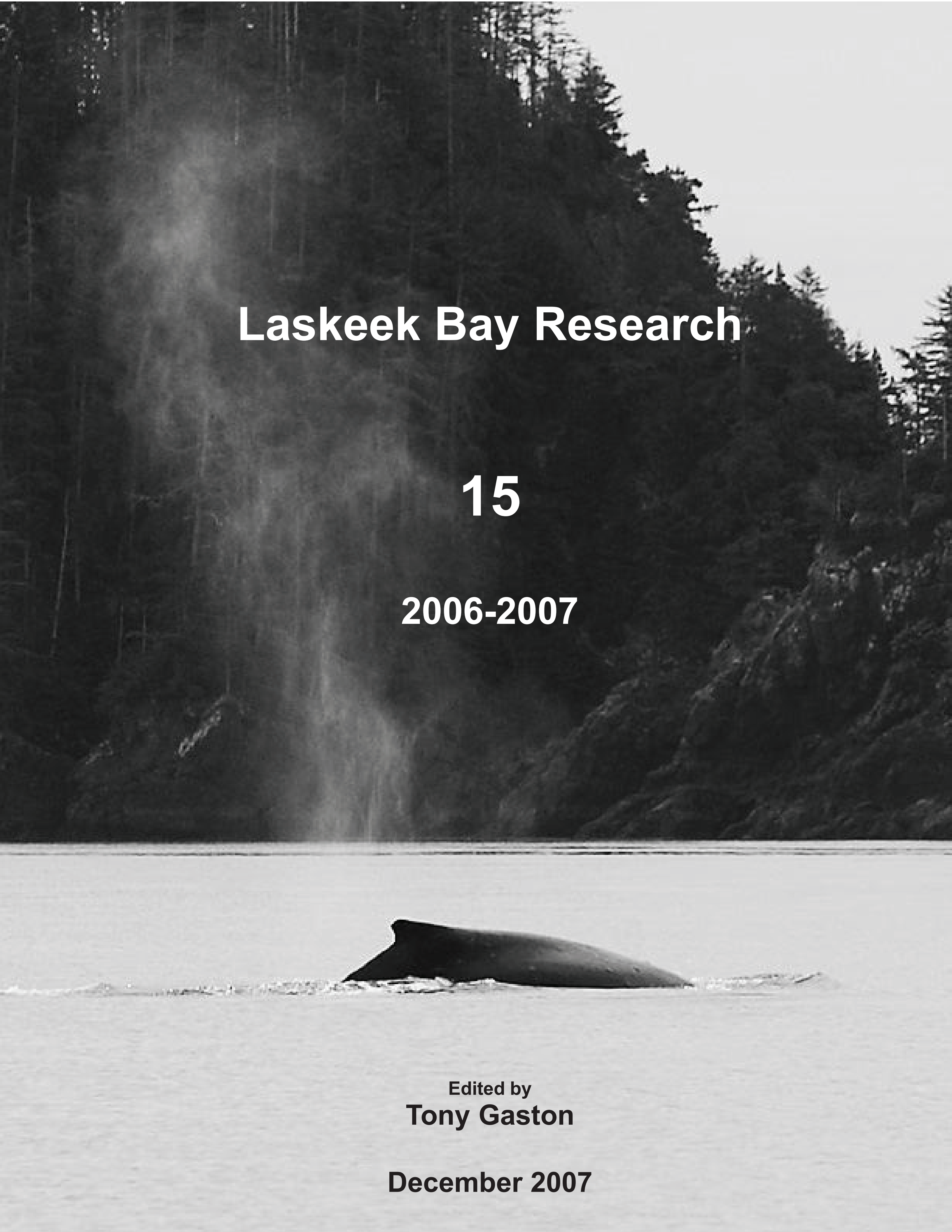

Laskeek Bay Research

15

2006-2007

Edited by
Tony Gaston

December 2007

LASKEEK BAY RESEARCH

15

LASKEEK BAY CONSERVATION SOCIETY
SCIENTIFIC REPORT, 2006 and 2007

Edited by

ANTHONY J. GASTON

Cover design: Tony Gaston

Picture: humpback whale off Reef Island, May 2007
(©Timothy J.F. Lash: lash@canada.com)

December 2007

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

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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

Since 1990, the Society has operated a field research station at East Limestone Island and is carrying out a diverse long-term monitoring, research and interpretation programme in the surrounding islands and waters of Laskeek Bay. We actively involve volunteers from our island communities, many other locations in British Columbia, as well as from overseas. For further information contact:

Laskeek Bay Conservation Society
Box 867, Queen Charlotte City, British Columbia, Canada V0T 1S0
Phone/fax (250) 559-2345; E-mail <laskeek@laskeekbay.org>

BACKGROUND

The goals and objectives of the Society are:

1. To undertake and support research and long term monitoring of wildlife populations of the marine and terrestrial ecosystems of Haida Gwaii, especially the Laskeek Bay area.

2. To provide opportunities for non-scientists, especially students and local residents of Haida Gwaii, to participate as volunteers in our field programs, and to offer training to impart necessary field research skills.

3. To promote better understanding of the marine and terrestrial ecosystems of Haida Gwaii, especially the Laskeek Bay area, by providing information to youth, local residents, and to the public in general in the form of publications, meetings, and exhibits.

4. To promote the conservation of native species and to develop public awareness of the changes caused by introduced species to Haida Gwaii.

5. To support and assist other programs aimed at providing better knowledge, management and conservation of ecosystems on Haida Gwaii.

INTRODUCTION

The scientific work of the Laskeek Bay Conservation Society has been carried out each summer on East Limestone Island and adjacent islands, and in the waters of Laskeek Bay since 1990. Much of the work has been conducted in collaboration with researchers and management agencies having ongoing interests in the ecology and conservation of Haida Gwaii. The research programme is coordinated and directed by a Scientific Advisory Committee that works closely with the Society's Board of Directors to develop research that is relevant to the conservation needs of Haida Gwaii and consistent with the goals of the Society.

Research activities include population monitoring of marine birds and marine mammals and ecological research on intertidal invertebrates, plants, and forest birds. The Society is a participant in the Research Group on Introduced Species, an umbrella organization devoted to studies of exotic species in Haida Gwaii and their impact on indigenous ecosystems. Research in Laskeek Bay focuses especially on the impacts of introduced mammals, including deer, raccoons and squirrels.

Our research programme is designed to provide long-term information on the biology and ecology of Haida Gwaii ecosystems. Ongoing monitoring, using simple, standard techniques that enable year-to-year comparisons to be made, and allowing the direct participation of volunteers, is the cornerstone of the Society's approach. By monitoring a variety of indicator species in ocean, inter-tidal and terrestrial ecosystems, we can obtain an overall measure of their health. 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. Such long-term monitoring is becoming increasingly important in the context of global climate change.

ACKNOWLEDGEMENTS

The Laskeek Bay Conservation Society would like to thank the following groups and individuals for their generous contributions:

- Coast Sustainability Trust
- South Moresby Forest Replacement Account
- BC Gaming Commission
- Gwaii Trust (Project Limestone)
- Canadian Wildlife Service, Environment Canada
- World Wildlife Fund and N. M. Davis Corporation
- Science Horizons Program, Environment Canada
- School District #50 & the Community Links Program
- Gwaii Haanas National Park Reserve and Haida Heritage Site
- Blue Water Adventures (t-shirt purchases and donations)
- Maple Leaf Adventures (t-shirt purchases and donations)

Thanks also to the following individuals and groups who gave generously of their time and services to the Society:

- LBCS Directors for their time and efforts in keeping the Society running year after year;
- Dr. Tony Gaston for his valuable advice and guidance throughout the field season;
- Graeme Ellis (Pacific Biological Station) for providing a camera and film to document whales;
- This year's crew of local and international volunteers for all their enthusiasm, hard work, good humor and good company;
- Project Limestone teachers and students for their dedication to the project and for teaching us just as much as we teach them;
- South Moresby Air Charters for the pick up/drop off of volunteers/staff all season long;
- Jeremie Hyatt and the *m/v Wanderlust* for transporting gear at camp start-up and take-down;
- The *m/v Gwaii Haanas* for help with freight delivery;
- The *s/v Anvil Cove, s/v Island Roamer* and *s/v Maple Leaf* for bringing such lively and interesting visitors and for their endless promotion of LBCS.

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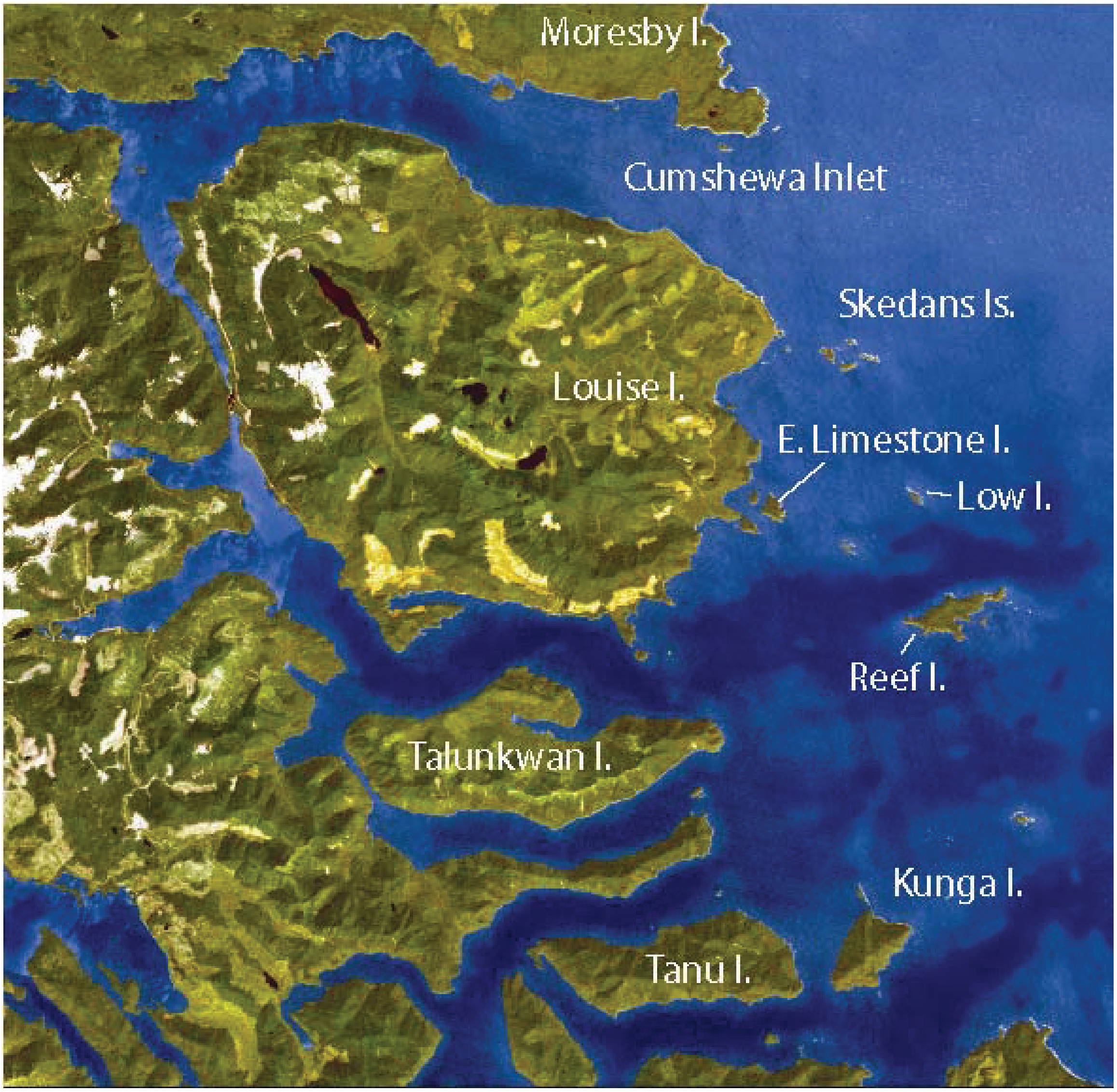
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Cumshewa Inlet
Skedans Is.
Louise I.
E. Limestone I.
Low I.
Reef I.
Talunkwan I.
Kunga I.
Tanu I.

Laskeek Bay

EAST LIMESTONE ISLAND FIELD STATION:
REPORT ON THE 2006 FIELD SEASON

Jen Rock and Jake Pattison
Laskeek Bay Conservation Society, Box 867, Queen Charlotte City, BC, V0T 1S0

SUMMARY

This season marks 17 years for the Limestone Island field camp. In 2006 our education and research programs involved 32 volunteers, six groups from four local schools, and three groups from sail boats totaling 268 volunteer and 105 visitor days. For a third consecutive year, Ancient Murrelet field work was restricted to chick capture work which ran from 10 May to 1 June and peaked on 17 May. We caught 446 chicks at funnels 1-6 in addition to 68 chicks caught either after hours, outside of the funnels or at the two new funnel set-ups. This year's chick total marks the fewest chicks recorded apart from 2004, and 2006 was the shortest chick season to date. From the end of May through to camp close we monitored Black Oystercatcher breeding territories extending from Laskeek Bay south to Juan Perez Sound. We located 95 territories occupied by adults, 81 of which had eggs or chicks at some point in the season and in total we banded 29 chicks. We identified 2438 prey remains at 27 Black Oystercatcher nests and limpets, mussels and chitons made up 99% of identified prey. We counted 283 Glaucous-winged Gull nests in Laskeek Bay and 89% were located at the Lost Islands colony. For a second consecutive year we found eggs and chicks in our Pigeon Guillemot nest boxes from which banded four chicks. We followed Cassin's Auklet and Fork-tailed Storm Petrel breeding activity N. Shore and Cassin's Tower sites by monitoring 108 burrows from which one Cassin's Auklet chick was banded. There were 103 marine mammal sightings of 8 different species this season, including 91 Humpback whales. We also identified 14 active wildlife trees with 15 nests: Red-breasted Sapsuckers (8), Chestnut-backed Chickadees (3), Hairy Woodpeckers (2), Northern Flicker (1), and Brown Creeper (1). One Bald Eagle nest was active on Limestone this year and the chick was flying by mid July.

INTRODUCTION

Our research and education programs offer a unique opportunity for participants to learn about the marine and terrestrial ecosystems of Haida Gwaii. In particular, we stress the importance of long-term monitoring to develop a better understanding of long lived species and their natural fluctuations. Consider for example that the oldest Ancient Murrelet we've recorded is at least 17 years old and that Black Oystercatchers banded as chicks in 1994 are currently breeding in Laskeek Bay.

A better understanding the life history of each of these birds will help to evaluate changes across time which is especially important given pressures from of introduced threats such as predation by non-native species, contamination from pollutants such as oil and recent concerns related to wind turbine developments. We hope that by promoting a better understanding and appreciation for wildlife we can help protect the marine and terrestrial ecosystems of Haida Gwaii and beyond. This field season marks 17 years of education and research in Laskeek Bay!

EDUCATION AND INTERPRETATION PROGRAM

A central mandate of LBCS is to raise awareness of local conservation issues through environmental education and to provide opportunities for members of the public to participate in hands-on research in the field. To this end LBCS runs several different programs aimed at public involvement, creating opportunities for local youth and adults, as well as visitors, to participate in the research activities on the island.

New on Limestone this year is the Visitor Interpretation Centre. Constructed during March of 2006 this new cabin provides a place where visitors can access the Limestone Island library and explore other interpretive materials. The space serves a dual role of providing a new 'office' space and has helped to reduce congestion in the old cabin. In addition it provides another heated space for volunteers to read, write or simply relax - a valuable addition to the camp!

Project Limestone

This year was the 16th season that Project Limestone has brought local students to participate in the Ancient Murrelet banding program. Students Participate in a tour during the day which introduces them to the island and gives an overview of the research carried out by LBCS with a focus on the Ancient Murrelet banding program. Students then return at night to help with chick banding and assist in capturing chicks from the funnels, bringing them to the banding shelter and releasing them. Students also have the opportunity to weigh the chicks, assist in recording data and observe the banding process. This is a unique opportunity for the students and they are always quick to say that it is one of the things they look forward to in the school year.

Six groups from four local schools visited the island, representing a total of 50 students and 13 chaperones/teachers. Our first group of the year was from GM Dawson Secondary School on May 19. The Living and Learning School brought two groups to the island this year, visiting on the nights of May 20 and May 22. Two groups from Queen Charlotte Secondary School visited on the nights of May 24 and 26. The last group of the season was from Anges L. Mathers School on May 31. The number of students participating this year was somewhat higher this year in comparison to previous years, highlighting the continued and growing popularity of the program among the island youth. Many students have visited in the past and are on their second or third visit to the island. Since 1991 there have been a total of 407 students that have participated in the program.

After banding finishes at 3:00 am school groups spend the remainder of the night on a specially built sleeping platform near Boat Cove on the West side of the island. In 2006, staff and volunteers constructed a new out-house at this site prior to the arrival of the first school group. When not on Limestone Island, school groups spend several days at nearby Vertical Point. Another out-house was constructed here in July after reports that the old one was in disrepair.

Volunteers

The volunteer program is a cornerstone of operations on Limestone Island: The enthusiasm and energy contributed by our volunteers goes a long way in accomplishing the many tasks necessary to keep camp running. This year saw a diverse range of volunteers visit the island to participate in research and partake in camp life. We had volunteers during every week and in total 32 volunteers contributed an outstanding 268 volunteer days over the course of the season. Of the volunteers this year, 23 were new to the island and 9 had volunteered in the past. Most volunteers spent a week on the island, however our most die-hard volunteer this season, Jen Smith (U.K.), contributed a full 6 weeks! Seventeen of this year's volunteers were from Haida Gwaii, 5 from other areas in BC, and the remainder from Italy, U.K., Japan, Texas, Nova Scotia and Alberta. Several people volunteered twice during the year, among them director Keith Moore and Barbara and Charlie Mack from Queen Charlotte. Work experience student Steve Botel (Sandspit) was on the island 14-21 July.

Moira Lemon (Canadian Wildlife Service, Pacific and Yukon Region) was on island 17-23 June and very much appreciated the help of volunteers Les Lowen and Michiko Nishimura in completing a census of the Ancient Murrelet colony. During 7-10 July Mike Cheney completed a plant survey of Limestone, looking in particular at the distribution of invasive species.

Visitors

Similar to Project Limestone, guests from tour boats visit the island during chick banding season to participate in an interpretive tour and subsequent night work. This service is provided by the society free of charge and serves to raise public awareness of the society's research and the importance of long-term monitoring. Most guests are not local and are, for the most part, on ecotourism excursions within Gwaii Hanaas. All are very keen to learn about the island ecosystem and the Ancient Murrelets in particular. Many guests say that visiting Limestone is one of the highlights of the trip.

Three boats visited the island this year bringing a total of 30 guests and 4 resource people. S/v Maple Leaf visited on 15 May and then again on 18 May followed by a group from s/v Anvil Cove, 24 May, and then by s/v Island Roamer on 29 May. Unfortunately, due to poor weather the group from the Island Roamer were given a tour of the island but were unable to stay for banding.

Reef Island camp was up and running from 17 May through 9 June. Dr. Tony Gaston with crew Melanie Farquar, Sophia Colantino, Siobhan MacPherson, Tim Lash and Gwenda Wells stopped by Limestone several times during this period. Limestone staff and volunteers had dinner with the Reef camp on two occasions and their good company was much appreciated. Siobhan also volunteered at Limestone on two separate occasions during the season: 28 May to 2 June and 9-17 June.

Other visitors were Laura Pattison (Jake's sister and a guide with Moresby Explorers) who stopped by for a visit on 17 May. As well, Moresby Explorers stopped by with a group of 7 people to view the deer exclosures on 30 June.

Field Staff

In 2006 the East Limestone field camp opened on 29 April and closed 21 July, making a 97 day season. Staff this year were: Jen Rock (camp supervisor / biologist – 9 weeks), Jake Pattison (assistant biologist / interpreter) and Laura Cowen (camp supervisor / biologist – 3 weeks).

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Ancient Murrelets

Adult Banding and Burrow Monitoring

For a third, consecutive year there was no Ancient Murrelet *Synthliboramphus antiquus* adult capture work or burrow monitoring at East Limestone. By suspending this work we hope to address whether previous adult capture work has deterred prospecting birds resulting in reduced recruitment and low chick numbers.

Chick Banding

Each night from 5 May to 2 June we monitored funnels at North Cove and Cabin Cove for Ancient Murrelet chicks. Chick trapping took place between 22.30h and 02.30h and after 19 May, in response to longer daylight hours the schedule was adjusted to begin trapping at 23.00h. Two new funnels were added to the Cabin Cove area totalling eight funnels, four at each trapping location. Chicks first arrived at funnels on 10 May and following the usual protocol banding continued until the first night when no chicks arrived at any of the eight funnels (Fig. 1). All chicks that passed through our funnels were weighed and banded and in total we caught 446 chicks in the six traditional funnel set-ups in addition to 48 chicks caught at the new funnels and 20 chicks caught after 02.30h or outside of the funnels (Table 1).

The number of chicks trapped at funnels 1 to 6 was lower this year than in any year apart from 2003 when we counted one less (Fig. 2). Chick departures peaked on 17 May which is a few days earlier than the average peak of 20 May ± 2.5d (SD). This year's chick banding season was the shortest to date (Table 1).

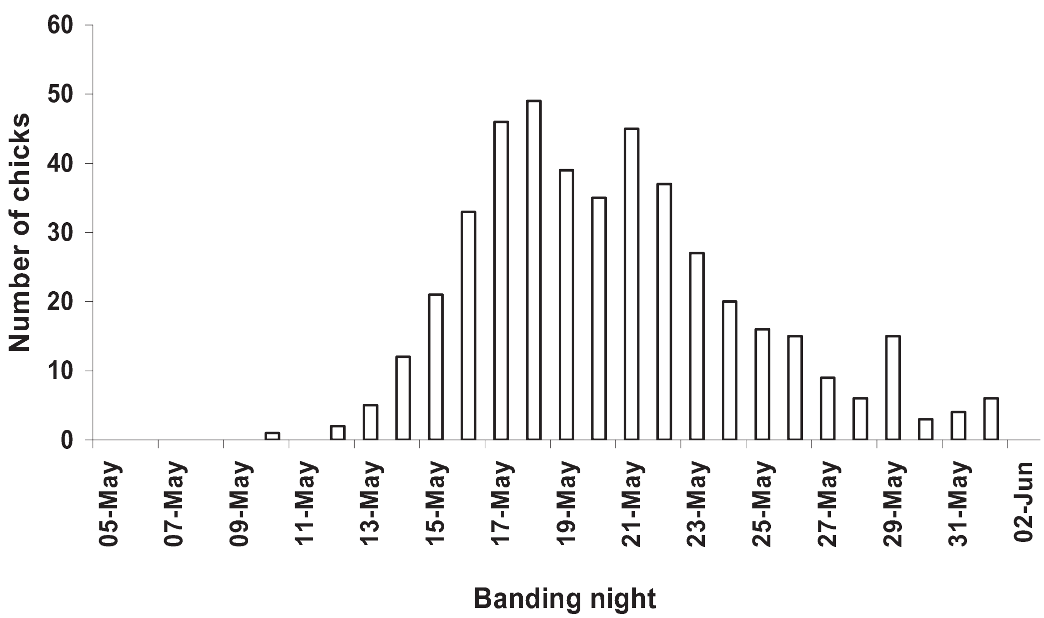

Figure 1
Nightly chick numbers caught at funnels 1-6 on Limestone Island, 5 May to 2 June 2006

Table 1
Summary of chick departures, peak nights and totals from funnels 1 to 6 on Limestone Island 1990-2006

Year	Opening night	First night with chicks	Last night	Peak night	Peak count	Total days	Total chicks
1990	12-May	12-May	15-Jun	22-May	65	35	873
1991	08-May	08-May	06-Jun	26-May	48	30	571
1992	12-May	12-May	03-Jun	21-May	73	23	674
1993	09-May	10-May	15-Jun	18-May	70	37	653
1994	07-May	07-May	08-Jun	22-May	52	33	618
1995	07-May	10-May	11-Jun	22-May	64	33	617
1996	10-May	11-May	09-Jun	19-May	48	30	587
1997	08-May	11-May	11-Jun	24-May	41	32	527
1998	07-May	11-May	22-Jun	20-May	55	43	495
1999	09-May	11-May	11-Jun	21-May	54	32	567
2000	11-May	11-May	11-Jun	20-May	62	32	595
2001	08-May	10-May	15-Jun	18-May	54	37	560
2002	07-May	09-May	03-Jun	21-May	65	26	566
2003	10-May	11-May	03-Jun	21-May	52	24	512
2004	08-May	08-May	02-Jun	16-May	45	26	445
2005	07-May	07-May	06-Jun	23-May	38	31	462
2006	05-May	10-May	01-Jun	17-May	49	23	446

Gathering Grounds
We counted Ancient Murrelets gathering west of Low Island daily from 30 April to 20 June 2006. Each day, we conducted five minute counts approximately two hours before sunset however, poor weather conditions prevented counts on 11 days and an additional five days were missed because the crew was absent during gathering ground hours. The peak count of Ancient Murrelets gathering west of Low I. was 123 birds on 14 May). On average, we counted 50.5 ± 40.0 (range: 3-123) birds on the gathering grounds in May and 23.1 ± 23.1 (range: 4-69) birds in June.

Point Counts
From 21 May to 2 June we conducted daily point counts for Ancient Murrelets following chick trapping sessions (at approximately 02.30h). We counted the number of calls heard and the number of individuals calling for five minute periods at both North Cove and Cabin Cove. Summing data collected from both locations, the peak numbers were 106 calls on 25 May and 13 individuals calling on 24 May.

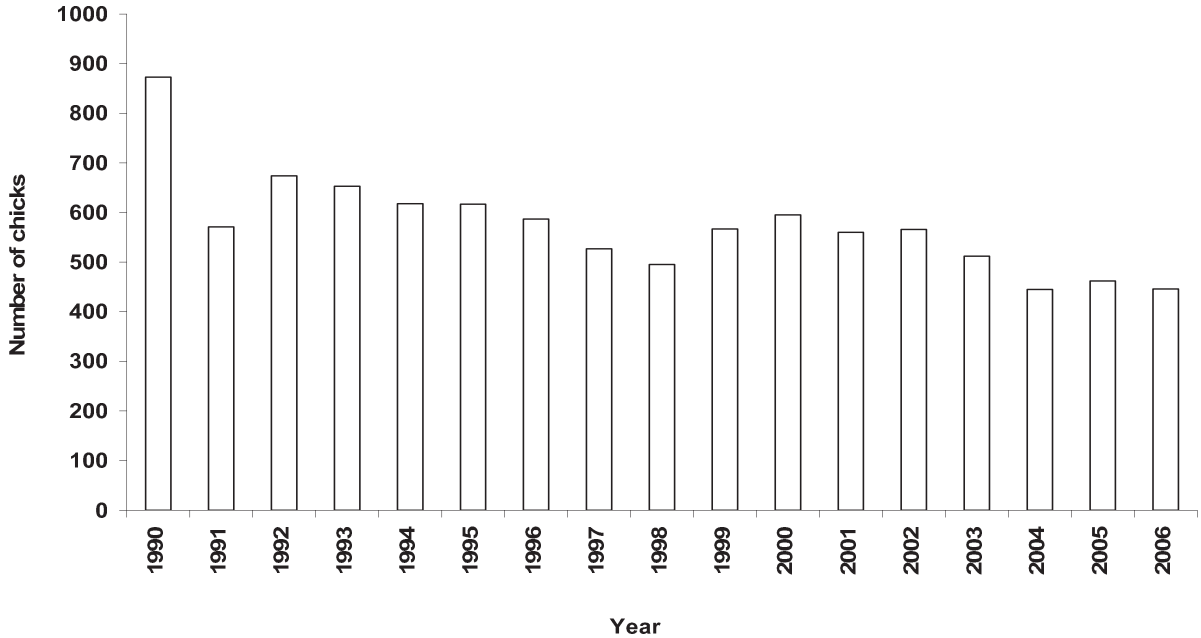

Figure 2
Trend in numbers of Ancient Murrelet chicks caught at funnels 1 to 6 on East Limestone Island

Population trends
We used similar protocols (plots were 7 x 7 m squares placed at 20 m intervals along transects) to those used in previous censuses on East Limestone (1983, 1989, 1995). Based on 13 of the 14 transects surveyed, the number of burrows we counted represented approximately 63% of those recorded in 1995 and in terms of occupancy, less than 50% of the burrows held evidence of current years breeding effort compared to 61% in 1995. There was no indication that the colony has shifted to other areas on the island so that the transect results are consistent with the decline in chick numbers observed at funnels and suggest that the number of breeding birds on Limestone is, as suspected, lower than in earlier years.

Black Oystercatchers

Occupancy and Reproductive Success
Since 1992 we have been monitoring Black Oystercatchers *Haematopus bachmani* in the Laskeek Bay area from Cumshewa Island to Lost Islands in Gwaii Haanas National Park/ Haida Heritage Site. In 2006 we visited Black Oystercatcher territories in Laskeek Bay to determine reproductive success by counting the number of breeding pairs and measuring eggs and chicks. This year we found 35 territories occupied by adults and at 26 of these we found either eggs or chicks at some point in the season. A total of 13 chicks hatched at nine territories (range: 1-2 chicks per nest) and eight chicks were big enough to band (we band chicks that exceed 100g in weight).

For a third consecutive year we extended our Black Oystercatcher monitoring to include additional sites in Gwaii Haanas National Park/ Haida Heritage Site. Not including sites in the Lost Island group, we identified 60 territories occupied by adults and at 55 of these we found either eggs or chicks. Thirty-eight chicks hatched at 26 territories (range: 1-3 chicks) and 21 chicks were big enough to band.

We band chicks with a uniquely numbered metal band in addition to colour band combinations indicative of where chicks were banded and the year they were banded. These band combinations allow researchers to examine dispersal and various life history aspects and as a result we are always keeping an eye out for banded adults. This year we re-sighted 12 banded Black Oystercatcher adults at 11 different sites (Table 2).

Table 2
Banded Black Oystercatchers re-sighted in Laskeek Bay 2006, * note that birds can lose colour bands (UB = unbanded)

Band Combination	Location seen / Nest site	Year Banded	Banded as Adult or Chick
UB – W/M	South Low (SLW-8)	1994	Chick
UB – BK/M	Reef I. (REE-2)	2000	Chick or Adult
AL – BK/M	Reef I. (REE-1)	2000	Adult
UB – BK/M	Lost I. (LOS-4)	2000	Chick or Adult
UB – BK/M	South Low (SLW-5)	2000	Chick or Adult
UB – BK/M	South Low (SLW-1)	2000	Chick or Adult
UB – M	Kingsway Rk. (KNG-2)	unknown	unknown
W – R/M	East Limestone I. (ELI-3)	2003	Chick (not breeding)
WH – BK/M	Skedans I. (SKE-6)	2000	Chick
UB – M	Cumshewa	unknown	unknown
UB – R/M,	Both at Reef I., in a flock of	2003	Chick
UB – BK/M	seven birds	2000	Chick or Adult

Diet

Chick diets comprised primarily marine invertebrates brought to chicks on the breeding territory until fledging (approx. 40 d.). Chick diet composition can be inferred from prey remains found within the breeding territory and we described chick diet composition and prey size by counting and measuring food remains in the vicinity of nest sites with chicks.

In Laskeek Bay we collected, identified and measured 2432 prey remains from nine nests. In Gwaii Haanas we identified 1263 prey remains from 18 nests but we did not measure these due to time constraints. Based on the mean proportion of prey remains at each nest site, limpets, mussels and chitons together made up 99% of the prey remains identified (Figure 3)

Figure 3
Invertebrate prey remains identified at Black Oystercatcher nest sites in Laskeek Bay and Gwaii Haanas in 2006 (n = 3795 prey from 27 nests)

Glaucous-winged Gulls

Since 1992 we have been censusing Glaucous-winged Gull *Larus glaucescens* colonies in Laskeek Bay. In 2006 we counted adults, nests and the number of eggs at Kingsway Rock, Lost, Low, Skedans and Cumshewa islands. We visited most sites between 25 and 26 June with the exception of the Lost Islands which we visited late this year (2 July) because of scheduling and weather. As usual, the largest colonies were Lost Island. with 252 active nests and Kingsway Rock, with 20 nests. Only a few additional breeding pairs were found at Skedans, Low and Cumshewa islands, where two, nine and zero nests were found respectively (Fig. 4). Because of the late date of the survey at Lost Island, more than half of the nests contained chicks with some chicks estimated to be 14d. old.

Pigeon Guillemots

Ten wooden Pigeon Guillemot *Cepphus columba* nest boxes were set up at Lookout Point in 2001. They are checked for nesting activity at the end of each season. We inspected the boxes on 18 July and seven nest boxes were active containing: one egg (n = 2 nests), one chick (n = 2 nests) and two chicks (n= 3 nests). Four chicks were banded with metal bands while the remaining four were just a few days old and too small to band.

Cassin's Auklets and Fork-tailed Storm Petrels

We monitored breeding activity at 74 burrows located at North Shore and Cassin's Tower sites by conducting weekly checks for knockdowns at burrow entrances. At the North Shore we monitored 25 burrows and at 18 of these we recorded activity (more than two records of knockdowns). Cassin's Auklets *Ptychoramphus aleuticus* were definitely active in this area, as telltale droppings and strong characteristic smells were noted at several of the burrows entrances. Nesting habitat in this area is very rocky making the majority of burrows inaccessible. However, this year we installed twenty four nest boxes at this site hopefully providing future opportunities for banding and monitoring chick growth.

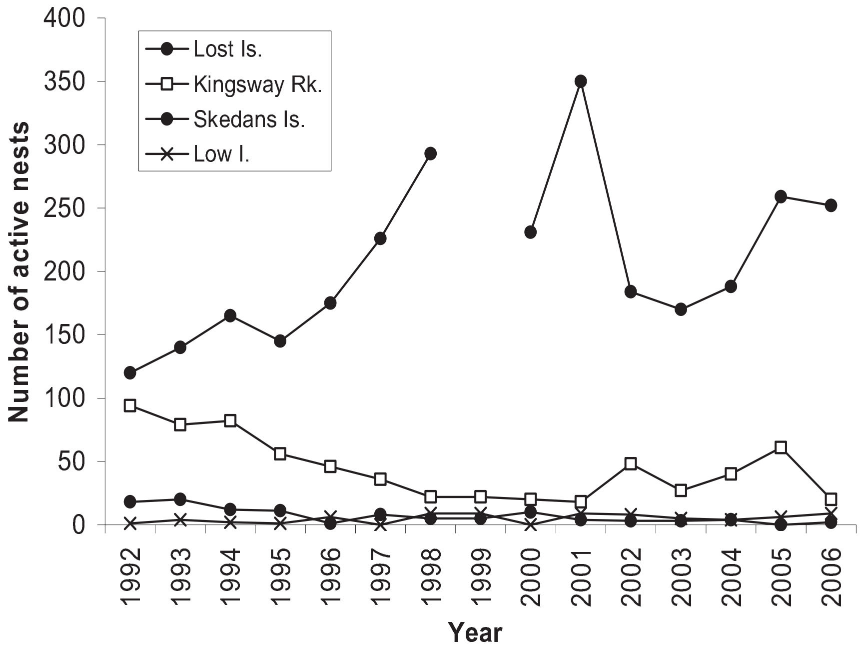

Figure 4
Number of active Glaucous-winged Gull nests in Laskeek Bay 1992-2006.

At Cassin's Tower we monitored 44 burrows and at 43 of these we recorded activity. We also monitored knockdown activity at one nest box and were able to use the hatch to access the Cassin's Auklet chick inside, which we later banded. Burrows in this area are occupied by Cassin's Auklets and Fork-tailed Storm Petrels *Oceanodroma furcata.*

We know this because some burrows possess distinct Cassin's Auklet attributes (see above) whereas others in contrast, have smaller openings, are characteristically 'musty' in smell and in one we found a Petrel egg.

At-Sea Surveys

To determine the abundance and distribution of different marine birds in Laskeek Bay we use boat transects, conducted regularly throughout each season and following the same routes each year.

Nearshore surveys

We conducted four nearshore surveys on 9-11 May, 4 June, 25 June and 15 July. During the four surveys, we counted 11 different marine bird species including: Ancient Murrelets, Marbled Murrelets *Brachyrhynchus marmoratus*, Rhinoceros Auklets *Cerorhinca monocerata*, Pigeon Guillemots, Pelagic and Double Crested Cormorants *Phacrocorax pelagicus* and *auritus*, Pacific Loons *Gavia pacifica*, Glaucous-winged Gulls, White-winged Scoters *Melanitta fusca*, Long-tailed *Clangula hyemalis* and Harlequin Ducks *Histrionicus histrionicus*. We also commonly observed Bald Eagles *Haliaaetus albicilla* and Black Oystercatchers. Marbled Murrelet encounters are of particular interest because this bird is provincially red listed and is designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Our peak count of Marbled Murrelets during nearshore surveys was 182 birds on 15 July, these birds were counted on the water or flying within our transects.

Hecate Strait surveys
Especially calm conditions are required for the 'offshore' / Hecate Strait surveys making it difficult to schedule regular trips and in 2006 we conducted 'offshore' surveys on 9 June and 16 July. We counted ten different marine bird species during the two offshore surveys including: Ancient Murrelets, Marbled Murrelets, Rhinoceros Auklets, Pigeon Guillemots, Pelagic Cormorants, Common Loons *Gavia immer*, Glaucous-winged Gulls, Sooty Shearwaters *Puffinus griseus*, Red-necked Phalaropes *Phaloropus lobatus*, and a Tufted Puffin *Fratercula cirrhata*.

Marine Mammals

In 2006 we recorded 103 marine mammal sightings of eight species (Table 3). Reports of marine mammals are a combination of observations made during sea surveys, sea watches and opportunistic observations made during other work.

Humpback whales *Megaptera novaeangliae* were a common sight in the spring and we counted 91 in total. Despite these frequent reports, we had only one opportunity to take photos of tail flukes for individual ID because most of our whale sightings occurred from a distance, from land, and/or during poor weather conditions.

We have one Killer whale *Orcinus orca* encounter to report this year. On 21 June at 17.00h a group of four individuals travelled through Cabin Cove. Members of the group included one bull, two smaller individuals and a juvenile. We watched the whales for approximately 20 minutes as they traveled towards Low I. En route the whales put on a fantastic acrobatic show complete with spy hopping, tail lobbing and breaching.

Although sightings of Pacific white-sided Dolphins *Lagemorhynchus obliquidens* were not a common occurrence this year, there were three notable encounters. On both the 12 and 19 May large groups (>150 individuals) were spotted beyond Low I. and as they travelled across Laskeek Bay, dolphins lined the horizon. On 3 July we spotted 15 Pacific white-sided dolphins on the SE side of Lyell I. This was a unique encounter because the dolphins were foraging around and under our boat providing excellent close-up views.

Steller's sea lions *Eumetopias jubatus* are commonly hauled out at sites on Skedans and Reef Islands. Our highest count at Skedans Islands was 60 individuals on 11 May and at Reef Island rocks 386 individuals on 4 June. During our 4 June visit we spotted two branded Steller's sea lions at the Reef haul-out: 'F1026' and '75Y'and that same day, the Reef I. crew reported seeing a third branded individual 'F1020'. It is likely that the 'F' individuals were branded at Forrester Island in Alaska.

Table 3
Total counts of marine mammal sightings by Laskeek Bay Conservation Society based on observations made during sea surveys, sea watches and opportunistically, 2002-2006. (note: Harbour seals *Phoca vitulina* and Steller's sea lion counts are not included)

Species (common name)	Scientific name	2006	2005	2004	2003	2002
Minke whale	*Balaenoptera acutorostrata*	1	0	2	0	0
Fin whale	*Balaenoptera physalis*	0	0	0	1	0
Grey whale	*Eschrichtius robustus*	1	1	1	3	2
Humpback whale	*Megaptera novaeangliae*	91	15	19	152	49
Killer whale	*Orcinus orca*	4	11	13	21	29
Harbour porpoise	*Phocoena phocoena*	4	3	12	5	21
Dall's porpoise	*Phocoenoides dalli*	0	1	0	0	29
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	365	8	0	325	22
Northern elephant seal	*Mirounga angustirostris*	0	0	0	1	0
California sea Lion	*Zalophus californianus*	0	1	1	0	0

Wildlife Trees

This year we monitored 44 snags for cavity nesting birds and after three, 30 min visits to each tree we determined nine of these trees to contain active nests (Table 5). In addition we found five new wildlife trees for a total of 14 active trees containing 15 nests that were occupied by five species of birds: Red-breasted Sapsucker *Sphyrapicus rubra* (8 nests), Chestnut-backed Chickadee *Poecile rufescens* (3 nests) Hairy Woodpecker *Dendrocopus villosus* (2 nests), Northern Flicker *Colaptes auratus* (1 nest) and Brown Creeper *Certhia americana* (1 nest). On average, cavity nesters' chicks fledged on 17 June ± 9.8d (Table 5) with Hairy woodpeckers averaging the earliest fledging (6 Jun ± 6.4 d) and Red-breasted Sapsuckers the latest (18 Jun ± 6.0 d).

NATURAL HISTORY

Daily Bird Checklist

We recorded 59 bird species seen or heard in the Laskeek Bay area during the 2006 season and our daily maximum count was 32 species on 9 July. Some of the less common sightings included four Red-necked Phalaropes seen during an offshore survey, and Western and Least Sandpipers *Calidris mauri* and *minutilla* spotted at Kingsway Rock on 16 July. Other species of note that we saw or heard during visits south of Laskeek Bay included Northern Saw-whet Owl *Aegoliua acadicus,* California Gull *Larus californicus*, Great blue Herons *Ardea herodias* and Blue Grouse *Dendragapus obscurus.*

Table 5
Wildlife tree use on East Limestone Island, 2006. (RBSA = Red-breasted Sapsucker, NOFL = Northern Flicker, CBCH = Chestnut-backed Chickadee, HAWO = Hairy Woodpecker, BRCR = Brown Creeper, Ss = Sitka spruce, Hw = Western hemlock)

Tree #	Cavity Nester	Tree Species	Fledge Date
10	RBSA	Ss	19-Jun
17	NOFL	Ss	30-Jun
45	CBCH	Ss	7-Jun
72	RBSA	Ss	20-Jun
90	RBSA	Ss	21-Jun
96	CBCH	Hw	6-Jun
96	RBSA	Hw	21-Jun
99	RBSA	Hw	11-Jun
103	HAWO	Hw	2-Jun
106	RBSA	Ss	19-Jun
107	HAWO	Ss	11-Jun
108	BRCR	Ss	11-Jun
109	RBSA	Ss	19-Jun
110	CBCH	Ss	5-Jul
111	RBSA	Hw	3-Jul

Birds of Prey

Our only active Bald Eagle nest on East Limestone Island this season was in tree #5 located at Cassin's Tower. The pair was observed at the nest regularly from 9 May and a chick was first spotted on 7 June. The ridge adjacent to Cassin's Tower provided an excellent perch from which to watch the nest and view the chick. On two occasions around 10 July the large chick was absent from the nest but following each of these watches the chick was seen back in the nest suggesting that by mid July the chick was flying. At camp shut-down on 21 July the chick was still in the nest.

Most years we have regular reports of Saw-whet owls calling in addition to the occasional nighttime sightings during Ancient Murrelet chick banding season. However, in 2006 there was no sign of Saw-whet Owls on Limestone.

Common Ravens *Corvus corax* nested on Limestone Island again this year and by 26 May the young had fledged. We suspect that Northwestern Crows *C. caurinus* also nested on the island because we found a handful of nests in Crow Valley and noted the presence of Crows in the area. We did not observe activity at any the nests, but they were discovered late in May and chicks may already have fledged.

Plants

We continue to inventory plants and bloom dates on Limestone throughout the field season and in early July, Mike Cheney visited Limestone to re-survey the plant community on the island. Of particular interest was the distribution of rare and invasive species. Several plant species that occur on Limestone are uncommon or occur no where else in the Archipelago while others are aggressive, non-natives that potentially threaten to compete with native species.

Introduced Species

In Haida Gwaii, non-native species such as Sitka Black tailed deer *Odocoileus hemionus sitkensis* and Raccoons *Procyon lotor* have had a considerable impact the island's ecosystem. For example, Sitka Black-tailed deer mark their presence on Limestone by browsing heavily on the forest under story. Our three deer exclosures provide visitors and volunteers with a chance to compare the difference between areas with and without deer browse. The effects of deer browse are especially highlighted when we visit the few deer-free islands in Laskeek Bay. These deer-free sites are often carpeted with wildflowers and dense under brush, features uncharacteristic of islands with deer.

Raccoons have had devastating effects on seabirds colonies that have no natural defense against these introduced predators that target adults, chicks and eggs. This year, poor weather prevented raccoon surveys by boat on most days with appropriate tide conditions and as a result we completed only one boat survey (6 June) to search for raccoons on Louise and Limestone Islands. Despite this reduced effort to scan for raccoons by boat, we surveyed East Limestone regularly by foot keeping an eye out for signs of diggings, predation and tell-tale latrines. No signs of raccoon activity on East Limestone Island were recorded in 2006.

CONCLUSIONS

Ancient Murrelet chick numbers remain low compared to early years suggesting that the overall number of breeding birds has declined over time. Results from this year's population census are consistent with this trend (Lemon, this volume) and it does not appear that the colony has shifted to other areas on the island. What has caused the decline in Ancient Murrelets on Limestone? The paper by Gaston (this issue) addresses some possible explanations.

In terms of the other research activities, this year saw the completion of a three year contract with Parks Canada to conduct Black Oystercatcher work south of Laskeek Bay. Overall, this project was very successful in collecting baseline data for the region and there is discussion that Parks Canada would like LBCS to continue this work by re-surveying territories every other year.

EAST LIMESTONE ISLAND FIELD STATION:
REPORT ON THE 2007 FIELD SEASON

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Photo courtesy of Jen Rock, LBCS

SUMMARY

Our 18th field season brought 27 volunteers and thirteen visiting groups to Limestone Island. In response to the Ancient Murrelet population decline at Limestone we limited our monitoring activities to conducting chick work at Cabin Cove and we did not carry out any banding. Between 15 May and 14 June we weighed all 166 chicks that passed our four funnels. Breeding season was late this year, with 2007 marking the latest start and peak dates for chick departures on Limestone since 1990. The chick total from funnels 5 to 8 marked a 15% decrease from last year's number and comparing totals from funnel 5 and 6 across years, 2007 produced the fewest chicks since 1990. A raccoon was present on the island throughout the breeding season and it was responsible for excavating burrows, predating eggs, chicks and adults. Raccoon predation could explain the decline in numbers that we observed this year although it is not clear whether additional factors are contributing to the population decline. Despite continuous efforts to capture the raccoon it was not removed until 20 June. This experience has highlighted the need for LBCS to adopt an early detection approach for raccoons, ideally starting before birds arrive at the colony.

We identified 36 Black Oystercatcher breeding territories in Laskeek Bay, 29 of which produced eggs or chicks. Based on 1358 prey remains that we collected at 17 different territories, chick diets contained three types of invertebrates: 67% limpets, 21% mussels and 12% chitons. A Glaucous-winged gull colony census revealed a total of 276 nests in Laskeek Bay with 86% counted at the Lost I. Pigeon Guillemot nest boxes located at Lookout Point on Limestone had the highest occupancy rate to date with eight out of ten boxes containing chicks or eggs. We installed 64 Cassin's Auklet nest boxes at three different sites on Limestone. This year was a productive year for marine mammal encounters with frequent sightings of Humpback whales (203 sightings), successful Id photos taken of Orcas and a few reports of California Sea Lions in the area. We identified 13 active wildlife trees containing 14 nests belonging to three species of cavity nesting birds including Red-breasted Sapsuckers, Chestnut-backed Chickadees Hairy Woodpeckers. It was another busy year on Limestone!

EDUCATION AND INTERPRETATION PROGRAM

Changes in 2007

The Ancient Murrelet program on Limestone underwent some major changes in 2007 and this has in turn affected the education and interpretation program. As of this season, chick capture work at North Cove funnels was terminated. Night visits by students now take place at the cabin funnels and maximum group size has been reduced to 10. Following night work, groups now spend the remainder of the night in the visitor interpretation centre, instead of walking across the island at night, as was done in the past. As well, night time visits by tour boats are being phased out this year in a move to further reduce the impact of night work within the colony.

Project Limestone

This was the 18th year of Project Limestone, a program that brings local students to the island to participate in Ancient Murrelet work. An afternoon interpretive tour (usually lasting 1-2 hours), introduces the students to the island and provides them with an overview of our research and activities. The group then assists in capturing Ancient Murrelet chicks at night, typically from 10:30 pm to 2:30 am. Due to the new location this year there were fewer opportunities for students to capture and handle chicks. However, they were still thrilled with the experience and gave very positive feedback. Smaller group sizes meant that the students had more opportunity to interact with staff and ask questions. The students love being able to participate and it is common for students to return several years in a row. So despite changes, this continues to be a very important and powerful experience for the students, as it makes them more aware and appreciative of the environment in which they live.

This season saw a total of 10 groups of students visit the island representing 5 different schools. The number of students participating continues to increase, 66 (19 teachers/ chaperones) this season as compared to 50 (13) in 2006. This reflects the continuing popularity of the program as well as the reduced group size and the reduction in night-time visits by tour boats. Four local schools visited the island this year: GM Dawson Secondary School, 11 May; Living and Learning School, 20 & 21 May; Queen Charlotte Secondary School, 23-25 May; and Agnes L. Mathers School, 28 & 29 May. Northwest Community College (Prince Rupert) also visited for the first time this year as part of their coastal ecology course. They brought 2 groups on island, 15 & 16 May. A total of 473 students have now participated in the program since it started in 1991.

Volunteers

From the beginning, LBCS has been committed to having volunteers in camp working alongside field staff, and this is an integral part of the operation of the field camp. In this way, members of the public have the unique opportunity of working in a field camp and participating in a variety of research projects on and around Limestone Island. This is one of the few places in the province where the public are invited to be a part of research. Their generous contribution of time and energy each season continues to be invaluable to operations on the island.

A total of 27 volunteers visited the island this year, contributing 237 volunteer days to various projects throughout the season. Of these volunteers, six had been on the island in previous years, and 21 were new to the island. LBCS director Keith Moore and executive director Lisa McKnight-Yeates both visited on two separate occasions. Eleven volunteers were on island for less than a week, eight for one week, seven for two weeks and one for three weeks. As in past years, volunteers hailed from diverse places: ten were from Haida Gwaii, eight from other areas of BC and the remainder from Saskatchewan, Ontario, Washington, France and Hawaii.

Visitors

The visitor program on Limestone provides opportunities for tour groups to stop on the island and learn about our research. As with student groups, this is an activity provided by the society at no cost, with the aim of raising public awareness and interest in local conservation issues on the island. Most guests are not local and are very excited to learn about the island's ecosystem, and the Ancient Murrelets in particular.

Although night time visits by tour groups have been phased out this season, groups are still being welcomed for day-time interpretive tours, and in total 36 guests from two vessels visited the island this year: *S/v Island Roamer* stopped on two separate occasions (17 & 31 of May), and *s/v Island Odyssey* on one occasion (22 May). One group (4 guests) was allowed to participate in night-work (17 May), by prior arrangement. As well, a group from Langara College (7 students, 1 teacher) was given a tour of the island on 8 June.

The camp on nearby Reef Island was very active this year (30 March to 21 June). Both Tony Gaston (Environment Canada) and Jean-Louis Martin (Research Group on Introduced Species) were on the island, along with Akiko Shoji, Jennifer Provencher, Thibaut Vergoz, Tim Lash, Sophia Colantino, Steve Stockton and others. Thibaut also spent three weeks as a volunteer on Limestone Island (23 June to 13 July).

Staff

This year's field staff comprised Jen Rock (camp supervisor / biologist) and Jake Pattison (assistant biologist / interpreter). The field season on Limestone Island spanned 11 weeks, from 28 April to 13 July, a total of 76 days. At the office in Queen Charlotte, Lisa McKnight-Yeates has replaced Greg Martin as LBCS executive director in 2007.

RESEARCH AND MONITORING PROGRAMS

Ancient Murrelets *Synthliboramphus antiquus*

Monitoring activities

In response to the declining in Ancient Murrelet population on Limestone Island, in 2007 LBCS adopted further measures to reduce the potential for negative interactions between birds and our research activities. In the fall of 2006 researchers and directors decided that a series of precautionary measures be adopted including:

- There would continue to be no adult capture work or burrow monitoring at East Limestone (this marks a 4th consecutive year).
- All disturbances to the North Cove area during the Ancient Murrelet breeding season would be eliminated (ie. off-limits to all, for any activity).
- Night-time visits by tour boats would be terminated.
- Visiting school groups would now visit the Cabin Cove area and further measures to reduce use of lights in the colony at night would be adopted.

- Predation transects would be reinstated (to monitor predation pressure on Ancient Murrelets).

Through these changes LBCS hopes to minimize our impact on the breeding colony and to gain insights in to what factors are causing the Ancient Murrelet population decline on Limestone.

Recaptures
Although there was no directed effort to capture adults, individuals that we opportunistically come across (ie: that fly in to staff or are sitting on the trails) are checked for bands. This year we encountered four adults previously banded on Limestone: three were banded as adults (1999, 2000, 2002) and one was banded as a chick (2006).

Researchers at neighbouring Reef Island conducted adult capture work this season. Among their recaptured birds was one banded as an adult in 1987, meaning that this bird was at least 22 years old, the oldest Ancient Murrelet known to date. They also captured two birds originally banded on Limestone Island, both as chicks, one in 1996, the other in 2002.

Band recoveries
Because predation is a fact of life at seabird colonies we are always on the lookout for banded legs among the remains of dead Ancient Murrelets that we come across. This year we recovered five bands from birds that were originally banded on Limestone: three birds were banded as adults (one in 2002, two in 2003) and two were banded as chicks (2004, 2005).

Recapture data and band recoveries can teach us about the life history of species: for example, how long these birds live and whether they return to their natal colony to breed. This type of information is key to understanding the dynamics of breeding populations and in turn, helps researchers identify measures that will effectively protect them.

Chick capture work
Each night from 7 May to 14 June we monitored Ancient Murrelet chicks arriving at four funnels (funnels 5 to 8) located at Cabin Cove. Following the usual protocol we closed funnels between 22.30h and 02.30h and after 19 May we pushed the start time back to 23.00h to take account of longer daylight hours. Chicks first arrived at our funnels on 15 May and funnel work continued until the first two consecutive nights when no chicks arrived at any of the four funnels (Fig. 1).

We weighed all 166 chicks that passed through our funnels and seven chicks caught after 02.30h or outside of the funnels (Table 1). The distribution of chick departures this season was different from most previous years, which typically showed a distinct, single peak surrounded by a shoulder period on either side. In contrast, this year's chick activity came in two waves of departures (Fig. 1). The 2007 chick total from funnels 5 to 8 was 15% less than last year's total of 197 chicks (Table 1).

Trends in chick departures across years from funnels 5 and 6 (funnels 7 and 8 were new in 2006) show that this year's total was the lowest since 1990 (Fig.2). Compared to last season, there were 31% fewer chicks at funnels 5 and 6 (Table 2).

The timing of chick departures in 2007 indicated a generally late breeding season with later than average dates for first departure and peak count (Table 2). Concurrent research at Reef showed that the timing of breeding for Ancient Murrelets at that colony was also late this year, indicating that this behaviour was not particular to Limestone birds.

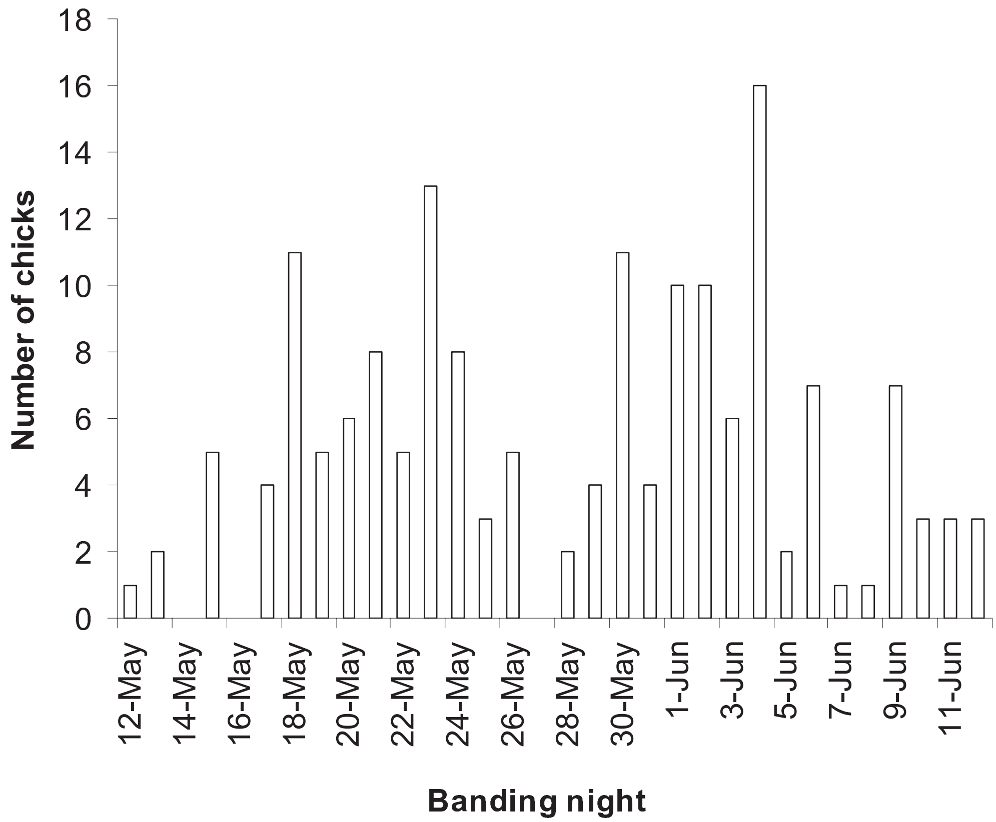

Figure 1
Number of chicks per night caught at funnels 5 to 8 on Limestone Island, 12 May to 12 June 2007

Table 1
Summary of chick departures, peak nights and totals from Cabin Cove funnels 5 to 8 on Limestone Island 2006 to 2007

Year	Opening night	First night with chicks	Last night	Peak night	Peak count	Total days	Total chicks
2006	5-May	10-May	30-May	21-May	24	21	197
2007	7-May	15-May	12-Jun	4-June	16	29	166

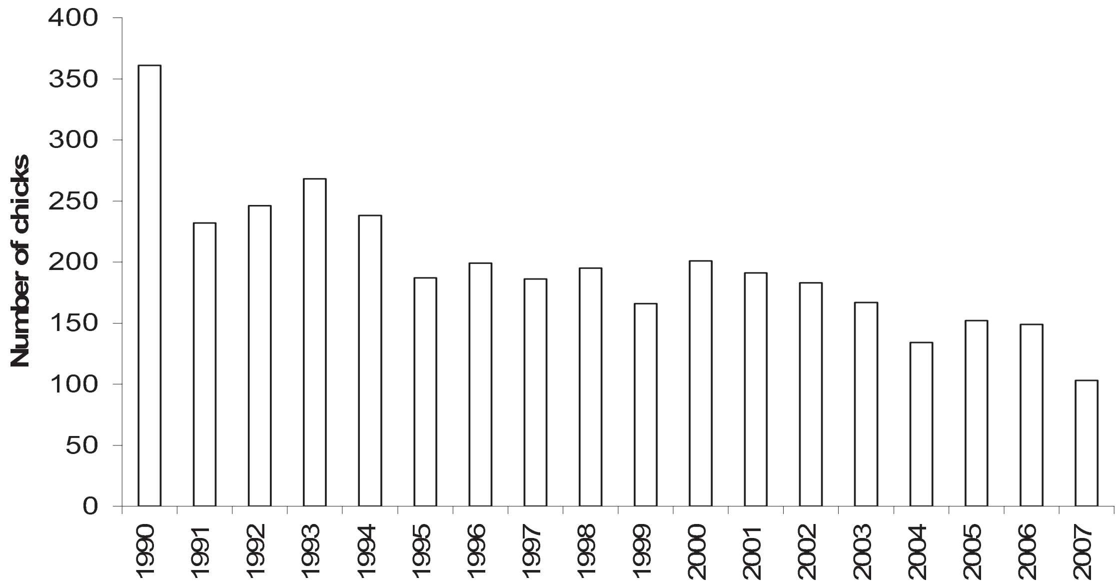

Figure 2
Total number of Ancient Murrelet chicks caught at funnels 5 and 6 on Limestone Island from 1990 to 2007

Gathering Grounds
Before coming in to the colony at night Ancient Murrelets congregate at a site just west of Low Island, known as the 'gathering grounds'. From 30 April to 20 June, we conducted five minute counts of birds on the gathering grounds approximately two hours before sunset. The peak count was 239 birds on 14 May. Poor weather conditions prevented counts on 15 days and an additional five days were missed because of reduced visibility or because the crew was absent during gathering ground hours.

Point Counts
At 2.30h we carried out point counts to determine the number of birds heard calling and the number of calls made over a single, five minute period. We conducted point counts from 21 May to 2 June at a site located behind the cabin. The maximum number of birds heard calling was eight individuals on 9 May and the maximum number of calls heard was 79 calls on 6 June. By conducting both gathering ground counts and point counts we hope to examine whether these measures can be used to monitor colony attendance.

Squirrel Surveys
Squirrels were introduced to Haida Gwaii by the BC Forest Service in the late 1940s as a means to facilitate cone gathering for the forestry industry. The introduction these non-native species has negatively impacted Haida Gwaii's ecosystem both directly and indirectly (http://www.rgisbc.com/squirrel.htm). However, the consequences of squirrel introduction are only partially understood and the interactions between introduced squirrels and burrow nesting birds have yet to be explored.

Because of the declining Ancient Murrelet population at Limestone we are interested in examining potential interactions between squirrels and burrow nesting birds. This year we re-instated squirrel surveys to monitor squirrel population changes across years and thus provide a baseline from which to evaluate the relationship between seabirds and non-native squirrels.

Table 2
Summary of chick departures, peak nights and totals from funnels 5 and 6 on Limestone Island 1990 to 2007

Year	Opening night	First night with chicks	Last night[†]	Peak night	Peak count	Total days	Total chicks
1990	12-May	13-May	15-Jun	20-May	28	33	361
1991	08-May	10-May	05-Jun	25-May	22	26	232
1992	12-May	14-May	02-Jun	22-May	29	19	246
1993	09-May	12-May	04-Jun	18-May	39	23	268
1994	07-May	08-May	06-Jun	20-May	29	29	238
1995	07-May	11-May	12-Jun	23-May	18	32	187
1996	10-May	11-May	07-Jun	18-May	17	27	199
1997	08-May	13-May	05-Jun	28-May	22	23	186
1998	07-May	11-May	20-Jun	20-May	23	40	195
1999	09-May	11-May	09-Jun	21-May	22	29	166
2000	11-May	11-May	06-Jun	21-May	22	26	201
2001	08-May	11-May	15-Jun	19-May	21	35	191
2002	07-May	09-May	01-Jun	21-May	33	23	183
2003	10-May	11-May	03-Jun	21-May	19	23	167
2004	08-May	08-May	01-Jun	16,17-May	15	24	134
2005	07-May	07-May	05-Jun	19,23-May	12	29	152
2006	05-May	10-May	31-May	21-May	20	21	149
2007	07-May	15-May	12-Jun	04-Jun	16	28	103
Average (± SD)	8-May ± 2d	10 May ± 2d	7-Jun ± 6d	22 May ± 4d	23 ± 7 chicks	27 ± 5 chicks	198 ± 58 chicks

[†]Last night of chick work was determined differently depending on year. From 1990 to 2006 the date of 'last night' was determined by the first night when no chicks arrived at funnels 1 to 6. In 2007 the date of 'last night' was determined by the first two consecutive nights with no chicks at funnels 5 to 8.

Predation Transects
Last years population census of the Ancient Murrelet colony revealed that although the number of occupied burrows on Limestone had declined over time, predation levels (measured concurrently) had not decreased. These data suggest that predation on Ancient Murrelets may be an important factor contributing to the population decline at Limestone and in response to this, predation transects were reinstated in order to measure and examine changes in predation pressure across years (last surveyed in 1995).

Once per week, during the Ancient Murrelet breeding season we counted the number of carcasses, feather piles, wings, and dug-up burrows located along five, 20m wide transects. Counts were started at first light in order to find any evidence of predation before scavengers altered or removed evidence.

On our second survey, on 19 May, we found a handful of dug-up burrows and six headless adult Ancient Murrelet carcasses located in two separate areas. River otters *Lutra canadensis* that live on Limestone will depredate adult birds and may dig up burrows. However, previous experience with raccoons *Procyon lotor* at this colony suggested that the decapitated and otherwise intact state of the murrelets indicated that a raccoon was responsible. Despite concerted efforts to locate and remove the raccoon from the colony, it was not until 20 June that the raccoon was caught, after the majority of Ancient Murrelets had left the colony.

Black Oystercatchers *Haematopus bachmani*

Occupancy and Reproductive Success

LBCS has been monitoring Black Oystercatcher breeding activity in Laskeek Bay since 1992. Each season we search coastal areas extending from Cumshewa Island to the Lost Islands in Gwaii Haanas National Park/ Haida Heritage Site to identify breeding pairs and to measure eggs and chicks. This year we identified 36 territories that were occupied by pairs and 29 of these sites were active with eggs or chicks at some point of the season. We banded 14 chicks from nine breeding territories: eight at Reef Island, five at Kingsway Rock and one at Low Island. Banded chicks received a uniquely numbered metal band in addition to a colour band combination that indicated where chicks were banded (ie: Laskeek Bay) and the year they were banded. In 2007 we re-sighted 12 banded birds, ten of which occupied breeding territories that we were monitoring and two were spotted among groups of birds loafing on islands in Laskeek Bay (Table 3).

Table 3
Banded Black Oystercatchers re-sighted in Laskeek Bay 2007

Band Combination*	Location seen (Territory site)	Year Banded	Banded as Adult or Chick
AL – BK / M	Reef I. (REE-1)	2000	adult
UB – R / M	Reef I. (REE-2)	2003 or 2004	chick
UB – BK / M	Reef I. (REE-2)	2000	unknown
UB - M	Low I. (LOW-3)	unknown	unknown
W- R/M	E. Limestone I. (ELI-2)	2003	chick
W-M	Skedans I. (SKE-6)	unknown	unknown
W-BK/M	Skedans I. (SKE-6)	2000	chick
UB-BK /M	S. Low (SLW-1)	2000	unknown
UB – W	S. Low (SLW-8)	1994	chick
UB- M	Kingsway Rk. (KNG-3)	unknown	unknown
UB – DB / M	W. Limestone I.	2006	chick
UB – R / M	Islet off Louise, SW of Skedans Village	2003 or 2004	chick

W = white, M = metal, BK = black, R = red, DB = dark blue, UB = unbanded.

Diet

For a fourth consecutive year we collected information on Black Oystercatcher chick diets. Adults provision chicks with marine invertebrates at the breeding territory until the chicks fledge (approx. 40 d.) making it possible to infer chick diet composition based on prey remains recovered at the breeding territory.

We collected 1358 prey remains from 17 nest sites [mean number of prey (±) SD per territory = 79.9 ± 49.5] that we later identified and measured. Based on the mean proportion of prey remains collected from each breeding territory, limpets were the most common type of prey fed to chicks followed by mussels and chitons (Figure 3).

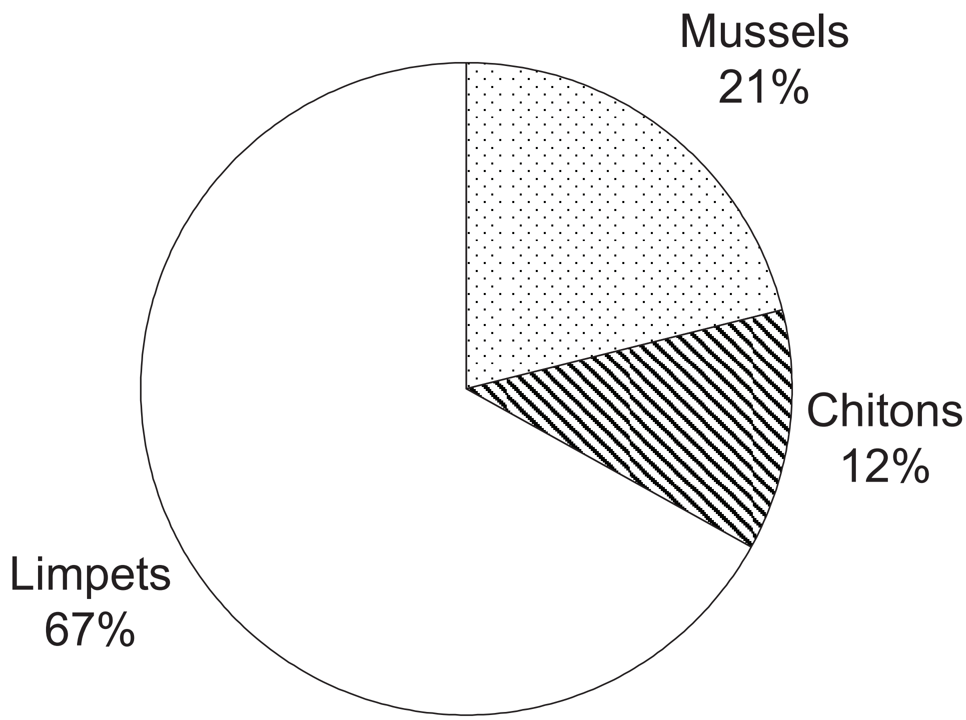

Figure 3
Average composition of Black Oystercatcher chick diets determined from prey remains collected at nest sites in Laskeek Bay (n = 1358 prey from 17 nests)

Glaucous-winged Gulls *Larus glaucescens*

Glaucous-winged Gull colonies in Laskeek Bay have been censused since 1992. Between 14 and 19 June we counted the number of adults, nests and eggs at Kingsway Rock, Lost I., Low I., Skedans I. and Cumshewa I. As usual the largest colony was Lost I. with 238 active nests followed by Kingsway Rock with 30 nests. We counted two breeding pairs at Skedans I., six at Low I., and zero at Cumshewa I. (Fig. 4). Overall, the total number of nests counted in Laskeek Bay this year (N = 276 nests) was consistent with the average counted across years [mean number of nests (±) SD per year = 253 ± 74].

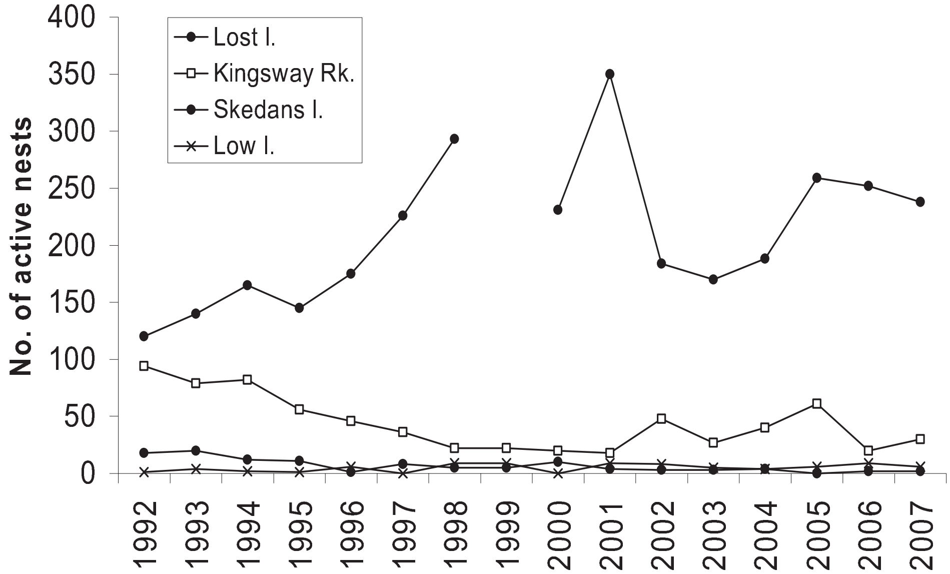

Figure 4
Number of active Glaucous-winged Gull nests in Laskeek Bay 1992-2007

Pigeon Guillemots *Cepphus columba*
At the end of each field season we check the contents of each of the ten wooden Pigeon Guillemot nest boxes installed at Lookout Point in 2001. We check boxes to determine occupancy rates and reproductive success. On 12 July we found eight active nest boxes: seven contained one or two chicks (eleven chicks total) and one contained a single egg, marking the highest occupancy rate to date (Fig 5).

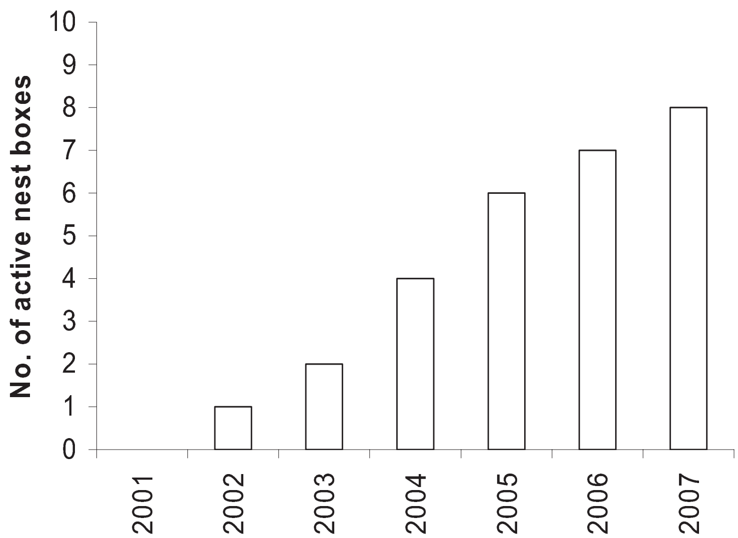

Figure 5
Number of Pigeon Guillemot nest boxes on East Limestone Island with either eggs or chicks

Cassin's Auklets and Fork-tailed Storm Petrels *Ptychoramphus aleuticus and Oceanodroma furcata*

To monitor Cassin's Auklet breeding activity we conducted weekly checks for knockdowns at burrow and nest box entrances at the site formerly called the 'North Shore' (this site was more appropriately renamed the 'East Coast' in 2007). Out of 25 burrows we identified 15 that were active (more than two records of knockdowns or having distinct tell-tale odors). None of the 24 nest boxes were active and we felt that this could be because the boxes were relatively exposed. In an effort to increase the appeal of nest boxes to breeding birds we re-installed all of the 24 nest boxes by embedding them in to the ground and covering them with soil and moss. Fifteen more nest boxes were installed in the same way just south of this site, in an area where a few Cassin's Auklet pairs were already nesting. In addition, we installed 25 nest boxes at the Lookout, another area where Cassin's Auklets are known to be breeding.

Birds that eventually occupy these nest boxes will provide good opportunities for researchers to monitor reproductive success and chick growth rates.

This year we scaled back monitoring efforts at burrows that were located on Cassin's Tower in order to limit disturbance to a pair of Bald Eagles that were nesting on top of the Tower. Based on knockdowns and characteristic smells we determined that at least 26 burrows were active with Cassin's Auklets and 11 were active with Fork-tailed Storm Petrels.

At-Sea Surveys

To describe the abundance and distribution of different marine birds across seasons and years we carry out regular boat based surveys that follow a series of transects located throughout Laskeek Bay.

Nearshore surveys

In 2007 we conducted five nearshore surveys on 8-9 May, 22 May, 6 June, 24 June and 6 July. During the five surveys we counted 16 different marine bird species including: Ancient Murrelets, Marbled Murrelets *Brachyrhynchus marmoratus*, Rhinoceros Auklets *Cerorhinca monocerata*, Pigeon Guillemots, Pelagic *Phacrocorax pelagicus*, Pacific Loons *Gavia pacifica*, Glaucous-winged Gulls, White-winged Scoters *Melanitta fusca*, Long-tailed *Clangula hyemalis* and Harlequin Ducks *Histrionicus histrionicus*, Common Loons *Gavia immer,* Herring gulls Black-legged Kittiwakes *Rissa tridactyla*, Red-necked Grebes *Podiceps grisegena*, Common Murres *Uria aalge*, and Black Oystercatchers.

We are particularly interested in counts of Marbled Murrelets because this bird is provincially red listed and is designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Our peak count of Marbled Murrelets during the nearshore surveys was 85 birds on 22 May.

Hecate Strait surveys

We carried out two Hecate Strait surveys on 12 May and 7 July. These 'offshore' surveys are less frequent because they require especially calm conditions. We counted thirteen different marine bird species during the two offshore surveys including: Ancient Murrelets, Marbled Murrelets, Rhinoceros Auklets, Pigeon Guillemots, Glaucous-winged Gulls, Sooty Shearwaters *Puffinus griseus*, Tufted Puffins *Fratercula cirrhata*, Herring Gulls, White-winged Scoters, Cassin's Auklet, Black Turnstones, Common Murres.

Marine Mammals

Throughout the field season we keep track of any marine mammal encounters (Table 4) that result from observations made during sea surveys, sea watches or opportunistically.

This season the crew was treated to some incredible Humpback whale *Megaptera novaeangliae* encounters. Humpbacks were common throughout the spring and there were numerous sightings of groups of whales feeding, displaying and on a few occasions the sounds of humpbacks could be heard echoing throughout Laskeek Bay! Our records show that we counted 203 humpback whales over the course of the field season however encounters may have been under reported because the crew became so accustomed to their presence. We were not able to get any photos of tail flukes for individual Id because whales either did not cooperate or sightings occurred from a distance, from land or during poor weather conditions.

We had four encounters with Killer whales *Orcinus orca* this season. On two occasions we spotted groups as they travelled by Limestone (four and seven individuals). Our last two encounters were boat based and provided excellent opportunities to take pictures of dorsal fins and saddle patches for individual Id.

The first boat encounter took place on 27 June when we followed two whales, one large male and one smaller individual. Towards the end of the encounter the large male was at the surface, apparently shaking as the smaller individual circled the large male. As the two whales then travelled away from the area, the crew noticed what appeared to be a rope looped around the male's dorsal fin. Once the two whales disappeared the remains of a Harbour seal floated to the surface and it then became clear that the 'rope' caught on the male's fin had in fact been a portion of the seals' intestines! Our photos identified T054 and T058, two known transient whales.

The following day on 28 June, we encountered a group of 13 Orcas that included a large bull, several smaller individuals and two juveniles. Our photos identified the group as transients: the bull was T162 and the others were T023, T023C, T023C1 (folded over dorsal fin), T023C2, T023D, T059, T059A, T059A1?, T060, T060C, T060D and T002B. Interestingly, we watched this group of mammal eating whales travel past the sea lion haul-out at Reef I. Many of the Steller sea lions *Eumetopias jubatus* became quite vocal as the whales passed by the haul-out and a number even slid in to the water and began posturing and vocalizing. The whales travelled past without incident.

Steller sea lions are commonly hauled out at Skedans and Reef I. Our highest count at Skedans was 132 individuals on 8 May and at Reef, 482 individuals on same day. We spotted one branded Steller sea lion at the Reef I. haul-out: 'F3000' branded at Forrester Island in SE Alaska.

We spotted four California sea lions *Zalophus californianus* in Laskeek Bay this season however, no more than two individuals were encountered at any given time. Sightings of California sea lions in Haida Gwaii are of interest because typically, this species is more common to our south.

Table 4
Total counts of marine mammals based on sightings in Laskeek Bay, 2002-2006. Observations were made during sea surveys, sea watches and opportunistically (note: totals do not include Harbour seals *Phoca vitulina* and Steller sea lions *Eumetopias jubatus*

Species (common name)	Scientific name	2007	2006	2005	2004	2003
Dall's porpoise	*Phocoenoides dalli*	0	0	1	0	0
Northern elephant seal	*Mirounga angustirostris*	0	0	0	0	1
Fin whale	*Balaenoptera physalis*	0	0	0	0	1
Grey whale	*Eschrichtius robustus*	0	1	1	1	3
Harbour porpoise	*Phocoena phocoena*	1	4	3	12	5
Humpback whale	*Megaptera novaeangliae*	203	91	15	19	152
Killer whale	*Orcinus orca*	26	4	11	13	21
Minke whale	*Balaenoptera acutorostrata*	3	1	0	2	0
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	81	365	8	0	325
California sea lion	*Zalophus californianus*	4	0	1	1	0

Wildlife Trees

Snags are decaying, standing trees that provide habitat for cavity nesting birds and each season we survey Limestone for snags with active nests (wildlife trees). We monitored 42 formerly active wildlife trees and eventually determined that eight were active (Table 6). In addition, we found five new wildlife trees for a total of 13 active trees with 14 nests, occupied by three bird species including: Red-breasted Sapsuckers *Sphyrapicus rubra* (9 nests), Chestnut-backed Chickadees *Poecile rufescens* (3 nests) Hairy Woodpeckers *Dendrocopus villosus* (2 nests). This year we did not locate any nests for Northern Flickers *Colaptes auratus* or Brown Creepers *Certhia americana*.

Table 6
Wildlife tree use in 2007. (RBSA = Red-breasted Sapsucker, CBCH = Chestnut-backed Chickadee, HAWO = Hairy Woodpecker, Ss = Sitka spruce, Hw = Western hemlock)

Tree #	Cavity Nester	Tree Species	Fledge Date
10	RBSA	Ss	16-jun
45	RBSA	Ss	26-jun
79	CBCH	Ss	4-Jun
96	CBCH	Hw	6-jun
98	RBSA	Ss	18-Jun
99	RBSA	Hw	14-Jun
106	RBSA	Ss	16-Jun
107	CBCH	Ss	16-Jun
107	RBSA	Ss	18-Jun
112	RBSA	Hw	20-Jun
113	HAWO	Ss	22-Jun
114	HAWO	Ss	10-Jun
115	RBSA	Hw	12-Jun
116	RBSA	Ss	24-Jun

NATURAL HISTORY

Bears

For the first time since LBCS has operated a field camp on Limestone, a black bear *Ursus americanus carlottae* was spotted on the island. Luckily the bear's visit to the island was brief and uneventful. After having encountered an unsuspecting volunteer at Lookout Point the bear ran away and was not seen again.

Daily Bird Checklist

We keep a daily record of birds seen or heard in the Laskeek Bay area. This year we recorded 64 different bird species and the daily maximum count was 36 species on 7 July. Some of our less common records included Green-winged Teal *Anas crecca*, Mallard *Anas platyrhynchos*, Black Scoter *Melanitta nigra*, Red-breasted Merganser *Mergus serrator*, Lesser Yellowlegs *Tringa flavipes*, Thayers Gull *Larus thayeri*, Western Gull *L. occidentalis*, Western Sandpiper *Calidris mauri,* Least Sandpiper *C. minutilla* and an American Pipit *Anthus rubescens*.

Birds of Prey

Peregrine Falcons were back on Limestone this year after a ten year hiatus. A pair of birds was active in the vicinity of the old nest site from 1 May to 4 July. However, it was difficult to confirm whether any chicks were produced because the cliff where the birds were suspected to be nesting was not easily observed.

Limestone was also home to two breeding pairs of Bald Eagles. Nest #5 located at Cassin's Tower was active for a second consecutive year and nest #7 located just east of North Cove was active for the 3rd time in four years. Activity at nest #5 was easily monitored from the ridge trail that provided open views of the growing chick which was first spotted on 23 June. In contrast, activity at nest #7 was not as easily determined and was initially inferred from alarming adults and fresh guano at base of tree. Later in the season a whole salmon (small) was found at the base of the tree and the chick was heard on 11 July. At camp shut-down on 13 July, both pairs were busy raising a single chick.

Common Ravens *Corvis corax* nested in the same tree as last year. The ravens produced two chicks that fledged on 26 May, fledging one day later than the chicks produced in 2006. We suspect that Northwestern Crows *C. caurinus* also nested on the island but we did not find any nests. Early in the season crows were active in the inaccessible cliff area adjacent to the Ridge Trail.

Plants

We keep track of bloom dates of flowering plants on Limestone by conducting regular visits to areas where flowers can persist because they are inaccessible to deer browse. We also take the opportunity to enjoy the blooms that carpet the handful of deer free islands located in Laskeek Bay, as deer free islands are a rarity in the archipelago.

Introduced Species

Black tailed deer Odocoileus hemionus

This year marked ten years since deer exclosures (20 m x 20 m) were erected at sites throughout the archipelago, including three on E.Limestone. These structures provide an interesting opportunity for visitors and volunteers to compare the difference between areas with and without deer browse and in turn, to learn about the significant impact that non-native species have on the forest understory. Researcher Steve Stockton from the Research Group on Introduced Species (RGIS) visited Limestone this season to examine how the vegetation in the exclosures has responded after ten years.

Raccoons

Raccoons can have devastating impacts on seabird colonies that have evolved no natural defense against introduced predators that target adults, chicks and eggs. This season a single raccoon was at large on Limestone throughout the Ancient Murrelet breeding season. The raccoon was responsible for digging up burrows, destroying adults, chicks and eggs causing much concern for the future of this small, peripheral colony.

CONCLUSIONS

LBCS completed our 18th field season in Laskeek Bay and thanks to all of the directors, staff, volunteers and visitors we continue to build on our unique, long-term data set initiated in 1990. In 2007 we made some significant adjustments to the visitor program and overall the changes were well received by volunteers and visiting groups. Raccoon predation could explain the decline in Ancient Murrelet numbers that we observed this year however LBCS has yet to determine whether other factors may be contributing to the downward population trend. This year's raccoon experience has highlighted the need to adopt a more preventative approach to predator control on the island. Unfortunately, the proximity of the colony to adjacent islands with raccoons means that this introduced species will continue to pose a threat to burrow nesting seabirds on Limestone. There is need for predator control to be conducted before birds arrive at the colony as well as while birds are incubating. By the time the field crew arrives at the end of April (once eggs are near hatching) raccoons that are present on the island will already have had serious impacts on prospecting birds, breeding adults and developing eggs. Ancient Murrelets are 'blue listed' by the province of British Columbia and are considered of 'special concern' by COSEWIC. The reason for these designations is because Ancient Murrelets are especially vulnerable to threats posed by introduced species, such as raccoons. Our hope is that LBCS and the province can work together to develop a plan that will ensure safe breeding habitat for burrow nesting seabirds within this Provincial Wildlife management area.

ACKNLOWLEDGEMENTS

With the generous contributions from the following groups the Laskeek Bay Conservation Society has been able to provide scientific monitoring and an outdoor educational program which raises the awareness and understanding of the marine and terrestrial ecosystesm of Haida Gwaii.

Our Funders:

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- Canadian Wildlife Service, Delta
- Canadian Wildlife Service, Ottawa
- School District #50 and the Community Links Program,
- Prince Rupert Regional Community Foundation,
- BC Hydro
- Mountain Equipment Co-op

Thanks also to the following individuals who gave generously of their time and services to the Society:

- LBCS Board of Directors for their time and effort ;
- Dr. Tony Gaston for his advice and guidance through the field season;
- Graeme Ellis (Pacific Biological Station) for providing a camera and film to document whales;
- 2007 staff and volunteers;
- Project Limestone teachers and students;
- The crew of the MV Gwaii Haanas for delivery of freight.

PIGEON GUILLEMOT NEST BOX USE AT EAST LIMESTONE ISLAND, 2001-2006

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SUMMARY

In 2001 ten Pigeon Guillemot nest boxes were installed on East Limestone Island. Each year we checked the nest boxes for breeding activity, measuring eggs and chicks if present and banding young. Birds first nested in the boxes in 2002 and the number of occupied nest boxes generally increased across years. These nest boxes will facilitate research on Pigeon Guillemots that typically nest in natural rocky crevices that are difficult monitor.

INTRODUCTION

Pigeon Guillemots (*Cepphus columba*) are common along the coastline of Haida Gwaii in spring and summer months and breeding birds occur throughout the archipelago, including East Limestone Island. Pigeon Guillemots nest in burrows typically located in rock cavities, often forming small colonies. Because nests in rocks are often difficult to access, monitoring breeding activity can be challenging. Breeding activity of Pigeon Guillemots on East Limestone was first monitored in 2001 when ten wooden nest boxes were installed at the SE corner, on the rock ledges at Look-out Point. The boxes were designed with a 7” x 8” x 30” entrance tunnel attached to a 7” x 18” x 18” nest chamber with a hatch on top. Once in place, the boxes were weighted down with rocks and lined with pebbles. The purpose of this paper is to summarize the results from Pigeon Guillemot nest box monitoring to date on East Limestone Island.

METHODS

Nest box checks occurred at the end of each field season. We checked the contents of nest boxes in July however the timing of checks varied across years according each field season schedule (Table 1). We measured length, breadth and mass for all eggs and recorded mass and wing chord for chicks. We also banded chicks that weighed more than 55 g with size 4 incoloy bands.

Table 1
Timing of Pigeon Guillemot nest box checks on East Limestone Is.

Year	Date checked
2001	~ mid July
2002	06 July
2003	02 July
2004	19 July
2005	23 July
2006	18 July

RESULTS

Pigeon Guillemots did not breed in the nest boxes in 2001 (Fig. 1), but droppings at entrances indicated that birds visited at least two of the nest boxes. At least one box has been occupied by a breeding pair every year since 2002 (range: 1-6 active per year; Fig. 1) and we first recorded the presence of chicks in 2005 (Table 2). The average egg was (± SD) 61.0 ± 2.8 mm in length, 40.5 ± 0.9 mm in breadth and 50.8 ± 3.5 g in mass. We banded eight chicks from five nest boxes in 2005 and four chicks from three boxes in 2006.

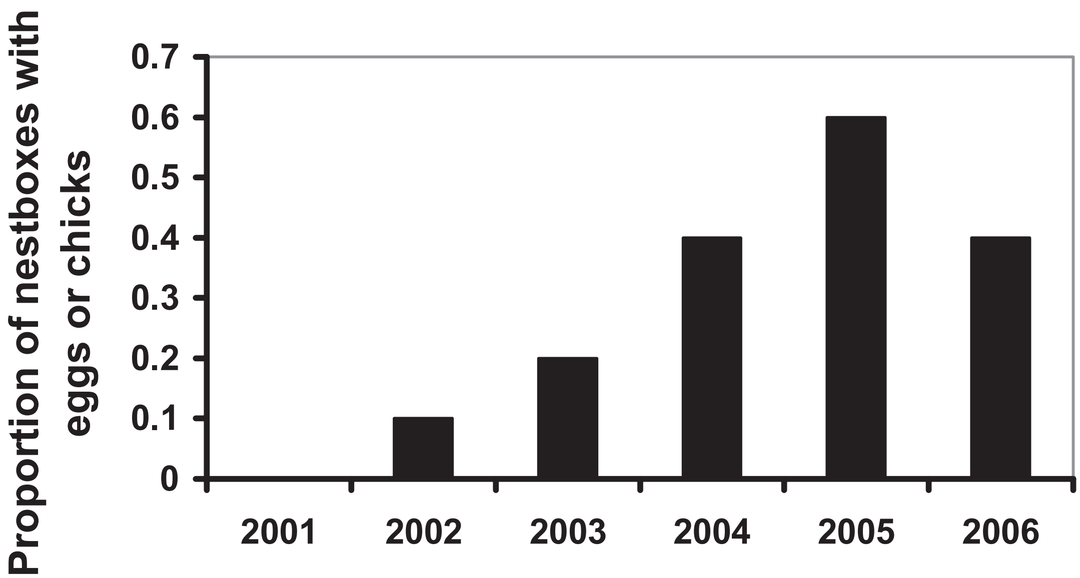

Figure 1
Proportion of Pigeon Guillemot nest boxes with eggs or chicks across years on East Limestone Is., 2001 to 2006 (n = ten nest boxes)

Table 2
Contents of Pigeon Guillemot nest boxes on East Limestone Island, 2001 to 2006
(E = egg, C = chick)

Nestbox #	2001	2002	2003	2004	2005	2006
P1	0	0	0	0	1E	0
P2	0	0	0	0	0	0
P3	0	0	0	1E	0	0
P4	0	0	0	2E	1C	1C
P5	0	0	0	0	1C	1E
P6	0	0	0	0	2C	2C
P7	0	0	0	0	0	0
P8	0	0	1E	1E	2C	0
P9	0	0	2E	1E	2C	2E
P10	0	3E	0	0	0	0

DISCUSSION

Pigeon Guillemots occupied the nest boxes within a year of installation and in general, nest box use at Lookout Pt. appears to be increasing across years. In 2006 fewer nest boxes were occupied compared to the previous year and this is likely attributed the fact that when checked in July, two boxes were unsuitable for nesting: one had a collapsed hatch and another lacked the gravel lining necessary for birds to form a shallow scrape.

The fact that birds are using the nest boxes might indicate that suitable nest sites are limited on East Limestone as nest site availability is considered to be an important factor affecting the size of some breeding populations (Ewins 1993).

In conclusion, the success of Pigeon Guillemot nest boxes on East Limestone is promising because these cavity nesting birds can be challenging to access and consequently difficult to study.

REFERENCES

Ewins, P. J. 1999. Pigeon Guillemot (*Cepphus columba*). In The Birds of North America, No. 49. (A.Poole and F.Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington D.C.: The American Ornithologists Union.

BLACK OYSTERCATCHER BANDING IN LASKEEK BAY, 1992-2006

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SUMMARY

Re-sighting information from marked populations can provide valuable insights in to the life history of species. Laskeek Bay Conservation Society has been banding Black Oystercatchers since 1992. To date 218 chicks and eight adults have been banded, resulting in 90 reports of re-sighted birds. This long-term study has shown that birds are pairing up and occupying territories as early as three years old, age at first breeding is between four and five years and the oldest known age breeders are twelve years old. By continuing to band and re-sight Black Oystercatchers during the field season, LBCS will help to build a better understanding of the life history characteristics of this bird.

INTRODUCTION AND METHODS

Laskeek Bay Conservation Society (LBCS) has monitored Black Oystercatchers (*Haematopus bachmani*) in Laskeek Bay since 1992. Each year breeding pairs are located, reproductive success is determined and chicks that weigh more than 100 g are banded. In addition to standard metal bands, all chicks receive two colour bands: one on the left leg indicating the general location banded and one on the right leg indicating year banded. During all territory surveys it is determined whether or not adults are banded and if so, the colour band combinations are recorded. In 2004 the survey area was expanded to include breeding territories in the north eastern section of Gwaii Haanas National Park Reserve and Haida Heritage Site (Gwaii Haanas). This report outlines some of the results of banding efforts from1992-2006.

RESULTS

Since 1992 the LBCS crew has banded 218 Black Oystercatcher chicks. A total of 154 of these chicks were banded in Laskeek Bay, averaging (SD) 10.3 ± 6.5 birds banded per year (Figure 1). From 2004 to 2006, 64 chicks were banded in the extended survey area in Gwaii Haanas averaging (SD) 28.7 ± 1.5 birds banded per year. In addition to chicks, eight adults have been banded in Laskeek Bay (2000: 7 adults, 2001: 1 adult) as part of a study conducted by grad student S. Hazlitt from Simon Fraser University.

The first reports of re-sighted banded birds (re-sights) occurred in 1994, two years after the banding programme started. Since then, a total of 90 re-sights have been reported averaging (SD) 5.5 ± 5.4 reports per year. After 2000 the number of re-sights per year increased (Figure 1) averaging (SD) 11.5 ± 2.1 from 2001 to 2006.

Based on re-sight data we have determined that the youngest known age birds to pair up and occupy a breeding territory are three years old and the youngest known age breeders in Laskeek Bay are between four and five years old. To date the oldest known age birds that we have observed breeding were each twelve years old, banded as chicks in 1994, breeding at South Low Island and Skedans Islands in 2006.

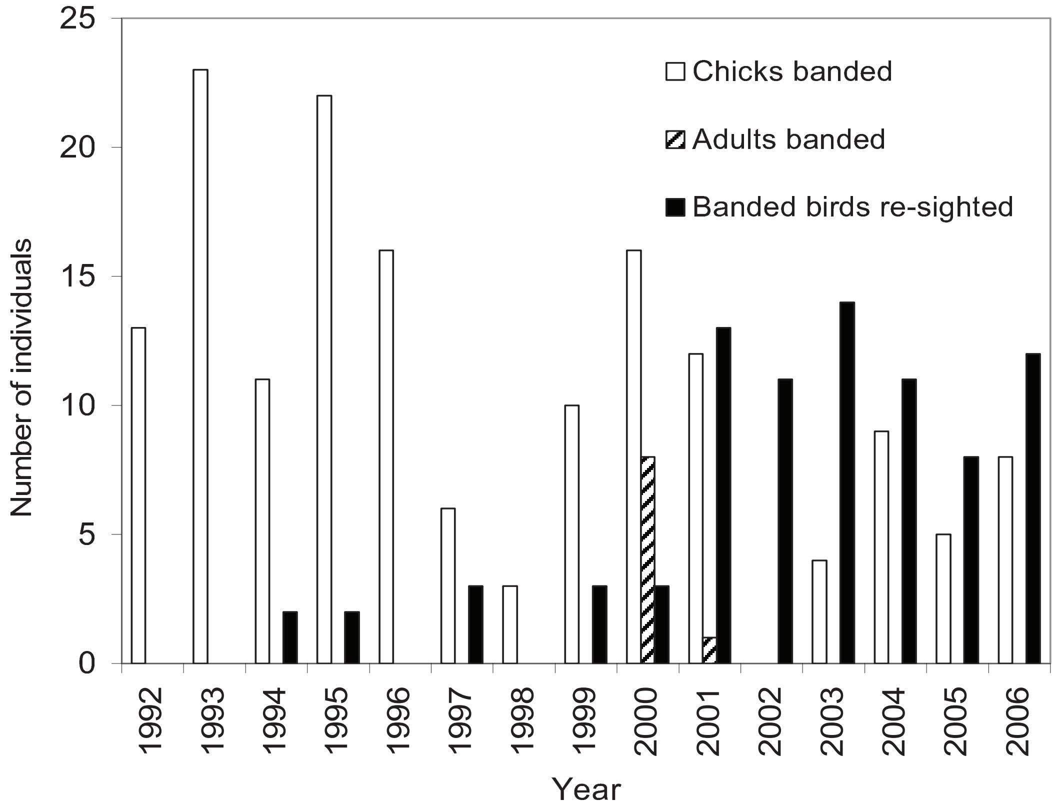

Fig. 2
Number of Black Oystercatchers banded and re-sighted from 1992 to 2006

DISCUSSION

Natural mortality rates for juvenile birds are suspected to be high (Hazlitt and Gaston 2002) meaning that only a small percentage of birds banded as chicks survive to be re-sighted and this would explain why more birds are not re-sighted each year (given that 218 chicks have been banded).

The increase in the number of re-sights following 2000 can be attributed to adult banding efforts in that year. Black Oystercatchers demonstrate philopatry (tendency of an individual to return to, or stay in, an area) to breeding sites (Andres and Falxa 1995, Hazlitt and Butler 2001) so marked breeders would be expected return to occupy the same territories year after year and be re-sighted.

Information on juvenile dispersal is lacking although this long-term study has shown that Black Oystercatchers exhibit a certain degree of natal philopatry (5% of chicks; Hazlitt and Gaston 2002). During the three years of monitoring in Gwaii Haanas no re-sights were reported. The lack of re-sights of birds banded as chicks in this region (with unique colour combinations for Gwaii Haanas) leads us to the question: where do the sub-adults go? Follow up surveys in years to come may provide information on the dispersal of these young birds

Overall, the Black Oystercatcher banding programme at LBCS has been very successful and the results presented here highlight how marking and re-sighting birds can help contribute to our understanding of Black Oystercatcher life history and population demographics.

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REFERENCES

Andres, B.A. & G.A Falxa. 1995. Black Oystercatcher (*Haematopus bachmani*). No. 155 *in* The Birds of North America. Ed. A. Poole and F. Gill. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists Union, Washington, D.C.

Gaston A. & K. Heise. 1994. Black Oystercatchers. Laskeek Bay Research 4: 49-53.

Hazlitt, S.L. & A.J. Gaston. 2002. Black Oystercatcher natal philopatry in the Queen Charlotte Islands, British Columbia. Wilson Bulletin 114:520-522.

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

Smith, A. 1995. Diet of Black Oystercatcher chicks at East Limestone Island. Laskeek Bay Research 5: 55-64.

Hazlitt, S.L. and R.W. Butler. 2001. Site fidelity and reproductive success of Black Oystercatchers in British Columbia. Waterbirds 24:203-207.

CHANGES IN NUMBERS AND BREEDING BIOLOGY OF ANCIENT MURRELETS AT EAST LIMESTONE ISLAND, 1990-2006

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SUMMARY

During 1990-2006, Ancient Murrelet chicks were trapped at East Limestone Island while departing to sea, using a standard trapping method carried on throughout the departure period. Numbers of chicks trapped declined during 1990-1995, probably due to raccoon predation, increased slightly from 1995-2000 and since then have declined again. Declines during 1992-2000 were greater than elsewhere at two funnels where disturbance from adult trapping and burrow inspections was highest. Declines after 2000 were similar at all but one funnel. The first chicks departed between 7-12 May, peak numbers were trapped between 16-26 May, median departure varied between 19-27 May and the last date of trapping between 1-22 June. The total duration of the departure period ranged from 23-42 days. The date of last departure was significantly more variable than dates of first or median departure. The date of first departures, which has varied by only 6 d over the study period, has shown no trend. However, when the strong ENSO year of 1998 was excluded from the analyses, median dates of departure and dates of peak departures both show trends that suggest they are becoming earlier, although neither was significant. Last departures have been significantly earlier since 2002. Reproductive success was 30% lower during 2000-2003 than in earlier years, mainly due to an increase in desertions. Information is lacking since 2003. The proportion of non-breeders in a sample of adult birds trapped at night after the beginning of chick departures declined from a mean of 76% during 1992-2000 to a mean of 48% in 2001-2003. Likewise, counts on the gathering grounds were more or less constant over the period of chick departures (8 May – 20 June) during 1990-1999, but showed a significant decrease over the departure period after 1999. The general population decline after 2000 may be related to diminished recruitment to the colony, as evidenced by the lower proportion of non-breeders in the trapped sample and the lower number of birds counted on the gathering grounds late in the season.

INTRODUCTION

The Ancient Murrelet *Synthliboramphus antiquus* breeds in Canada only in the islands of Haida Gwaii (Queen Charlotte Islands). This archipelago supports about 50% of the world population (Gaston 1994). Monitoring of breeding population in Haida Gwaii has been carried out for the past two decades at several colonies, mainly through periodic line-transect censuses, or by counting burrows in demarcated study plots (Rodway *et al.* 1988, Lemon ..). More intensive monitoring of a variety of breeding biology parameters and population indices has been carried out by the Laskeek Bay Conservation Society at East Limestone Island, in Laskeek Bay, since 1990.

During the period since the Laskeek Bay Conservation Society began operations at East Limestone Island (1990-2006), Ancient Murrelet chicks have been trapped throughout the period when they depart from the colony. As trapping methods have remained constant, these records give comparable measurements of numbers and dates of departure for the East Limestone Island population over a 17-year period. In this paper, I review the information obtained and discuss the evidence that it provides for population trends and for changes in timing of breeding for the colony. I also present data on the breeding success of a sample of pairs during 1991-2003, on the proportion of non-breeding birds visiting the colony, and on numbers of birds recorded during evening counts of the gathering grounds situated to the east of the island. Comparable information for some of those parameters is available for the period 1984-1989 from studies at the adjacent colony on Reef Island (Gaston 1990, 1992). These observations contribute to a general understanding of changes observed during the study period.

Non-breeding birds generally attend the colony in their second and third years to assess and select breeding sites for their first nesting attempt (at 3 or 4 years; Gaston 1990). During the 1980s at Reef Island non-breeders attended the colony irregularly between early May and late June (Jones *et al*. 1990). A similar pattern was observed at East Limestone Island in the 1990s, based on the proportion of non-breeders trapped. However, from 2002 onwards, numbers of adult birds trapped in flight nets (see methods) after the period of peak chick departures fell sharply. This and other evidence that points to changes in the timing of colony attendance by pre-breeding birds are presented and discussed.

METHODS

Chick captures

Chicks were trapped annually using plastic fences to funnel the departing chicks to trapping stations near the shore, where they were weighed, banded and released to the sea (Gaston 1992, 2003). Six funnels were used in each year (Fig. 1), four situated along the North Cove coast (1-4), one beside the cabin (5) and one in Spring Valley (6). Dates of trapping in each year are given by Rock and Pattison (2006). Chicks were trapped from the time of first departures (22.30-23.00, depending on date) to 02.30 h. Up to 1995, trapping extended until dawn and in those years 94% +/- 3% (S.D.) were captured before 02.30 h. At the end of the season trapping ceased after the first night when no chicks were trapped.

The years of observation were divided into four periods. (1) 1990-92, (2) 1992-1995, (3) 1995-2000 and (4) 2000-2006. In 1991, raccoon *Procyon lotor* predation on adult birds at East Limestone Island was heavy

(Hartman *et al*. 1997). An abrupt reduction in chick departures in 1991, compared with 1990, was probably associated with this predation. Likewise, the steep increase in 1992 is assumed to represent a recovery, as pairs that had failed in 1991 because of raccoon disturbance, returned to normal levels of reproductive success: hence the exclusion of 1990 and 1991 for most analyses. Raccoon predation continued at a lower level until at least 1994, after which raccoons seem to have been absent in all years except 2001 and possibly 2002 (LBCS data). 1995 was taken to represent the start of the raccoon-free period. In 1998, a strong ENSO event was followed by a strong La Nina (cold phase of ENSO) event in 1999 (Gaston & Smith 2000). The fluctuating environmental conditions associated with these events, which had a significant effect on Ancient Murrelet reproduction at East Limestone Island (Gaston & Smith 2000) stabilized by 2000.

Adult captures

During the period from 1990 – 2003, adult Ancient Murrelets were captured during the night after 20 May, by which time chick departures had begun in all years. In 1990-1994, trapping was conducted by locating birds on the surface with a flashlight or headlight and catching them with hand-held dip nets. From 1995, large plastic flight nets, reaching from the ground to about 6 m high were used to intercept birds departing from the colony from 02.30 h onwards, until dawn. Some birds were also caught with dip nets in 1995, but from 1996-2003 all adults sampled were caught with flight nets, more than 95% while departing from the colony.

Reproductive success

Following the departure of chicks in 1990, a sample of burrows in the vicinity of funnels 5 and 6 was inspected for signs of occupation (egg shells or membranes). Occupied burrows were numbered and marked for relocation. In succeeding years, the burrow sample was checked daily from 5 April onwards to detect the presence of eggs.

Ancient Murrelets leave the first egg unattended for 7-8 d before laying the second, after which the clutch is incubated more or less continuously (Gaston 1992). Once the first egg was laid a temperature probe was inserted into the nest chamber so that the progress of incubation could be monitored. After 30 d (normal incubation period for Ancient Murrelet, Gaston 1992), the burrow was inspected, the contents noted and the adult and chick(s) banded. The burrow was then inspected daily until chicks departed, usually within 2 d. Reproductive success was measured as the number of chicks departing per burrow where at least one egg was laid.

Breeding failure most often occurred owing to desertion of the clutch. Clutches not being incubated 38 d after the laying of the first egg were removed. The proportion of clutches deserted was also used as a measure of reproductive success.

Gathering ground counts

Numbers of birds attending the gathering grounds adjacent to the colony each night were monitored by means of a ten-minute count two hours before sunset of all birds seen flying through the field of a 25x telescope pointed directly at the Low Island light and centred with the horizon 1/3 of the way from the top of the field. We counted flying birds only, as the visibility of birds sitting on the water was affected much more by sea state than sightings of those in flight.

Figure 1
Photo of East Limestone Island showing the position of the chick trapping funnels (numbers 1-6)

RESULTS

Trends in numbers

The highest number of chicks was trapped in 1990, the first year of operation, and the lowest in 2004 (Fig. 2). Overall, there was a negative trend of numbers with year (adjusted $R^2 = 0.46$, $P = 0.002$). Taking the period from 1992, trends were downwards for all capture funnels and significantly negative for funnels 2, 5 and 6 (Table 1). When 1990 and 1991, the years affected by heavy raccoon predation, were excluded, trends remained negative for total numbers and for all funnels except #1 (again, significant for funnels 2, 5 and 6). The decrease between 1992-2006 was highest at funnel 5 (Cabin, -53%) and lowest at funnel 1 (-5%).

Inspection of Figures 3 and 4 suggests that trends in numbers of chicks departing differed among the four periods initially defined: (1) the period of heavy raccoon disruption in 1990-1992 was associated with an overall decrease of 22% (-11.6% annually) and negative tends at all but funnel 1; (2) the period of lower raccoon disturbance between 1992-1995 saw a further 18% reduction (-6.4% annual), with zero or negative trends at all funnels; (3) the period from1995-2000 was associated with increases at all funnels (total 14% increase; 2.6% annually), although increases were smaller at funnels 5 and 6 than elsewhere; (4) from 2000-2006 numbers decreased at all funnels except funnel 1. The total number of chicks departing decreased by less than 1% annually during 1992-2000, but decreased by 4.5% annually after 2000.

Table 1
Results of regression analyses for numbers trapped on year, including and excluding 1990 and 1991

Funnel	All years				Years from 1992-2006			
	B	F (1,15)	Adjusted R2	P	B	F (1,13)	Adjusted R2	P
1	0.57	1.61		>0.1	0.08	0.08		>0.1
2	-0.63	9.80	0.35	0.01	-0.75	16.92	0.53	0.001
3	-0.30	1.53		>0.1	-0.17	0.39		>0.1
4	-0.41	3.08		0.10	-0.43	3.00		>0.1
5	-0.86	44.54	0.73	<0.001	-0.89	48.01	0.77	<0.001
6	-0.81	29.17	0.64	<0.001	-0.83	28.56	0.66	<0.001
Total	-0.70	14.59	0.46	0.002	-0.78	19.89	0.57	<0.001

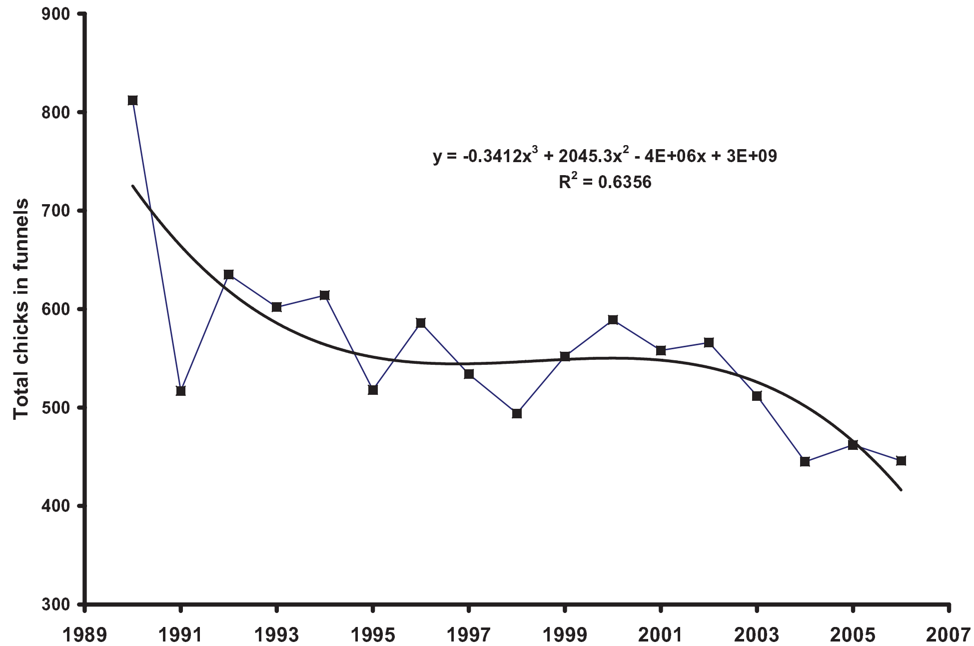

Figure 2
Total chicks captured in funnels before 02.30 h, 1990-2006

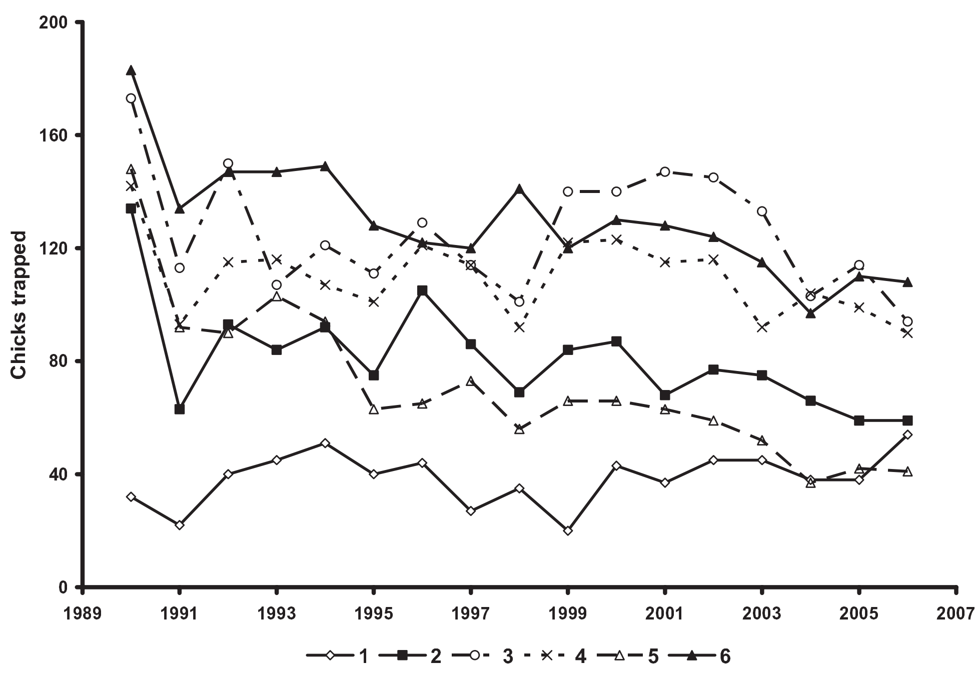

Figure 3
Trends for individual funnels: N. Cove funnels, dashed lines; Cabin (5) and Spring Valley (6) funnels, solid lines

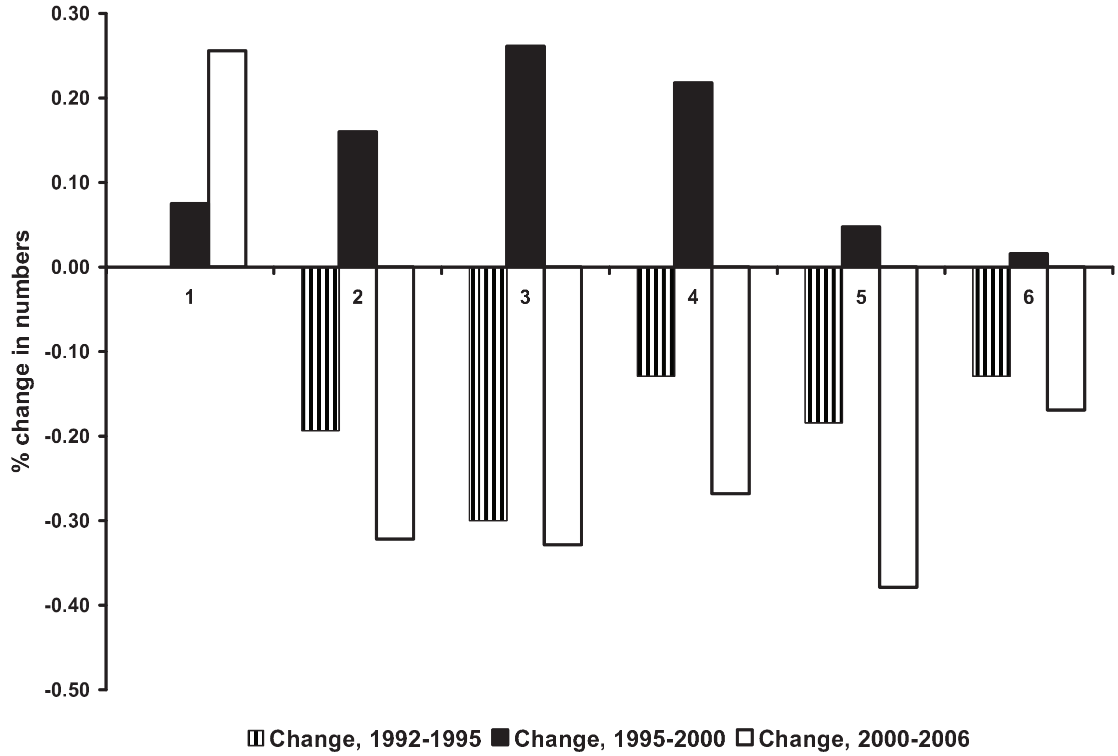

Figure 4
Change in numbers of chicks departing each funnel between 1992-1995, 1995-2000 and 2000-2006, as a proportion of the numbers in the initial year

Reproductive success

We monitored 12-29 active burrows each year between 1991 and 2003 (Table 2). The number of chicks departing per occupied nest declined significantly over the study period (adjusted $R^2 = 0.38$, $P = 0.01$) while the number of clutches deserted rose (adjusted $R^2 = 0.45$, $P < 0.01$). During 1991-1999 the number of chicks departing per nest averaged 1.49 ± 0.25 chicks without any clear trend (1.57 ± 0.11 if the ENSO year of 1998 is omitted). From 2000-2003 the average was 1.10 ± 0.15 chicks/nest. Hence, reproductive success during 2000-2003 averaged only about 70% of the level characteristic of the preceding decade.

Comparison with similar data collected at Reef Island in 1984-1989 (Gaston 1992) suggests that reproductive success at East Limestone Island during 1991-1999 was similar to that at Reef Island, but during 2000-2003 it was generally lower (Figs 5, 6).

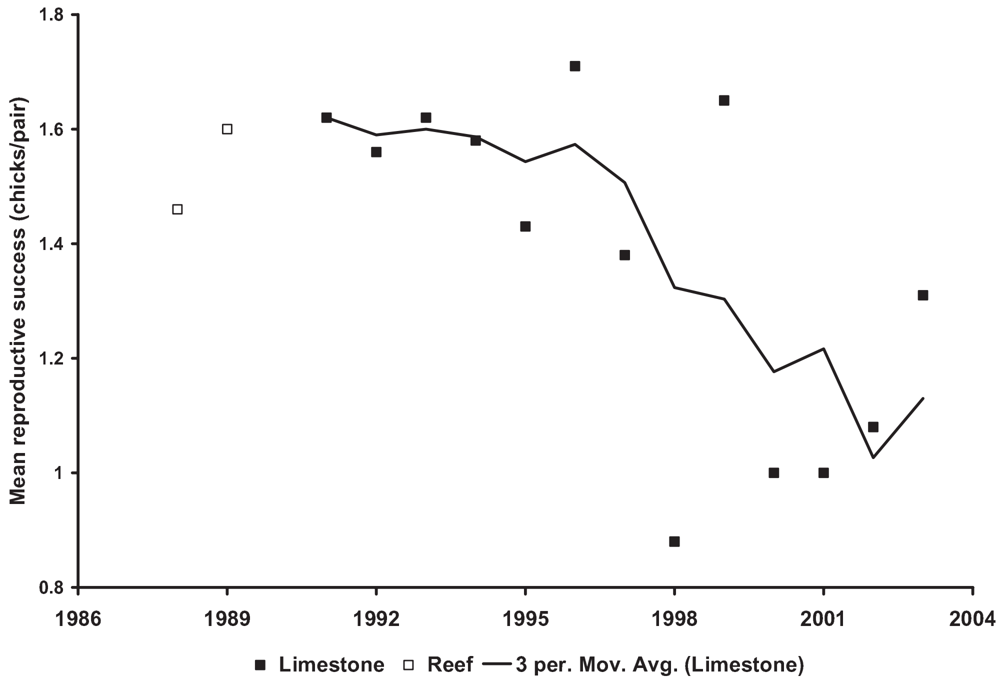

Figure 5
Mean reproductive success at Reef and East Limestone islands during 1988-2003

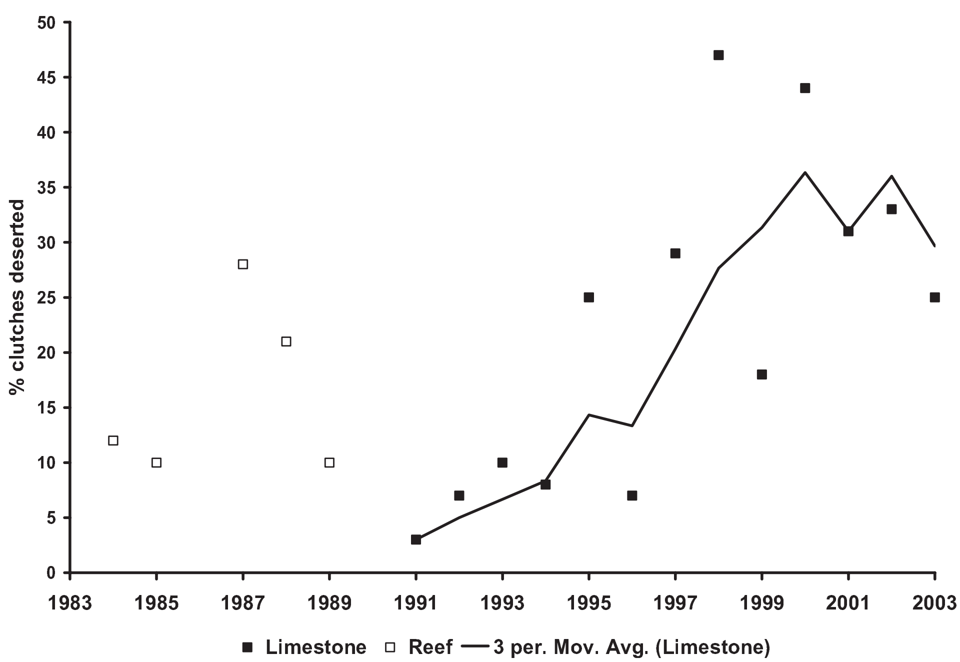

Figure 6
Proportion of clutches deserted at Reef and East Limestone islands during 1987-2003

Non-breeding adults in the trapped sample

Although the method of trapping changed between 1992 and 2000, there was little evidence of a change in the proportion of non-breeders among adults trapped until 2001, when the proportion fell to 42%, only a little over half the average for the preceding nine years (Fig. 7). The general trend was negative (r_{11} = -0.76, P = 0.004).

Table 2
Results of monitoring reproductive success at study burrows on East Limestone Island, 1991-2003

Burrows	Number monitored	Number occupied	Fledged 2 chicks	Fledged 1 chick	Deserted prior to full term	Chicks/nest
1984	--	51			6 (12%)	
1985	--	63			6 (10%)	
1987	--	47			13 (28%)	
1988	--	39	29 (74%)	2 (5%)	8 (21%)	1.46
1989	--	49	36 (73%)	8 (17%)	5 (10%)	1.60
1991	45	29	19 (66%)	9 (31%)	1 (3%)	1.62
1992	50	27	17 (63%)	8 (30%)	2 (7%)	1.56
1993	65	29	21 (72%)	5 (18%)	3 (10%)	1.62
1994	83	26	17 (65%)	7 (27%)	2 (8%)	1.58
1995	89	28	19 (68%)	2 (7%)	7 (25%)	1.43
1996	89	28	22 (79%)	4 (14%)	2 (7%)	1.71
1997	72	21	14 (67%)	1 (5%)	6 (29%)	1.38
1998	62	17	6 (35%)	3 (18%)	8 (47%)	0.88
1999	86	17	14 (82%)	0 (0%)	3 (18%)	1.65
2000	75	18	8 (44%)	2 (11%)	8 (44%)	1.00
2001	75	13	4 (31%)	5 (38%)	4 (31%)	1.00
2002	52	12	5 (41%)	3 (26%)	4 (33%)	1.08
2003	53	16	9 (56%)	3 (19%)	4 (25%)	1.31

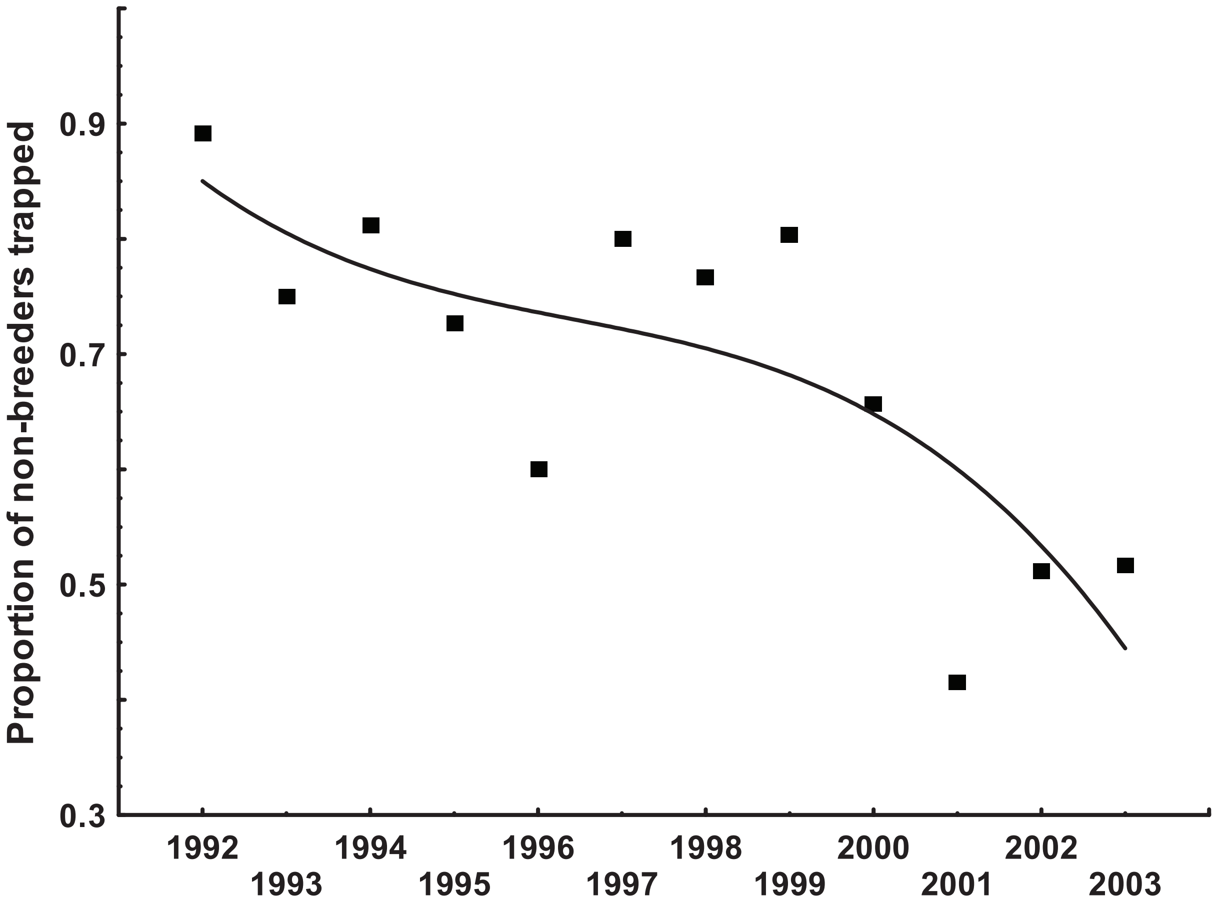

Figure 7
Proportion of non-breeders among all adults captured. Fitted line is a cubic polynomial

Dates of departure

The earliest date of first departure was observed in 1994, on 7 May and the latest on 12 May, recorded in 1990 and 1992. Median dates of departure ranged from 19 May in 2004 to 27 May in 1997, while dates of peak numbers varied from 16 May in 2004 to 26 May in 1991. Dates of last chick departures were much more variable, ranging from 2 June in 2004 to 22 June in 1998. The variance in dates of last departure was significantly higher than the variance in dates of first departures (28.6 days vs 2.7 days; Levene's F = 12.10, $P = 0.002$; Fig. 8). In pairwise comparisons, only median and peak dates were significantly correlated ($R^2 = 0.50$, $P < 0.01$). All of the information on timing (first, peak, median and last departures), showed slight trends towards becoming earlier, but none of the linear trends was significant (Fig. 9). Despite the lack of overall trends, the dates of last departures recorded from 2002 onwards are all earlier than in any of the preceding nine years.

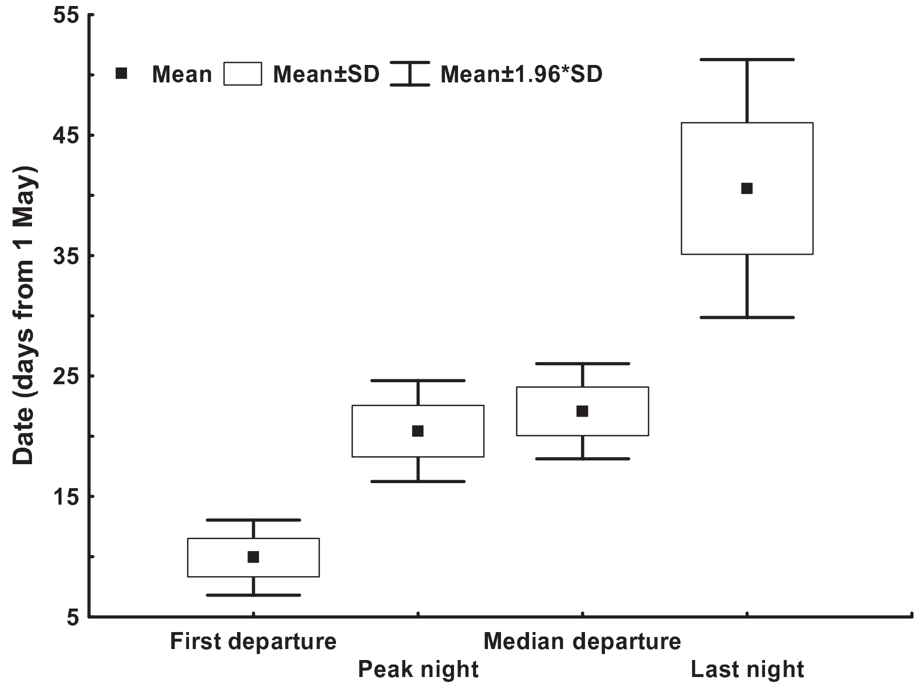

Figure 8
Mean dates of first, peak, median and last chick departures from East Limestone Island during 1990-2005

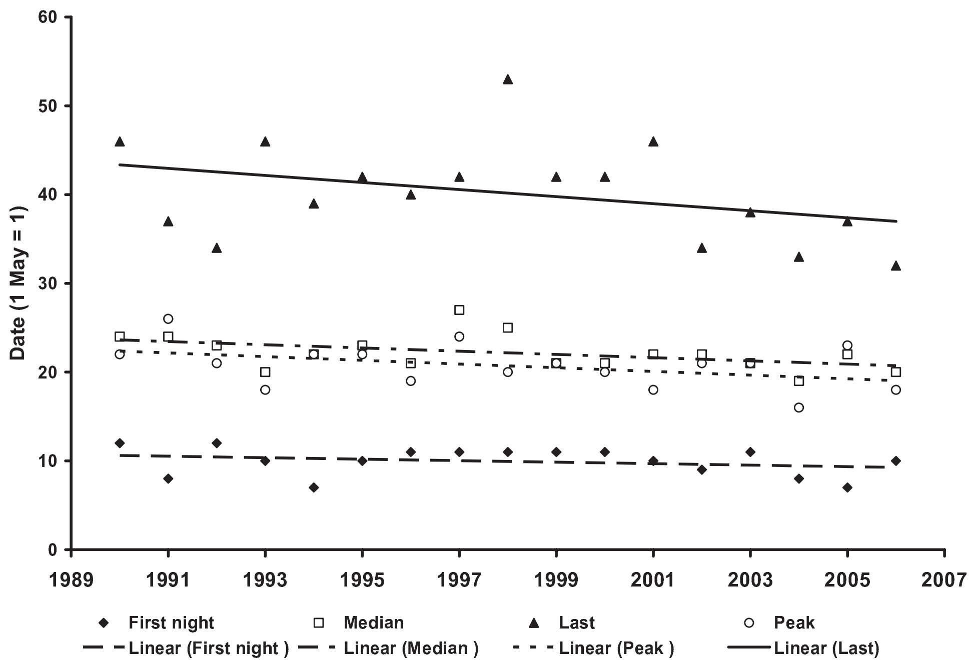

Figure 9
Dates of first, peak, median and last departures by Ancient Murrelet chicks at East Limestone Island, 1990-2006

Gathering ground counts

Evening counts of birds flying over the gathering grounds during 8 May – 20 June (approximate limits of the chick departure period) ranged up to 478 birds, with annual mean counts ranging from 26 (2003) to 157 (1999). After applying Bonferroni corrections, significant trends of counts with date were evident only in 1998 (negative) and 1999 (positive, Fig. 10). Desertion of nests was higher in 1998 than other years (Table 2) suggesting that feeding conditions during this strong ENSO year were poor during incubation (Gaston and Smith 2001). When years were averaged for the periods 1990-1999 and 2000-2006 there was no trend of mean count on date for the 1990s, but a significant negative trend was apparent for the 2000s ($r_{44} = -0.31$, $P = 0.04$; Fig. 12).

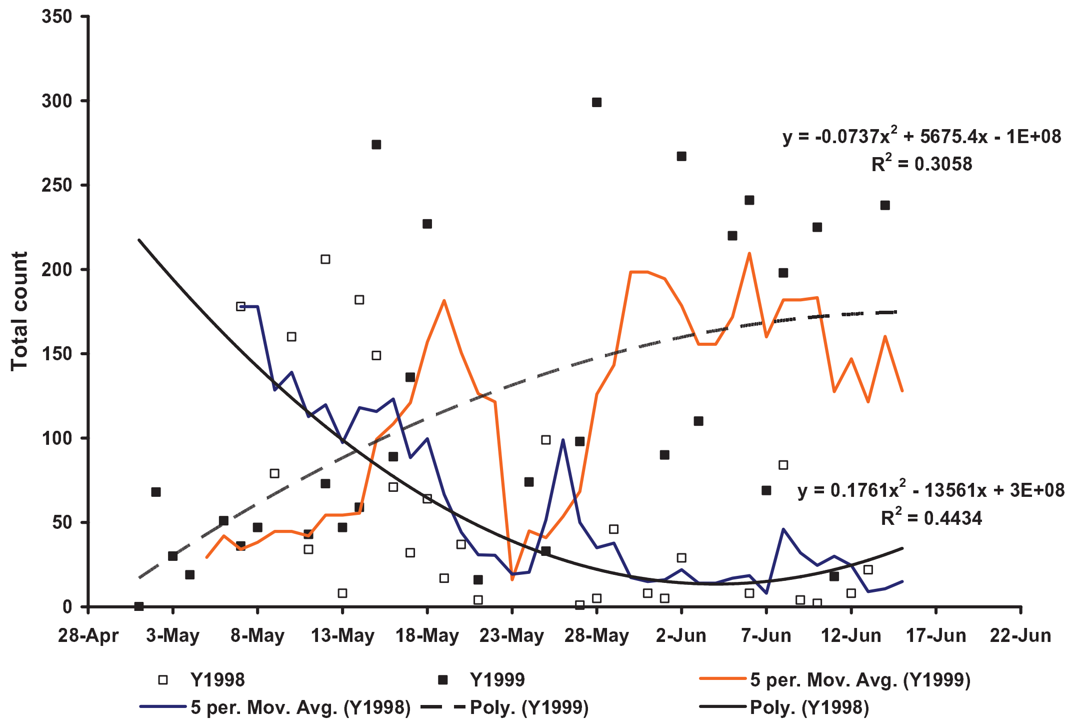

Figure 10

Gathering ground counts from East Limestone Island in relation to date for 1998 (ENSO) and 1999 (La Niña)

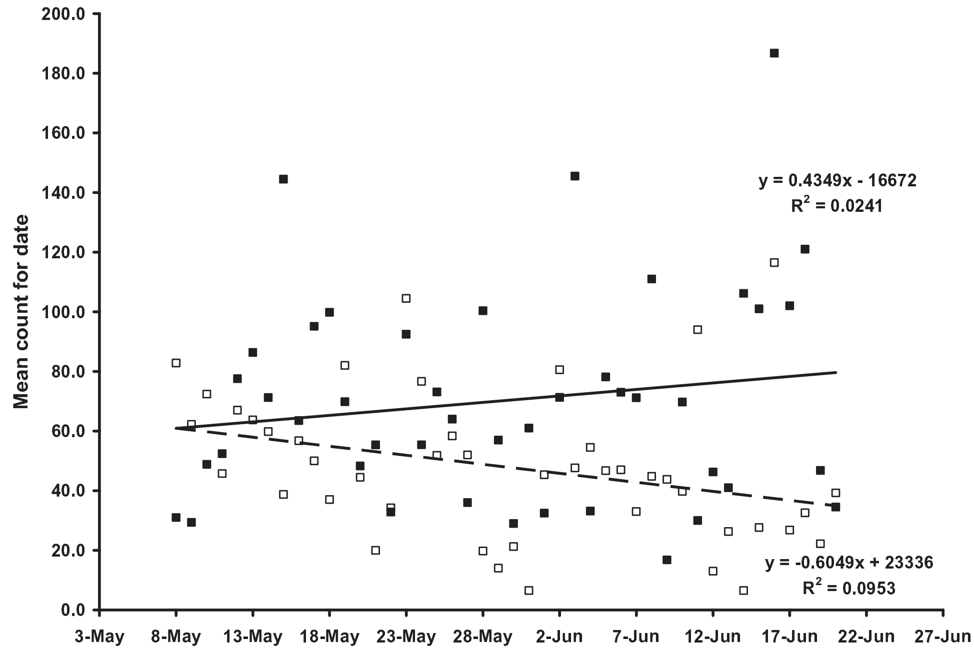

Figure 11
Mean counts by date for 1990-1999 (solid symbols, line) and 2000-2006 (open symbols, dashed line)

DISCUSSION

The four time periods identified at the outset seem to be associated with different trends in the numbers of chicks captured in the trapping funnels at East Limestone Island. After the expected, and previously documented, decline between 1990 and 1992 (Hartman et al. 1997), numbers continued to decline, at a slower pace, until 1995. After that there was a small recovery up to 2002. There was then a sharp drop in 2003 and 2004 and no recovery was apparent up to 2006 (Fig. 2). Losses before 1995 (the raccoon period) were highest at North Cove funnels 2 and 3. The persistent decline after the major raccoon eradication in 1992 may have been due to continued low-level disturbance by raccoons, or to a lack of recruiting breeders of the 3-4 year age classes, discouraged as 2-year olds by the major raccoon disturbance in 1991.

During the period of partial recovery from 1995-2000, increases were greatest at funnels 2-4 and lowest (almost non-existent) at funnels 5 (Cabin) and 6 (Spring Valley). The area from which chicks would have originated at the latter two funnels was subject to disturbance by burrow inspections throughout that period. In addition, adult trapping, initially by dip-netting and later by flight nets, was also carried out in the catchment area of those funnels. At the North Cove, a flight net was deployed, but on the beach outside the forest and the catching rate, relative to the number of burrows involved, was lower than at the Cabin and Spring Valley sites. Probably only funnels 2 and 3 would have been affected by the North Cove net.

Because, up to 2003, the catchment areas of funnels 5 and 6 were subject to greater disturbance than those of the other (North Cove) funnels, we must consider the possibility that our research activities may have caused part of the ongoing decline in chick production. This possibility was the reason why burrow inspections and the use of flight nets were terminated in 2003. However, the evidence for research effects was not consistent. A difference in trend between funnels 5 and 6 and the rest was clear only during 1995-2000. During the preceding and following periods, losses at funnels 5 and 6 were not obviously different from those at the other funnels.

The decline in chick captures during 2000-2006, especially, was not confined to Cabin and Spring Valley, but was seen at all funnels except #1. This trend was accompanied, from 2000-2003, by a reduction in the proportion of non-breeding birds among the sample of adults trapped after 20 May (Fig. 7) and a reduction in the numbers counted on the gathering ground after 1999 (Fig. 11). It is likely that non-breeders trapped at the end of the breeding season and those present on the gathering grounds in June are mainly birds prospecting breeding sites for the following year. Hence a reduction in the proportion of prospectors is likely to be a precursor to a reduction in the recruitment of breeders: that is exactly what we observed. Anecdotal observations of a sharp decrease in the level of vocalisations at night after 2001 (LBCS unpublished) also support this hypothesis. In addition, as first-time breeders generally lay later than experienced birds, a hypothesis of reduced recruitment is supported by the earlier cessation of chick departures in recent years (Fig. 10).

Reproductive success in study burrows remained fairly constant or fell slightly during 1991-1997, during which period it was similar to observations at Reef Island in the 1980s. It fell sharply in response to the 1998 ENSO event and recovered in 1999. From 2000-2003 it was 30% lower than during earlier non-ENSO years. Data were not available after 2003. The reduction in reproductive success seems to have been caused principally by an increase in desertions, suggesting either than feeding conditions were poor, so that birds could not maintain a normal incubation schedule, or that predation on breeding adults had increased. The apparent rebound in 2003 is difficult to evaluate, as the sample of occupied burrows was very small by that time, as it was from 1998 onwards. Reduced reproductive success at East Limestone Island also may have contributed to the lower numbers of recruits attending the colony after 2000.

For many marine birds, timing of egg laying is an important indicator of environmental conditions. Birds tend to lay earlier in years when conditions for feeding are good and to delay laying in years when they are bad (Birkhead & Harris, 1985, Ainley & Boekelheide 1990). Generally, experienced breeders lay before inexperienced breeders (de Forest & Gaston 1996). Consequently, dates of laying tend to be skewed, with the date of peak laying coming before the mean date (e.g. Ainley & Boekelheide 1990). For the same reason, a declining population, with little recruitment, may tend to breed more synchronously than expanding populations where there are many first-time breeders.

The timing of breeding of Ancient Murrelets at East Limestone Island has shifted relatively little over the 17 years of the study. The date of first egg-laying, as manifested by the earliest chick departures, varied by only six days during the study and there was no significant trend. As conditions for breeding varied substantially from year to year, especially in the case of the ENSO year of 1998 (Gaston and Smith 2001), the inflexibility of first laying dates suggests that the timing of laying is determined by intrinsic factors, rather than responding to environmental conditions. Conversely, there was much greater variation in dates of last departures (spread of 21 d), suggesting that, although the earliest laying was determined intrinsically, later laying may have been affected by environmental conditions, so that not all females managed to lay at the optimum date. The earlier dates of last departure recorded since 2002 seem to support the idea that recruitment may have been reduced over that period.

CONCLUSIONS

The total number of Ancient Murrelet chicks leaving the colony at East Limestone Island decreased by 45% between 1990-2006. Losses during the early 1990s were probably attributable to raccoon predation and disturbance. It is possible that during a period of partial recovery between 1995-2000 research activities may have been responsible for some reductions. However, after 2000, and especially after 2002, the observed declines were accompanied by reductions in reproductive success, in the attendance of prospecting birds, in an advance in the date at which the last chicks of the season were captured and in a reduction in numbers counted on the gathering grounds in the later part of the season. All these observations suggest that declines after 2000 had a different cause from earlier declines, probably a consequence of reduction in recruitment to the breeding population. As research activities at night have been substantially reduced since 2003, it appears that the change in prospecting must be related either to changes taking place away from the colony (e.g. availability of food), or to increased predator activity, for which some evidence is provided by Lemon (this volume).

Changes to LBCS research and future recommendations

After 2003 the Laskeek Bay Conservation Society directors decided that, in view of the overall downward trend in the numbers of Ancient Murrelet chicks trapped, burrow inspections and adult trapping should be discontinued. A recent workshop of researchers and LBCS directors concluded that the following steps should be taken from 2007 onwards until such time as a population recovery is clearly indicated:

(1) the current moratorium on burrow inspections and adult trapping should continue;
(2) all disturbance to the North Cove area during the Ancient Murrelet breeding season, will be eliminated by discontinuing the chick trapping there and keeping the area out of bounds to all visitors and researchers;
(3) there will be a moratorium on night-time visits by tour boats;
(4) visits by school parties will be re-arranged to eliminate the need for lights in the colony area during the period when Ancient Murrelets are active on the surface;
(5) the daytime monitoring of predation, carried out during the early 1990s be reinstated;
(6) parallel investigations will be undertaken at Reef Island to ascertain whether some of the trends evident at the East Limestone Island colony are detectable there also and hence form part of a regional pattern.

REFERENCES

Ainley, D.G. & Boekelheide, R.J. 1990. Seabirds of the Farallon Islands. Stanford University Press, Stanford, CA.

Birkhead, T.R. & Harris, M.P. 1985. Ecological adaptations for breeding in the Atlantic Alcidae. Pp. 205-232 in The Atlantic Alcidae. Academic Press, London.

De Forest, L.N. & Gaston, A.J. 1996. The effect of age and timing of breeding on reproductive success in the Thick-billed Murre. Ecology 77: 1501-1511.

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

Gaston, A.J. 1992. The Ancient Murrelet. T. & A.D. Poyser, London. 249 pp.

Gaston, A.J. 1994. Status of the Ancient Murrelet, *Synthliboramphus antiquus*, in Canada and the effects of introduced predators. Canadian Field-Naturalist 108: 211-222.

Gaston, A.J. 2003. Influence of chick mass and date of departure from the colony on adult characteristics in a precocial seabird. Auk 120: 818-826.

Gaston, A.J. & Smith, J. 2001. Changes in oceanographic conditions off northern British Columbia (1983-99) and the reproduction of a marine bird: the Ancient Murrelet (*Synthliboramphus antiquus*). Canadian Journal of Zoology 79: 1735-1742.

Jones, I.L., Gaston, A.J. & Falls, J.B. 1990. Factors affecting colony attendance by ancient Murrelets (*Synthliboramphus antiquus*). Canadian Journal of Zoology 68: 433-441.

Rock, J & Pattison J. 2007. this report

OBSERVATIONS ON A COMMON RAVEN *CORVUS CORAX* NEST ON REEF ISLAND, HAIDA GWAII

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SUMMARY

During May and June 2006, I observed a pair of Common Ravens (*Corvus corax*) nesting within an Ancient Murrelet (*Synthliboramphus antiquus*) colony on Reef Island, Haida Gwaii. In 59 hours of observation over a three-week period the ravens fed their chicks primarily Ancient Murrelet adults, using trees around the nest as short-term caches between feedings. The Ancient Murrelets are burrow-nesting seabirds that are only active on the colony during dark hours, raising questions about how and when the ravens are killing their prey.

INTRODUCTION

The Ancient Murrelet has been studied on Reef Island for the past 23 years (Gaston, 1992). Throughout this period, it was thought that predation by Common Ravens was responsible for many of the Ancient Murrelet carcasses distributed throughout the study area (Gaston, personal communication). In this study I set out to test the hypothesis that Common Ravens are important predators of Ancient Murrelets: I also collected information on the diet of the Common Raven in North America, on food caching, and on territorial behavior. In addition, I report on predatory behavior, on deceptive tactics used to conceal the whereabouts of prey, and on a possible example of tool use.

REVIEW OF PREVIOUS STUDIES

The Common Raven is cited as a scavenger and opportunistic feeder (Engel & Young 1989, Harlow 1922, Heinrich 1988, Murray 1945, Nelson 1934, Stahler *et al.* 1986, Stiehl & Trautwein 1991, Temple 1974, White 2004, Wilmers *et al.* 2003), and also a predator (Gaston 1992, Kelly *et al.* 2005, Maccarone 1992, Nelson 1934, Parmelee & Parmelee 1988, Temple 1974). Raven chicks are fed a wide variety of food by both parents (Murray 1945, Engel & Young 1989, Harlow 1922). Studies of Common Raven diet in North America over the last century demonstrate its diversity in North America. Large vertebrate species, rodents, birds, reptiles and a wide selection of insects figure prominently in these studies, as well as garbage, seeds, leaves and bark. The list includes species from over 39 families of vertebrates, arthropods, and mollusks. Studies from different regions report different, but not mutually exclusive, diets, demonstrating how opportunistic this bird is in its feeding. Steil and Trautwein (1991) explain differences in Raven diet between studies by pointing to local variations in availability of different food types.

Table 1
A review of the diet of the Common Raven based on North American studies over the past century

		Region	Food type	Citation
Vegetation				
		Region	**Food type**	**Citation**
		W Virginia	American holly *(Ilex opaca)*	Harlow et al., 1975
		SW Idaho	Barley	Engel and Young, 1989
		Pennsylvania mountains, SE Oregon, W Virginia, SW Idaho	Corn	Harlow, 1922; Nelson, 1934; Harlow et al., 1975; Engel and Young, 1989;
		W Virginia	Forbs and grasses	Harlow et al., 1975
		W Virginia	Hemlock *(Tsuga canadensis)*	Harlow et al., 1975
		S California	Livestock feed	Webb et al., 2004
		SW Idaho	Oats	Engel and Young, 1989
		SW Idaho	Russian olive	Engel and Young, 1989
		Pennsylvania mountains	Tree buds	Harlow, 1922
		SW Idaho	Wheat	Engel and Young, 1989
Animal Carrion, or unknown cause of death				
	Reptiles, amphibians, fish			
		SE Oregon	Carp (*Cyrpinus carpio*)	Stiel and Trautwein, 1991
		SE Oregon, SW Idaho, Se Oregon,	Fish	Nelson, 1934; Engel and Young, 1989; Stiehl and Trautwein, 1991
		Pennsylvania mountains	Frogs	Harlow, 1922
		SE Oregon	Horned toad (*Phrynosoma* spp.)	Nelson, 1934
		SW Idaho, SE Oregon	Reptiles	Engel and Young, 1989; Stiehl and Trautwein, 1991
		SE Oregon	Sceloporus lizards	Nelson, 1934
		Pennsylvania mountains, SE Oregon	Snakes	Harlow, 1922; Nelson, 1934
		SE Oregon	Spadefoot toad (*Scaphiopus hamondii*)	Nelson, 1934
		SE Oregon	Toad (*Bufo* spp.)	Nelson, 1934
	Mammals			
		W Virginia	Bat (*Chiroptera*)	Harlow et al., 1975
		W Virginia, SW Idaho, SE Oregon	Cow (*Bos taurus*)	Harlow et al. 1975; Engel and Young, 1989; Stiehl and Trautwein, 1991
		Pennsylvania mountains, W Virginia, Taiga forest, SE Oregon	Deer	Harlow, 1922; Harlow et al., 1975; Heinrich, 1988; Stiehl and Trautwein, 1991
		Pennsylvania mountains, W Virginia	Dog	Harlow, 1922; Harlow et al., 1975
		W Virginia	Domestic sheep (*Ovis aries*)	Harlow et al., 1975
		Taiga forests, Wyoming	Elk	Heinrich, 1988; White, 2004
		W Virginia	Goat (*Capra* spp.)	Harlow et al. 1975
		W Virginia	Hog (*Sus* spp.)	Harlow et al. 1975

W Virginia	House cat (*Felis domesticus*)	Harlow et al., 1975
Taiga forests	Moose	Heinrich, 1988
SE Oregon	*Mustela*	Stiel and Trautwein, 1991
SE Oregon, W Virginia, SE Oregon	Rabbit	Nelson, 1934; Harlow et al. 1975; Stiehl and Trautwein, 1991
W Virginia	Raccoon (*Procyon lotor*)	Harlow et al., 1975
W Virginia	Striped skunk (*Mephitis mephitis*)	Harlow et al., 1975
W Virginia	Virginia oppossum (*Didelphis marsupialis*)	Harlow et al., 1975
W Virginia	Woodchuck *(Marmota monax)*	Harlow et al., 1975
Rodents		
SE Oregon	*Ammosphermophilus leucurus*	Stiel and Trautwein, 1991
SE Oregon, W Virginia	Chipmunk (*Eutamias* spp.)	Nelson, 1934; Harlow et al. 1975
SW Oregon	Cricetidae	Stiehl and Trautwein, 1991
SW Idaho	Deer Mouse (*Peromyscus* spp.)	Engel and Young, 1989
W Virginia, SW Idaho	House Mouse (*Mus musculus*)	Harlow et al. 1975; Engel and Young, 1989
SW Idaho, SE Oregon	Kangaroo Rat (*Dipodomys* spp.)	Engel and Young, 1989, Stiel and Trautwein, 1991
SE Oregon	*Lagurus curtatus*	Stiel and Trautwein, 1991
SE Oregon	*Marmota flaviventris*	Stiel and Trautwein, 1991
W Virginia	Mole (*Talpidae*)	Harlow et al. 1975
SE Oregon	*Neotoma* spp.	Stiel and Trautwein, 1991
SW Idaho, SE Oregon	*Perognathys* spp.	Engel and Young, 1989; Stiehl and Trautwein, 1991
SE Oregon, SW Idaho	Pocket gopher (*Thomomys* spp.)	Nelson, 1934; Engel and Young, 1989
SE Oregon	*Reithrodontomys megalotis*	Stiel and Trautwein, 1991
Pennsylvania mountains, SE Oregon, SE Oregon	Rodents	Harlow, 1922; Stiehl, 1985; Stiehl and Trautwein, 1991;
W Virginia, SW Idaho, SE Oregon	Shrew (*insectivoria, Sorex*)	Harlow et al. 1975, Engel and Young, 1989; Stiel and Trautwein, 1991
SE Oregon	*Spermophilus* spp.	Stiel and Trautwein, 1991
SE Oregon	*Thomomys* spp.	Stiel and Trautwein, 1991
W Virginia, SW Idaho, SE Oregon	Vole (*Microtus*)	Harlow et al. 1975; Engel and Young, 1989; Stiehl and Trautwein, 1991
W Virginia, SE Oregon	White footed mouse (*Peromyscus* spp.)	Harlow et al. 1975; Stiehl and Trautwein, 1991
Other		
SE Oregon, SW Idaho, W Virginia, SE Oregon,	Birds	Nelson, 1934; Engel and Young, 1989; Harlow et al. 1975; Stiehl and Trautwein, 1991
SE Oregon, SE Oregon	Carrion	Nelson, 1934; Stiehl, 1985
W Virginia	Crayfish	Harlow et al., 1975
S California	Desert tortoise (*Gopherus agassizii*)	Webb et al., 2004

		W Virginia	Snail	Harlow et al., 1975
Insects				
		Pennsylvania mountains, SE Oregon, SW Idaho	Coleoptera	Harlow, 1922; Nelson, 1934; Engel and Young, 1989
		SE Oregon	Diaptera	Nelson, 1934
		SE Oregon	Heteroptera	Nelson, 1934
		SE Oregon	Homoptera	Nelson, 1934
		SE Oregon	Hymenoptera	Nelson, 1934
		W Virginia, SE Oregon	Insects	Harlow et al., 1975; Stiel and Trautwein, 1991
		SE Oregon	Lepidoptera	Nelson, 1934
		SE Oregon, SE Oregon, SW Idaho	Orthoptera	Nelson, 1934; Stiehl, 1985; Engel and Young, 1989
Live Prey				
		N British Columbia	Ancient Murrelet (*Synthliboramphus antiquus*)	This study
		N California	Black crowned Night-Herons	Kelly et al., 2005
		SW Alaska, SW Alaska, Newfoundland, Norway	Black Legged Kittiwakes (*Rissa tridactyla*)	Parmelee & Parmelee, 1988; Klicka & Winker, 1991; MacCarone, 1992; Tella et al., 1995
		SE Oregon, SE Oregon, N California	Eggs	Stiehl, 1985; Stiehl and Trautwein, 1991; Kelly et al., 2005
		N California	Great Blue Herons	Kelly et al., 2005
		N California	Great Egret (*Ardea alba*)	Kelly et al., 2005
		N California	Nestlings	Kelly et al., 2005
		N California	Snowy Egret	Kelly et al., 2005
Other				
		W Virginia	Aluminum foil, cloth, paper, plastic, rubber, etc..	Harlow et al., 1975
		S California	Landfill, sewage	Webb et al., 2004
		W Virginia	Stones (quartz, shale, sandstone)	Harlow et al., 1975

Engel and Young (1989) report inter-seasonal variation in Common Raven diet in Idaho. They found, through pellet analysis, that raven predation of birds peaks in spring, although Nelson (1934) showed that in June, less than 10% of stomach contents of ravens were made up of birds, the majority of their diet being small mammals (rabbits mostly) and insects.

Kelly *et al*. (2004) reported that energy obtained by ravens exploiting heronries in California represent at least 76% of their daily energy requirement. Relative frequency of predation of adult Snowy Egret, Black crowned Night Heron and Great Blue Herons was related to size, with the smallest being the most likely prey. This study indicates that the rate of depredation of nests for eggs and nestlings of ardeids is correlated to Common Raven brood size, suggesting that manipulation of their reproductive success could be a viable management solution for heronries.

Predation of eggs, nestlings and adult Black legged Kittiwakes, a colonial seabird, has been reported in Alaska and Newfoundland (Klicka & Winker, 1991; MacCarone, 1992; Parmelee & Parmelee, 1988; Tella *et al.,* 1995). Tella *et al.* (1995) suggest that ravens depend on predation of Black legged Kittiwakes for most or all of their energetic needs. Gaston and Elliot, (1996) report predation of Thick-billed Murre eggs and nestlings on cliff colonies in Nunavut.

Ravens are known to cache food (de Kort & Clayton, 2006), usually small, expensive food packages for short periods (Gwinner, 1965 in Bugnyar & Kotrschal, 2002). While caching around conspecifics, ravens display observational learning and deceptive tactics, such as the use of large objects to conceal information on cache location (Bugnyar & Kotschal, 2002).

STUDY AREA AND METHODS

Study area

Reef Island has been studied since 1983, when the Canadian Wildlife Service first surveyed the Ancient Murrelet colony (Gaston, 1992). The island continues to be a site for studies on the Ancient Murrelet, songbirds, and vegetation browsing by the Sitka Black-tailed deer. The island is situated in Laskeek Bay, British Columbia (52”52’N, 131”31’W). It is 4 km long and 1.6 km wide and is located about 7 km off the coast of the main archipelago (Gaston 1992). It is mainly covered with dense primary coastal temperate rainforest, with predominantly Western Hemlock *Tsuga heterophylla* and Sitka Spruce *Picea sitchensis* and some Western Redcedar *Thuja plicata* and Red Alder *Alnus rubra*. The study site was situated on the north side of the island, extending from a ridge approximately 300 m inland down an average 45° slope to the coast (Gaston 1992). The terrain includes some sheer cliffs.

The only mammalian predators are the River Otter (*Lutra canadensis*), of which we found some evidence in the study area, and deer mice (*Peromuscus maniculatus*), both indigenous to Reef Island. We found no evidence of the other mammalian species indigenous to Haida Gwaii, which include two species of shrew, ermine, pine marten and black bear. There were few signs of browsing by the Sitka Black-tailed Deer *Odocoileus hemionus* which is an invasive species modifying the habitat of most islands in the archipelago. Reef Island has had multiple deer culls since the late 1990’s, resulting in low deer population densities and gradual regeneration of the forest’s natural vegetation (A.J. Gaston, personal communication).

Cassin’s Auklet *Ptychoramphus aleuticus* nests in the study area at a lower frequency than the Ancient Murrelet. Bald Eagles *Haliaeetus leucocephalus* also nest in the study area. As many as six Bald Eagles could be seen at any time during the day, circling above the study area. The Northwestern Crow *Corvus caurinus* is common in the area, feeding primarily in the intertidal zone (Gaston 1992).

Observations of ravens

Observations were made in May and June 2006; and involved a single pair of Common Ravens with nestlings. A second pair of Common Ravens was discovered more than 1.5 km away from the nest of pair under study. Chicks associated to the second nest were never observed, although their presence was inferred by evidence such as defecation remains under the nest. A Common Raven nest in the current location was observed during previous field seasons (A.J. Gaston, personal communication). The nest was conspicuously located at a height of 21.4 m in a mature, gnarly, 51.6 m tall Sitka Spruce which stands in an area where, along with natural burrows Ancient Murrelets also occupy a number of artificial nest boxes. The boxes were surveyed daily for activity by other members of the field camp.

I erected a temporary blind 45 m from the nest, on top of the ridge running the length of the island. It afforded a view of the nest from 15° below it, from which any activity at the nest site could be seen easily. From the blind one could observe the adults' direction of arrival, and most activity in the general vicinity. Observation of the nest began as early as 04:00 and ended as late as 21:00. After the first three days the blind became redundant because the birds had become accustomed to the presence of an observer.

The Ancient Murrelet is a seabird that only arrives at and leaves the colony under cover of darkness. To determine whether there was temporal overlap between the activity of the Common Ravens and the Ancient Murrelets, observers stationed along the colony before sunrise noted the time of the last Ancient Murrelets departures while I watched the Common Ravens on their roosts near the nest until they became active. The dawn watch began in the complete darkness before 4 AM and concluded at 6:30 AM.

Census of Ancient Murrelet burrows

A census of Ancient Murrelet burrows was conducted along five North-South transects (A, B, C, D, E, Fig 1), running from the coast to the inland edge of the colony. All burrows were counted in circular plots 5 m in diameter (area = 78.5 m^2). The first plots were placed either at 5 m or 30 m from the shore, alternating between transects. The plots were 50 m apart, and transects were every 100 m (excluding transect E, which was 50 m from transect D due to terrain constraints). Ancient Murrelet burrows were distinguished from Cassin's Auklet burrows by smell, since Cassin's Auklet burrows have a strong and recognizable odor. Along each transect number and type of predations (feather pile, wings, bones) were recorded within 5 m on either side of each transect. Transects were terminated at the edge of the colony, which was determined by inspecting the adjacent area for burrows.

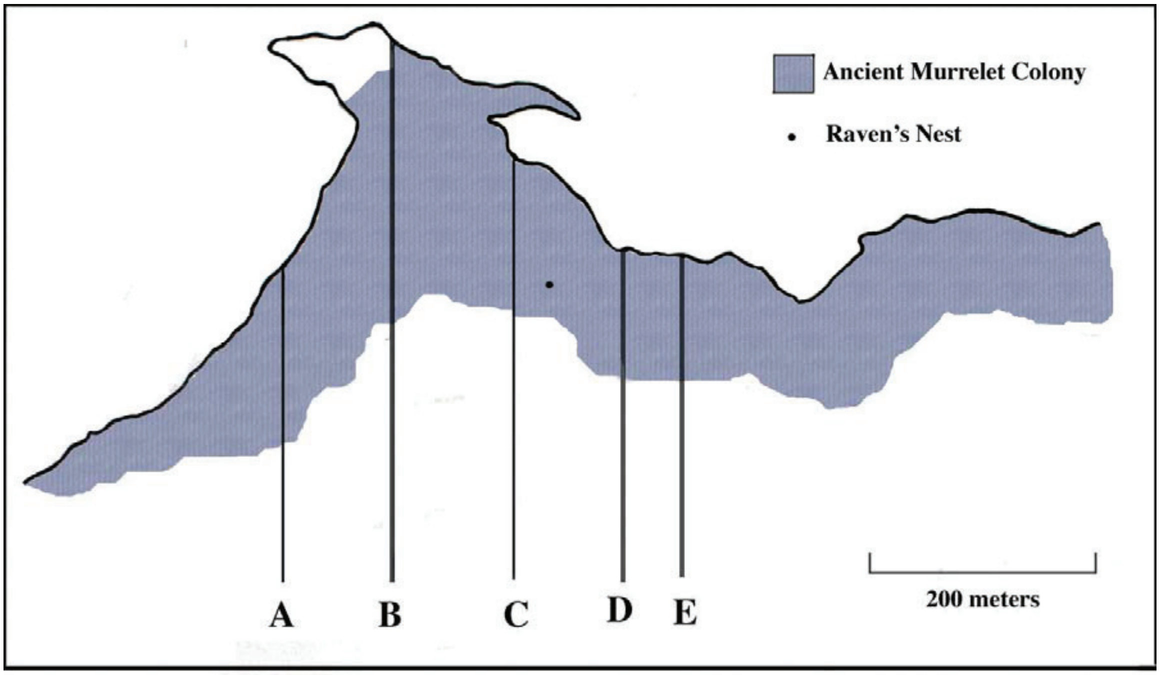

Fig.1
View of Raven's nest with respect to the census transects (A, B, C, D, E) and the Ancient Murrelet colony

RESULTS

Behaviour at the nest

The Common Raven pair under study had three nestlings when observation began on 20 May. The raven pair was initially disturbed by our presence near the nest, and no feedings occurred on the first morning of observation. However, by the afternoon, when a blind had been erected, the Common Raven pair had ceased alarm calling and fed the chicks twice.

By the second day of observation, the two adults could be differentiated by sight due to differences in beak anatomy. The bird denoted as A has a longer and more curved bill, whereas B's bill had a distinctive knob on the top due to plumage. Observations of incubation behaviour by the same pair in 2007 confirmed that A, which undertook most or all incubation, was the female. A was seen cleaning the nest cup, whereas B was not. The nest cup was cleaned after defecation by the chicks, which often occurred after a feeding. Common Witch's Hair (*Alectoria sarmentosa*), was removed and replaced by A on many of the observed cleanings. Some nest cleanups took as long as 5 min., and involved removing and replacing sticks and lichen contaminated with feces (samples were recovered from where they were dropped more than 100 m from the nest).

Food caching

On the second day of the study, immediately following harassment by a Bald Eagle, one of the ravens was observed bringing the carcass of an Ancient Murrelet to the top of a nearby over-mature spruce. The raven proceeded to pluck its prey, sending a cascade of feathers to the ground. On subsequent days, similar cascades of feathers allowed me to identify three other cache trees, all of which were used on a regular basis to pluck and/or temporarily store Ancient Murrelet carcasses. The four 'cache' trees identified were all within 100 m of the nest (Fig. 2). All cache trees were similar to the nest tree in that they were among the largest and most moss laden Sitka spruce or Western hemlock in the vicinity. Arrival to a cache tree with an unplucked carcass was only observed once.

When approaching a cache tree, bird A would fly to a low branch on a nearby tree and perch while B called loudly and repeatedly. Bird A would then gradually ascend by hopping from branch to branch to where the carcass was cached, always on a large moss laden branch. It would pluck the carcass, holding it down with one foot, plucking and tearing at flesh with the beak. After a few mouthfuls were consumed, it would fly to the nest and pass by beak or regurgitate to one or two chicks. Feedings of this nature often occurred in bouts of three to five feedings over a ten minute period. Only the remains of adult Ancient Murrelets were seen being fed to the nestlings.

The ravens arrived from three general directions, denoted X, Y and Z (Fig. 2). The likelihood that an arriving bird would be carrying food was approximately equal for all three directions, although Z was the most used. Crows were chased by ravens to the East, following the path Z. Eagles arrived from Y most often, and left between Z and X.

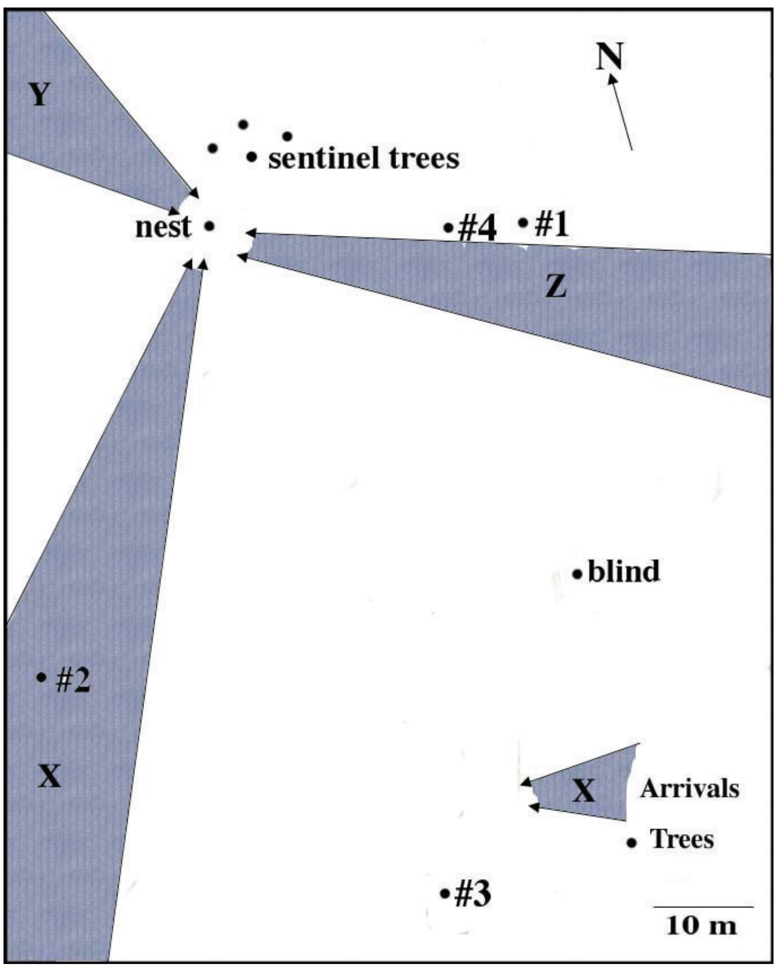

Fig. 2
View of study site showing the position of the nest and cache trees (#1, #2, #3, #4) and directions of arrivals (X, Y, Z)

The ravens were observed driving off Northwestern Crows and Bald Eagles. On one occasion, while I observed B plucking and tearing off pieces of meat from an Ancient Murrelet carcass in cache tree #1, three people arrived in the vicinity of the nest. B silently left the cache, to alarm call from the sentinel trees (Fig. 2). At the same time, a crow, evading B's notice, perched in cache tree #1 and picked at the carcass, then moved to an older cache in Y and fed on the remains there. The crow moved between cache trees for 15 minutes before leaving the area undisturbed by the raven. B was within my sight and preoccupied by the group of humans the entire time. B was observed snapping twigs and dropping them when humans were present. On several occasions Bald Eagles (both adults and juveniles) perched within 10 m of the nest, remaining there until the adult ravens drove them away. The chicks would crouch down in the nest, invisible to me, when this occurred.

The pre-dawn observation of the colony and roosting ravens revealed that all the Ancient Murrelets had departed from the colony by 04.20, while the ravens did not leave their nightly perches until 05.15. The ravens had a relatively constant rate of feeding throughout the day, with a slight increase in the morning and before midday (Fig. 3).

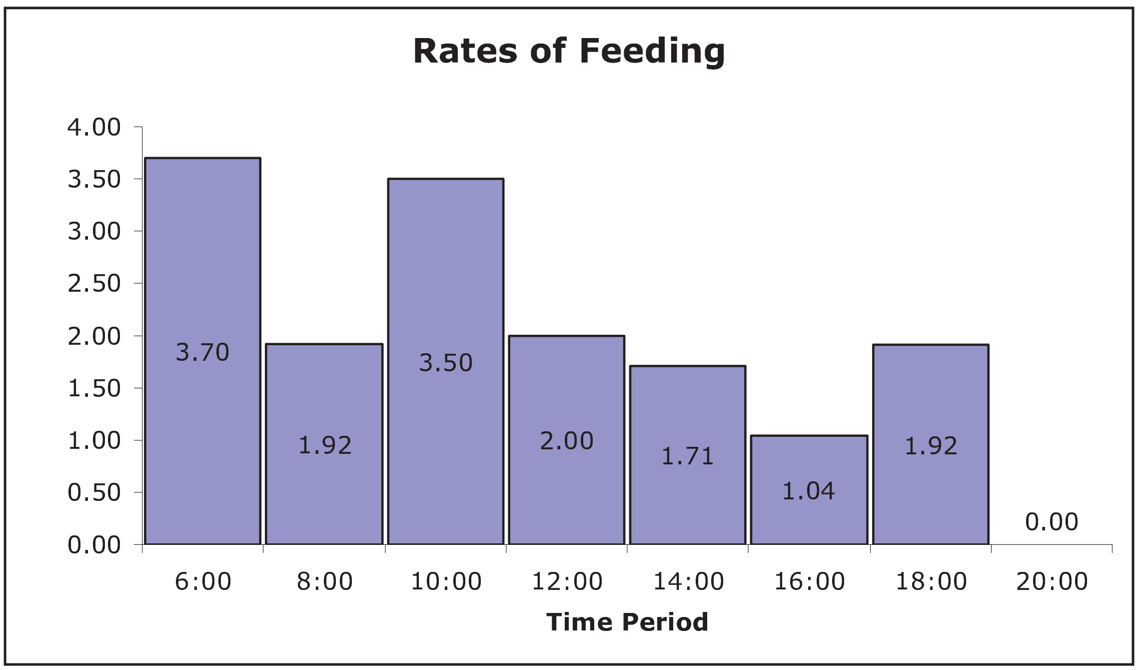

Fig. 3
Number of feedings in two hour intervals averaged over 12 days.

Census Results

We found 104 burrows and evidence of 51 predations on the five transects. There was a weak positive Pearson correlation between the number of burrows in a plot and number of predations in the plot and around it (Pearson r = 0.383, P (2-tailed) = 0.064).

Feathers at a burrow entrance and evidence of digging indicated that a breeding burrow had been dug up and the adult depredated. Eleven such cases were documented during the study period: two during the census on transects and nine prior to the census.

DISCUSSION

Observation of the Reef Island raven pair confirmed that they were responsible for many of the Ancient Murrelet carcasses scattered around the study area. Ancient Murrelet adults are the primary food source for raven chicks. These results raise questions about the means by which the ravens take the Ancient Murrelets, as the two species are active on the colony at different times of day. Along the census transects, only two burrows showed evidence of digging, but 51 predations were found along the transects. Ancient Murrelets occasionally use shallow burrows where they are not completely concealed (Gaston 1992), which would allow easy access to ravens. However, I did not observe any such easily accessible Ancient Murrelets in my exploration of the colony, an indication of the disadvantages of that kind of behavior.

Ravens are capable of learning, planning ahead and taking advantage of situations (Fritz & Kotrschal 1998, Heinrich 1999) and have the capacity to solve novel problems relating to food acquisition (Heinrich & Bugnyar 2005). Also, they can use olfaction in food location (Harriman & Berger 1986). This raises the possibility that the ravens were locating their prey by smell and dragging them out of burrows. This hypothesis is supported by a single observation (when the ravens were unaware of my presence) of the two ravens on the ground hopping around in an area of high burrow density in the early evening.

The ravens arrived at the nest site most frequently from areas of high burrow density on the colony (Fig. 2). By flying directly and silently to a cache tree, they could either evade my notice or use trees to block my view of them, making it impossible to see anything in their beaks. This behavior occurred throughout the day, suggesting that they were killing Ancient Murrelets during the day, when the only birds present at the colony were in their burrows.

Common Ravens are certainly capable of killing birds the size of Ancient Murrelets: they have been observed killing the larger Black-legged Kittiwake (*Rissa tridactyla*) in Alaska (Klicka & Winker 1991, Parmelee & Parmelee 1988) and in Newfoundland (MacCarone 1992). While Parmalee and Parmalee (1988) reported dive-bombing tactics, Klicka and Winker (1991) described face offs between ravens and gulls at the nest site. In these situations the seabird prey is exposed on the nest, during the day, making them easy targets. How this behavior is adapted to burrow nesting birds needs further research.

Ravens are known to depredate heron nests, most often between 10.00 and 14.45 h (Kelly *et al.* 2005). Engle and Young (1989) found that during spring and summer months, ravens foraged primarily in the morning and evening. MacCarone (1992) reported that patrols occurred at a constant frequency throughout the day. This corresponds with the results from this study, where ravens plucked Ancient Murrelet carcasses throughout the day.

According to de Kort and Clayton, (2006), the common ancestor of corvids was a cacher, and both the Common Raven and the Northwestern Crow are considered moderate cachers. The ravens at Reef Island did cache regularly throughout the study, using specific cache trees as indicated in Fig.2. Observation revealed that crows have the capacity to raid raven caches, when given the opportunity. This may be the basis behind the secretive behavior observed when the ravens were accessing their caches. The twig snapping behavior observed supports Heinrich's hypothesis that corvids dislodge objects as a displacement behavior when they are agitated (Heinrich, 1988).

This study has raised as many questions as it has answered, leaving an opening for future research. Delving into the mysterious ways of the raven is a challenge. However, the ravens on Reef Island provide a particularly good opportunity to study their predatory behavior. Not only is the nest well-positioned for observation, but the pair seemed uncharacteristically unfazed by human presence, once they became accustomed to it.

REFERENCES

Bugnyar, T. & Kortschal, K. 2002. Observational learning and the raiding of food caches in ravens, *Corvus corax*: is it 'tactical' deception? Animal Behavior 64: 185-195

Engel, K.A., Young, L.S. 1989. Spatial and temporal pattern in the diet of Common Ravens in Southwestern Idaho. Condor 91: 372-378

Fritz, J. & Kortschal, K. 1999. Social learning in common ravens, *Corvus corax*. Animal Behavior 57: 785-793

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

Gaston, A.J. 1992. The Ancient Murrelet. Academic Press Inc, San Diego, CA.

Gaston, A.J., Cairns, D.K., Elliot, R.D. & Noble, D.G. 1985. A natural history of Digges Sound. Canadian Wildlife Service Report No. 46.

Gaston, A.J. &. Elliot, R.D. 1996. Predation by Ravens *Corvus corax* on Brunnich's Guillemot *Uria lomvia* eggs and chicks and its possible impact on breeding site selection. Ibis 138: 742-748

Gwinner, E. 1964. Untersichungen uber das Ausdrucks- und Sozialverhlaten des Kolkraben. Zeitschrift fur Tierpsychologie 21: 387-394

Harriman A.E. & Berger, H.B. 1986. Olfactory acuity in the Common Raven (*Corvus corax*). Physiology and Behavior 36: 257-262

Heinrich, B. 1988. Winter foraging at carcasses by three sympatric corvids, with emphasis on recruitment by the Common Raven, *Corvus corax*. Behavioral Ecology and Sociobiology 23:141-156.

Heinrich, B. 1988B. Common Raven tool use? Condor 90: 270-271.

Heinrich, B. 1999. Planning to facilitate caching: possible suet cutting by a Common Raven. Wilson Bulletin 111: 276-278

Heinrich, B. & Bugnyar, T. 2005. Testing problem solving in Ravens: string-pulling to reach food. Ethology 111: 962-976

Kelly, J. P. Katherine, L. E. & Roth, J. E. 2005. Factors influencing the nest predatory behaviors of Common Ravens in heronries. Condor 107: 402-415

Klicka, J. & Winker, K. 1991. Observations of Ravens Preying on adult Kittiwakes. Condor 93: 755-757

MacCarone, A.D. 1992. Predation by Common Ravens on cliff-nesting Black-legged Kittiwakes on Baccalieu Island, Newfoundland. Colonial Waterbirds15: 253-256

Murray, J. J. 1945. The food of the Common Raven in Virginia. Auk 62: 306

Nelson, A.L. 1934. Some early summer food preferences of the American Common Raven in Southeastern Oregon. Condor 36: 10.

Opermanis, O., Mednis, A. & Bauga, I. 2001. Duck nests and predators: interaction, specialization and possible management. Wildlife Biology 7: 87.

Parmelee, D.F. & Parmelee, J.M. 1988. Common Ravens observed killing roosting Kittiwakes. Condor 90: 952

de Kort, S. R. & Clayton, N.S. 2006. An evolutionary perspective on caching by corvids. Proceedings of the Royal Society B 273: 417-423

Stahler, D., Heinrich, B. & Smith, D. 2002. Common ravens, *Corvus corax*, preferentially associate with grey wolves, *Canus lupus*, as a foraging strategy. Animal Behavior 64: 283-290

Stiehl, R. 1985. Brood chronology of the Common Raven. Wilson Bulletin 97: 78-87

Stiehl, R. & Trautwein, S. 1991. Variations in diets of nesting Common Ravens. Wilson Bulletin 103: 83.

Temple, S.A. 1974. Winter food habits of ravens on the Arctic Slope of Alaska. Arctic 27: 41-46.

Tella, J.L., Torre, I. & Ballesteros, T. 1995. High consumption rate of Black-Legged Kittiwakes by Common Ravens in a Norwegian seabird colony. Colonial Waterbirds 18: 231-233.

Webb, W., Boarman, W. & Rotenberry, J. 2004. Common Raven juvenile survival in a human-augmented landscape. Condor 106: 517-528

White, C. 2004. Hunters ring dinner bell for Ravens: experimental evidence of a unique foraging strategy. Ecology 86: 1057-1060.

Wilmers, C.C., Crabtree, R.L., Smith, D.W., Murphy, K.M., & Getz, W.M. 2003. Trophic facilitation by introduced top predators: grey wolf subsidies to scavengers in Yellowstone National Park. Journal of Animal Ecology 72: 909-916.

EAST LIMESTONE ISLAND ANCIENT MURRELET COLONY SURVEY, JUNE 2006

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SUMMARY

Population estimates of breeding Ancient Murrelets on East Limestone Island have declined since the initial estimate of greater than 5000 pairs in 1971 (Summers 1974). After a detailed census by the Canadian Wildlife Service in 1983 estimated the population at less than 1500 pairs (Rodway et al 1988), two other surveys, conducted at six year intervals showed that the colony was certainly not increasing. Recent concern about the declining trend in the number of chicks captured in monitoring studies on East Limestone Island suggested that another colony survey was warranted. This report presents the results of that survey and compares those results to the previous three surveys.

METHODS

The same methods were used to determine the nesting population of Ancient Murrelets in 2006 as were used in previous colony surveys on East Limestone Island in 1983, 1989 and 1995. A detailed description of survey methodology can be found in Rodway et al 1988. Fourteen transects, spaced approximately 100 meters apart around the island were established in 1983. Along these transects the number of burrows were counted within plots placed every 20 meters. A few modifications were made over the years which should not affect comparisons. Plot size was 5m x 5m in 1983 and 1989, but since the density of burrows on East Limestone Island is low, plots were enlarged to 7m x 7m in 1995 and 2006 to provide better coverage. In the 1995 survey, the number of burrows in the 5m x 5m portion of the larger plot was recorded separately for comparison to the larger 7m x 7m plot. Transect 8 was extended in 1989 and subsequent years to better cover this portion of the colony (Gaston et al 1989). Timing of the surveys differed somewhat between years. In 1983, the survey was conducted in the beginning of May. In 1989 the survey was in late May to mid June, while in 1995 and 2006 the survey was carried out from mid to late June.

This most recent survey was carried out from 18 – 22 June; and 13 & 17 July, 2006. We surveyed the same fourteen transects established during the initial CWS survey in 1983. At that time, the start of each transect was plotted on an airphoto of the island and the beginning points described in relation to the topography and measured from coastline features. During the 1995 survey, wooden marker stakes were placed at the beginnings of the transects, all of which were relocated in 2006, with the exception of transect 4. There may be some small discrepancies in the transect start locations between 1983 and the other years, but not between 1995 and 2006. In the 2006 survey, we georeferenced the transects with a Garmin GPS unit, to further define the transect locations, and attached engraved metal tags to nearby trees labeling the particular transect**.** (Table 1).

Colony areas were defined as including all areas with burrows. If there were no burrows within a quadrat, the surrounding area was searched to determine if the quadrat fell within the colony boundaries. If burrows or signs of activity were found within a distance halfway to adjacent quadrats along the transects or half the distance laterally to adjacent transects, the area was considered part of the colony and the data obtained from the quadrat was included in calculations of burrow density. If no burrows were found within this range, the area was not considered to be part of the colony and the quadrat data was not used in density calculations. The mean density of burrows and its standard error for the colony was calculated as the mean of the burrow densities found within each quadrat within the colony boundaries.

We attempted to determine occupancy (breeding effort in the current year) of all burrows that fell within the quadrats. Since the 2006 survey was at the end of the Ancient Murrelet breeding season, recently hatched egg membranes were the main evidence of occupied burrows. Earlier in the season, adult birds with eggs or chicks, and cold eggs in burrows are evidence of occupied burrows. If no evidence was found in burrows that were completely explored, then these were designated as empty (no nesting effort in 2006). Exploring burrows longer than an arm's reach required digging one or more small access holes until the end was encountered. Excavated holes were immediately patched with cedar shakes and soil. Very few burrows were accessible within the quadrats, so to increase the sample we explored every burrow encountered within a 10m expanding radius from three locations along transects in denser portions of the colony, until 5 or more burrows with known contents were found. A similar strategy was used in the 1989 survey, while in 1983 and 1995, occupancy rate was determined from the quadrats alone. Additionally, in 2006, we determined the current year breeding effort in most of the burrows within the Spring Valley and Cabin reproductive success plots. Occupancy rate (current year's breeding effort) was calculated as the number of occupied burrows/total burrows of known status for each quadrat or plot sample. Thus the mean occupancy rate and standard error for the colony is determined from the rates for each sample.

In addition to the burrow counts, we recorded evidence of predation (number of depredated eggshells, feather piles, wings and carcasses) within the quadrats and as a continuous 5m strip along the transect.

RESULTS

Colony area changes

The total area of the Ancient Murrelet colony on East Limestone Island was estimated to be 12.55 hectares in 2006, about 15% smaller than it was in 1983. (Fig. 1). It is difficult to define colony boundaries where burrow density is very low. However, there are several areas of the colony that have definitely contracted since 1983. In the area of transect 14, south of the Boat Cove, there was no sign of recently used burrows from 1989 to 2006. A concentrated search of the area in 2006 found one or two old burrows, but these held no recent sign. There may be a few birds nesting in the area, but since it would be very minimal, this portion of the original colony extent was excluded from the delineation of the 2006 colony boundaries. We searched a small cove to the south of Transect 14 area where a small pocket of burrowing had been previously described in 1989. Two burrows were found there, but since the area is so small, it is not included in the estimated size of the colony.

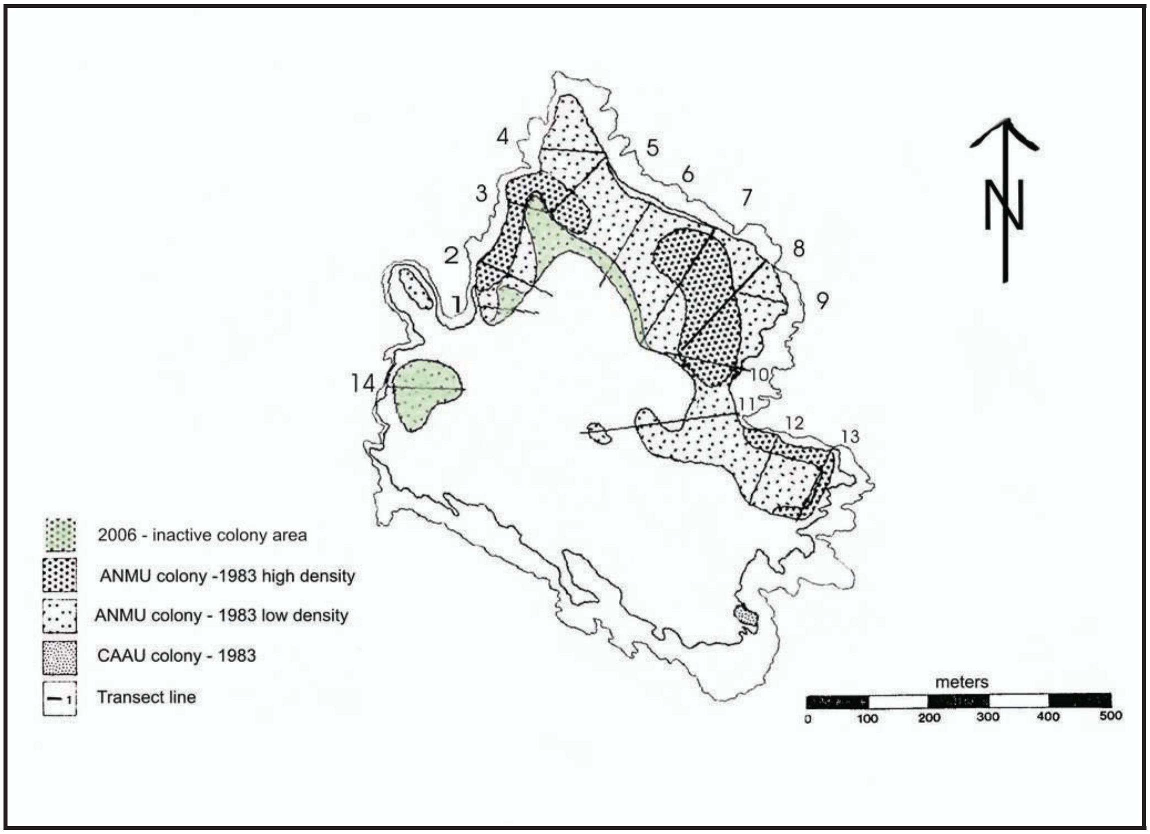

Figure 1
Comparison of the 2006 Ancient Murrelet colony boundaries to the 1983 colony extent on East Limestone Island

The 2006 colony extent is narrower on the west side of the island north of Boat Cove, where there is now no sign of burrows beyond the edge of the slope in the vicinity of transect 1 and 3. As well, the colony does not extend as far inland in the North Cove area in the region of transects 5 and 6. Burrows were very sparse along these two transects making colony boundary delineation very difficult, and it could actually be less than indicated.

In the inland part of transect 9 and the mid part of transect 8, there is a pocket of regenerating spruce where no burrows were found. The size of the area is such that it is too difficult to delineate on the map, and since similar small pockets likely occur elsewhere within the colony, it is not excluded.

Although the colony appears to extend further along transect 11 in 1983 than in 2006, this transect cuts through a low wet area beyond camp, and may have run in a slightly different location each year, making it hard to judge any apparent changes in colony boundaries. Pockets of burrows occur on raised forest ridges on the north side of the inland end of the transect, which likely fell along the transect in 1983 and 1995, while in 1989 and 2006 the transect at this point ended up in the flat wet area. Therefore, the boundaries of the colony in 2006 are depicted the same as in 1983 for this area.

Estimated number of burrows, occupancy and breeding population

On re-examination of the previous surveys, a few errors were found in the table presenting counts of burrows in the 1989 report (Gaston et al 1989), so the revised table is presented here – table 2. Similarly, the burrow occupancy rate is revised from the one that appears in the 1989 report. The report for the 1995 survey did not contain the raw data on burrow counts, so it is presented here as well, in table 3. Because of the refinement of the colony boundaries, and the above amendments, the estimates of total burrows presented in this report differ slightly from those presented in Gaston and Lemon 1996 and Lemon and Gaston 1999.

During the 2006 survey, we searched for burrows in 106 quadrats which fell within the boundaries of the colony as it was outlined in 1983. The larger plot size (49 m^2) increased the proportion of the colony covered from about 1.6 percent (with 25 m^2 plots) to 3.3 percent. We counted 47 burrows within the 85 quadrats that fell within the current colony boundaries (Table 4), giving a mean density of 113 +/- 22 burrows per hectare in 2006, less than the density of 150 +/- 26 bur/ha determined in 1995, and the lowest density found during the four colony surveys. Based on the revised figure of 12.55 hectares for the colony (omitting portions of the 1983 colony that no longer have evidence of nesting birds), the estimate of the total number of burrows is 1418 +/- 276. (Table 5). (The 1995 estimates of burrow density from 25m^2 and 49m^2 plots were virtually the same. However, since the coverage in the larger plots was greater, the standard error of the resultant estimate was reduced, and therefore it was better to use the larger plot).

Out of 64 burrows that could be completely examined, 23 showed signs of breeding effort in 2006, nineteen with hatched egg-membranes and four burrows containing cold abandoned eggs (Table 6). Occupancy rates in the other three survey years were all significantly higher, with the rate in both 1983 and 1995 about 61%, (Table 7 for 1995, see Rodway et al 1988 for 1983) while in 1989 the occupancy rate was 49.1 +/- 9.1% (Table 8). Applying the 2006 burrow occupancy rate of 35.9 +/- 6 % to the total number of burrows on the island, gives an estimate of 509 +/- 132 breeding pairs of Ancient Murrelets on East Limestone Island in 2006. (Table 5; Fig. 2).

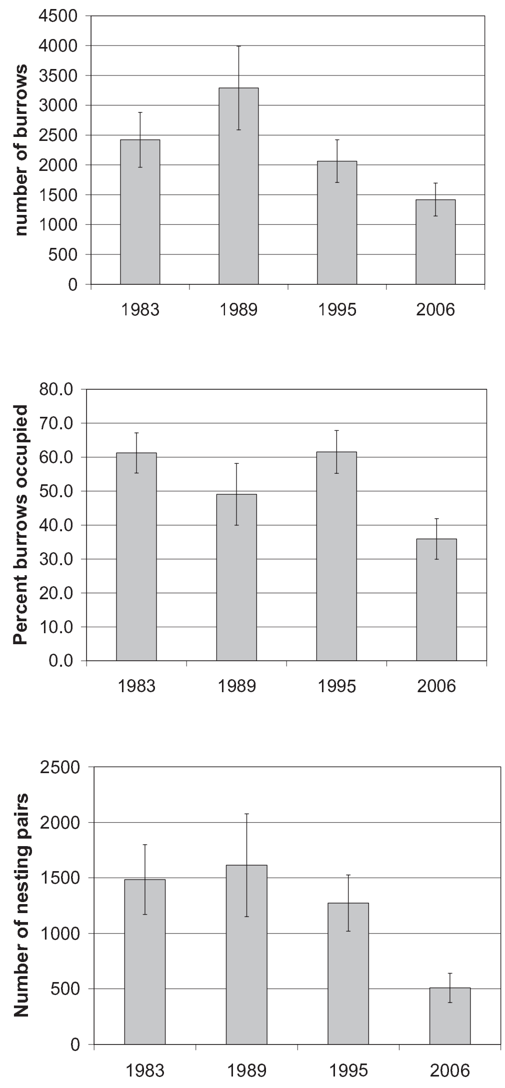

Figure 2
Estimates of total number of burrows, occupancy rate and number of nesting pairs of Ancient Murrelets on East Limestone Island in 1983, 1989, 1995 and 2006

Predation

Evidence of predation on Ancient Murrelets within the quadrats was recorded during each of the four surveys. (Tables 9, 10, 11 for 2006, 1995, 1989 respectively; 1983 data is presented in Rodway et al 1988). Feather piles from Ancient Murrelets were found scattered throughout the colony. Using these as an indicator of depredation on adult birds, I calculated a mean density of 48 feather piles/ha from data collected within all the quadrats along the transects in 2006. This is similar to the estimate of 45 feather piles/ha determined in the 1995 survey, but less than the 78 feather piles/ha determined in 1989 (Table 12). There was a much lower estimate of 16 feather piles/ha in 1983, but this might be due to the survey occurring early in the breeding season, while the other three surveys were at or after the end of the breeding season, when the counts of feather piles would represent the accumulated predation evidence from the whole nesting season. There was a notable absence of depredated eggshells through the colony in 2006, unlike what is often observed in other Ancient Murrelet colonies. Only one depredated egg was found in the surveyed plots in 2006, and although not abundant, more were found in quadrats during the surveys in the other three years, when estimates ranged from 9 to 32 depredated eggs/ha.(Table 12).

DISCUSSION

The results from the 2006 survey showed a considerable decline in the estimated total number of Ancient Murrelet burrows on the East Limestone Island colony from values determined in 1983. (Figure 2 and table 5). The 1989 estimate appears to be the highest of all years, but not significantly different than 1983 and 1995. The higher burrow density in that year is mainly driven by three plots which have 6 burrows each (table 2) and particularly in two of those plots, on transect 8 and 11, where there were no burrows recorded in the other three survey years.

Burrow occupancy rates were highest in 1983 and 1995, and at just over 61% were similar to the approximated median occupancy rate of 63% for Ancient Murrelets in B.C. (Rodway et al 1988). Although lower, the occupancy rate in 1989 was not significantly different from those values (table 5). However, the 2006 survey showed the lowest burrow occupancy rate of all survey years (36%), and consequently that combined with the lower total number of burrows yields an estimated breeding population that is about one third of the 1983 population, and a marked decline since 1995.

Other observations providing supporting evidence for a decline in the breeding population of Ancient Murrelets on East Limestone Island was the lack of hatched eggshell membranes seen on the surface of the colony in 2006. At the end of the nesting season on other Ancient Murrelet colonies in Haida Gwaii, the leathery white hatched membranes are frequently seen at the mouths of burrows and scattered about below burrows on steeper slopes. Notes from the surveys conducted on East Limestone Island in 1989 and 1995, which occurred late in the nesting season, indicated that it was not uncommon to see these hatched membranes scattered through the colony. Short burrows, with a concentric ring of twigs around the entrance, seem to occur on colonies where new burrows are being constructed and the colony is perhaps increasing. These are quite obvious, and are recorded when encountered during the transect surveys. We saw none in 2006, whereas in 1983 there were 5 of these "twiggy entrance" burrows recorded, 4 in

1989 and 1 in 1995 on East Limestone Island.

The similar depredation rate on adult birds estimated in the 2006 survey and in the previous survey in 1995 is disturbing, since compared to the estimated breeding population, it suggests increased predation pressure on the remaining birds. Predation on adult birds expressed as the estimate of the number of feather piles per hectare, was highest in the 1989 survey, almost double that of the subsequent surveys.

Extensive squirrel cone scale caches and middens are present throughout the colony now. They were recorded along all transects in 2006, though they were less frequently encountered along the west side of the island. Squirrel sign was also abundant in 1995 and was noted frequently in 1989. Some anecdotal notes of squirrel caches near the east coast of the island in 1983 confirm that squirrels were present on the island then. Partway through the survey in 2006, we attempted to quantify the occurrence of squirrel sign in the Ancient Murrelet burrows. Although we collected no direct evidence of squirrels negatively impacting the breeding murrelets, of fifty-three Ancient Murrelet burrows investigated, 10% had a continuous layer of chewed cone scales throughout the tunnel, 33% had scattered cone scales in the tunnel and nest cup, while the remainder didn't contain any chewed cone scales. Along the transects we did find some cavities and tunnels under tree roots and stumps that were completely filled with chewed cone scales. Some of these held small fragments of very old murrelet eggshells, suggesting that squirrels are likely opportunistically taking over Ancient Murrelet burrows.

We explored Crow Valley on the southeast shore of the island, but found no burrows or evidence of Ancient Murrelets nesting there. We found no indication that the colony had shifted to anywhere else on the island. The majority of the Ancient Murrelet colony in 2006 was mostly close to shore near transects 2 -4 on the west side of the island and around the east coast from transect 7 through 12 (from the east end of North Cove to Lookout Point and on the slopes above Camp Cove). Higher densities of burrows were also found at the inland sections of transects 7 & 8, which is close to the area of the old Spring Valley reproductive success plots.

This decline in the estimated nesting population of Ancient Murrelets on East Limestone Island contrasts with the increasing trend in burrow densities in plots on George and Ramsay islands and the stable trend on Rankine Island, three of the Ancient Murrelet colonies in Gwaii Haanas that are monitored regularly. (Hipfner 2004; Lemon 2003; 2005).

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LITERATURE CITED

Gaston, A.J., K. Heise, A. Lawrence, and M.J.F. Lemon, 1989. Studies of Ancient Murrelets on the Limestone Islands, May-June 1989. unpublished Canadian Wildlife Service report.

Gaston, A.J. and M.J.F. Lemon. 1996. A tale of two islands: Comparison of population dynamics of Ancient Murrelets at two colonies in Haida Gwaii, Canada. Pp. 29 - 38 in Gaston A. J. (ed.) 1996. Laskeek Bay Research 6. Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Hipfner, J.M. 2004. Surveys of permanent seabird monitoring plots on Ramsay Island, Gwaii Haanas, in June 2002. Pp. 35 - 39 in Gaston, A.J. (ed.) 2004. Laskeek Bay Research 13. Laskeek Bay Conservation Society, Queen Charlotte City, B.C.

Lemon, M.J.F. and A.J. Gaston, 1999. Trends in Ancient Murrelet populations since 1980. in Bird Trends, Canadian Wildlife Service, Environment Canada. No. 7, Spring 1999 : 22 – 25

Lemon, M.J.F. 2003. Surveys of permanent Seabird Monitoring Plots on George Island and East Copper Island, Gwaii Haanas National Park, June 2003. unpublished CWS report to Parks Canada, Dec. 2003.

Lemon, M.J.F. 2005. Surveys of permanent Seabird Monitoring Plots on Rankine Island, Gwaii Haanas National Park, June 2005. unpublished CWS report to Parks Canada, Feb. 2006.

Rodway, M.S., M.J.F. Lemon, and G.W. Kaiser. 1988. British Columbia Seabird Colony Inventory: Report #1 - East Coast Moresby Island. Technical Report Series, No. 50. Canadian Wildlife Service, Pacific and Yukon Region, B.C.

Summers, Kenneth R. 1974. Seabirds breeding along the east coast of Moresby Island, Queen Charlotte Islands, British Columbia. Syesis 7:1-12

Table 1
Descriptions and locations of start and end points for transects on East Limestone Island, June 2006

Tran. #	Bearing (°)	GPS location	GPS Accuracy	Location of transect point from GPS position	Description	markers
1 - start	95	N 52.90880 ° W 131.61689 °	13.6 m	7m at 122° to tran start	west side of island in Boat Cove on north side of trail - starts at 70cm dbh cedar tree	wooden stake in front of cedar; metal tag on north
end		N 52.90893 ° W 131.61564 °	9.2 m	at end (plot 6)	at edge of drop into a transverse valley;	
2 - start	114	N 52.90967 ° W 131.61639 °	5.5 m	7m to transect start	west side of island approx 75m north of	wooden stake with tag at
end					plot 6 on east side of gully heading down into broad valley	
3 - start	100	N 52.91046 ° W 131.61582 °	6.9 m	5m at 280° to tran start	approximately 120m north of Tran 2, on	wooden stake 5m from start
end		N 52.91055 ° W 131.61443 °	8.9 m		plot 5 at higher end of North Cove area	
4 - start	90	N 52.91161 ° W 131.61510 °	9.4 m	10 m east to tran start. GPS on beach	approx. 105m N of tran 3. Small beach with large Alder just S of trans begin. In level area between 2 rock ribs.	No wooden stake. Tag on cedar 3m along tran line.
end		N 52.91172 ° W 131.61363 °	8.6 m		at transect end 97m (just before plot 6)	
5 - start	221	N 52.91128 ° W 131.61325 °	7.4 m	GPS position at transect start	West end of North Cove, shorewards of Funnel # 4	wooden stake on edge of veg. Metal tag on 60cm dbh Spruce 2m along trans.
		N 52.91040 ° W 131.61442 °	11.5 m	7m at 90° to transect end	Transect end at plot 8, at top end of North Cove forest	
6 - start	210	N 52.91039 ° W 131.61206 °	8.4 m	GPS position at transect start	approx. 105m SE of tran 5 in North Cove.	wooden stake at transect start; metal tag on Spruce beside stake

		N 52.90941 ° W 131.61267 °	11.3 m		plot 9	
7 - start	210	N 52.91038 ° W 131.61080 °	7.5 m	GPS position at transect start	North Cove approx 115m SE of tran 6 on mossy knoll at shore	wooden stake at trans start; metal tag on Cedar 3m along trans.
		N 52.90803 ° W 131.61174 °	12.3 m	GPS approx 20m along tran line from plot 12		wooden stake 7m beyond plot 12
8 - start	220	N 52.90998 ° W 131.60943 °	9.8 m	GPS position at transect start	approx. 105m SE of tran 7 around onto east coast from North Cove. Approx 20m W of channel in rock shelf	wooden stake 2m along line. Metal tag on Spruce, 3m W of Tran
		N 52.90849 ° W 131.61077 °	8.6 m	at end (plot 11)	Plot 11 in valley floor	
9 - start	280	N 52.90958 ° W 131.60876 °	6.7 m	GPS position at transect start	east coast of island in small CAAU area, above vertical cliff; 15m north of odd limestone rock arches in moss	wooden stake at tran start; metal tag on Spruce 4m along line
		N 52.90941 ° W 131.60981 °	7.2 m	GPS position 4m before plot 5	end of transect at plot 5	
10 - start	280	N 52.90853 ° W 131.60914 °	4.6 m	GPS position at transect start	east side of island on rock knoll to N of beach (N side of biffy gully)	wooden stake at start; metal tag on small spruce
10 - end		N 52.90823 ° W 131.61130 °	9.8 m	GPS position 6m S of 130m trail peg	167m along tran line (end of plot 9) is 5m at 50° from 130m trail peg	
11 - start	260	N 52.90778 ° W 131.60981 °	10.8 m	GPS position 8m at 80° from trans start	east side of island at S end of camp beach at large spruce	metal tag on tree; wooded post had been removed
end		N 52.90695 ° W 131.61319 °	16.0 m	GPS position at plot 13	plot 13 is 10 m at 260° from snag # 19	
12 - start	200	N 52.90716 ° W 131.60864 °	8.8 m	GPS position 8m at 20° from tran start	80m east of east corner of camp bay (heading out toward Lookout Point)	Wooden stake at start; metal tag on large 90cm dbh cedar

end		N 52.90630 ° W 131.60898 °	7.7 m	GPS position at plot 6	plot just before drop down steep slope	
13 - start	200	N 52° 54.417' W 131° 36.443'		GPS position at transect start	approx 105m east of transect 12; 30m from end of vegetation on LookOut Point	
end		N 52° 54.356' W 131° 36.472'		GPS taken at 120m; plot 7	near edge of cliff	
14 - start	90	N 52.90736 ° W 131.61849 °	10.7 m	GPS position 8m at 90° from tran start	70m south of chasm on south side of boat bay peninsula.	wooden stake at start; metal tag on cedar 1m south of stake

Table 2
Number of Ancient Murrelet burrows in 5 x 5m quadrats along transects on East Limestone Island in June 1989. (-) = plots considered outside the colony

Transect	PLOT NUMBER														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	-	-									
2	1	0	1	0	1	0	-								
3	1	0	6	1	0										
4	0	0	0	0	1	1									
5		0	0	0	0	0	0	0							
6	-	0	0	2	1	0	0	0	-	-					
7	0	2	0	0	0	0	1	1	2	0	0				
8	1	0	0	0	0	0	1	2	0	0	6	-	-		
9	0	1	4	0	0										
10	0	0	1	0	1	0	0	0	0						
11	6	1	0	2	0	2	0	1	-	-	-	-	-	-	-
12	1	0	0	1	0	0									
13	2	0	0	0	0	0	0								
14	-	-	-	-	-										

Note : Transect 9, plot 1 - 2 CAAU burrows

Table 3
Number of Ancient Murrelet burrows in 7m x 7m quadrats along transects on East Limestone Island in June 1995. (-) = plots considered outside the colony

Transect	PLOT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	-	-									
2	2	1	0	0	0	0	-								
3	2	3	0	1	0										
4	1	0	0	1	0										
5		0	0	0	0	0	0	0							
6	-	0	0	2	0	1	0	0	-						
7	0	2	0	0	0	0	0	0	1	0	0	1			
8	6	0	1	1	3	0	0	0	0	0	0				
9	0	3	0	2	0										
10	0	3	1	0	2	0	0	1	1						
11	0	3	5	4	3	3	0	1	1	-	0	1	-	-	-
12	2	0	0	2	0	0									
13	0	0	1	0	0	2	0								
14	-	-	-	-	-										

Note : Transect 9, Plot 1 - 3 CAAU burrows; Transect 14, Plot 4 - 1 old ANMU burrow

Table 4
Number of Ancient Murrelet burrows in 7m x 7m quadrats along transects on East Limestone Island in June 2006. (-) = plots considered outside the colony

Transect	PLOT NUMBER												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	0	-	-	-	-							
2	4	0	0	0	0	0							
3	0	0	-	-	-								
4	1	0	2	0	2								
5		0	0	1	0	0	0	0					
6	-	1	0	0	1	0	0	-	-				
7	0	3	0	0	0	0	2	1	3	0	0	-	
8	4	0	1	0	0	0	0	1	3	0	0		
9	0	2	0	0	0								
10	0	3	0	0	0	0	0	0	0				
11	0	1	0	0	1	2	1	1	-	-	-	-	-
12	2	0	0	2	0	0							
13	0	0	0	0	1	1	0						
14	-	-	-	-	-								

NB: Transect 9, plot 1 - 3 Cassin's Auklet burr; Transect 9, plot 2 - 1 Cassin's Auklet burr.

Table 5
Population estimates of Ancient Murrelets on East Limestone I. from 1983, 1989, 1995 and 2006

Variable		1983	1989	1995	1995	2006
Plot size m^2		25	25	25	49	49
Burrows/m^2	mean	0.0163	0.0239	0.0152	0.015	0.0113
	s.e.	0.0031	0.0051	0.0031	0.0026	0.0022
	N	98	92	95	95	85
Occupancy	mean	0.613	0.491	0.615	0.615	0.359
	s.e.	0.059	0.091	0.063	0.063	0.0603
	N*	44	11	22	22	10
nest status	occupied	49	26	24	24	23
nest status	known	80	53	39	39	64
Colony area	(ha)	14.85	13.76	13.76	13.76	12.55
Total	mean	2421	3289	2092	2064	1418
	s.e.	460	702	427	358	276
Nesting Pop.	mean	1485	1614	1284	1273	509
(pairs)	s.e.	314	463	296	254	132

N* - N is the number of quadrats or plots where an occupancy rate was investigated, and from which the mean occupancy rate of the colony was determined.
nest status occupied - total number of burrows that were occupied
nest status known - total number of burrows with known occupancy status (occupied or empty)

Table 6
Occupancy (current years' breeding effort) of Ancient Murrelet burrows on East Limestone Island June 2006

Transect	Quad. or plot	Date	empty	1 cold egg	2 cold eggs	hatched membrane	Total Occup	Total Known
2	1-2	21-Jun	1			1	1	2
4	3	20-Jun				1	1	1
7	2 (OccupPlot)	19-Jun	5		1	4	5	10
8	1-2 (OccupPlot)	20-Jun	2			2	2	4
8	8 (OccupPlot)	20-Jun	3			1	1	4
8	9	20-Jun				1	1	1
11	5	18-Jun		1			1	1
12	4	22-Jun	1				0	1
11	CabinPlot	13-Jul	21			7	7	28
8	SV Plot	17-Jul	8		2	2	4	12
	Totals		41	1	3	19	23	64

Table 7
Occupancy (current years' breeding effort) of Ancient Murrelet burrows on East Limestone Island June 1995

Trans	Quad.	Date	empty	1 cold egg	1 cold E, 1 pred E	2 cold egg	hatched membr.	pred burr	Total Occ.	Total Known
2	2	17-	2						0	2
3	2	18-	1						0	1
4	1	21-		1					1	1
4	4	21-	1						0	1
6	4	20-			1				1	1
6	6	20-					1		1	1
7	2	20-	2				4		4	6
8	1	22-	1	1			2		3	4
8	4	22-	1						0	1
8	5	22-	1				1		1	2
8	8	22-	1				1		1	2
10	3	21-					1		1	1
10	9	21-					1		1	1
11	2	18-	1				1		1	2
11	3	18-	1			1	1		2	3
11	4	18-	1						0	1
11	5	18-	1				1	1	2	3
11	6	18-					1		1	1
12	1	19-					1		1	1
12	4	19-					2		2	2
13	6	19-					1		1	1
14	4	23-	1						0	1
Totals			15	2	1	1	19	1	24	39

Table 8
Occupancy (current years' breeding effort) of Ancient Murrelet burrows on East Limestone Island June 1989

Trans	Quad.	Date	empty	1 cold egg	Adult + 2 eggs	hatched membrane	pred. burr	Total Occup	Total Known
3	3	9-Jun	1			5		5	6
4	4	10-Jun	4			1		1	5
6	4	9-Jun	3			1	1	2	5
7	3	1-Jun	3			2		2	5
7	6	1-Jun	3			2		2	5
7	9	1-Jun			2	1		3	3
8	8	10-Jun	5					0	5
8	11	10-Jun	4			1		1	5
9	3	9-Jun	2	1	1	1		3	5
11	1	8-Jun				3		3	3
12	4	8-Jun	2			2*	2	4	6
	Totals		27	1	3	19	3	26	53

Incidental evidence of Current Years Breeding effort along transect lines 1989.

Trans	Quad.	Date	empty	1 cold egg	Adult + 2 eggs	hatched membrane	pred. burr	Total Occup	Total Known
2	3	25-May	1					0	1
2	line	25-May	1					0	1
4	5	10-Jun	1					0	1
4	6	10-Jun	1					0	1
7	7	1-Jun			1			1	1
7	8	1-Jun	1					0	1
10	5	26-May			1			1	1
10	7	26-May			1**			1	1
11	6	8-Jun				1		1	1
11	8	8-Jun	1					0	1
	Totals		6	0	3	1	0	4	10

* one of these had the nest cup dug up
**eggs not reached

Table 9
Depredated remains of Ancient Murrelets within 7m x 7m quadrats and in 5m strips between quadrats along transect lines on Limestone Island in 2006

Transect	Plot	Pred. egg	feather pile	single wing	pair wings	BAEA pellet
1	2		1			
1	3-4		1			
2	1		2	1		
2	1-2			1		
2	3		1			
4	2		1			
5	3		1			
6	1-2		1			
6	5		1	1		
7	2		1			
8	2-3					1
8	3		1	1		
9	1-2			1		
9	2		2			
10	1		1			
10	1-2		1			
10	4			1		
10	4-5			1		
10	5-6		1			
11	1		1			
11	4		1	1		
11	5		1			1
11	5-6		1			
11	6		1			
11	7		1			
11	8		1	1		
12	1		1	2	1	
12	1-2		2	1		
12	4	1				
12	4-5		1			
12	5		1			
13	1			1	1	
13	2			1		
13	4-5		1	1		
14	4					1
TOTAL	in quads.	1	20	10	2	2
TOTAL	along transects	1	29	15	2	3

Table 10
Depredated remains of Ancient Murrelets within 7m x 7m quadrats and in 5m strips between quadrats along transect lines on Limestone Island in 1995

Transect	Plot	Pred. egg	feather pile	single wing	pair wings	BAEA pellet	dug up burrow
1	1-2		1				
1	3					1	
2	1		1	1			
2	1-2	1		1			
2	2		1	2			
3	1		1				
3	1-2	2	1	1			1
3	2-3		1				
3	4-5	1					
4	1		2				
4	1-2		2				
4	2		2				
4	2-3			1			
4	5	1				1	
5	3-4		1				
5	6					2	
6	1		1				
6	1-2		1				
6	4		1				
7	1		1				
7	1-2		1				
7	2		1				
7	2-3		1				
7	10		1	2			
7	10-11		1				
7	11		1				
8	1-2		1				
8	3-4		1	2			
9	1-2		1				
9	2-3		1				1
10	1	1					
10	1-2	1		1			
10	3		1				
10	4-5		1				
10	6		1				
10	7-8		1				
11	3		1				
11	4-5		1				
11	5						1
11	5-6						1

11	6		1				
11	6-7	1					
11	7	1					
11	7-8	1	3	1			
11	8-9	2	1				
11	13		1				
12	1		2	1	1	2	
12	3		1	1			
12	5		1	1			
12	5-6		1				
13	1		1				
13	1-2		1				
13	6	1					
13	6-7		1				
14	3-4		1				
14	4-5					1	
TOTALS	Colony	4	21	8	1	6	1
TOTALS	along trans	13	48	15	1	7	4

Table 11
Depredated remains of Ancient Murrelets within 5m x 5m quadrats and incidental records of remains in 5m strips between quadrats along transect lines on Limestone Island in 1989

Transect	Plot	Pred. egg	feather pile	single wing	pair wings	BAEA pellet	invert carcass
1	1-2		1				
1	2-3		2		2		
2	2-3		1				
2	3		1	1			
2	6-7		1				
4	3					1	
4	3-4		1				
5	8		1	1			
6	4	1					
6	7		1				
8	2		1				
8	5		1				
8	10-11		1				
8	11		1				1
8	12		1		1		
9	1		2				
9	3	1					
10	3		1	1			
10	4-5		2		1		
11	1		1				
11	4		1				
11	6		1		1		
11	7		1				
11	8		1				
11	14		1				
11	14-15		1		1		
12	3-4	1					
12	4	1	1				
12	5	1	1				
13	1		2				
13	5-6	1					
13	7	1					
TOTALS	in quads	5	18	3	1	1	1
TOTALS	with incidentals	7	30	3	6	1	1

Table 12
Results of predation estimates of Ancient Murrelets on East Limestone Island in 1983, 1989, 1995 and 2006

Variable		1983	1989	1995	2006
Plot size m^2		25	25	49	49
Colony area	(ha)	14.85	13.76	13.76	12.55
feather piles/ha	mean	16	78	45	48
	s.e.	8	19	10	11
	N	99	92	95	85
	# plots with fp	4	16	18	18
	# fp in plots	4	18	21	20
# of depredated birds in colony	mean	238	1073	619	602
	s.e.	119	261	138	138
depred eggs/ha	mean	32	22	9	2
	s.e.	11	10	4	
	N	99	92	95	85
	# plots with ep	8	5	4	1
	# ep in plots	8	5	4	1
# of depredated eggs in colony	mean	475	303	124	25
	s.e.	163	138	55	

N* - N is the number of quadrats surveyed within the colony area
fp - feather piles (representing depredated Ancient Murrelets)
ep - depredated Ancient Murrelet eggs

PREDATION BY RACCOONS ON ANCIENT MURRELETS

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INTRODUCTION

Seabird islands all over the world are faced with threats posed by introduced species and East Limestone Island (ELI) is no exception. A particular concern for burrow nesting seabirds in Haida Gwaii is the threat of non-native raccoons *Procyon lotor* that dig up burrows to take eggs and defenceless adults that have not evolved any way of protecting themselves against these invaders.

Raccoons were introduced to Haida Gwaii in the early 1940s to provide an alternate source of fur for trappers after the local sea otter population was decimated. Because raccoons have no natural predators in the archipelago their population has grown and spread across the islands. Raccoons are believed to pose a risk to seabirds nesting on islands within 1 km of a source area (Harfenist et al. 2000) and they have been implicated in the disappearance of seabirds on Helgesen and Saunders islands (Gaston & Masselink 1997) and declines on East and West Limestone Islands that occurred in the early 1990s (Hartman et al 1997, Gaston 2007)

In 2007 a raccoon was active on ELI and it was believed responsible for digging up Ancient Murrelet burrows (ANMU), predating on adult birds, chicks and eggs. This report outlines our experience with the raccoon in 2007 and examines the impact of predation on the ELI colony.

EVENTS IN 2007

We first considered the possibility that raccoons were present on the island at camp start up on 29 April when two volunteers came across an ANMU head. Accounts of raccoon predation on seabirds nesting at Limestone in the 1990s refer to a 'distinctive style of predation' in which ANMUs were decapitated and then left uneaten. Over the course of the next two weeks we discovered 11 dug up ANMU burrows: one burrow contained a depredated egg and three showed evidence that an adult had been predated, one of which contained two intact eggs. The contents of the burrows were of particular interest because previous reports from Limestone suggested that raccoons almost certainly remove eggs from seabird burrows. Resident River otters *Lutra Canadensis* were also considered suspects because they are known to predate on adult birds but do not necessarily take eggs.

We did not detect any raccoons on West or East Limestone on our first night time raccoon survey by boat on 12 May. Predation transects conducted at first light provided our first firm indication that a raccoon was active on ELI. On 19 May we found six headless ANMU carcasses on our transects and further investigations across the island turned up another three more decapitated birds (Fig 1). The nature of the bird remains was consistent with raccoon predation.

We set up four baited raccoon traps in the areas where the carcasses were found. We checked and re-baited these traps regularly for the remainder of the season. Traps were baited with different combinations of: marshmallows, canned fish, fresh fish carcasses, eggs and peanut butter. We had no success with the baited traps and incidentally caught four Common Ravens and two Red Squirrels.

On our way to conduct the second night time raccoon survey on 27 May we confirmed that a raccoon was indeed on the island when we spotted a raccoon at Boat Cove. This sighting prompted a visit on 6 June by provincial Conservation Officers (CO) to eliminate the offending raccoon(s). Efforts were launched solely by boat at night and the COs succeeded in removing several raccoons from Louise Island but none from either of the Limestone islands. We continued to find decapitated adults and excavated burrows containing remains of predated adults and eggs. And for the first time on record, we found two decapitated chicks, apparently dug out from their burrow.

On 18 June a CO returned to direct two night hunts for raccoons by boat. During this visit the CO helped ELI staff to improve the raccoon trap set-ups on the island. Raccoons are apparently hesitant around the metal traps (Fig. 2) and the more natural the traps appear, the more likely raccoons will enter. Ideally traps should be placed in cave-like settings (ie: in rotted out tree trunks) and camouflaged using moss, dirt and bark (Fig 3). The CO also mentioned that creating scent trails by dragging bait along a path leading up to a trap might help to attract raccoons.

Figure 2
Metal traps are less appealing to raccoons if they are placed in the open

Figure 3
Camouflaged raccoon traps on East Limestone, 2007. Traps are more appealing to raccoons if they are placed in dark, cavernous locations such as a rotted out tree trunks and camouflaged with bark, soil and moss. Red arrows point to trap entrances

Despite unfavourable weather conditions (rain and winds: SE 40 knots) the crew succeeded in removing 2-3 raccoons from Louise I. but none from ELI. A second night of surveys with the CO turned up no raccoons. On 20 June the crew carried out a survey around ELI just before dusk. Weather conditions were favourable and a raccoon was spotted on top of the cliffs above Anenome Cove. The crew managed to tree the raccoon and the individual was shot and killed. No more signs of raccoon activity were evident on ELI after that day and a raccoon survey on 9 July detected no raccoons on either of the Limestone Islands.

RESULTS FROM PREDATION TRANSECTS

Once per week starting 12 May, we counted the number of carcasses, depredated eggs, feather piles, wings, and dug-up burrows (see Laskeek Bay Research 4 for a detailed description of classifications) located along five, 20m wide strip transects. Transects ranged in length from 100m to 200m, totalling 800m of transects. Based on the 2006 census (Lemon 2006), the 1.6 hectares covered by our predation transects represents 12.7% of the current ANMU breeding colony on ELI. Counts were started at first light in order to locate signs of predation before scavengers altered or removed evidence. We found 40 adult ANMU predations (feather piles, wings or headless carcasses), five fresh diggings, six depredated eggs and three headless chicks (Table 1). Some of the eggs and chicks were found in or nearby burrows that were recorded as dug up. Counting feather piles, wings and carcasses, mean ± (SE) density was 29 adult birds predated/ha ± 8.7 which equals 364 birds for the entire colony.

Table 1
Predation remains found on transects in 2007 at East Limestone Island

Date	Feather piles or wings	Burrow diggings	Carcasses	Eggs or chicks
12 May	3	0	0	2 eggs
19 May	7	1	6	1 egg
26 May	1	3	0	2 eggs
3 June	11	1	0	1 egg
10 June	11	0	0	3 headless chicks

Outside of transects we found another 17 dug up burrows (2 contained depredated eggs and three contained adult remains), six headless adult carcasses and one adult head. Three of adults killed by the raccoon were banded (the raccoon was believed responsible because birds were either headless or the remains were found inside excavated burrows). One of these predated birds was originally banded as a breeding adult occupying a monitored burrow in 2003. The other two birds were banded as chicks that departed from funnels # 3 and #6, banded in 2004 and 2005, respectively (Table 2). ANMUs typically start breeding between 3-4 years old (Gaston 1990) and thus the two year old bird banded as a chick in 2005 was probably attending the colony as a prospector. Thus the raccoon on Limestone in 2007 apparently targeted not only breeding adults but also prospecting birds.

SUMMARY

Ancient Murrelets are 'blue listed' by the province of British Columbia and are considered of 'special concern' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because they are especially vulnerable to threats posed by introduced species, such as raccoons. Our estimate of the number of birds killed could explain the decline in the number of Ancient Murrelet chicks that we observed this season. A portion of the predations on our transects were clearly the result of the raccoon which targeted prospecting birds, breeding adults, chicks and eggs, consequently posing a serious threat to this small colony.

RECOMMENDATIONS

The proximity of the colony to nearby islands with raccoons means that this introduced species will continue to pose a threat to burrow nesting seabirds on ELI. Our experience this season has highlighted a few important considerations / recommendations:

1) Boat and walk through surveys for raccoons should ideally be conducted before birds arrive at the colony and throughout their incubation period. The Limestone field crew arrives at the end of April (once eggs are near hatching) and raccoons that are present on the island will already have had

serious impacts on prospecting birds, breeding adults and developing eggs.

2) The traps set out in 2007 did not work. Traps should be set out using the methods suggested by the COs ie: placing them in dark, cavernous locations, camouflaging the traps (Fig. 3) and ideally baiting them with fresh fish.

3) As indicated in earlier reports, it is imperative that predation transects are checked at first light. Within hours of discovering headless carcasses that were otherwise intact, the remains were inverted, cleaned out, turned in to feather piles or missing altogether.

4) Relying on COs to remove raccoons from ELI is not the most effective strategy for eliminating raccoons from the colony because this requires a combination of conditions come together: COs have to be available and tides, weather and raccoons have to cooperate.

REFERENCES

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. The Condor 92:999-1011.

Gaston, A.J. 2007. Changes in numbers and breeding biology of Ancient Murrelets at East Limestone Island, 1990-2006. Laskeek Bay Research 16: 39-54.

Gaston, A.J. and M. Masselink.1997. The impact of raccoons (Procyon lotor) on breeding seabirds at Englefield Bay, Haida Gwaii, Canada. Bird Conserv. Int. 7:35-51.

Harfenist, A., K. MacDowell, T. Golumbia, and G. Schultz. 2000. Monitoring and control of raccoons on seabird colonies in Haida Gwaii (Queen Charlotte Islands). Pages 333-339 in L.M. Darling (ed.), Proceedings of a conference on the biology and management of species and habitats at risk, Kamloops, B.C., 15-19 February 1999. Vol. 1. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C., and University College of the Cariboo, Kamloops, B.C.

Hartman, L., A.J. Gaston, and D. Eastman. 1997. Raccoon predation on Ancient Murrelets on East Limestone Island, British Columbia. J. Wildl. Manage. 61: 377-388.

Lemon, M. 2006. East Limestone Island Ancient Murrelet colony survey. Laskeek Bay Research 16: 67-86.

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