S. Dept. of Commerce.

Nichol, L. & Heise, K. 1992. The historical occurrence of large whales off the Queen Charlotte Islands., Unpubl. Rep., South Moresby/Gwaii Haanas National Parks Reserve, Parks Canada.

Olesiuk, P. & Bigg, M. 1988. Seals and sea lions on the British Columbia coast. Dept. of Fisheries and Oceans.

Rodway, M.S. 1988. British Columbia seabird colony inventory: report no. 3 -- Census of Glaucous-winged Gulls, Pelagic Cormorants, Black Oystercatchers and Pigeon Guillemots in the Queen Charlotte Islands, 1986. Pacific and Yukon Region, B.C.: Canadian Wildlife Service Tech. Rep. Ser. No. 87.

CONTRIBUTED PAPERS

DIET OF BLACK OYSTERCATCHER CHICKS AT EAST LIMESTONE ISLAND

ANDREA SMITH
Dept of Biology, Queen's University, Kingston, ONT.

Black Oystercatchers begin breeding in the Laskeek Bay area in about the middle of May. The female lays from 1-3 eggs in a scrape, often situated in a slight depression in the rocks and lined with gravel and/or shells. After approximately 30 days of incubation the eggs hatch and the semi-precocial young are fed and cared for by both parents for another 35 days until fledging (Ehrlich *et al.* 1988).

During the chick-rearing period, the adults tend to forage in the intertidal zone closest to the scrape, bringing food items such as limpets, mussels and chitons to the chicks. As the chicks grow and develop, they become increasingly mobile, and may move away from the scrape altogether within a day or two of hatching.

In 1994, 36 active nests were monitored from 11 June - 15 July to study the feeding ecology of oystercatcher chicks and the parental care provided by adults. Food collections were made periodically at 13 sites to see if chick diet changed with age.

In addition, observations of parental care behaviour were made at the three sites on East Limestone Island to examine if food remains around the scrape are representative of what chicks are fed by adults and if parental care varies as chicks develop.

METHODS

A transect line was extended out from each active nest, 15m toward the intertidal zone, along the longest stretch of land between scrape and water. At the first visit to each site following chick hatching, all food remains found within 5m on either side of the transect were cleared away. Food remains were then collected from within the 150m^2 area at each site every 5-7 days and sorted by species and size. Chitons, limpets and mussels were organized according to the size class system used by Leduc in 1992 (mussel: A <40mm, B 40-70mm, C >70mm; limpet: A <12mm, B 12-33mm, C >33mm; chiton: A <20mm, B 12-25mm, C >25mm, Report #3, Leduc 1993). Chick weight, bill and wing-length were also recorded at each visit.

Feeding activity was observed for a total of 38 hours at the three active nest sites on East Limestone Island. Observations were made during various stages of the tide and at varying times of the day from blinds set up at each site within 100m of the intertidal foraging zones.

During observations, the distance between each chick and its closest parent (where visible) were recorded every 15 minutes. Information on the response of adults to potential predators (Bald Eagle, Glaucous-winged Gull, Northwestern Crow, Common Raven) observed in the vicinity of the site were also recorded.

The chick-rearing period was divided into early (0-11 days), mid (12-23 days) and late (24-35 days) stages and all food remains and behavioural observations (feeding activity, parent-chick distance and adult response to predators) were analyzed on the basis of these stages. Chicks of unknown age were classified according to a weight scale based on measurements taken on chicks of known age (0-100g = early, 100-300g = mid and 300g+ = late). Regression analyses were performed on the wing length, bill length and weight data of random sample of known-age chicks (one set for each chick) to determine which measurement was the best predictor of age.

RESULTS

Growth

Of the three body measurements, wing length was the best predictor of chick age (R^2 = 0.99, $P < .001$, $N = 5$). However, the sample size was small (Figure 1), and more data are needed to develop an accurate predictor of age. Weight was the second best predictor of chick age (R^2 = 0.90, $P < 0.01$, $N = 7$). Because weight increases more continuously than wing length (Figure 2) it may give a better prediction of age, especially for younger chicks. Again, more measurements would increase confidence in these values. Bill length was a poor predictor (R^2 = 0.83, $N = 7$).

FIGURE 1

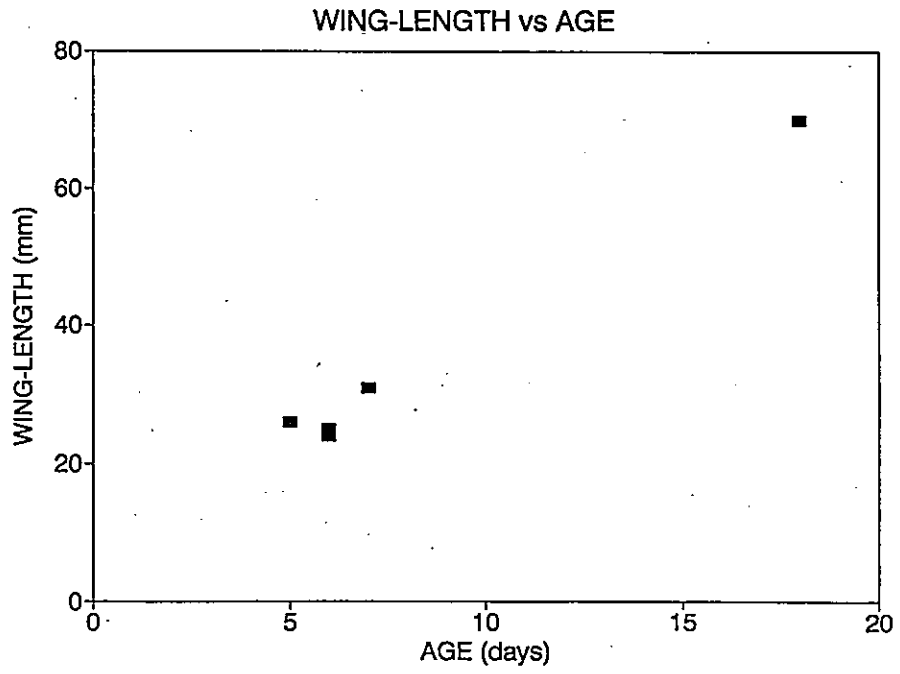
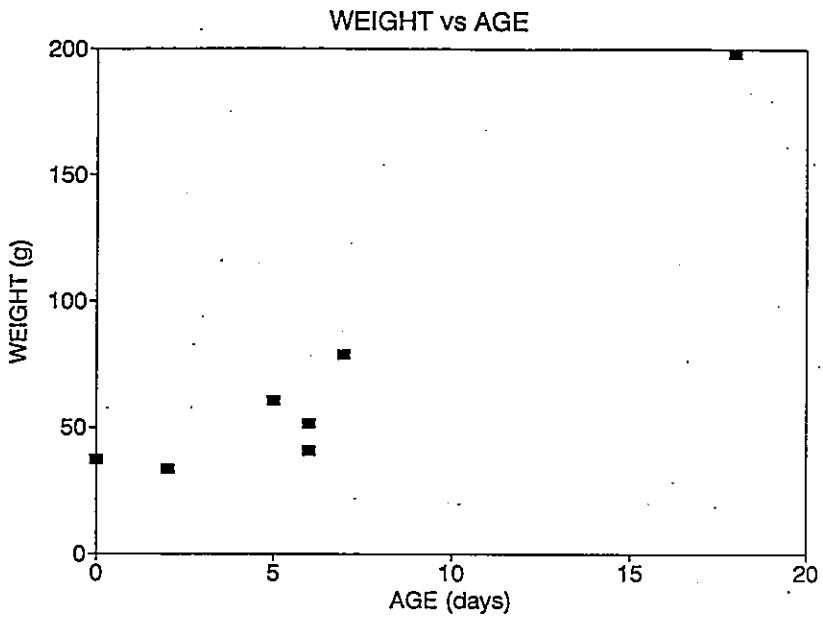


FIGURE 2



Food Collections

Six species of limpets were identified in food remains collected at 13 sites. The most common was the shield limpet, especially during the early period, but four species contributed 10% or more by number (Table 1). All mussels were identified as blue mussels. Most chitons in food remains were black chitons (98%), the exception being a single lined chiton.

To compare the food remains found around the nest site with observations of food delivered to the chicks, I used only the data from the three sites at East Limestone Island. Limpet shells were the predominant food remains collected throughout chick development, comprising 81% (N = 375) of all items over the season (Table 2). Of these, 96% were in the middle size class for limpets (12-33 mm length). Mussels and chitons made up 11% and 7% respectively of food remains, while snail and crab made up the remaining 1%. Among mussels collected, 90% were in the middle size class (40-70mm length), while 56% of chitons were in the largest size class.

During the early period of chick development, limpets comprised 74% (N = 162) of food remains, 96% of them within the middle size class. Mussels made up 15% of total food remains, 96% of them in the middle size class and chitons made up 9% of items collected, 79% of which were in the largest size class. Other food items (two ribbed whelks and one kelp crab) made up the remainder.

During the middle period, all three sites were sampled and 198 items collected. Limpets made up 85% of remains, nearly all in the middle size range, while mussels

made up a further 9%, most of which were in the middle size range. Chitons made up 6%, mainly middle sized.

Only one site was sampled during the late period. All food remains found were limpets, 93% in the middle size class.

Table 1. Limpet species identified in food collections

SPECIES	AGE OF CHICKS (days) 1-11	12-23	> 23	TOTAL
N	120	168	15	303
Shield	53%	37%	34%	41%
Plate	24%	29%	19%	24%
Speckled	18%	19%	26%	21%
Finger	4%	10%	13%	10%
Whitecap	1%	4%	2%	2%
Keyhole	0	1%	6%	2%

FIGURE 3

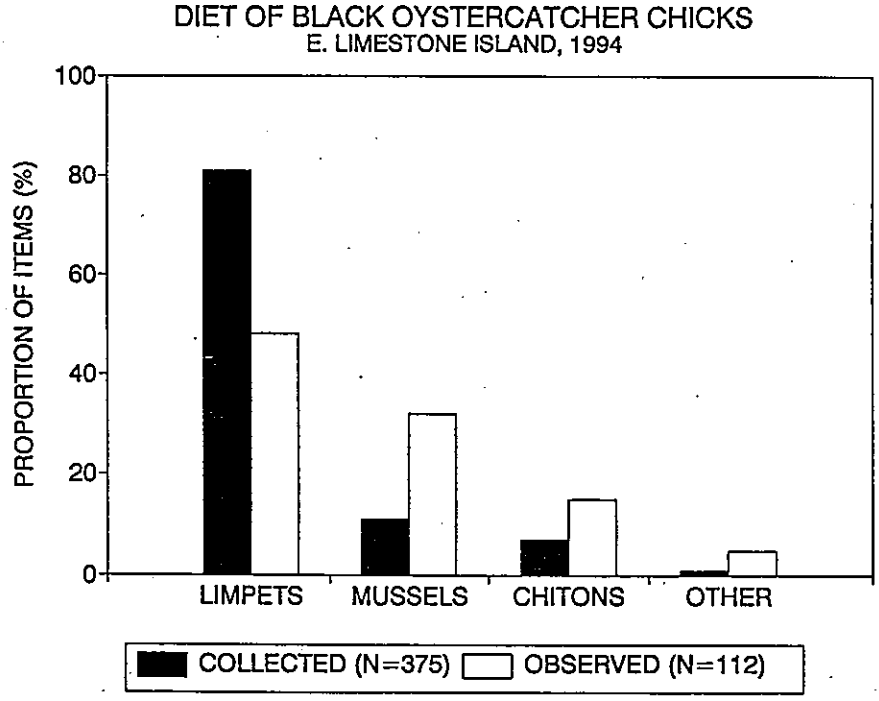


Table 2. Diet of Black Oystercatcher chicks at East Limestone Island, by species group

PERIOD	SIZE	COLLECTED			SEEN			COLL vs SEEN	
		LIMP.	MUSS.	CHIT.	LIMP.	MUSS.	CHIT.	Chi^2_2	P
EARLY	SMALL	1	1	0	14	1	1		
	MEDIUM	115	24	3	17	2	4		
	LARGE	4	0	11	0	0	0		
	TOTALS	120	25	14	31	3	5	1.8	NS
MIDDLE	SMALL	5	3	0	9	7	5		
	MEDIUM	163	14	9	5	11	4		
	LARGE	0	0	4	0	0	0		
	TOTALS	168	17	13	14	18	9	49.1	<0.001
LATE	SMALL	0	0	0	5	0	0		
	MEDIUM	14	0	0	4	15	1		
	LARGE	1	0	0	0	0	2		
	TOTALS	15	0	0	9	15	3	17.5	<0.001
PERIODS	COMBINED								
	SMALL	6	4	0	28	8	6		
	MEDIUM	292	38	12	26	28	9		
	LARGE	5	0	15	0	0	2		
	TOTALS	303	42	27	54	36	17	42.9	<0.001

Comparing size distributions (combining medium and large sizes to give df=1) between collected and observed samples:

	LIMPETS			MUSSELS			CHITONS		
	EARLY	MID	LATE	EARLY	MID	LATE	EARLY	MID	LATE
χ^2	49.3	60.0							
P*	<.01	<.01	<.01	NS	NS	-	<.01	<.01	-

* Where no Chi^2 value is given, probabilities are from Fisher exact tests

Table 3. Minimum distances between adults and chicks in relation to chick age

DAYS FROM HATCH	DISTANCE FROM PARENT TO CHICK		
	< 1 m	1 - 5 m	6 - 10 m
1 -11 (EARLY)	27 (77%)	6 (17%)	2 (6%)
12-23 (MIDDLE)	19 (59%)	13 (41%)	0
> 23 (LATE)	1 (9%)	4 (36%)	6 (55%)
OVERALL	47 (60%)	23 (29%)	8 (11%)

Feeding Observations

According to the observational data, limpets were the main food item fed to chicks at the three sites on East Limestone. They comprised 48% (n=112) of diet items recorded, 52% in the smallest size class (<12 mm) and the rest middle sized (12-33 mm). Mussels, most middle sized, made up 32% of diet items and chitons 15%, half being middle sized (Table 2). The remaining 5% of items fed to chicks could not be identified. The relative proportions of limpets, mussels and chitons in the observed sample differed significantly from that in the collections, having fewer limpets and more of other organisms ($\chi^2 = 42.9$, $P < 0.001$, Figure 3). In addition, the size of limpets seen delivered differed significantly from that in the collections, with a greater proportion in the smallest size class ($\chi^2 = 132$, $P < 0.001$, Figure 4).

No trend in the size of limpets fed to chicks in relation to their age was detected, but older chicks were fed less limpets and more middle sized mussels and large chitons than young chicks (Table 2).

Of the molluscs (limpets, chitons and mussels) delivered to chicks 89% ($N = 109$) had their shells already removed. The number of food items brought to chicks out of the shell decreased significantly with time.

Adult diet

I made periodic observations of adults at the East Limestone Island sites feeding themselves. Throughout the season, mussels comprised 46% (n=35) of the adult diet, 37% of which were of the middle size class. Chitons made up 20% of observed adult feedings, with 11% of these in the middle size range. Limpets made up another 15%, 60% falling in the smallest size class. Isopods (sowbugs) and snails

made up 8% and 3% respectively while the remaining 8% of items were not identified.

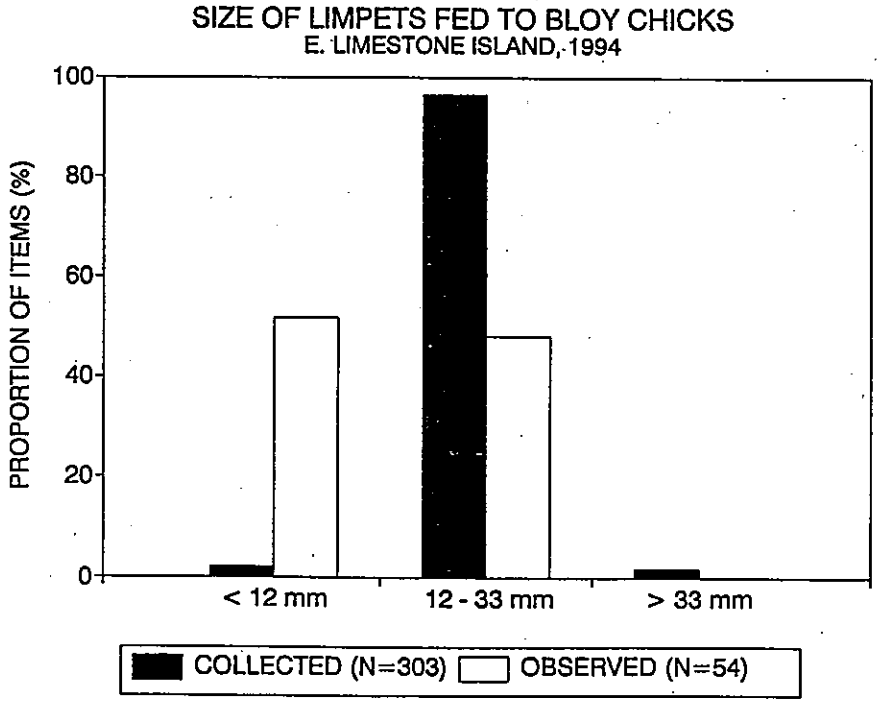
Chick guarding and reactions to predators

At least one adult was within 10m of the chicks during each 15 minute observation interval throughout the season (N=78). One adult was within 1 m of the chicks 60% of the time, 1-5m away 29% of the time and 6-10m away 11% of the time.

The proportion of time within 1 m of the chicks decreased from 77% (N=35) of observations during the early part of the season, to 59% (N=32) during the middle period, and only 9% during the late period (N=11), at which stage parents and chicks were spending 55% of the time 6-10m of each other (Table 3).

Over the course of the season, potential predators were recorded in the vicinity of the East Limestone Island oystercatcher sites (either seen or heard from the sites) on 72 occasions. Adult oystercatchers were observed responding to the presence of predators (a response was defined as a noticeable change in adult activity within 1 minute of my detection of the predator (e.g. vocalization, chasing etc.) 39% of the time. Bald eagles elicited the most frequent response (55% of time an eagle detected by me and 61% of total responses), followed by Northwestern Crows (30% of time a crow detected and 25% of total responses) and Common Ravens (30% of time a raven detected and 11% of total responses). A Peregrine Falcon flew by a site once during my observations and the adult oystercatchers responded with loud vocalizations. Although Glaucous-winged Gulls were recorded in the vicinity of sites seven times, the oystercatcher adults never responded to their presence.

FIGURE 4



DISCUSSION

Limpets were the main food fed to chicks, based on both food collections and observations. However, adults fed themselves on more mussels and chitons than limpets. Hence the diet fed to chicks appears to be highly selected.

According to the data obtained from food collections, the proportion of limpets in chick diets remained fairly constant over the season. However, in feeding observations, the proportion of the diet made up by limpets declined and the proportion of mussels increased with chick age. Mussel remains decreased with age in food collections. The proportion of chitons in the chick diet remained fairly constant throughout in both food collections and feeding observations, although no chitons were found in the late food collection.

Most food items collected and observed fell into the middle size range. However, limpets in the smallest size class made up a greater proportion of the diet in observations than in collections.

The most useful finding, from the point of view of diet studies, was the difference observed between the diet measured on the basis of food remains collected and that derived from observations of items being fed to chicks. The difference in the proportional representation of different types and sizes of prey may relate to differences in the likelihood that the flesh would be removed from the shell before delivery to the chicks. In addition, small shell remains may have been more easily overlooked than larger shells when remains were collected.

As I was only able to observe feeding at the three sites on East Limestone, data collected may not be representative of all the sites monitored in the Laskeek Bay over the season. Moreover, in the late period, I was able to collect food remains from only one site on East Limestone. For future study of feeding activity, it would be preferable to monitor a minimum of five sites dispersed throughout the area (eg. one at each of Limestone, Reef, Skedans, Cumshewa and Kingsway if feasible) in order to cover different features of habitat and conditions.

The area over which parent oystercatchers feed may vary in size and location from site to site and often over time, at a given site. Hence, the transect method of food collection may not always cover active feeding grounds. A more accurate picture of food remains might be obtained by setting up several transect lines radiating out from the nest, and increasing the area covered in each one. Alternatively, the entire breeding site could be cleared of remains, although this might be difficult at a number of extensive sites monitored this season.

Adult oystercatchers on East Limestone Island removed molluscs from the shell most of the time before presenting food to their chicks. Sometimes, the adults chiselled out the flesh and deposited the empty shell close to the feeding area, but often I observed an adult flying or walking in from elsewhere with only flesh in its bill. This behaviour suggests that at least some of the molluscs fed to chicks were not represented in food remains at the site. In addition, food collections were only possible for hard-bodied items such as molluscs, crabs and isopods. Any soft-bodied items in the diet would go undetected (eg. insects).

During feeding observations, I was unable to identify several items fed to chicks, thereby affecting calculations of diet composition. Food remains were often found in rock crevices, and some smaller items may have thus gone undetected. Adults were also observed feeding themselves within the area from which collections were made, suggesting that some proportion of food remains collected may represent the adults' diet and not the chicks.

The shield limpet was the most common species identified in food collections, suggesting that it makes up a major part of the chicks' diet. Identification of food items to species was not possible during feeding observations and thus I was unable to compare frequencies of species found in collections to those observed fed to chicks. It would be interesting to know whether the frequency of the shield limpet in the oystercatcher's diet is related to its abundance and distribution in breeding areas. Oystercatcher handling time of this species and its size-to-meat ratio could also be studied in comparison to other limpet species to determine why the shield limpet predominates in food remains.

Adult oystercatchers responded more to the presence of Bald eagles than to other avian predators. Bald Eagles were the most abundant predator observed in the vicinity of sites and the high frequency of oystercatcher response to this species may be due to its sheer numbers (ie. perhaps adults develop a "predator image" of the most abundant threats in their habitat).

Oystercatchers have been found to select for nesting sites close to breeding Glaucous-winged gulls (Vermeer et al. 1992). Although gulls could be predators of oystercatcher eggs and chicks, proximity to their colonies may provide oystercatchers with increased protection against mammalian predators (as gulls tend to exhibit aggressive, mobbing behaviour towards intruders) and early warning of danger (gull alarm calls). This trade-off of costs and benefits may account for the oystercatchers' lack of response to the presence of gulls at East Limestone Island.

Appendix A: Latin names of invertebrate food items

Limpets
Shield limpet- *Collisela pelta*
Finger limpet- *C. digitalis*
Plate limpet- *Notoacmea scutum*
Speckled limpet- *N. persona*
Keyhole limpet- *Diodora aspera*
Whitecap limpet- *Acmaea mitra*

Mussels
Blue mussel- *Mytilus edulis*

Chitons
Black chiton- *Katherina tunicata*
Lined chiton- *Tonicella lineata*

Crab
Kelp crab- *Pugettia producta*

Snail
Ribbed whelk- *Thais emarginata*

Isopod
Sowbug- *Porcellio scaber* or *Oniscus asellus*

REFERENCES

Ehrlich, P., Dobkin, D.S., and Wheye, D. 1988. The birder's handbook. Simon & Schuster, New York.

Leduc, L. 1993. Ecology of Black Oystercatchers at East Limestone Island. Laskeek Bay Research 3: 56-63.

Vermeer, K., K.H. Morgan and F. Rikardson. 1992. Black Oystercatcher habitat selection, reproductive success and their relationship with Glaucous-winged Gulls. Col. Waterbirds 15: 14-23.

THE IMPACTS OF RED SQUIRREL AND BLACK-TAILED DEER ON FOREST BIRDS AND VEGETATION IN LASKEEK BAY: A PROGRESS REPORT

JEAN-LOUIS MARTIN
CEFE - CNRS, B.P. 5051, 34033 Montpellier Cedex, France

Between June 24 and July 1st 1994 I investigated the impacts of Red squirrel and of Black tailed deer on the forest ecosystem. Two short studies were conducted. In the first study,cameras and decoy nests baited with a quail egg were installed to photograph in the act potential predators of song bird nests. The objective was to confirm that the high level of nest predation observed on East Limestone Island during the experiments run in 1993 was caused by introduced squirrels. The second study examined the impact of deer browsing at 5 islands in Laskeek Bay, to verify the generality of the pattern of deer impact observed in Juan Perez Sound in 1993 (see Martin et al. 1994 in LBCS report).

METHODS AND RESULTS

Impact of Red squirrels on songbird nests

Experimental design. -- To catch the culprits in action we installed 5 decoy nests, each electronically connected to a camera. The nests were baited with one Japanese quail egg. Each time an egg was removed from the nest the camera caught a picture of the predator. Nests were checked up to three times each day over a period of 7 days. Predated eggs were replaced.

An additional 15 artificial nests were scattered within the study area for 4 days to crudely compare predation levels in 1994 with those observed on East Limestone Island in 1993 (with a much larger sample size). Nests were checked daily, but eggs were not replaced after predation.

Results. -- Nine predations and nine pictures resulted from the 5 nests monitored by the cameras. All but one of these five nests were predated at least once. The Red squirrel was the culprit in all cases.

Eleven of the 15 other artificial nests (73%) were predated during the 4 days of exposure. Among those, there were two sightings of squirrels eating the quail egg near the decoy nest. One of the sightings was photographed.

Impact of deer on the vegetation

Methods. -- Following the method used in Juan Perez Sound in 1993 (LBCS Report #4), I selected 4 islands covering a range of different sizes among isolated

islands within Laskeek Bay: Lost (5.3 ha), Low (9.6 ha), Reef (250 ha) and Louise islands (the latter representative of the main islands). We also surveyed East Limestone island (48 ha) as a medium sized island that is not much isolated from the main islands. We focused on the two commonest shrubs, salal *Gaultheria shallon* and huckleberry *Vaccinium* sp. Plants were divided into two categories: well developed shrubs (height $\geq$ 0.5 m and several stems or main branches) and shoots (height < 0.5 m and only one stem; see details of the methods in LBCS report #4).

As in 1993, the impact of deer on tree seedlings (young trees between 0.10 and 0.5 m high) was also quantified. There were three target species: Sitka spruce *Picea sitchensis*, western hemlock *Tsuga heterophylla* and red cedar *Thuya plicata*.

Impact on well developed shrubs. -- No impact of browsing by deer was observed on the two small isolated islands (Lost and Low, Figures 1 and 2). The impact was severe or very severe on the three larger islands. On Louise Island, impact tended to be slightly lower than on Limestone and Reef islands, at least for some of the features measured. Although the difference between the main island and the large islands in Laskeek Bay was less pronounced than in Juan Perez Sound, the trend was similar in both areas. As in Juan Perez Sound, the observed differences were statistically significant (Tables 1 and 2 in appendix). On the small islands (Low and Lost), salal cover was close to 100%. On the larger islands, the cover of shrubs was significantly reduced by deer. Dead stumps of salal were a common sight. Most shrubs showed heavy signs of browsing (Fig. 1) and were devoid of foliage below 1.5 meter from the ground (Fig. 2). The size distribution of shrubs was skewed on the larger islands, where a deficit of shrubs smaller than 1.5 m was observed. Finally, the proportion of shrubs that grew in places that cannot be reached by deer increased with increasing island area (unpubl. data). These are the shrubs that show no signs of browsing on the larger islands (Fig. 1). On East Limestone Island, only one salal shrub was recorded along the transects. It grew on the top of a stump and was therefore protected from browsing.

Impact on shrub shoots and tree seedlings. -- On the two small islands (Low and Lost), salal and huckleberry shoots showed little signs of browsing (Fig. 3). On the large islands shoots were heavily clipped. No salal shoot was found along the transects on East Limestone island. Tree seedlings were less common on the small islands. Where present, they showed no impact of browsing (Lost Island, Fig. 4). The impact on seedlings

was most severe on East Limestone and Reef islands. No Red cedar seedling was found during these surveys.

DISCUSSION

The impact of the Red squirrel. -- The results obtained in 1994 confirmed the high predation rate observed at artificial nests on East Limestone Island in 1993. They showed unambiguously that the red squirrel was the main predator (all pictures and all direct observations). Despite the presence of a Raven nest with fledged young near the decoy nests no case of predation by a Raven was observed (this species was the main predator of nests in a similar experiment on islands in the Mediterranean). As far as the reproductive success of land birds is concerned, all this evidence suggests that the presence of squirrels probably has a severe impact on breeding songbirds. The evaluation of that impact on natural nests should be one of the priorities for future research on forest birds in Gwaii Haanas.

The impact of the Black tailed deer. -- The data gathered in 1994 in Laskeek Bay confirmed those obtained in Juan Perez Sound in 1993. The impact of Deer on the understory vegetation was important and widespread across the islands. However, small isolated islands (less than 10 ha) escaped severe impact and impact tended to be slightly lower on the main islands. On East Limestone Island, the presence of numerous *Vaccinium* shoots clipped at the point where they emerged from the moss, suggests that, in the absence of deer, the structure of the understory vegetation might change very rapidly. Recent studies in the eastern United States (DeCalesta 1994) have shown that differences in deer densities affect both vegetation and forest bird community structure. The impact of deer on the vegetation through its direct effect on bird habitat and its indirect effect on nest predation by squirrel (increased nest detectability) may therefore profoundly affect the forest bird communities of East Limestone Island. We hope that further research will enable us to understand the consequences of the introduction of deer and squirrels for the diversity of ecosystems in Gwaii Haanas and assist us in finding ways to mitigate their effects.

Acknowledgments: I wish to thank Ginny Collins, Colin French, Keith Moore, Peter Lake and Andrea Smith for their assistance in the field or in town and the Laskeek Bay Conservation Society for its logistic support. John Andres and Joanna Broadbent offered their excellent hospitality while I was in town.

REFERENCES

DeCalesta D.S. 1994. Effect of White-tailed deer on song birds within managed forests in Pennsylvania. J. of Wildlife Manage., 58: 711-718.

Martin J.L., Brown J., Widmer-Carson L., Harfenist A., Heise K. et Mercier S. 1994. The impact of introduced mammals on the vegetation and land birds of old growth forests in Haida Gwaii (Queen Charlotte Islands): preliminary results. Laskeek Bay Conservation Society, Report on Scientific Activities 4: 78-103.

APPENDIX

*Table 1: Results of Kolmogorov Smirnov tests of similarity of character distributions among ordered categories for browsing on Salal on the different islands (Limestone is not shown as only one Salal shrub was recorded on the transect). n.s. = the similarity hypothesis cannot be rejected; *, **, *** = the similarity hypothesis is rejected at the 0.05, 0.01 and 0.001 probability level.*

Impact	Island	Lost	Low	Reef
Browsing	Low	n.s.		
	Reef	***	***	
	Louise	***	***	n.s.
Foliage height	Low	n.s.	-	
	Reef	***	***	
	Louise	*	*	***

*Table 2: Results of Kolmogorov Smirnov tests of similarity of character distributions among ordered categories for browsing on Huckleberry on the different islands. n.s. = the similarity hypothesis cannot be rejected; *, **, *** = the similarity hypothesis is rejected at the 0.05, 0.01 and 0.001 probability level.*

Impact	Island	Lost	Low	Limestone	Reef
Browsing	Low	n.s.			
	Limestone	***	***		
	Reef	***	***	n.s.	
	Louise	***	***	*	n.s.
Foliage height	Low	n.s.			
	Limestone	***	***		
	Reef	***	***	n.s.	
	Louise	***	***	n.s.	n.s.

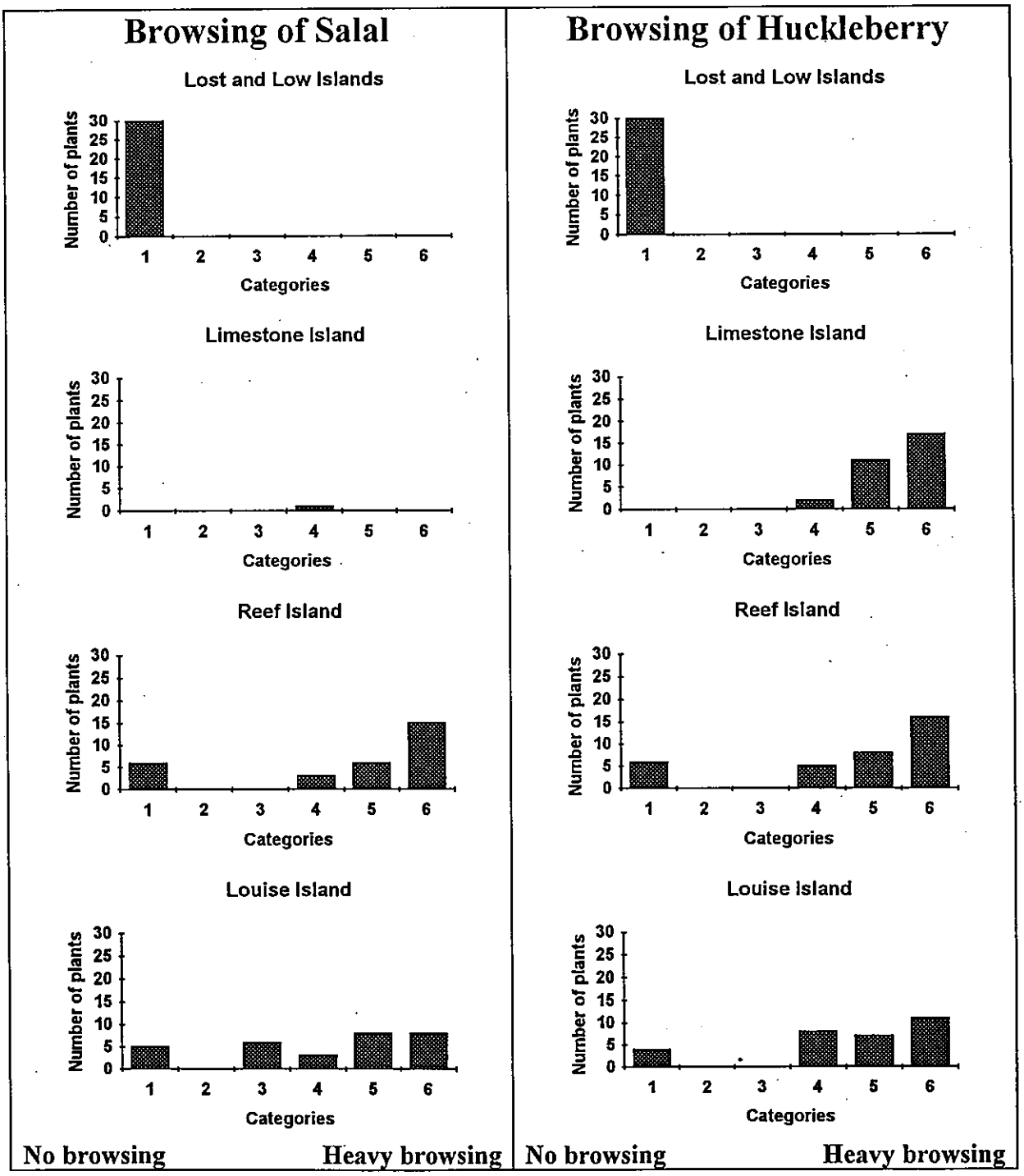


Figure 1: *Pattern of browsing on Salal and Huckleberry shrubs on the 5 islands surveyed. Categories of browsing from 1 = no signs of browsing to 6 = very heavy signs of browsing. Sample size is 30 in all cases except for Huckleberry on Reef (=35) and Salal on Limestone (=1).*

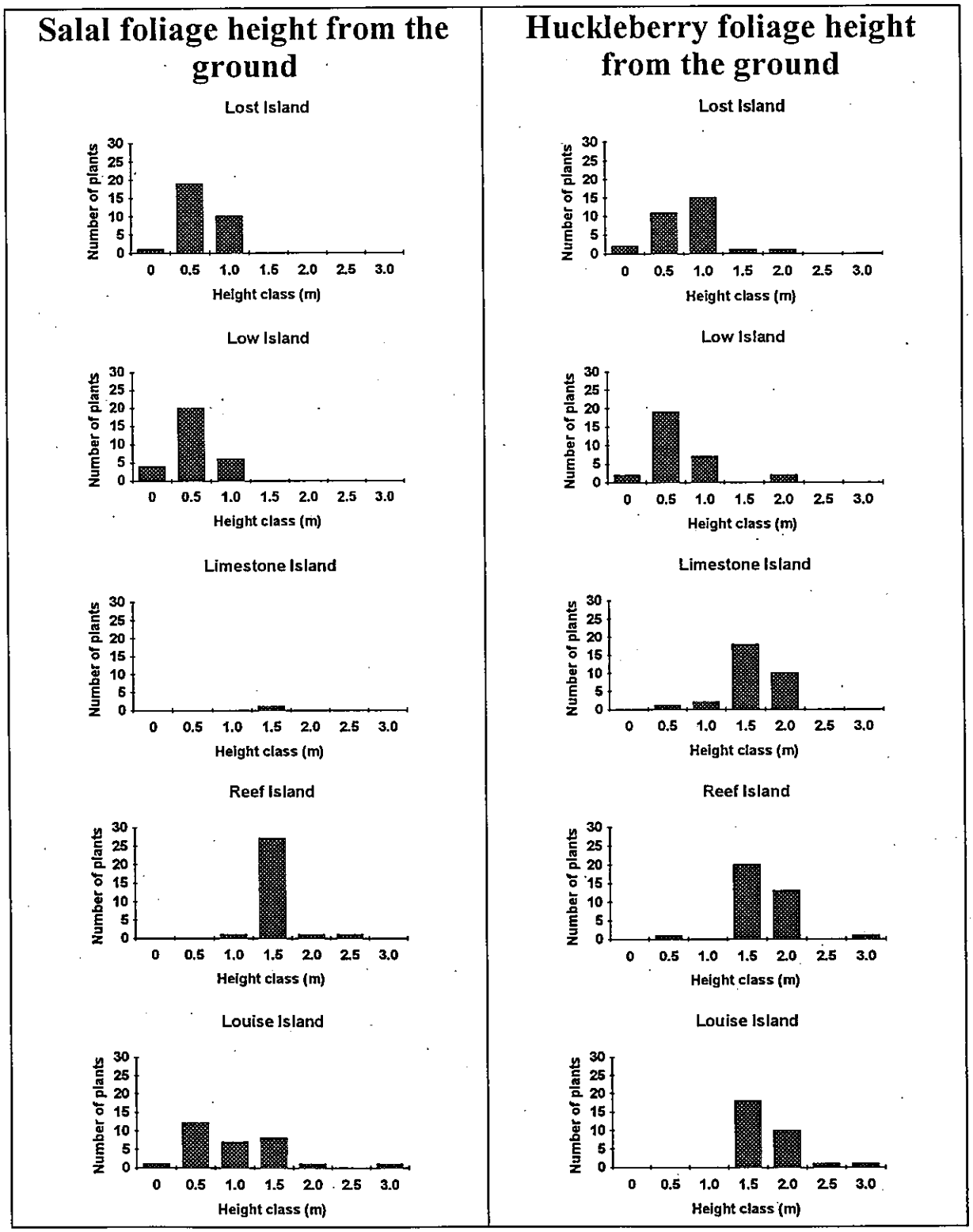


Figure 2: Height from the ground at which the foliage of Salal and Huckleberry shrubs starts on the 5 islands surveyed (for details on sample sizes see legend of Figure 1).

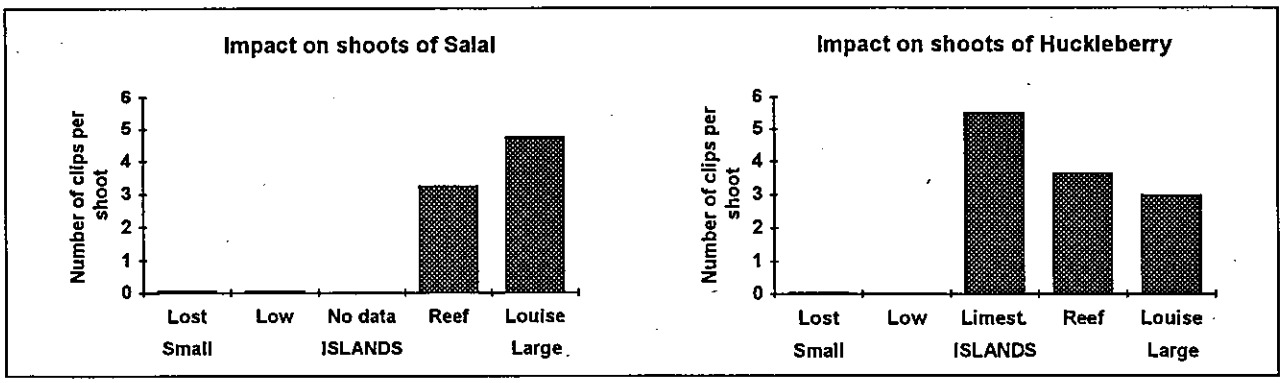


Figure 3: *Impact of Black tailed deer on Salal and Huckleberry shoots on the 5 islands. Impact is measured as the average number of browsing clips per shoot recorded in the samples. For Salal sample sizes are: 30, 30,no seedling observed, 30 and 30 respectively, standard deviations are: 0.17, 0.17, no value, 1.65 and 4.30 respectively. For Huckleberry sample sizes are: 30, 4, 30, 30 and 30, standard deviations are 0.17, 0, 4.29, 1.72 and 2.27 respectively. No shoots of Salal where found along the transects on Limestone.*

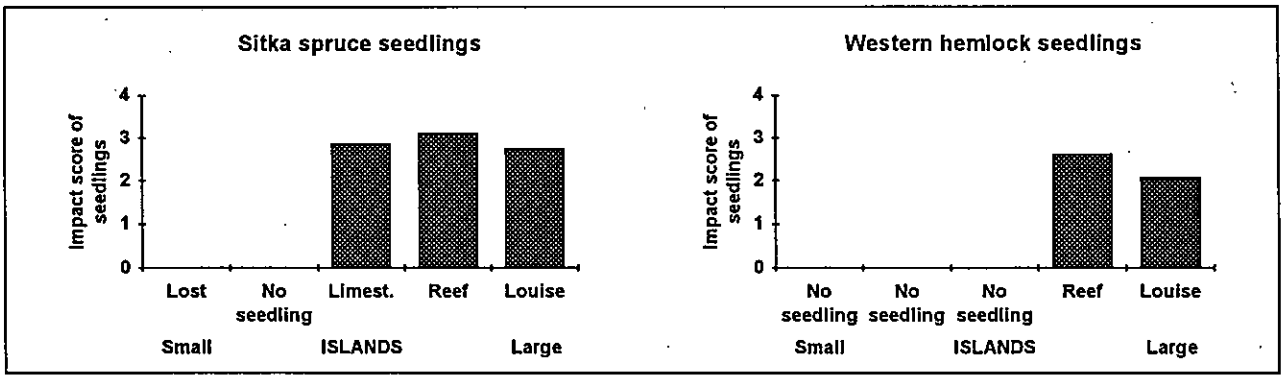


Figure 4: *Impact of Black tailed deer on tree seedlings on the islands with sufficient sample size. Seedlings were scored from 0 (no sign of browsing) to 5 (very heavily browsed). Sample size = 100 seedlings (from 10 different locations) in all cases except for Sitka spruce on Lost where it equals 52.*

HOW MASS AND DATE AT DEPARTURE AFFECT THE SURVIVAL OF ANCIENT MURRELET CHICKS AFTER LEAVING THE COLONY

ANTHONY J. GASTON

Canadian Wildlife Service, National Wildlife Research Centre, 100 Gamelin Blvd., Hull, Quebec K1A 0H3

(Precis of a paper submitted to Ibis)

Because the breeding success of colonial seabirds is fairly easy to measure, we have information on this aspect of population dynamics for many species. However, post-fledging survival is more difficult to measure. Several studies have used the weight of chicks at departure from the nest as an index of their condition. Such studies tend to assume that weight at departure is likely to be related to subsequent survival (Gaston 1985, Cairns 1987). In addition, chick weight, or some related measurement (e.g. growth rate, weight at a given age), often declines as the season proceeds, so that the earliest hatched chicks are the heaviest. These observations have led to the general consensus that, among most seabirds, good quality breeders tend to lay early and produce heavier chicks, and hence are more likely to contribute to the next generation, than breeders that lay later (Ryder 1980, Reid 1988).

Among auks, the weight of chicks at departure has often been found to decreases with date of hatching. For Common Guillemots at the Isle of May, Scotland, survival after leaving the colony was found to be greater for chicks that left the colony early. However, survival was not affected by growth rate at the colony (Harris *et al.* 1992).

At Limestone Island, 22 chicks banded at departure from the colony were retrapped as adults up to 1994. As the weight and date of colony departure of all these chicks was recorded, it is possible to analyze this information to see:

(1) whether early-departing chicks are more likely to return than those departing late;

(2) whether heavier chicks have a better chance of returning than those that were light at departure.

RESULTS

As most Ancient Murrelets do not visit the colony until they are two years old, the only cohorts retrapped as adults so far are those banded in 1990-92. In those years, respectively, 867, 589 and 643 chicks, were both banded and weighed. During the 2-4 years subsequent to banding (1991-94), 1.04% of those banded at East Limestone Island were retrapped at the colony as adults. Most birds were retrapped as 2-year-olds (64%).

Chicks were trapped in funnels between 9 May and 15 June, but 50% of

all captures were between 19-28 May in 1990, between 21-28 May in 1991 and between 20-26 May in 1992. The date by which half of the chicks had left was 23 May in 1990 and 1991 and 22 May in 1992. Those chicks that were retrapped at the colony as adults had mostly departed from the colony during the latter part of the departure period (Table 1, Figure 1). Only one returning adult had left before the median date of departure for its cohort (1992). The median date of departure of returning birds was 26 May.

Most chicks were captured in the funnels between midnight and 02.00 (77%), with the peak between 00.30 and 01.00 h. The time of departure gets later as the departure period progresses, so to compare the departure times of chicks recaptured as adults with the departure times of other chicks, I used only the period 21-29 May, when most of the returning chicks departed. Using this sample, most of the chicks recaptured as adults left the colony between midnight and 02.00 (76%). There is no evidence that time of departure had much effect on subsequent rates of return (Figure 2).

Chicks trapped in the funnels were leaving the colony at weights ranging from 17-33 g, but 90% fell between 24-30 g. Although the distribution of weight at departure for those that were retrapped as adults was very similar to that of all chicks, no chicks were retrapped that had left at less than 24 g; the lightest retrapped chick weighed 25 g at departure. Only 0.7% (n = 579) of those chicks weighing less than 26 g at departure were recaptured, compared to 1.7% (n = 1198) for those weighing 26 g or more (Figure 3).

FIGURE 1

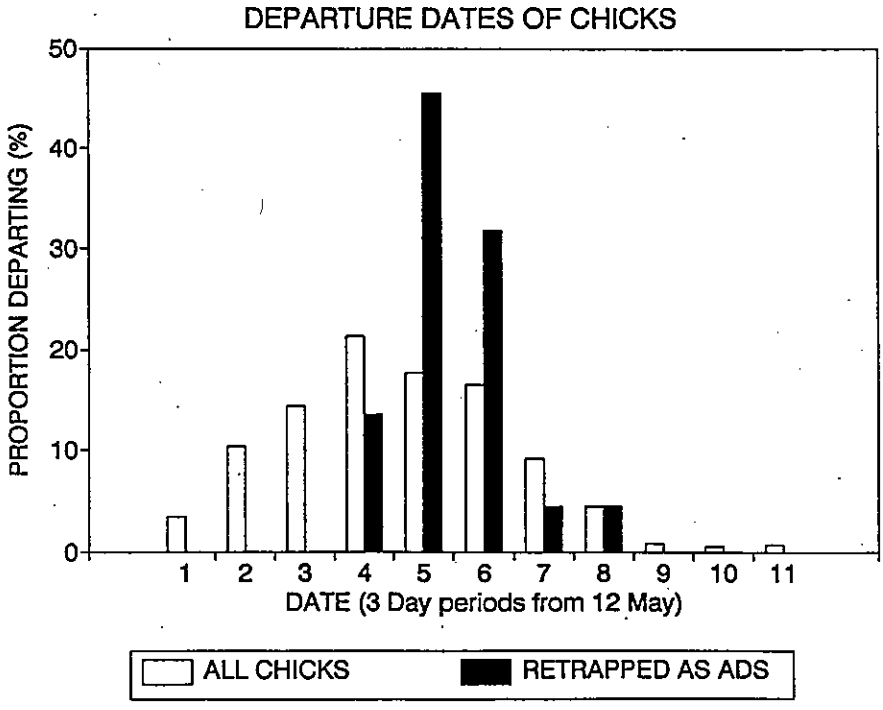


Table 1. Numbers of chicks recaptured in relation to their date of departure

Year	Median departure	3-day periods from median departure								
		-4	-3	-2	-1	0	+1	+2	+3	+4
1990	23					4	4			1
1991	23					4	6			
1992	22				1		1	1		
Totals					1	8	11	1		1

FIGURE 2

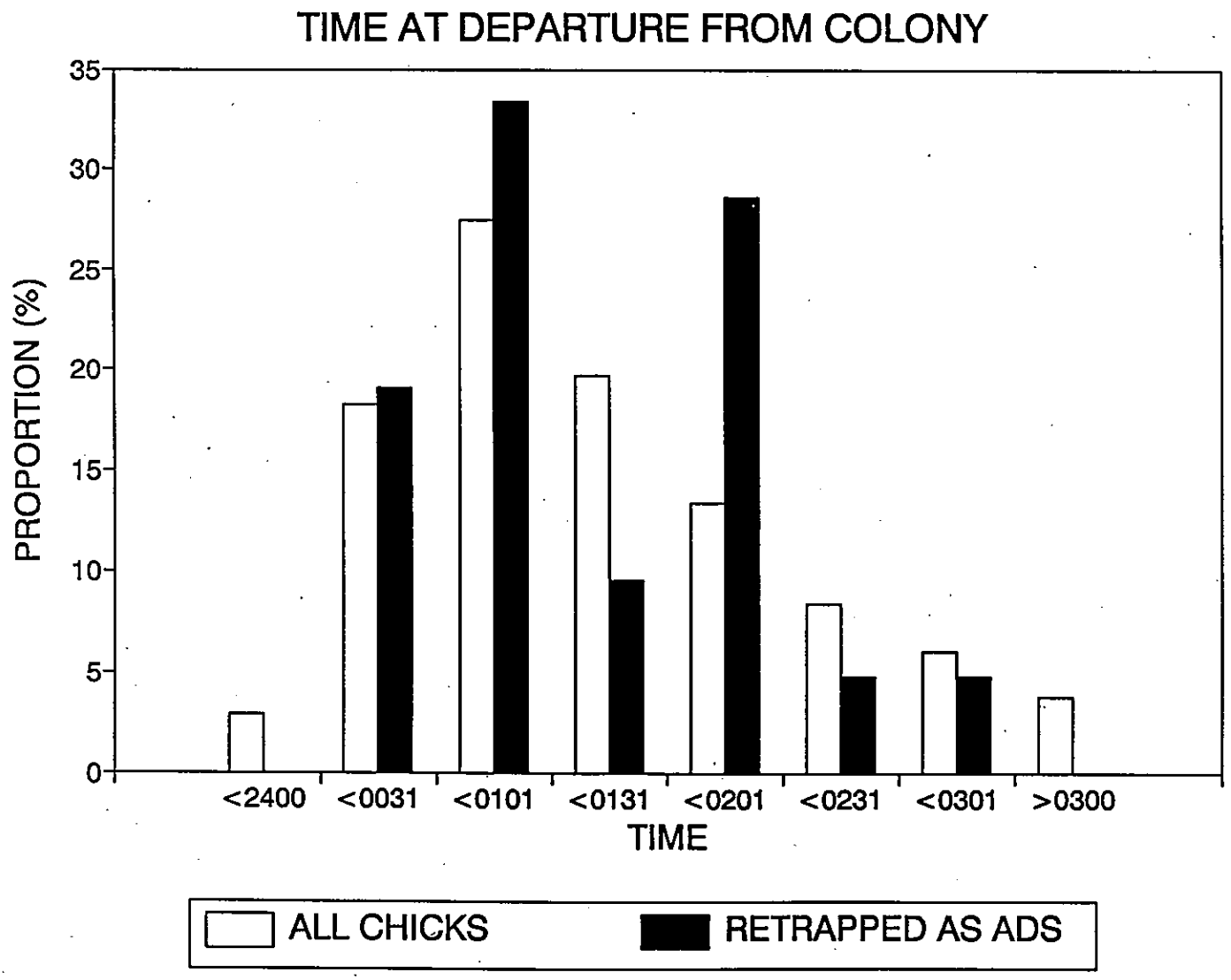
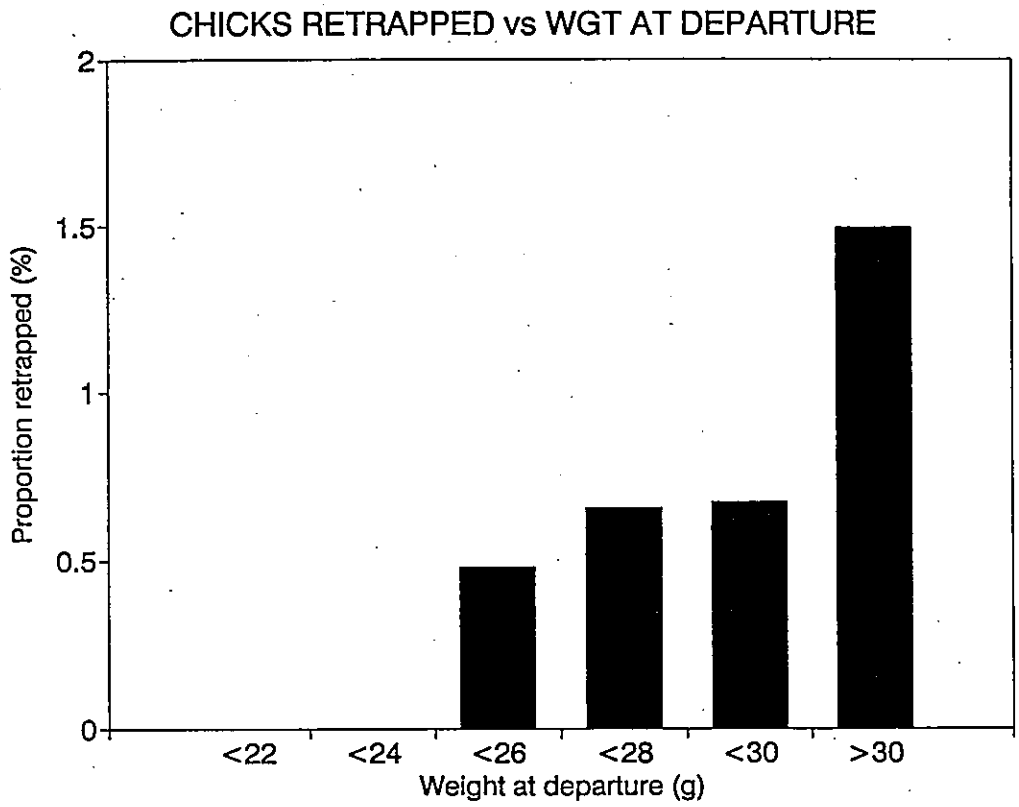


FIGURE 3



DISCUSSION

By comparing the time, date and weight at which chicks later retrapped as adults left the colony with the norms for the years in which they were reared, we get an idea of what factors may affect their subsequent survival. As the chicks leave at a very young age and do most of their growing at sea, differences in rates of return probably relate to effects that occur soon after leaving the colony. The weight of the chicks presumably gives some indication of the energy reserves that they have at their disposal and these may be important if feeding conditions are poor in the first few days (perhaps because of adverse weather conditions). There is a suggestion in the results that very light chicks (< 26 g at departure) survived less well than heavier chicks. This result is supported by similar evidence from Reef Island, where only 0.2% of chicks that left at less than 26 g were recaptures, compared to 2.1% of heavier chicks (AJG unpubl.).

At departure, chicks averaging 27 g in mass have a lipid index (g lipid/g lean dry mass) of 0.41 (lipid 32% of dry mass), giving them sufficient energy reserves for a maximum of 48 h of activity before

they need to be fed (Duncan & Gaston (1990). Gaston (1992) showed that chicks lose more than 3 g daily while they remain in the burrow and suggested that the length of time elapsing between hatching and departure may be an important factor determining the weight of chicks at departure. The chicks from East Limestone and Reef islands are reared in the comparatively sheltered waters of Hecate Strait. Chicks from colonies elsewhere may be more dependent on carrying large energy reserves at departure. At those colonies we might find that weight has a greater effect.

Given the very low overall retrap rate (<2%), the present results need to be interpreted cautiously. However, it seems that, while time of night has very little effect on subsequent survival, the date of departure has a strong effect at Limestone island, with chicks departing early being much less likely to be recaptured at the colony than those leaving later. This finding seems to contradict evidence from other seabirds. Apparently, in 1990-92, conditions for chick survival improved as the season progressed. Late-departing chicks were retrapped more often than those departing early, despite the fact that earlier chicks tended to be heavier at departure than those hatched later (see previous reports). Consequently, the effects of mass and date appear to have operated independently at East Limestone Island.

If the survival of chicks after leaving the colony improves as the breeding season progresses, we need to explain why Ancient Murrelets breed so early. At this stage, any suggestions must be speculative, but in the case of the Ancient Murrelet, breeders suffer heavy mortality at the colony from avian and mammalian predators, sufficient to give them an unusually low adult survival rate, for a seabird (Gaston 1990).

At the latitude of Limestone Island (53° N), Ancient Murrelets come to land only for about 3 h in mid-summer (mainly non-breeders at that date, Jones *et al.* 1990). The behaviour of family parties at departure from the colony requires that breeders call loudly and persistently on the ground for up to 20 min, following which the parents await the chicks on the sea, close inshore (Jones *et al.* 1987a). Possibly the timing of breeding of Ancient Murrelets at the latitude of Haida Gwaii is adjusted to avoid taking the chicks to sea in late June, because of the attendant risk of predation inherent in the departure process. Pairs leaving in mid-May have a 2-3 h longer period of darkness in which to complete the departure and put some distance between themselves and land. Hence, the timing of breeding in the Ancient Murrelet may represent a compromise between selection for chick survival and for predator avoidance by adults. The increased survival of chicks departing late in the season may be

related to greater availability of food as the season progresses.

REFERENCES

Duncan, D.C. & Gaston, A.J. 1990. Movements of Ancient Murrelet broods away from a colony. Stud. Avian Biol. 14: 109-113.

Gaston, A.J. 1985. Development of the young in the Atlantic Alcidae. *In* Nettleship, D.N. & Birkhead, T.R. (eds) The Atlantic Alcidae: 319-354. London: Academic Press.

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. Condor 92: 998-1011.

Gaston, A.J. 1992. The Ancient Murrelet: a natural history in the Queen Charlotte Islands London: T. & A. D. Poyser.

Harris, M.P., Halley, D.J., & Wanless, S. 1992. The post-fledging survival of young Guillemots *Uria aalge* in relation to hatching date and growth. Ibis 134: 335-339.

Jones, I.L., Falls, J.B. & Gaston, A.J. 1987. Colony departure of family groups of Ancient Murrelets. Condor 89: 940-943.

Jones, I.L., Gaston, A.J. & Falls, J.B. 1990. Factors affecting colony attendance by Ancient Murrelets. Can. J. Zool. 68: 433-441.

Reid, W.V. 1988. Age-specific patterns of reproduction in the Glaucous-winged Gull: increased effort with age? Ecology 69: 1454-1465.

Ryder, J.P. 1980. The influence of age on the breeding biology of colonial nesting seabirds. *In* Burger, J., Olla, B.L. & Winn, P.H.E. (eds) Behavior of Marine Animals, Vol. 4, Marine Birds: 153-168. New York: Plenum Press.

DATA APPENDICES

APPENDIX 1. Chicks captured on East Limestone Island in 1994

DATE	FUNNEL						TOTAL	CUM. TOTAL
	1	2	3	4	5	6		
May 7-8	0	0	0	0	0	1	1	1
8-9	0	0	0	0	0	0	0	1
9-10	0	0	2	0	0	0	2	3
10-11	0	2	1	0	0	0	3	6
11-12	1	0	2	0	0	2	5	11
12-13	0	0	0	2	0	2	4	15
13-14	4	4	10	8	5	5	36	51
14-15	3	8	8	6	5	3	33	84
15-16	4	0	2	2	7	7	22	106
16-17	4	6	4	6	2	9	31	137
17-18	1	2	4	0	5	7	19	156
18-19	1	6	4	6	6	13	36	192
19-20	7	9	4	5	11	12	48	240
20-21	1	4	6	8	9	13	41	281
21-22	7	7	8	6	6	8	42	323
22-23	4	11	14	12	7	4	52	375
23-24	9	6	9	5	4	9	42	417
24-25	2	2	12	8	4	11	39	456
25-26	4	4	7	6	6	6	33	489
26-27	0	5	9	2	3	6	25	514
27-28	1	5	4	11	4	1	26	540
28-29	2	2	0	4	1	9	18	558
29-30	0	4	1	7	3	3	18	576
30-31	0	0	6	0	0	3	9	585
Jun 31-1	0	2	0	2	1	1	6	591
1-2	0	4	0	0	0	4	8	599
2-3	0	0	0	0	0	2	2	601
3-4	0	1	0	0	0	2	3	604
4-5	1	1	0	1	0	2	5	609
5-6	0	0	2	1	2	0	5	614
6-7	0	0	0	0	0	0	0	614
7-8	0	0	2	0	0	0	2	616
8-9	0	0	0	2	0	0	2	618
Totals	66	95	121	110	91	145	618	

APPENDIX 2. Proportions of birds trapped in May and June with and without brood patches (excludes found dead)

YEAR	STATUS	BROOD PATCH STATE		
		0	>0<20	FULL(>19)
1990	New	117(39%)	19(6%)	162(55%)
	Retrap	4(27%)	3(20%)	8(53%)
1991	New	115(53%)	22(10%)	82(37%)
	Retrap	13(30%)	8(18%)	23(52%)
1992	New	168(71%)	24(11%)	31(18%)
	Retrap	7(27%)	5(19%)	14(54%)
1993	New	59(69%)	10(12%)	17(20%)
	Retrap	15(75%)	1(5%)	4(20%)
1994	New	77(77%)	6(6%)	18(18%)
	Retrap	16(53%)	5(17%)	9(30%)

APPENDIX 3. Details of numbers of adult Ancient Murrelets banded and retrapped at Limestone Island, as used for SURGE analysis.

	Breeders					Non-breeders				
	1989	1990	1991	1992	1993	1989	1990	1991	1992	1993
Total banded	106	197	133	20		183	141	172	196	
Year retrapped										
1990	9					5				
1991	7	30				6	12			
1992	3	6	21			1	5	7		
1993	3	4	3	3		0	3	4	5	
1994	5	8	7	3	3	1	3	5	4	4
Year last seen										
1989	89					171				
1990	8	156				5	117			
1991	2	24	105			6	11	126		
1992	0	5	19	31		1	5	7	176	
1993	2	4	2	1	17	0	3	4	5	65

APPENDIX 4. Measurements of Ancient Murrelet eggs from the Queen Charlotte Islands

Locality	Year	Weight(g)			Length(mm)			Breadth(mm)			Ref
		Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.	N	
Reef I.	1984	43.8	3.2	57	58.7	2.0	98	37.1	1.2	98	(1)
	1985	46.7	3.3	53	59.3	1.9	99	37.9	1.1	99	(1)
	1986	45.7	2.8	52	59.3	2.1	52	37.6	1.1	52	(1)
	1987	47.6	3.4	50	60.0	2.2	50	38.1	1.1	50	(1)
	1988	45.3	2.6	41	59.3	2.0	41	37.5	0.9	41	(1)
	1989	46.4	3.2	39	59.3	2.4	39	37.9	1.5	39	(1)
Limestone I.	1991	48.1	4.4	26	59.5	2.1	26	37.8	0.9	26	
	1992	48.0	3.1	23	59.2	1.5	23	37.4	2.0	23	
	1993	45.2	3.9	26	59.6	2.0	26	37.5	1.3	26	
	1994	45.7	2.4	25	59.2	1.3	25	37.9	1.3	25	

(1) Gaston (1992)

APPENDIX 5. Fresh weights of Ancient Murrelet eggs from Reef and Limestone islands, relative to date of laying.

Year	Regression of weight on date (weight=A-(date*B)	Estimated weights	
		15 April	15 May
1984	45.04-(date*0.066)	44.05	42.07
1985	47.57-(date*0.056)	46.73	45.05
1986	48.74-(date*0.122)	46.91	43.25
1987	48.49-(date*0.044)	47.84	46.52
1988	45.90-(date*0.036)	45.36	44.28
1989	47.36-(date*0.047)	46.65	45.24
1991	53.17-(date*0.464)	49.92	36.00
1992	50.43-(date*0.170)	47.88	42.78
1993	53.23-(date*0.378)	47.56	36.22
1994	47.01-(date*0.047)	46.29	44.88

LASKEEK BAY CONSERVATION SOCIETY

The Laskeek Bay Conservation Society is a volunteer group based in the Queen Charlotte Islands. The society is committed to increasing the appreciation and understanding of the natural environment through:

sensitive biological research that is not harmful to wildlife or its natural habitat

interpretation and educational opportunities for residents of and visitors to the Queen Charlotte Islands

Established in 1990, the society is committed to a long-term seabird research programme in the Ancient Murrelet colony at Limestone Island. For further information, contact:

Laskeek Bay Conservation Society
Box 867, Queen Charlotte City
British Columbia V0T 1S0
Phone (604) 559-4582 or 559-8889 (fax/phone)