LASKEEK BAY RESEARCH

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LASKEEK BAY CONSERVATION SOCIETY
SCIENTIFIC REPORT 2010, 2011 and 2012

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Cover Photo: Ancient Murrelet chick on the water
Taken by Jake Pattison

April 2013

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

Suggested citation: Gaston, A.J. (ed.) 2013. Laskeek Bay Research 17
Laskeek Bay Conservation Society, Queen Charlotte, 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 program 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:

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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 (LBCS) 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 program 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.

LBCS also conducts research in Gwaii Haanas focused on Black Oystercatchers and how their populations are changing in relation to introduced rats. This monitoring work is being done in collaboration with a larger rat eradication project that Gwaii Haanas is currently undertaking.

Our research programs are 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

Laskeek Bay Conservation Society would like all those who provide financial contributions to support our programs. In 2010-2012, these included:

- BC Hydro
- Canada Summer Jobs
- Coast Sustainability Trust
- Environment Canada – Canadian Wildlife Service, Pacific Region
- Environment Canada – EcoAction
- Environment Canada – Habitat Stewardship Program
- Environment Canada – Wildlife Research Section
- Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site
- Gwaii Trust
- Mountain Equipment Co-op
- Northern Savings Credit Union
- NSERC Promo-Science
- Public Conservation Assistance Foundation
- School District 50 Community Links

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

- Dr. Tony Gaston & Jean-Louis Martin for advice and guidance during the season
- The LBCS Directors for their time and efforts
- Staff and volunteers at East Limestone Island
- Fellow researchers and staff on Reef Island for support and good company
- Bluewater Adventures for bringing guests for tours of Limestone Island and for donations
- City Centre Stores for contributions to our food bills
- Danny Robertson and the m/v Highlander for transport of gear to camp
- George Pattison and Bridgeview Marine for donations of fuel barrels
- Haida Fisheries Program and the crew of the m/v Haida Provider
- Haida Gwaii Watchmen for their hospitality during visits to Skedans, Tanu and Hotsprings
- Heron Weir and Laura Pattison and the staff of Moresby Explorers
- Inland Air and the pilots for transporting volunteers to Limestone Island
- Isabel Creek for providing us with great groceries and donations
- Jeremie Hyatt and the s/v Kode Isle for transport of gear out of camp at the end of season
- Lynne Lee, Leandre Vigneault and the m/v Victoria Rose for transport of gear to camp
- Maple Leaf Adventures for bringing guests for tours and for donations
- Mike Hennigan for assisting with our camp maintenance
- Project Limestone teachers, students and parents for their dedication to this outdoor education program
- Research Group on Introduced Species
- Terry and Ron Husband of Watchman Forestry Services for an amazing job of clearing the blow-down
- The m/v Haida Guardian & crew for help with freight delivery
- The Observer

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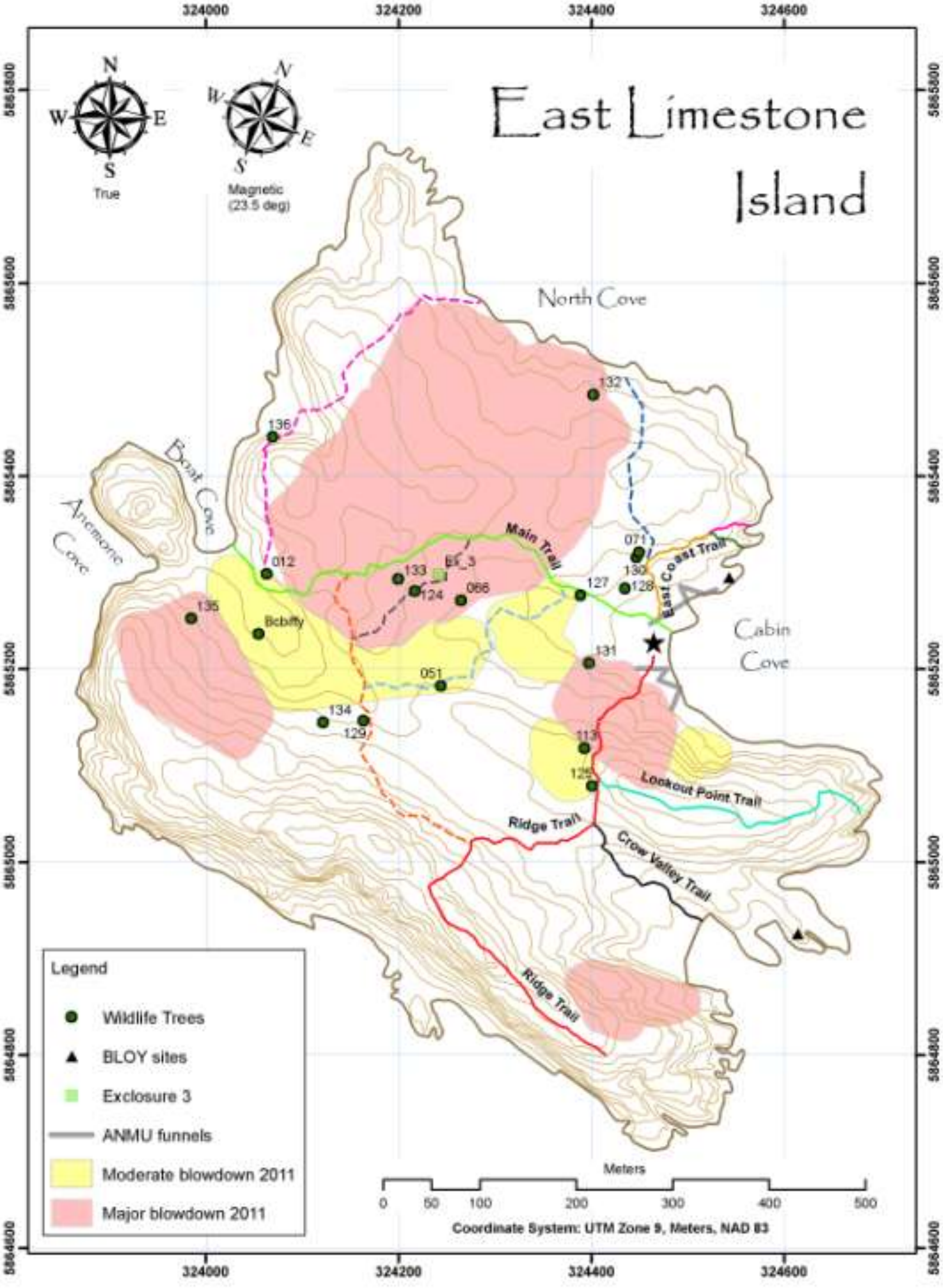

Map of Limestone Island
Produced by LBCS volunteer Kelly Runyon

EAST LIMESTONE ISLAND FIELD STATION:
FIELD SEASON REPORTS 2010 - 2012

Jake Pattison and Ainsley Brown
Laskeek Bay Conservation Society, Box 867, Queen Charlotte, B.C. V0T 1S0

Bald Eagle in Laskeek Bay, Photo: Jake Pattison

SUMMARY

The Laskeek Bay Conservation Society continued its field programme at East Limestone Island, Laskeek Bay, in 2010-2012, being the 21st, 22nd and 23rd field seasons. Field work ran from 1 May to 9 July in 2010, bringing 20 volunteers, 5 school groups (from three schools), and 45 visitors to the island. In 2011 the season was from 29 April to 8 July, bringing 2 student interns, 13 volunteers, 2 school groups (QCSS), and 69 visitors and in 2012 from 4 May to 12 July, with 19 volunteers and 42 visitors.

In 2010 Ancient Murrelet chicks were captured at both Cabin and North coves, following three years in which North Cove had been left undisturbed. Despite the lack of disturbance, North Cove numbers showed a similar decline to those at Cabin Cove during 2006-2010, suggesting that chick catching had little effect on changes in numbers in the two areas. During the 2010-2011 winter a major blow-down event severely affected approximately half the island. It left the camp intact, but brought down most of the trees in the North Cove area. Consequently the funnels could not be operated there in 2011 and 2012. Numbers captured at Cabin Cove remained fairly stable over the three seasons. No raccoon activity was detected on the island in any year.

In 2010, we found 25 occupied Black Oystercatcher territories in Laskeek Bay, 21 with chicks or eggs at some point in the season, but only 3 oystercatcher chicks were banded. Two 5-day oystercatcher surveys were completed in Gwaii Haanas in 2011, but we did not complete surveys or band chicks in Laskeek Bay. In 2012, Black Oystercatcher surveys were conducted in both Laskeek Bay and in Gwaii Haanas with 25 occupied territories among 46 inspected, of which 20 had eggs or chicks at some point during the season. In 2010 we re-sighted 16 birds banded in previous years, one of which has occupied the same breeding territory on Reef Island for 11 years,

while in 2012 there were 21 sightings of banded birds in Laskeek Bay and seven in Gwaii Haanas. The oldest bird sighted was banded as an adult in 2000 on the Skedans Islands and resighted in 2012.

Censuses of Glaucous-winged Gulls in Laskeek Bay were carried out in all three years, although the timing of surveys in 2010 was not ideal. The number of active nests ranged from 215 in 2010 to 333 in 2011. Pigeon Guillemots used 8 of the 10 nest boxes at Lookout Point, and 5 Cassin's Auklet nest-boxes were active with adults incubating eggs, but only one chick fledged. In 2011 Pigeon Guillemots used all 10 original nest boxes at Lookout Point, and 7 of the 18 new boxes installed in 2010 were also active, while in 2012 16 of the 28 nest boxes were used. Eight Cassin's Auklet nest boxes were active in 2011, all with healthy chicks and seven were active in 2012, although only one chick fledged.

At-sea surveys of marine birds were carried out twice in 2010, and three times in 2011 and 2012. Maximum counts of Marbled Murrelets were 50 on 20 June 2010, and 356 on 16 June 2011, and 55 on 9 June 2012. Numbers of Humpback whales seen in Laskeek Bay varied from 193 in 2011 down to 14 in 2012 – the lowest total since 1998. Killer whales were encountered in all three years, with the highest number in 2011.

In 2010, 11 Red-breasted Sapsucker, 3 Chestnut-backed Chickadee, 1 Hairy Woodpecker, and 4 Brown Creeper nests were found, the last being the highest number recorded to date. In 2011, 14 wildlife trees were active, with 12 Red-breasted Sapsucker, 2 Chestnut-backed Chickadee, and 1 Brown Creeper nests, while in 2012 there were 8 Red-breasted Sapsucker, 2 Chestnut-backed Chickadee, 1 Hairy Woodpecker, 1 Brown Creeper and 1 Red-breasted Nuthatch nests. A pair of Peregrine Falcons successfully fledged two chicks and a pair of Common Ravens also had two young in 2010. In 2011, two Bald Eagle nests were active, the Peregrine Falcons had three young and the Common Ravens fledged two young, while in 2012 there were three active Bald Eagle nests and one each of Common Raven and Peregrine Falcon.

EDUCATION AND INTERPRETATION PROGRAM

Project Limestone

For over 20 years Project Limestone has brought local students to Limestone Island to participate in Ancient Murrelet research. The students are led on an interpretive walk across the island and are given an introduction to the projects that we run. A walk to Lookout Point allows the students to learn more about the natural history and geography of the area, and ends with a panoramic view of Laskeek Bay. The group then assists with the Ancient Murrelet work from 10:30 pm to 2:30 am, which involves capturing chicks and weighing them before releasing them near the ocean. The group then spends the remainder of the night in the Visitor's cabin before heading back to their camp at Vertical Point the next morning.

Volunteers

Volunteers play an integral role in the operation of the field camp on Limestone Island. Volunteers generally stay for one week and work alongside field staff, contributing their time and energy to the many different tasks that are required throughout the season. These tasks include both research oriented work as well as general camp maintenance and chores. This is a unique opportunity for the public to get involved in long-term monitoring work while living in a remote field camp on Haida Gwaii.

Visitors

The LBCS visitor program provides opportunities for tourist groups to visit Limestone Island, participate in an interpretive tour and learn about the research that we are involved in. Through this program, LBCS aims to raise public awareness and appreciation of local conservation issues. Most of these visitor groups are part of ecotourism excursions in Gwaii Haanas.

2010

Project Limestone

Five groups with a total of 31 students and 10 teachers / chaperones visited Limestone Island in 2010. The groups represented three local schools: Anges L. Mathers School (Sandspit) on 11 and 12 May, Queen Charlotte Secondary School on 19 and 21 May, and Tidal Elements on 24 and 25 May. This was the first time that Tidal Elements had visited the island.

Volunteers

Twenty volunteers visited the island in 2010, contributing 165 volunteer days to projects, both on Limestone, on surrounding islands, and within Gwaii Haanas. Five of the volunteers had been to the island in previous years. The majority of volunteers stayed for one week, three for two weeks and one for 4 days. Six were from Haida Gwaii, eleven from elsewhere in BC and three from other countries (Germany, France, China). Executive Director, Christine Pansino assisted in camp during the first week and LBCS Director, Keith Moore volunteered during the second week.

Visitors

No formal tours were booked in 2010 but we received several impromptu visits from Moresby Explorers (13 May, 25 May, 25 June, 6 July) and Gwaii Haanas staff (31 May, 4 June). Rob Pettigrew and Shirley Ireland stopped in on 11 May, and a group of 15 from the *Island Roamer* took a short walk to see the deer exclosures on 11 June. In total, 45 people visited the island this season (excluding visits by the research crew based on nearby Reef Island). Akiko Shoji stayed on Limestone from 28 May – 9 July to work on an independent Pigeon Guillemot project at Lookout Point. Simon Chollet and Flore Saint-Andre were also in camp during the last week monitoring vegetation plots.

Staff

LBCS Staff in 2010 consisted of Christine Pansino (Executive Director), Jake Pattison (Camp Supervisor / Biologist), and Ainsley Brown (Assistant Biologist / Interpreter). Ainsley Brown worked in camp 14 May to 25 June and then took over as interim Executive Director at the LBCS office on 28 June. A six week student Intern Position was created this season. Shari Ikoma (Burnaby) completed an internship over the last half of the field season.

2011

Project Limestone

Only two school groups, both from Queen Charlotte Secondary School, visited the island in 2011, bringing 13 students and 3 teachers/chaperones. Visits were on the 18 and 20 of May. Since 1991, 603 students have visited the island as part of this program.

Volunteers

A total of 13 volunteers visited the island in 2011, contributing 92 days to LBCS projects. Five of the volunteers had been to the island in previous years. Most volunteers stayed for one week, with one staying for 4 days, and another for one day. Five were from Haida Gwaii, 3 from other parts of BC, 3 from Alberta, 1 from Quebec, and 1 from N.W. Territories.

Visitors

The *Maple Leaf* visited the island with three groups on 9 and 23 May and 1 June and *Island Roamer* brought in 2 groups on 16 May and 10 June. Jeremie Hyatt, Luke Hyatt, and Miray Campbell visited the island on 8 May. In total there were 69 visitors to the island this season, not including frequent visits by researchers from nearby Reef Island.

Staff

LBCS Staff in 2011 consisted of Alan Moore (Office Manager), Jake Pattison (Camp Supervisor / Biologist), and Ainsley Brown (Assistant Biologist / Interpreter). Two 6-week Student Interns took part in our field programs: Selina Dhanani (Burnaby) weeks 1-6, and Marcus Stein (Vancouver) weeks 6-11, contributing 84 days altogether.

RGIS

A crew from the Research Group on Introduced Species (RGIS) was based in the Laskeek Bay area from mid-March until the fall. 2011 was the first year of project BAMBI, a four year project focused on understanding deer behaviour and how it changes in response to predation risk.

2012

Project Limestone

Due to the BC teacher's strike, no school groups were able to participate in Project Limestone in 2012.

Volunteers

Nineteen people volunteered in 2012, contributing 133 volunteer days to LBCS projects. Ten came from Haida Gwaii, five from other parts of BC, two from Winnipeg, one from Germany, and one from France. Five of the volunteers had been to the island in previous years. All stayed for one week.

Visitors

Three tour groups visited in 2012: *Island Roamer* on May 22 and June 22 and *Island Odyssey* on June 12. In total there were 42 visitors to the island this season, not including frequent visits by researchers from Reef Island.

Staff

LBCS staff this season were Alan Moore, Operations Manager; Jake Pattison, Camp Supervisor (June/July); Ainsley Brown, Camp Supervisor (May), Assistant Biologist/Interpreter (June/July); and Vivian Pattison, Assistant Biologist/Interpreter (May). There were no student interns this year.

RGIS

A crew from Research Group on Introduced Species (RGIS) worked in the Laskeek Bay area from March through to October. This was the second year for project BAMBI, a four year project focused on understanding deer behaviour and how it changes in response to predation risk.

RESEARCH AND MONITORING PROGRAMS

2010-2011 Blow-down Event

There was major blow-down on Limestone Island during the winter of 2010. Approximately half of the island area (20-25 hectares) was affected, particularly the stands of large trees in the centre of the island extending to the shoreline of North Cove. Virtually all of the trees within the Ancient Murrelet colony in North Cove were completely blown down. The slope behind camp was also hit hard, but the camp was left intact. The extent of the blow-down was first recognized in early March and the trails were cleared in early April by two fallers working with the RGIS crew. There was also very extensive blow-down on Reef Island, destroying the camp, and on nearby Vertical Point, a popular camp site. Several different storm events appear to have been involved in the blow-down. Most of the trees in the interior of Limestone were blown down from the SW, while the area behind camp was primarily hit from the NE. Counting the rings on 17 mature trees near camp, and along the main trail yielded an average age of 147 (range 114-210). Many trees were very similar in age perhaps pointing to a similar natural disturbance event approximately 150 years ago. This event strongly affected the field work carried out in 2011 and 2012, compared with earlier years.

Aerial Photo of Limestone Island 2012

Ancient Murrelets

Synthliboramphus antiquus

Monitoring Program

Since 2007 LBCS has focused on reducing the impact of research related activities within the Ancient Murrelet colony. No chick capture work was carried out in the North Cove colony area for a three year period (2007 – 2009), during which time this area was off-limits and not visited during the breeding season. Chicks were again captured in North Cove in 2010, and as at Cabin Cove, involved only weighing and releasing chicks. In this way we are confident that we had an absolute minimum impact on departing chicks, while still gathering information on population trends and condition of chicks on departure. Comparison of data collected in 2010 in North Cove and Cabin Cove gave some insight into the impact of our activities during the breeding season.

The blow-down event in the winter of 2010-2011 resulted in the complete loss of North Cove chick capture funnels 1-4. The colony area and funnel lines in this location were buried under fallen trees and it was not possible to carry out any monitoring work in the area in 2011. Staff spent 2 nights at the shoreline in North Cove during the chick departure period in 2011 and detected no Ancient Murrelet activity there. We do not known to what extent the blow-down will impact Ancient Murrelet breeding activity on the island in future years. Chick capture funnels 5-8 at Cabin Cove required only minor repairs, however the colony behind funnels 5 and 7 was heavily impacted.

Chick capture work

2010 --. Eight chick-capture funnels (numbers 1-8) were monitored in Cabin Cove and North Cove beginning on 7 May. Funnels were checked every 10-15 minutes and we recorded date, time, location (funnel number) and mass for each departing chick. Funnel location and monitoring protocols are kept constant across years so that the number of chicks departing gives a consistent index of the overall breeding population. Funnels were monitored nightly from 22:30-2:30 for the period of 7-19 May and 11:00-2:30 after 19 May to compensate for increasing day length. Capture work ends after two consecutive nights with no chick captures in any of the funnels. In 2010 the first chicks arrived on the night of 8 May and the last on 2 June (Table 1). In total, 285 chicks were captured in funnels 1 to 8 (Fig. 1). The peak night of departures (34 chicks captured) occurred on 21 May.

2011 --. Funnels 5-8 were monitored in Cabin Cove beginning 7 May. The first chicks arrived 11 May and the last on 9 June. A total of 106 chicks were captured in funnels 5 to 8. Peak night of departures (11 chicks captured) occurred on 15 May.

2012 --. A total of 83 chicks were captured, more than in 2011 but fewer than 2010 (Fig. 2). First chicks arrived on 13-May and peak night (12 chicks) occurred on 22 May (Table 1). Chick captures continued until the 31-May this season for a total of 19 days with chicks.

Table 1. Summary of chick departures, peak nights and totals from funnels 5 to 8 on Limestone Island in 2006 to 2012

Year	First night with chicks	Peak night	Peak count	Last night	Total days	Total chicks
2006	10-May	21-May	24	30-May	21	197
2007	15-May	4-Jun	16	12-Jun	29	166
2008	12-May	14-May	13	3-Jun	23	125
2009	10-May	18-May	16	29-May	20	104
2010	8-May	21-May	19	2-June	26	121
2011	11-May	15-May	11	9-June	30	106
2012	12-May	17, 22-May	14	31-May	20	110

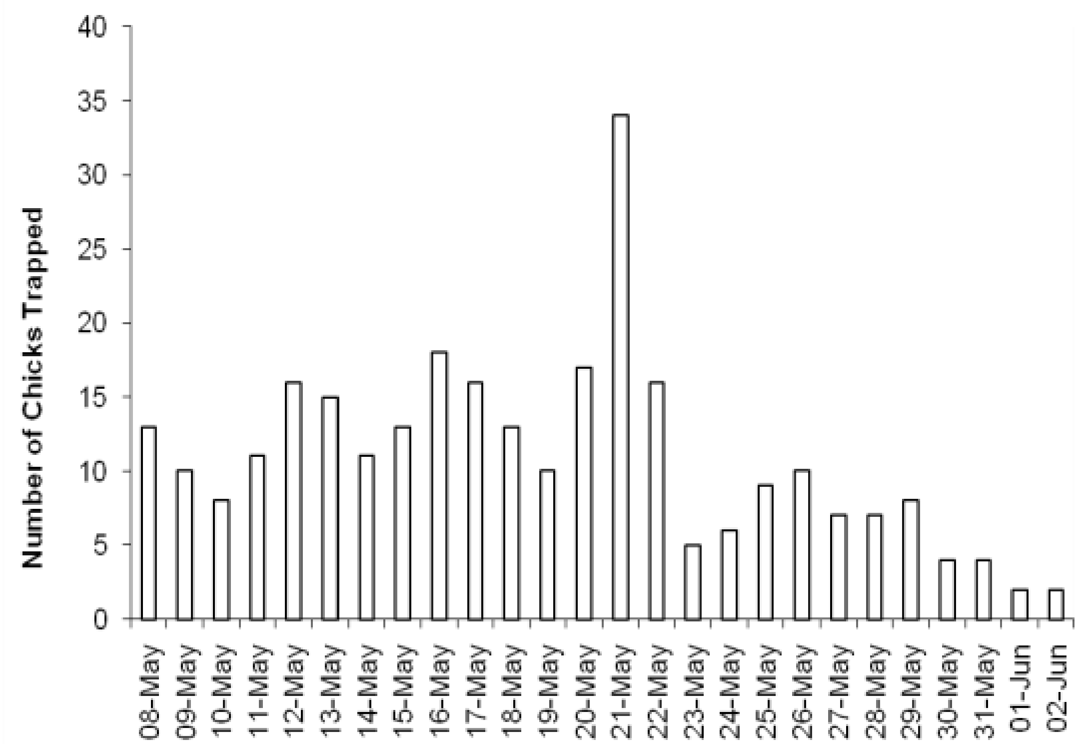

Figure 1. Nightly chick captures, Funnels 1-8, East Limestone Island, 8 May – 2 June 2010.

Funnels 5 & 6

Funnels 5 and 6 are the only funnels to have been monitored annually since 1990 (21 years) and are therefore our primary means of assessing the long-term population trend in the Cabin Cove colony area. Funnels 7 and 8 were installed in 2006 flanking funnels 5 and 6 to see if the colony area had shifted, resulting in decline. Comparison of chick numbers between funnels 5 and 6 and funnels 7 and 8 do not suggest a shift in the colony area.

A total of 86 chicks were captured in 2010 in funnels 5 and 6, 77 in 2011 and 83 in 2012 (Fig. 2). These results suggest that the steady decline in numbers seen during 2000-2009 has been arrested in the past three years. There is also little evidence that the blow down affected number of pairs breeding within the catchment of funnels 5 and 6.

Table 2. Summary of chick departures, peak nights and total captures at funnels 5 and 6 on Limestone Island, 1990 to 2012.

Year	**1st night with chicks**	**Peak night**	**Peak count**	**Last night**	**Total days**	**Total chicks**
1990	13-May	20-May	28	15-Jun	34	361
1991	10-May	25-May	22	05-Jun	27	232
1992	14-May	22-May	29	02-Jun	20	246
1993	12-May	18-May	39	04-Jun	24	268
1994	08-May	20-May	29	06-Jun	30	238
1995	11-May	23-May	18	12-Jun	33	187
1996	11-May	18-May	17	07-Jun	28	199
1997	13-May	28-May	22	05-Jun	24	186
1998	11-May	20-May	23	20-Jun	41	195
1999	11-May	21-May	22	09-Jun	30	166
2000	11-May	21-May	22	06-Jun	27	201
2001	11-May	19-May	21	15-Jun	36	191
2002	09-May	21-May	33	01-Jun	24	183
2003	11-May	21-May	19	03-Jun	24	167
2004	08-May	16,17-May	15	01-Jun	25	134
2005	07-May	19, 23-May	12	05-Jun	30	152
2006	10-May	21-May	20	31-May	22	149
2007	15-May	04-Jun	16	12-Jun	29	103
2008	13-May	20,22,23-May	8	03-Jun	22	92
2009	12-May	18,19-May	10	29-May	20	66
2010	8-May	21-May	16	2-June	25	86
2011	11-May	21-May	9	9-June	30	77
2012	13-May	22-May	12	31-May	19	83
Average ± SD	11-May ± 2 days	21-May ± 3.8 days	20 ± 7.8 chicks	6-Jun ± 5.5 days	27 ± 5.5 days	172 ± 71 chicks

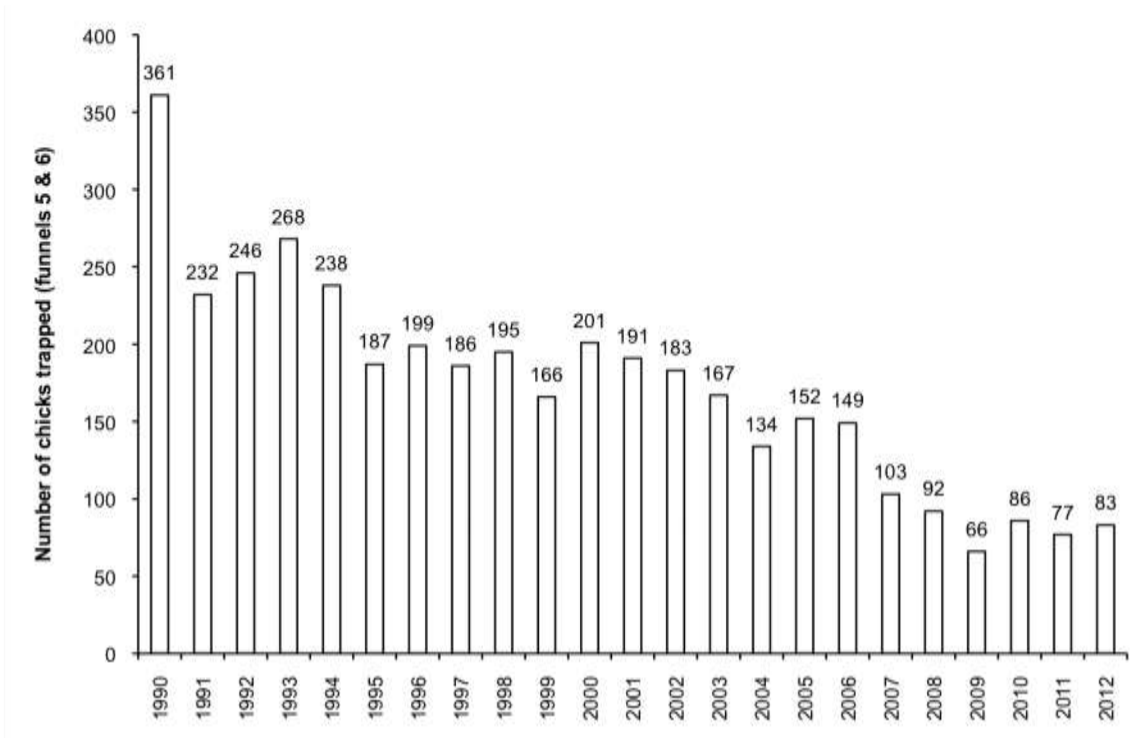

Figure 2. Total Ancient Murrelet chick captures at funnels 5 and 6 East Limestone Island, 1990-2012.

North Cove: Funnels 1-4

A total of 164 chicks were caught in funnels 1-4 in 2010, a 45% decrease from when chicks were last captured from these funnels in 2006 (Fig. 3). Chicks were captured in funnels 1-4 between 8-31 May, with peak numbers on 21 May (15 chicks). However, the median departure date was earlier for these funnels (17 May) than for funnels 5-8 (20 May). Overall, the percentage of chicks captured in funnels 5 and 6 has declined relative to the numbers captured in funnels 1-4 (Fig. 4), but it appears that this trend has stabilized since approximately 2002. In 2010, funnels 5 and 6 did better in comparison to funnels 1-4 than in any year since 2001 for which data are available. This slight increase in chick numbers in the area around camp relative to North Cove provides strong evidence that research activities, as they are now conducted, have not caused the decline of the colony since 2000 (see also Gaston and Descamps 2011).

As a result of the blow-down events of 2010/11 we were unable to monitor North Cove funnels 1-4 in 2011 and 2012. However, two partial funnels (95% of funnel 4 and a small section of funnel 3) were set up in 2012 to see if this colony was still active. An infrared, motion activated camera was set at the mouth of each funnel to determine activity. The cameras recorded from 20 to 27 May during which time seven chicks came down these funnels: five from funnel 4 and two from the portion of funnel 3.

Two nights were also spent observing activity in North Cove (18 and 24 May 2012). The first night was very active, with adults calling steadily from the water. Two chicks and one adult were also seen at point N-6 along the North Cove trail, along with other adults near the funnels. However, the second night was completely quiet, with no adults or chicks heard on the water or in the forest.

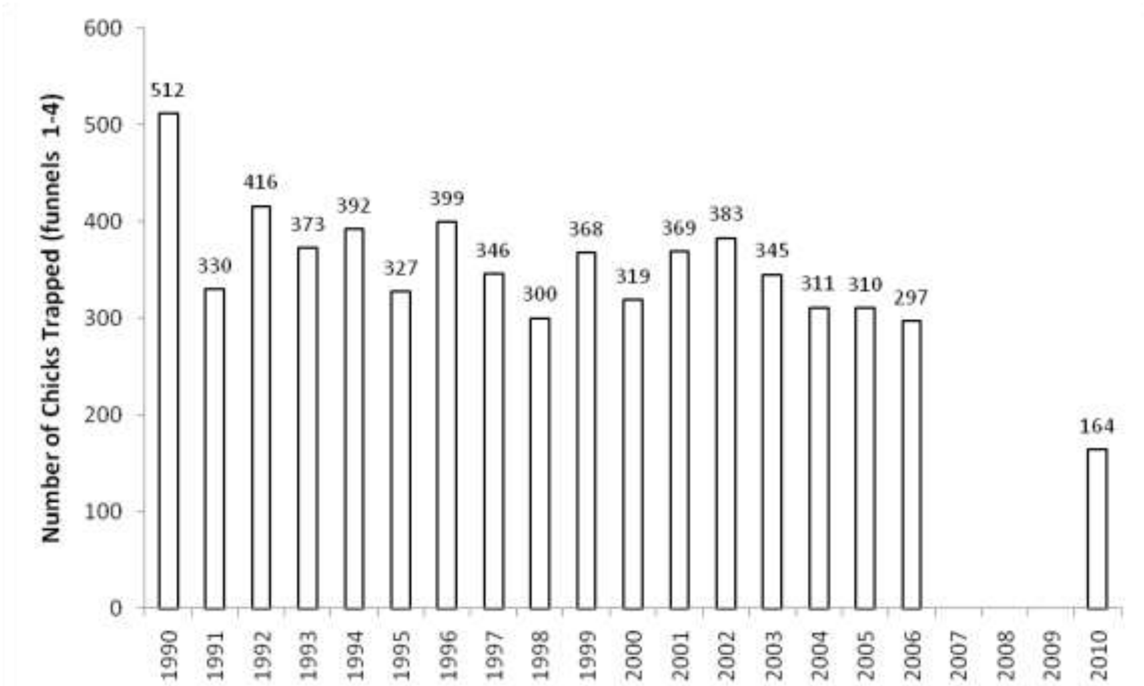

Figure 3. Total Ancient Murrelet chicks captured at funnels 1-4, East Limestone Island, 1990-2010.

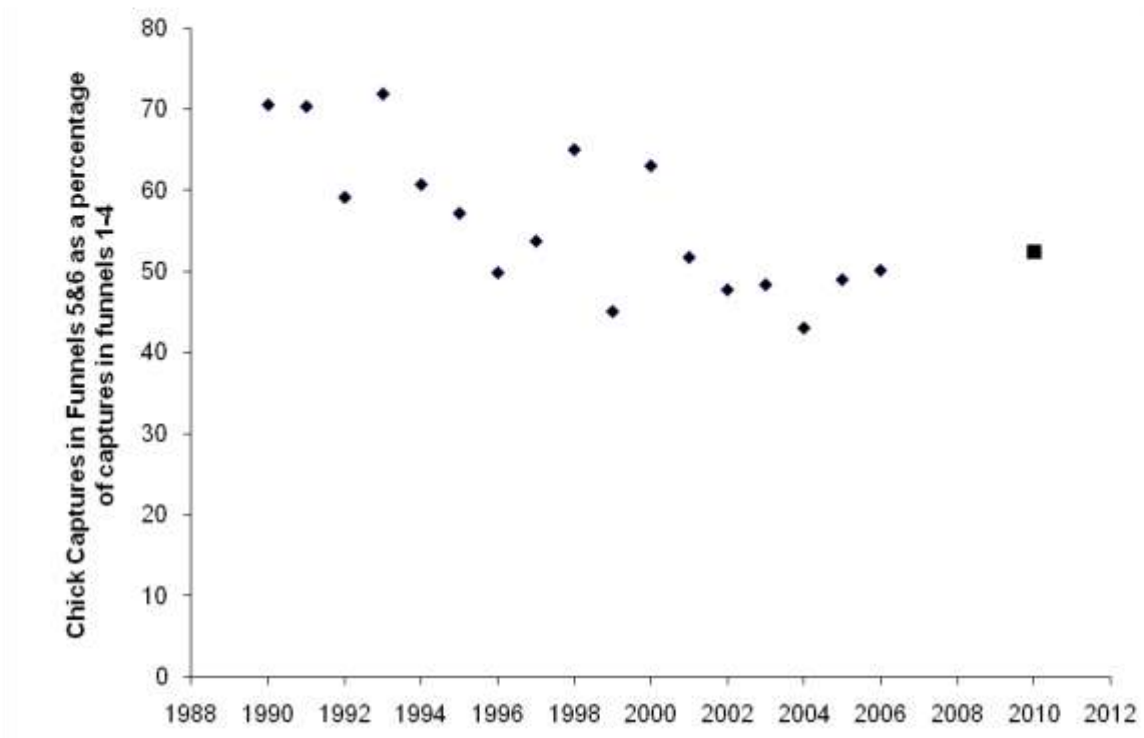

Figure 4. Proportionate distribution of chick captures between funnels 5 and 6 and funnels 1-4, 1990-2010.

Gathering grounds

Ancient Murrelets enter and leave the breeding colony at night and in late afternoon and evening the birds gather on the water in areas called gathering grounds, where they wait until it is sufficiently dark before entering the colony. Both breeding and non-breeding birds are thought to gather in these areas and important social interactions also take place during this time. The Limestone Island gathering ground is located between Low Island and East Limestone Island and this season, as in the past, we conducted standardized 10 min counts of birds on the gathering grounds between 5 May and 20 June.

2010 --. The peak count occurred on 17 May, with a total of 203 birds observed; an unusually high number. Counts averaged (±SD) 26.9 ± 39.8 this season, consistent with the downward trend in numbers that has been observed over the years.

2011 --. Standardized 10 minute counts of birds on the gathering grounds were made between 2 May and 20 June. The highest count occurred on 17 May, with a total of 121 birds observed. Counts averaged (±SD) 43.7 ± 36.2 this season, an increase from 2010.

2012 --. Counts were conducted between 6 May and 19 June. The highest count occurred on 8 June, with a total of 73 birds observed. Counts averaged (±SD) 15.5 ± 15.4 this season, a major decrease from 2011 (43.7±36.2).

Point counts

2010 --. We conducted point counts in the colony area to monitor the activity of adult birds. Five minute counts were made at approximately 2:30 each night for the period of 21 May to 4 June. Counts were conducted both at Cabin Cove and North Cove colony areas. Maximum counts occurred at Cabin Cove on 22 May (10 individuals; 108 calls), and at North Cove on 21 May (8 individuals; 68 calls) but most nights were much quieter. No birds were recorded during the 1 June count.

2011 --. Five minute counts were made at approximately 2:30 each night for the period of 21 May to 2 June. Counts were conducted in Cabin Cove but not at North Cove due to the blow-down. The maximum count, (16 birds 124 calls) occurred on 24 May.

*201*2 --. Five minute counts were conducted in Cabin Cove at approximately 2:30 each night for the period of 21 to 31 May. The maximum count, (15 birds 106 calls) occurred on 25 May. Two point counts were also conducted at North Cove 18 and 24 May. On 18 May adults were recorded calling steadily for 5 minutes but no calls were heard on 24 May.

Band Recoveries and Recaptures

Recapture of adult birds was phased out in 2003, however we still opportunistically capture adult bird that are trapped in funnels or are otherwise easily captured as we check funnels. We also scan feather piles, raven pellets and other predation remains looking for bands. Four banded birds were recaptured from the funnels in 2010, two of which were banded as chicks (1990, 1994) and two as adults (1990, 2002). Murrelets breed at a minimum age of 2 years making the adult banded in 1990 a minimum of 22 years old, the second oldest record for an Ancient Murrelet (a bird was re-captured on Reef Island in 2009 with a minimum age of 25). There were no bands recovered from predation remains this season. There were no band recoveries or recaptures in 2011 or 2012.

Predation transects

2010 --. To estimate predation rates in the colony, we checked for predation remains along 5 fixed, 20m wide transects in 2010. Transects were cleared of remains on 8 May and checked weekly until 30 May (three surveys). During each survey we were careful to remove remains, or otherwise mark them to avoid double-counting on subsequent weeks. Transects cover 1.6 ha of the total 12.6 ha area that the colony is estimated to cover. In 2010 a minimum of 8 adult murrelets were estimated to have been killed by predators in the colony area over the 3 weeks period (2.7 birds per week). This estimate is conservative, as it is based only on feather piles and carcasses and excludes wings which are potentially associated with feather piles. This estimate is dramatically lower than in previous years: the estimate in 2009 was 20.4 birds per week, and 70.6 per week in 2008. Field staff noted that there were very few predation remains in the forest this season in comparison with previous years. Native predators on Ancient Murrelets include Common Ravens, Peregrine Falcons, Bald Eagles, and River Otters (*Lutra Canadensis*). All these species were observed this season, although the amount of otter activity seemed lower than usual. There were no signs of Raccoons on Limestone Island in 2010, perhaps accounting for a reduction in predation.

2011, 2012 --. The predation transects were heavily impacted by blow-down and not monitored in 2011 or 2012. In general, very few predation remains were seen on the island in either year. There were essentially no Ancient Murrelet remains below the Common Raven nest, and very few feather piles were observed along the trails.

Population trends

The number of departing Ancient Murrelet chicks has declined since 1990 (Figs 2, 3). The colony census completed in 2006 estimated 509 ± 132 (SE) breeding pairs compared to 1273 ± 254 pairs estimated in 1995. Chick numbers declined by another 56% between 2006 and 2009 in funnels 5 and 6 indicating a rapidly shrinking breeding population. Since then, numbers at funnels 5 and 6 have stabilized. Funnels 1-4 in North Cove, which were not operated during 2007-2009, showed no rebound in chick numbers relative to Cabin Cove over the closed period. We assume that the colony area at North Cove, and other areas hit hard by the blow-down have experienced a decline in breeding activity due to the loss of established burrows and creation of numerous obstructions to the movement of adults and chicks.

Social Attraction Experiment

In 2011 we initiated a project aimed at increasing the recruitment of Ancient Murrelets to the East Limestone Island colony. Megaphones (TOA model ER-2230W) were placed in two different locations (Station 1: N52.90889, W131.61024; Station 2: N52.90760, W131.61069) and used to broadcast murrelet colony sounds to attract the attention of prospecting birds. By artificially increasing the amount of colony noise we hope to attract young birds to the colony and by doing so increase the breeding population over time. Megaphones were played between 0:00 and 2:30 on 17 nights between 7 May and 3 June. Megaphones were not played on nights with high winds or heavy rain. The megaphones appeared to be successful in attracting birds (birds were seen sitting next to the megaphone on several occasions), but we did not detect increased prospecting activity in burrows near to the megaphone stations.

We continued this project again in 2012 using the same protocol, playing the megaphones between 0:00 and 2:30 on 8 May to 17 May and again on 22 May to 31 May. It is unclear whether this activity is causing an increase on the number of nesting pairs. Further details appear in a separate report titled "Ancient Murrelet Social Attraction Experiment on East Limestone Island 2011".

Black Oystercatchers

Haematopus bachmani

Background

LBCS has been monitoring the breeding population of Black Oystercatchers in Laskeek Bay since 1992. Because they are entirely dependent on the intertidal system, these birds are thought to be a good indicator species for this ecosystem. Each season we attempt to locate all oystercatchers breeding within Laskeek Bay between Cumshewa Island and Lost Islands by visiting known territories and scanning for new territories. In the past, the shoreline of Louise Island was not included in the survey, but since 2005 the shoreline area between Dass Point and Nelson Point has also been included. A breeding territory was located on Haswell Island in 2009 and is now included in the survey as well.

LBCS was contracted in 2010 to carry out oystercatcher surveys within Gwaii Haanas and two surveys were completed. The first was conducted on 6-10 June and the second on 27 June – 1 July. The survey area was extended slightly in 2010 and methodology standardized. Survey length was increased to 5 days to allow for these changes.

Site occupancy and reproductive success

2010 --. Most visits to oystercatcher territories in Laskeek Bay occurred in late June. In most previous years, territories were checked beginning in late May or early June, but the schedule of the Gwaii Haanas surveys did not allow this in 2010. We visited all territories known to have been active in past years and also completed shoreline surveys of all areas except E. Limestone Island, S. Low Island and Haswell Island. Shoreline surveys followed the same protocol developed for the Gwaii Haanas surveys and involved scanning shoreline areas from ~50m offshore at 11 km/hr (2000rpm) to search for new territories. In total we found 33 territories being occupied by adult birds, and of these, 21 had eggs or chicks at some point during the season. As most areas were only visited once this season, there was little information gathered on timing of laying, chick hatch dates or chick survival. Only three chicks were banded this season, all on Kingsway Rock.

2011 --. Surveys were not conducted in Laskeek Bay in 2011, as there was insufficient time in the field season to complete a full survey of the Laskeek Bay area, although a number of territories were visited opportunistically. LBCS was again contracted in 2011 to complete two 5-day oystercatcher surveys within Gwaii Haanas. The first survey was conducted 4-8 June and the second survey 25-29 June. Details appear in a separate report titled "2011 Black Oystercatcher survey in Gwaii Haanas".

2012 --. Oystercatcher territories were visited in Laskeek Bay beginning the end of May through to the middle of July. We visited all territories known to have been active in past years except for the five territories on Cumshewa Island. All segments of shoreline surveys were also completed. Shoreline surveys followed the same protocol developed for the Gwaii Haanas surveys and involved scanning shoreline areas from ~50m offshore at 11 km/hr (2000rpm) to search for new territories. Out of 46 territories visited, 25 were occupied, and of these, 20 had eggs or chicks at some point during the season. No new territories were found. During the first survey, between 27 May and 27 June, we found 37 eggs and seven chicks. During the second survey (8 - 11 July) we found four eggs and 15 chicks. The low chick survival rate might have been due to a cool, wet and windy spring.

Banding and re-sighted birds

Birds banded in previous years have a combination of one metal band on the right leg that carries a unique number and a colour band combination that indicates the year of banding as well as the area where the bird was banded. Metal bands are permanent, while the plastic bands tend to be lost over time. Oystercatchers in Laskeek Bay were banded as chicks in most years from 1992 onwards and as adults in 2000 and 2001. Chicks were banded in Juan Perez Sound and islands between there and Laskeek Bay in 2004-2006. All oystercatchers seen during the course of the season were checked for bands as this gives us information on the age and dispersal of these birds.

In 2010, there were 16 sightings of banded birds in Laskeek Bay and 10 sightings in Gwaii Haanas, in 2011 there were three sightings in Laskeek Bay and 11 sightings in Gwaii Haanas, while in 2012 there were 21 sightings in Laskeek Bay and seven in Gwaii Haanas. Figure 5 presents the number of birds banded and re-sighted in Laskeek Bay over the period 1992-2012. Details of re-sighting in all three years are given in Appendix 1.

Although the number of identifiable re-sightings has been small, it is clear from resightings during 2009-2012 that young birds have a strong tendency to return to the area in which they were reared. No chicks banded in the LBCS study area from Lost Islands to Cumshewa Rocks have been detected holding territories outside of their banding area, whereas a minimum of 11 have bred within the study area. Two, perhaps three individuals were sighted in non-breeding flocks at Kunga Island, just outside the southern edge of the study area. Conversely, among chicks banded at sites in Juan Perez Sound, two have been seen holding territories and two or three in non-breeding flocks in the same area, but none has been sighted in the LBCS study area. These results confirm the findings of Hazlitt and Gaston (2002) and Rock (2008).

Age at first breeding in Black Oystercatchers was first described on the basis of early banding in Laskeek Bay by LBCS. Our current data support the suggestion made by Hazlitt and Gaston (2002) that age at first breeding is about 5 years. The youngest bird seen holding a territory during 2009-2012 was four years old, at which age 4/6 birds were holding territories. All birds seven years and older were holding territories apart from one fifteen-year-old (Fig. 6). Consequently, age at first breeding probably ranges from 4-7 years.

A puzzling feature of our band re-sightings is the relative paucity of one-year and two-year-old birds. Through natural mortality the number of birds available to be sighted decreases with age and in band recovery data it is usual for first year birds to predominate over older birds. In the case of Black Oystercatchers in Haida Gwaii, it seems that birds in their first year and, to a lesser extent perhaps, their second year, are less likely to be seen in the area than older birds (Fig. 6), suggesting that during the first year or two of life they disperse away from the natal area, returning only when they approach breeding age. The same happens in the case of many seabirds, which do not generally visit breeding colonies in their first year. We have no indication of where the young birds are during their first summer.

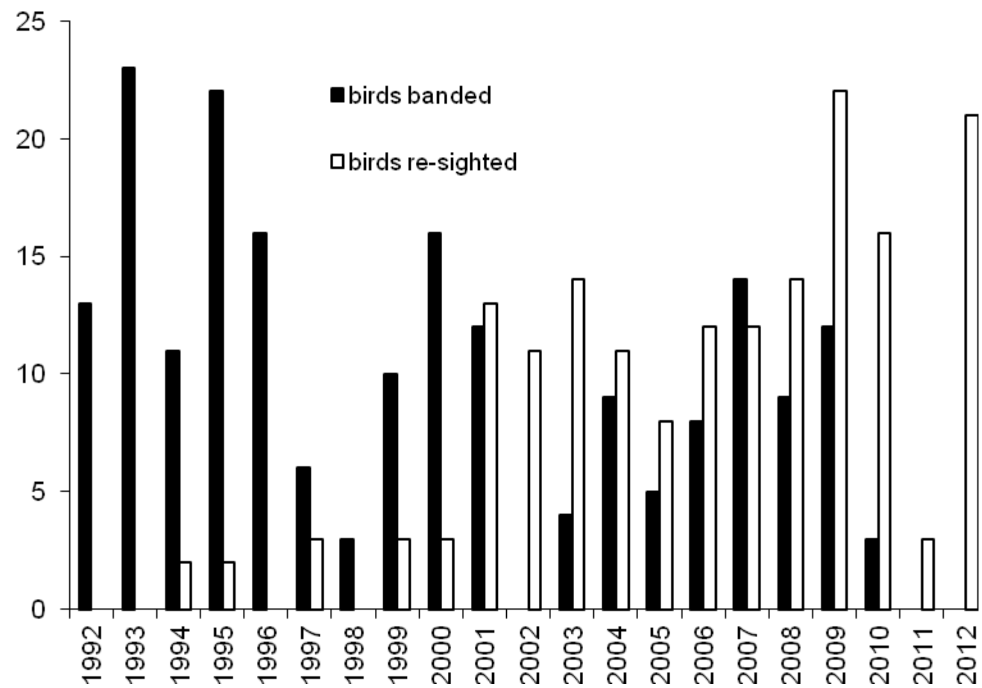

Figure 5. Number of Black Oystercatchers banded and re-sighted, Laskeek Bay, 1992-2012.

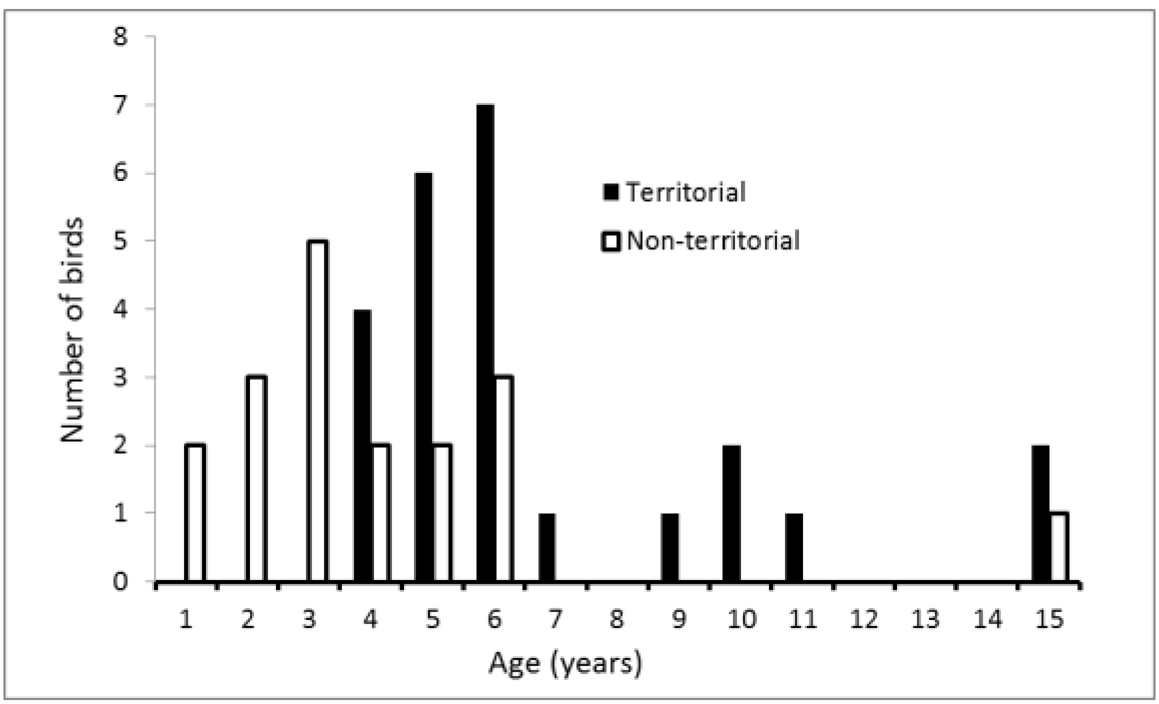

Figure 6. Numbers of territory-holding and non-territorial birds sighted in relation to age during 2009-2012.

Chick Diet
Oystercatchers feed their chicks hard-shelled invertebrates which they bring intact to the breeding territory. We collect prey remains from territories in Laskeek Bay in order to quantify average diet composition being fed to the chicks.

2010 --. Limpets were the primary prey item (67%), followed by mussels (21%) and chitons (11%) (Fig. 7). As in previous years, these three items made up more than 99% of the diet.

2012 --. We collected prey remains from 14 territories in 2012. Remains comprised limpets (60%), mussels (26%) and chitons (14%) (Fig. 7).

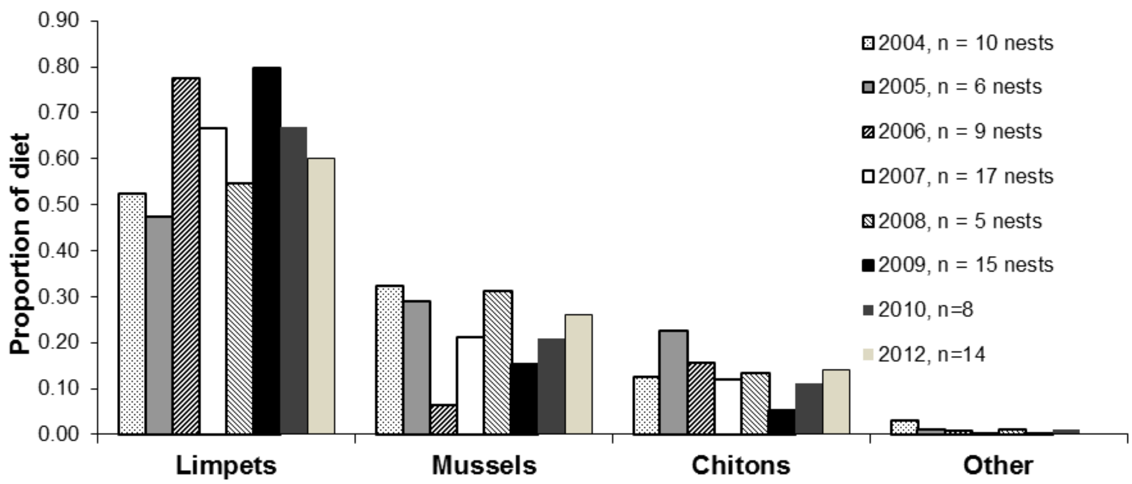

Figure 7. Black Oystercatcher chick diet from prey collections at Laskeek Bay territories 2004-2012 (n = number of nests).

Glaucous-winged Gulls

Since 1992, LBCS has been censusing gull colonies within Laskeek Bay. We visit sites where gulls were found nesting in the past and also keep an eye out for signs of new activity. Surveys are usually made in June, after gulls have laid eggs, but before chicks, which tend to wander away from the nest, have hatched.

Census counts
2010 --. Counts were made between 29 May and 21 June. Lost Island, the largest colony in the area had a total of 195 active nests (21 June), followed by Kingsway Rock with 17 nests (29 May), Low Island with 2 nests (19 June), and Skedans Islands with a single nest. Because Kingsway Rock was visited in May, the number of nests is probably an underestimate of the total active in June. In total we counted 215 nests on these three colonies containing either 1 egg (13% of nests), 2 eggs (19%), 3 eggs (68 %). No chicks where seen hatched at any of the colonies. Only one nest was active at Skedans Islands this season. We did not find activity at Cumshewa Island or at any other locations.

2011 --. At Lost Island, the largest colony in the area, we found 236 active nests (14 June), at Kingsway Rock 92 nests (23 June) and at Low Island 5 nests (19 June). In total we counted 333 nests on these three colonies containing either 1 egg (5% of nests), 2 eggs (16%), 3 eggs (79 %). Only one nest (Kingsway Rock) was found with hatched chicks. We did not check Skedans Islands or Cumshewa on foot, because no adult gulls were present at either location. The total number of nests counted this season was well above the long-term average (±SD) of 258 ± 70.

2012 --. We visited the known colonies on Kingsway Rock, Low Island and Lost Island but did not visit the colony on Cumshewa Island. No gulls were seen from a boat at the Skedans Islands so this area was not searched on foot. At Lost Island we found 196 active nests (21 June), at Kingsway Rock 33 nests (27 May) and at Low Island 2 nests (14 June). The number of active nests at Kingsway Rock was lower than usual likely because it was visited early in the season. Sixty-one empty nests were recorded, any of which might have been active later in the season. In total we counted 229 nests on these three colonies containing either 1 egg (12% of nests), 2 eggs (18%), or 3 eggs (67 %). Eight nests on Lost Islands contained chicks. The total number of nests counted this season was below the long-term average of 256 ± 68 (SD), probably due to the earlier visit to Kingsway Rock.

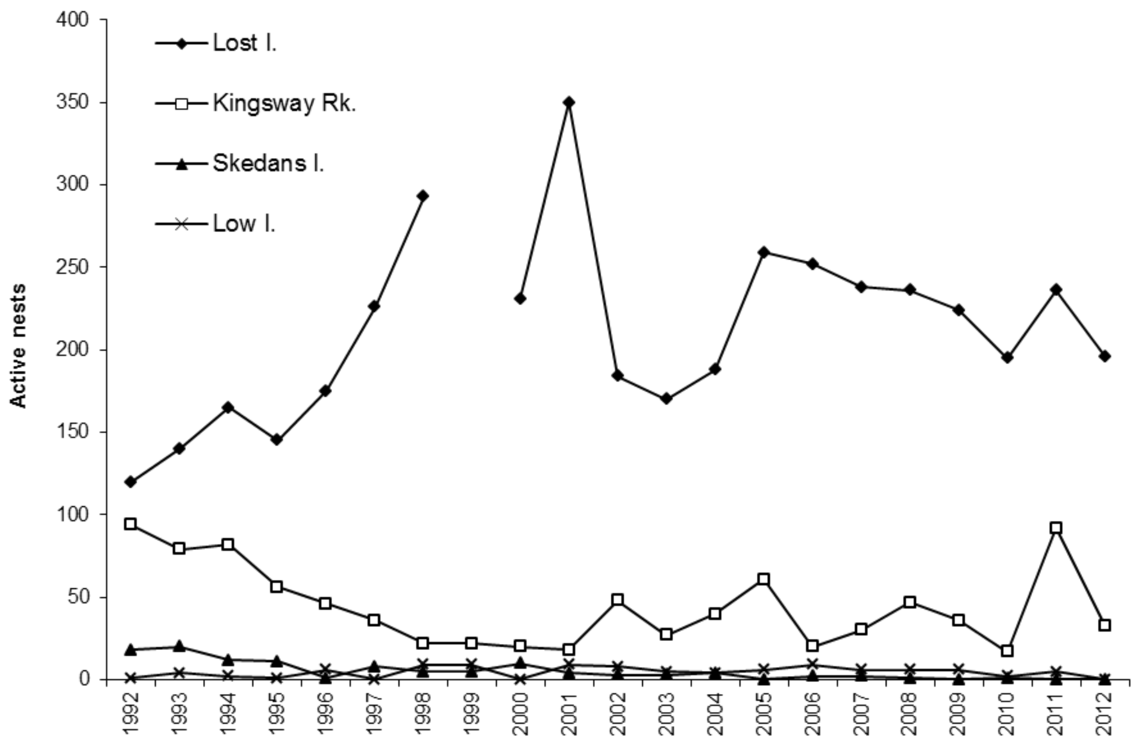

Figure 8. Glaucous-winged Gull nests containing eggs or chicks at four colonies in Laskeek Bay, 1992-2012.

Pigeon Guillemots *Cepphus columba*

Ten nest boxes for Pigeon Guillemots were installed at Lookout Point, East Limestone Island in 2001. Use of the boxes increased steadily until 2007 and there has been a high level of occupancy since then (Fig. 9). We check the boxes in early May to make sure they are intact and contain enough gravel. Boxes are checked again at the end of the season. In 2010 an additional 18 boxes were installed to the South of the earlier boxes and weighted down with rocks and a layer of gravel placed in the nest chamber. Many of the new boxes were installed in such a way that they can be viewed from a distance, making future observational work possible.

Nestboxes installed in 2010, Lookout Point

Breeding activity

2010 --. On 9 July we found eight boxes active, containing either chicks (seven boxes) or eggs (one box). Of the 11 chicks present, six were dead. No Pigeon Guillemot chicks were banded. Akiko Shoji, a graduate student from University of Ottawa, completed a pilot project using the nest boxes at Lookout Point. She installed small video cameras at the entrances of several nest boxes to observe adult birds coming and going from the boxes and to observe fish being brought to the chicks in the boxes. Time-depth recorders were placed on two adult birds to record depth and duration of diving behavior. However, re-capturing the birds to recover the devices proved to be difficult and the one device retrieved provided no information.

2011 --. All boxes were checked on 7 July. All ten old boxes were active, containing either chicks (seven boxes) or eggs (three boxes). Of the 13 chicks present, eight were large enough to band. Seven of the boxes installed in 2010 were active: three with chicks and four with eggs. All five chicks were banded. It took four years for this level of occupancy to be reached in the original boxes, suggesting that use of nest boxes occurs more rapidly once birds are familiar with them.

In order to address concerns that nest boxes may get too warm during hot weather resulting in chick mortality, we placed plywood shades on boxes 1-10 in an attempt to reduce the maximum temperatures. Temperature loggers (I-buttons) were placed in two of these shaded boxes as well as two of the new boxes that do not currently have shades.

2012 --. Boxes were checked at the beginning of the season and one box was found to have been damaged over the winter (box #3) and was unusable. Boxes were then checked on 12 July, to determine activity. Eight of the 10 original boxes were active, all containing chicks and one with one egg and two chicks. Eight of the 18 new boxes were active: four with chicks, three with live and dead chicks, and one with an egg. No banding was done this year. Due to the cooler weather this year, temperature was not a concern for the nest boxes and no shades were installed.

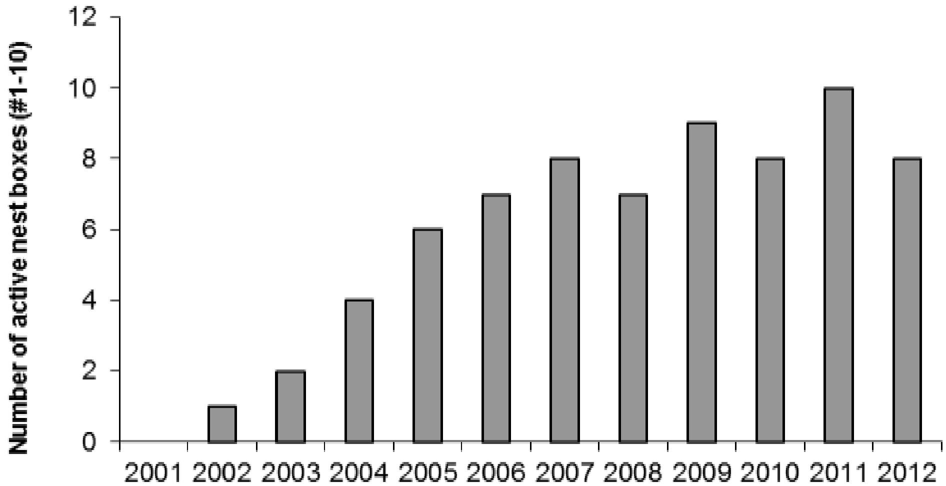

Figure 9. Use of nest boxes by Pigeon Guillemots, Lookout Point, East Limestone Island, 2001-2012.

Cassin's Auklets and Fork-tailed Storm Petrels

Ptychoramphus aleuticus and Oceanodroma furcata

Small populations of Cassin's Auklets and Fork-tailed Storm Petrels breed on Limestone Island. Like Murrelets, these species are nocturnal burrow nesters and are only active in the colony at night. Breeding activity on the island has fluctuated over the years, partly attributed to predation by introduced raccoons. Each season we monitor several locations on the island for breeding activity in order to obtain an index of the breeding population. Knock-down sticks are placed at the entrances of all known burrows (natural nest cavities) and nest boxes (artificial nest cavities) early in the season and we return regularly to monitor activity.

Breeding activity

2010 --. We monitored Cassin's Auklet breeding activity at Lookout Point and on the East Coast. At the East Coast plots (North and South) we monitored a total of 46 nest boxes: 44 installed in 2007 and two old boxes. At Lookout Point we monitored 25 boxes, also installed in 2007. A total of eight boxes were active at the East Coast plots, and three at Lookout Point based on knockdown activity. We checked these boxes for chicks beginning on 16 May, at which time boxes #31 (E. Coast N. Plot) and #3 (E. Coast S. Plot) contained an adult incubating, and box #1 on E Coast S. plot had a cold egg. Because of the number of incubating adults found at the E. Coast site, a complete check of the Lookout Point boxes was deferred until 30 May at which point box #7 contained a large chick and box #6 contained an adult incubating. A young chick was found in box #3 (E. Coast S. Plot) on 30 May, but subsequently died. The only box from which a chick fledged successfully was #7 at Lookout Pt. The chick in this box was banded on 24 June at which point it had all its adult plumage and appeared to be near fledging. It was later verified that the chick had left the box and presumably fledged.

Natural burrows were monitored at the East Coast site and at Lookout Point using knockdown sticks. There were a total of 24 active burrows at the East Coast site, and five active at Lookout Point. No monitoring of Casssin's Auklet burrows took place at Cassin's Tower this season.

The amount of Storm petrel activity in 2010 was greater than in past years, based on the number of days the species was recorded in the daily bird checklist (36). Petrels were very noisy at night during May, particularly in the area NE of funnel 6 and near Lookout Point.

2011 --. There were chicks present in eight boxes this season: four in North Plot (#19, 21, 30, 31), three in South Plot (#1, 4, 5), and one at Lookout Point (#7). Chicks were weighed at four day intervals and we banded six chicks on 6 July. The chicks in box #1 and box #31 fledged between 1-4 July and were not banded. There were 26 active burrows at the East Coast site, and four active at Lookout Point. No monitoring of Cassin's Auklet burrows took place at Cassin's Tower this season.

The amount of Storm petrel activity this season was similar to the average, based on the number of days the species was recorded in the daily bird checklist. Petrels were heard frequently at night during the murrelet season, particularly in the area NE of funnel 6 and near Lookout Point.

2012 --. Seven boxes contained chicks: four in North Plot (#18, 23, 25, 30), one in South Plot (#4), and two at Lookout Point (#6, 7). Chicks were weighed at five day intervals and two chicks were banded. The chick from #18 fledged between 21 and 26 June. There was one chick remaining (#23) at the end of the season. The other five chicks died before fledging, presumably from a shortage of food in the local area. Cassin's feed mainly on krill and it was presumed this feed was further offshore this year, making it more difficult for adult birds to bring food to their young.

There were 25 active burrows at the East Coast site, and five at Lookout Point. There was no monitoring of Cassin's Auklet burrows at Cassin's Tower. We also set up an infrared, motion activated camera in front of nestbox #25 and got several photos of the adult entering the box and the chick in the entrance way.

Cassin's auklet visiting nestbox at night.

The amount of Storm petrel activity this season was similar to average, based on the number of days the species was recorded in the daily bird checklist (2012= 32, 2011 = 30, 2010 = 36, 2009 = 31, 2008 = 28, 2007 = 34). Petrels were heard frequently at night during the murrelet season, particularly in the area NE of funnel 6 and less frequently near Lookout Point.

At-Sea Surveys

Boat surveys are conducted throughout the season to monitor the distribution and abundance of marine birds and mammals encountered along pre-determined 100m wide transects in Laskeek Bay. The objective of the surveys is to develop a strong baseline dataset for marine wildlife in the Laskeek Bay area as well as to specifically monitor the abundance and distribution of Marbled Murrelets (*Brachyramphus marmoratus*), a forest canopy nesting seabird that is provincially red listed and designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These surveys have been conducted since 1991 and represent a very important dataset within the province.

2010

Due to poor weather and time constraints, we completed only one full nearshore survey in 2010. Another survey was started but had to be called off due to deteriorating weather conditions. Nearshore surveys cover the inshore waters as far North as Cumshewa Island and South to Haswell Island. We completed a partial survey on 11 May, and a complete survey on 20 June. On these two surveys we recorded 12 species: Marbled Murrelet, Pigeon Guillemot, White-winged Scoter, Pelagic Cormorant, Red-necked Grebe, Common Loon, Ancient Murrelet, Herring Gull, Rhinoceros Auklet, Common Murre, Glaucous-winged Gull and Harlequin Duck. A total of 50 Marbled Murrelets were counted on the 20 June survey.

2011

We completed three nearshore surveys, on 9 May, 22 May and 16 June. On these three surveys we recorded 18 species: Marbled Murrelet, Pigeon Guillemot, White-winged Scoter, Pelagic Cormorant, Red-necked Grebe, Common Loon, Ancient Murrelet, Herring Gull, Rhinoceros Auklet, Common Murre, Glaucous-winged Gull, Harlequin Duck, Black Oystercatcher, Pacific Loon, Black-legged Kittiwake, Belted Kingfisher, Brant and Cassin's Auklet. A total of 224, 291 and 356 Marbled Murrelets were counted on the 9 May, 22 May, and 16 June surveys, respectively.

Hecate Strait surveys were also conducted in 2011. This survey takes us approximately five nautical miles into Hecate Strait, and allows us to see species that tend to stay farther from shore. Hecate Strait surveys were carried out on 18 May and 19 June. Large flocks of Red-necked Phalaropes (1230 estimated), and a flock of approx 100 Whimbrel were seen migrating North on the first survey. Sooty Shearwaters, not commonly seen in nearshore waters, were seen on both surveys.

2012

Three nearshore surveys were completed: 23 May, 9 June and 19 June. On these surveys we recorded 15 species: Bald Eagle, Marbled Murrelet, Pigeon Guillemot, White-winged Scoter, Pelagic Cormorant, Common Loon, Ancient Murrelet, Rhinoceros Auklet, Common Merganser, Harlequin Duck, Glaucous-winged Gull, Black Oystercatcher, Pacific Loon. A total of 15, 55 and 22 Marbled Murrelets were counted on the 23 May, 9 June, and 19 June surveys, respectively. The numbers of Marbled Murrelets were much lower than those in previous years.

Due to poor weather and lack of time we only completed one Hecate Strait survey this year, on 28 May. Sightings included Common Murres, Sooty Shearwaters and Cassin's Auklets.

Marine Mammals

We keep a daily record of all marine mammal sightings, with the exception of Harbour seals (*Phoca vitulina*) and Steller sea lions (*Eumetopias jubatus*) which are seen daily from camp. These species are counted at specific haulouts during sea surveys in order to keep an index of population trends. There are several sea lion haulouts in Laskeek Bay. The largest of these is on rocks off the East end of Reef Island and there are smaller haulouts on the Skedans Islands, Cumshewa Rocks and Helmet Island. We regularly count the number of individuals on the Reef and Skedans haulouts and inspect them for brands applied by biologists in Alaska. Recent trends are summarized in Table 3.

Table 3. Total counts of marine mammals reported by ELI crew from sea surveys, sea watches and other sightings, 2006 to 2012†

Common Name	Scientific name	2012	2011	2010	2009	2008	2007	2006
Dall's porpoise	*Phocoenoides dalli*	0	8	0	0	0	0	0
Grey whale	*Eschrichtius robustus*	1	1	0	0	0	0	1
Harbour porpoise	*Phocoena phocoena*	4	19	0	10	0	1	4
Humpback whale	*Megaptera novaeangliae*	14	193	86	102	261	203	91
Killer whale	*Orcinus orca*	13	49	11	14	18	26	4
Minke whale	*Balaenoptera acutorostrata*	2	1	0	0	1	3	1
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	0	0	46	334	0	81	365
California sea Lion	*Zalophus californianus*	0	1	1	0	0	4	0

† Harbour seal *Phoca vitulina* and Steller sea lion *Eumetopias jubatus* sightings are not reported here. Sightings do not necessarily reflect number of individuals, as individuals may be recorded more than once.

Humpback whales

2010 --. Humpback sightings were fewer in 2010 than in recent years. As in the past, most of the sighting took place in the first half of May and then became less frequent. On 17 May we counted approximately 20-30 humpbacks feeding East of Reef, and the Reef crew reported having seen more than 50 individuals on one occasion. There were continued reports of large numbers of humpbacks East of Reef Island later in the season, but they had moved further offshore and we did not see them.

2011 --. We recorded more humpback sightings in 2011 than in the previous two years. They were frequently seen in the vicinity of Reef Island through May, before they moved on in early June. On 25 May we saw a large group of approximately 20-30 humpbacks feeding between Reef and Hemming Head. The last Humpback sighting was on 11 June.

2012 --. There were far fewer humpback sightings in 2012 than in recent years. Some tour boats reported seeing the whales much further out into Hecate Strait this year, indicating the feed was further offshore. The 14 humpbacks we did encounter were relatively close to shore and all appeared to be travelling, not feeding.

Killer whales

2010 --. There were four sightings of Killer whales: two in Laskeek Bay in May, and another group was sighted along the E. shoreline of Ramsay Island while we were surveying oystercatchers on 7 June. We took ID photographs of these 3 groups to contribute to the Killer whale database at the Pacific Biological Station in Nanaimo. Our last sighting occurred on 1 July, from camp on Limestone. It was too late in the evening to follow this group or get photographs.

2011 --. There were 9 sightings of Killer whale groups, and we were able to take ID photographs of 6 of them. Eight of the sightings were in the Laskeek Bay area and the other sighting was of two large males seen off the west end of Faraday Island during the BLOY survey on 5 June. The number of Killer whale sightings this season was higher than in previous years.

2012 --. There were five sightings of Killer whale groups, and we were able to photograph three of them. All five sightings were in the Laskeek Bay area.

Steller's sea lion

2010 --. The maximum number counted this season was 505 individuals at Reef Rocks (11 May) and 115 at Skedans Islands (6 may). No marked individuals were seen this season.

2011 --. The maximum numbers counted this season were 649 individuals at Reef Rocks (18 May) and 65 at Skedans Islands (9 May). No marked individuals were seen this season. At least one California sea lion was present at Reef Rocks this season.

2012 --. The maximum numbers counted were 521 individuals at Reef (10 May) and 68 at Skedans Islands (10 May). On 8 June, a branded individual (904R) was present at Reef Rocks. No California sea lions were seen or heard this year.

Wildlife Trees

Cavity nesting birds have been monitored on Limestone Island since 1990. Wildlife trees (dead standing snags used by cavity nesting birds) were monitored opportunistically from 1990-94, and since 1995 there has been a systematic effort each year to cover the island thoroughly looking for active trees. Through this monitoring program, LBCS has amassed a long-term data set on tree use across many years, showing the importance of these trees as habitat for cavity nesting species. A total of 139 wildlife trees have been identified over the past 23 field seasons. New trails cut in 2012 allowed some of the more difficult trees in the blow-down to be more accessible. The nest history of five of the longest active trees is presented in Table 4. Tree 45 fell in 2010, and Trees 16 and 33 fell as a result of the blow-down in winter 2010-2011. Tree 10 was reduced in height and 17 was intact in 2011, but neither was active in 2011 or 2012.

Table 4. Activity by cavity nesting bird species† at wildlife trees #10, #16, #17, #33 and #45.

	Wildlife Tree #				
Year	**10**	**16**	**17**	**33**	**45**
1992	RBSA				
1993		RBSA	RBSA		
1994					
1995				RBSA	
1996		HAWO	RBSA	RBSA	RBSA
1997			CBCH	RBSA	
1998				NOFL	
1999			RBSA	RBSA & HAWO	
2000		RBSA	RBSA	RBSA	RBSA
2001	RBSA			RBSA	RBSA
2002	CBCH	RBSA	RBSA		RBSA
2003	CBCH		RBSA		RBSA
2004			RBSA	RBSA	RBNU
2005	RBSA		RBSA		CBCH
2006	RBSA		NOFL		RBSA
2007	RBSA				RBSA
2008			RBSA	RBSA	RBSA
2009	CBCH	RBSA	RBSA	RBSA	RBSA
2010		RBSA	RBSA		Fallen
2011		Fallen		Fallen	Fallen
2012		Fallen	Fallen	Fallen	Fallen

†RBSA = Red-breasted Sapsucker, CBCH = Chestnut-backed Chickadee, NOFL = Northern Flicker, HAWO = Hairy Woodpecker

2010

Observations of wildlife trees began in early May. We found 18 active trees, seven of which were newly identified this year. Eleven nests were occupied by Red-breasted Sapsuckers, three by Chestnut-backed chickadees, one by Hairy Woodpeckers, and four by Brown Creepers (Table 5). One tree (#107) was used by both RBSA and CBCH in 2010. There were more than usual BRCR nests found in 2010. Creeper nests have only been located in nine years, and 1998 (two nests) was the only other year when multiple nests were found.

Table 5. Wildlife tree activity on East Limestone Island in 2010. †

Tree #	Cavity Nester	Tree Species	Fledge Date
16	RBSA	Hw	14 June*
17	RBSA	Ss	19 June
71	RBSA	Ss	21 June*
72	RBSA	Ss	19 June
106	RBSA	Ss	17 June
107	RBSA / CBCH	Ss	17 June / 3 July
111	RBSA	Hw	13 June*
112	RBSA	Hw	4-13 June
121	RBSA	Hw	6-11 June
124	RBSA	Hw	19-27 May
129	RBSA	Ss	4-16 June
119	BRCR	Cr	30 May*
125	BRCR	Ss	30 May*
127	BRCR	Ss	4-13 June
128	BRCR	Cr	4-13 June
117	CBCH	Ss	2 June
130	CBCH	Ss	After 8 July
126	HAWO	Ar	6-13 June

†RBSA = Red-breasted Sapsucker, CBCH = Chestnut-backed Chickadee, NOFL = Northern Flicker, HAWO = Hairy Woodpecker, BRCR = Brown Creeper, Ss = Sitka spruce, Hw = Western hemlock, Cr = Red Cedar, Ar = Red Alder.
*Fledge dates approximate within 2 days. For dates given as a range, fledging may have occurred on any day between the dates given.

2011

Beginning in early May, we inventoried known wildlife trees to determine which had survived the blow-down of the past winter. Once this was complete, we began to visit the intact trees looking for signs of activity. Finding and accessing trees was more complicated this year because of the difficulty presented by the blow-down. There were 14 active trees, six of which were newly identified this year: 12 were occupied by Red-breasted Sapsuckers, two by Chestnut-backed Chickadees and one by Brown Creepers (Table 6). One tree (#66) was used by both RBSA and BRCR in 2011.

Table 6. Wildlife tree activity on East Limestone Island in 2011. †

Tree #	Cavity Nester	Tree Species	Fledge Date*
12	RBSA	Ss	15-20 June
51	RBSA	Ss	-
66	RBSA/BRCR	Hw	-
109	RBSA	Ss	-
113	RBSA	Hw	11-15 June
115	CBCH	Hw	-
116	CBCH	Ss	-
129	RBSA	Hw	15-18 June
131	RBSA	Hw	-
132	RBSA	Ss	-
133	RBSA	Hw	19 June
134	RBSA	Hw	11-15 June
135	RBSA	Hw	20-23 June
136	RBSA	Ss	-

† Abbreviations as in Table 5.

2012

There were 14 active trees in 2012, three of which were newly identified this year. Eight were occupied by Red-breasted Sapsuckers, two by Chestnut-backed Chickadees, one by Hairy Woodpeckers, one by Brown Creepers and one by Red-breasted Nuthatches (Table 7). The last time a Red-breasted Nuthatch was found nesting on Limestone was in 1996.

Table 7. Wildlife tree activity on East Limestone Island in 2012. †

Tree #	Cavity Nester	Tree Species	Fledge Date*
12	RBSA	Ss	14 June
98	RBSA	Ss	19-22 June
103	BRCR	Hw	14-23 June
107	RBSA	Ss	19 June
109	RBSA	Ss	19-22 June
113	RBSA	Hw	12-15 June
115	CBCH	Hw	24 June
120	CBCH	Ss	28 June-8 July
129	RBSA	Hw	13-15 June
131	HAWO	Hw	2-7 June
134	RBSA	Hw	24 June
137	RBSA	Ss	19-21 June
138	RBNU	Ss	24 June
139	RBSA	Ss	19-20 June

† Abbreviations as in Table 5.

NATURAL HISTORY

Daily Bird Checklist

We keep a daily record of all the bird species seen or heard within Laskeek Bay.

In 2010 61 species were recorded, and in 2011 and 2012, 64 species. Peak dates for species recorded fell on 6 May 2010 (39 species), 9 May 2011 (42 species) and 5 May 2012 (38 species). Bald Eagles, Common Ravens, Black Oystercatchers, Glaucous-winged Gulls, Pigeon Guillemots and Northwestern Crows were recorded most frequently. The less frequently sighted species in 2010 included Black Scoter, Common Merganser, Whimbrel, Wandering Tattler, Black Turnstone, Wilson's Warbler, Tree Swallow, Spotted Sandpiper, Northern Pintail, Greater White-fronted Goose, American Widgeon, Common Goldeneye, and Western Grebe; in 2011 Black Scoter, Red-necked Phalarope, Greater White-fronted Goose, Common Goldeneye, Snipe, Snow Goose, Greater Scaup and Eurasian Collared Dove and in 2012 a Wilson's Warbler, Red-breasted Nuthatch, Northern Flicker, Red-tailed Hawk, Tree Swallow, Spotted Sandpiper, Western Sandpiper, Surfbird, Whimbrel (four sightings), and Red-throated Loon. Two Tufted Puffins were also seen in 2012 (11 July) flying north near South Low.

There were more daily records of woodpeckers in 2012 than in the past. Hairy Woodpeckers were recorded on 44 days and Northern Flickers on 52 days (out of 59 days). In 2011, Hairy Woodpeckers were recorded 29 days and Northern Flickers on only one day (out of 61 days). This could be due in part to the more open forest post blow-down, with more dead trees available for nesting or feeding.

Raptors and Corvids

As in the case of cavity nesting birds, we make a concerted effort through the season to keep track of large predatory birds including Bald Eagles, Peregrine Falcons, Common Ravens and Northwestern Crows.

2010

In 2010, no Bald Eagles were confirmed nesting on East Limestone Island. They were seen frequently in the vicinity of the NE point (BAEA #7), but because it is difficult to see this nest, breeding activity was not confirmed. Eagles also breed on other islands in Laskeek Bay: eagle chicks were observed in nests on S. Low, Skedans Islands, and Lost Islands. Peregrine Falcons raised two chicks on the cliff located at the South side of the island. The nest ledge was observed on 2 & 25 June and appeared to be active, although no chicks could be seen. The adult peregrines were nearby and agitated. Two young peregrines were observed flying with their parents in early July, confirming that the pair was successful in raising chicks this season. The Common Raven nest near the deer exclosures was again active this season. Young could be heard in the nest upon arrival on the island on 1 May, and the chicks were observed taking their first flights from the nest on 29 May. Inspection of the area below the nest showed fewer murrelet remains and more abalone shells (23) than seen in past seasons.

2011

Two pairs of Bald Eagles were confirmed nesting this season on Limestone Island. Eagles were seen sitting on the nests at both BAEA-3 and BAEA-7. Peregrine Falcons raised three chicks on the cliff located at the South side of the island. The nest ledge was observed on 11 June at which point an adult peregrine was observed feeding three large chicks which already had many of their adult feathers, and likely fledged by mid to late June. The Common Raven nest near the deer exclosures was destroyed by the blow-down, but the pair built a new nest in a smaller spruce tree approximately 100m to the south. Young could be heard in the nest in early May. The chicks were observed hopping between branches near the nest on 26 May and fledged shortly afterwards. The area below the nest was checked for predation remains shortly after the chicks fledged. No murrelet wings were found and only a few pellets containing murrelet feathers. Unlike last season there were no abalone shells found under the nest.

2012
Three pairs of Bald Eagles nested on Limestone Island: two in previously identified trees BAEA-3 and BAEA-7 and one in new tree BAEA-9. The Peregrine Falcon reared three chicks this year at their usual location along the south cliffs. The nest ledge was observed on 29 May at which point an adult was observed feeding three downy chicks. The Common Raven nested in the same tree as in 2011. Young chicks could be heard from the main trail in early May and were confirmed in the nest on 9 May. The chicks were confirmed fledged by 27 May and could be seen in the trees nearby.

Plants

Relatively few wildflowers and berry bushes remain on Limestone Island as a result of heavy browsing by introduced deer. Most flowering plants are restricted to cliff areas where the deer cannot reach them. We recorded the dates on which particular species were first observed in bloom. Anecdotal observations suggest that plants bloom much earlier on islands such as S. Low where deer are absent.

2010 --. A number of rare plants are present on Limestone due to the limestone geology which is uncommon on the rest of the Haida Gwaii. Showy Jacob's Ladder (*Polemonium pulcherrimum*), Few-flowered Shootingstar (*Dodecatheon pulchellum*), Richardson's Geranium (*Geranium richardsonii*), Tufted Saxifrage (*Saxifraga cespitosa*) and Cut-leafed Anemone (*Anemome multifida*) were all seen in bloom this season. Several invasive plants have become established on Limestone Island including bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), prickly Sow-thistle (*Sonchus asper*), and wall lettuce (*Lactuca muralis*).

We continued a pilot project began last season to address the problem of invasive plants in Laskeek Bay. Plots where we had pulled plants last season were re-visited to assess the impact of last season's treatment. In general, only a slight reduction in plant density was noted in areas where thistles were pulled last season. Some manual removal of thistles was completed this season, and black plastic sheeting was put down over one particularly large patch of Canada thistle to test the effectiveness of this treatment.

2011
Only Showy Jacob's Ladder and Few-flowered Shootingstar were recorded blooming in 2011, and it appears that the one known clump of Tufted Saxifrage was washed away by storm waves last winter.

2012
Lichenologist Stu Crawford spent a week volunteering this year, identifying different lichen specimens on Limestone Island. He identified a large number of *Plasmatia*, *Lobaria*, *Pseudocyphellaria*, *Nephroma*, and *Peltigera* species as well as many others. He also found a rare *Lichenompholina* sp., growing on a rotten log near Cassin's nestbox #1 (East Coast, South Plot). See the separate report titled 'Lichens of East Limestone Island' (page 71-78) for more details.

Introduced Species

Sitka Black-tailed Deer

Odocoileus hemionus

Deer were intentionally introduced to Haida Gwaii in 1878 to provide game meat for local people. Because they have no major predators on the islands, the deer population has reached very high density and has dramatically altered plant communities, particularly in the forest understory. LBCS is a partner in the Research Group on Introduced Species (RGIS, www.rgisbc.com) which has carried out extensive research on this topic in Laskeek Bay, as well as elsewhere in Haida Gwaii. On Limestone Island, we maintain three 20m x 20m deer exclosures that dramatically demonstrate the impact of deer browsing on native vegetation. The interior of the exclosures contain abundant understory vegetation including huckleberry, salal, ferns, and young trees that are almost entirely absent from areas accessed by deer. Unfortunately, the deer exclosures are difficult to maintain, due to damage caused by falling trees in the winter months.

2010

Deer exclosure #3 was breached at some point between the 2009 and 2010 field seasons and deer had entered and eaten much of the vegetation. This exclosure was repaired during the first week in camp and the vegetation showed a marked recovery over the course of the season. In 2009 we installed a small deer exclosure around a pair of large huckleberry bushes near the main trail. These old bushes are dying of old age all over the island and this experiment illustrated how quickly these bushes can regenerate from their base if browsing is prevented. By the end of the 2010 season, some of the new growth within this exclosure was close to a metre tall.

2011

Exclosures 1 and 2 were completely destroyed by blow-down in the past winter. Exclosure #3 was also badly damaged but we were able to complete repairs, although it was made slightly smaller in the process. The huckleberry, salal, ferns, and young trees in the interior of exclosure #3 had been browsed by deer over the winter, but showed substantial recovery by the end of the season. This type of understory vegetation is almost entirely absent from areas that deer can access, and the exclosures provided a dramatic demonstration of how quickly the understory can recover in the absence of deer. The huckleberry exclosure installed near the main trail in 2009 was also destroyed by blow-down.

2012

The understory vegetation (huckleberry, salal, ferns, and young trees) in the interior of exclosure #3 (the only one remaining after the blow-down) is almost entirely absent from areas accessible to deer. We also started recording all deer sightings on Limestone Island this year to assist with the BAMBI project. The date/time, location, tag colour/number, collar and sex were recorded along with notes on behaviour.

Raccoons *Procyon lotor*

Raccoons were introduced in the early 1940s to provide local trappers with a source of employment but, along with rats, have become one of the largest threats to ground and burrow nesting seabirds on Haida Gwaii. With few defenses against mammalian predators, birds such as Ancient Murrelets, Cassin’s Auklets and Fork-tailed Storm Petrels are very vulnerable to raccoon predation and are likely to experience rapid decline where these predators become established on colonies.

Raccoon predation is an ongoing concern on Limestone Island. During 1990 and 1991 there was considerable raccoon presence on the island and very high rates of predation. Based on predation rates observed during earlier visits to the island, it is reasonable to assume high levels of predation for the period of 1983-1989 as well (see LBCS Science Report #3 for further discussion). Raccoons were removed from the colony in 1992 and predation rates dropped dramatically. Raccoons were again present in 1993, 1994 and were suspected in 1995 and 2001. More recently a raccoon was removed from the island in 2007, and raccoon presence was confirmed again in 2009.

Due to the large raccoon population on Louise Island it seems likely that raccoons will continue to disperse to Limestone Island in future years. It is therefore very important to initiate spring surveys for raccoons to eliminate them on the breeding colony before birds begin breeding in early April. By the time field camp opens in early May raccoons, if present, can already have had considerable impact.

2010

George Schultz carried out a cull of raccoon on the shorelines of Louise Island opposite East Limestone and West Limestone Islands in March and removed approximately 10 raccoons from the adjacent shorelines. This was apparently effective in keeping raccoons off Limestone in 2010. No signs of raccoon activity were noted, and predation transects this season showed dramatically lower levels of predation.

2011

There were no spring-time surveys or culls on Limestone or Louise Island this season, however the RGIS crew was based on Limestone in the first half of April and did not see any evidence of raccoons. Baited cameras were being used on the island during deer capture work and no raccoons were seen in any of the photos. Experience from testing these cameras in Skidegate Inlet in winter 2010 indicated that raccoons were very attracted to the apples which were being used as bait. Based on this evidence we were confident that there were no raccoons present on Limestone in the early part of the season. Baited cameras were also deployed in May and no evidence of raccoons was detected.

2012

In March, director Jan Oord and trapper Len Morgan came to Limestone to monitor for raccoons. They spent seven nights (24 March to 31 March) searching the island by foot for signs of raccoons. They did not find any evidence of raccoons on Limestone, although they did see many on adjacent Vertical Point. They set traps on Vertical Point although none was successful. In April, Jake Pattison visited Vertical Point and successfully shot and killed one raccoon. To continue monitoring for raccoons throughout the Ancient Murrelet season we set up two infrared cameras on Limestone, baited with sardines and cat food. One camera was stationed in Anemone Cove and one near the cache. These cameras, along with those from RGIS, were set for the majority of the field season and captured photos of deer, ravens, and deer mice, but no raccoons.

Red Squirrels *Sciurus vulgaris*

Squirrels were introduced to Haida Gwaii in 1950, perhaps to aid in cone gathering for the forest industry. Squirrels may have been introduced to Limestone directly at this time. In any case, squirrels are well established on Limestone and are known to be a nest predator on various songbird species (see www.rgisbc.com). Since 2007 we have been completing squirrel surveys on Limestone Island to measure the annual abundance of squirrels on the island. Over time we hope to describe population cycles of this introduced species and gain a better understanding of the consequences of squirrel presence. General observations in 2011 suggested that the population of squirrels was particularly high, likely due to an abundance of cones.

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CONCLUSION

Since 1990, LBCS has focused on developing baselines and long-term data sets for the marine and terrestrial ecosystems of Laskeek Bay, as well as allowing volunteers, students and visitors the chance to visit our research camp. The society remains dedicated to long-term monitoring and engaging the public in addressing local conservation issues.

Data gathered in North Cove in 2010 shed more light on the causes of decline in the Ancient Murrelet colony on Limestone Island. The decline in chick numbers over the period from 1990 to 2006 led to the closure of all activities in North Cove for a three year period (2007, 2008, 2009). The area was re-opened in 2010 but chick numbers showed no recovery relative to Cabin Cove where chick work had continued annually. This evidence strongly suggests that our research activities, as they are now conducted, are not involved in the decline seen since 2006. Our presence on the island may well be the sole defense that Ancient Murrelets have against raccoons, and therefore the importance of raccoon eradication on Limestone Island and the adjacent shorelines of Louise Island, particularly early in the season, cannot be overstated.

Major challenges arose in 2011 due to the extensive blow-down that occurred over the previous winter. The murrelet colony area was severely disrupted, particularly in North Cove. It is hard to assess what the long-term consequences will be for the population. Large areas of the island are now difficult to access which has created difficulties for wildlife tree monitoring and other island based activities. Despite the challenges, this natural disturbance event may open up new opportunities to study forest recovery. LBCS will welcome any opportunity to collaborate with individuals or organizations interested in the monitoring of rejuvenation and recovery following this large natural disturbance in our coastal temperate rainforest.

Social attraction was used in 2011 and 2012 in an attempt to increase the Ancient Murrelet breeding population of Limestone Island. The disturbance to the colony area caused by the blow-down will make it difficult to assess if the approach is effective. However, we feel that there is enough evidence from other studies to warrant the continuation of the project in future years. Along with the core long-term monitoring programs, LBCS also hopes to incorporate more island restoration techniques in future field seasons. The amount of blow-down has prevented us from continuing our regular funnel monitoring work in North Cove, although cameras did indicate that at least some parts of the colony are still active.

The continued viability of the Ancient Murrelet colony on Limestone depends on the absence of introduced predators, and therefore the importance of raccoon eradication on Limestone Island and the adjacent shorelines of Louise Island, particularly early in the season, cannot be overstated. The lessons that we learn on Limestone Island will be of great importance when considering the prospects of other colonies threatened by introduced raccoons and rats as they continue to disperse throughout the many islands of Haida Gwaii.

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Appendix 1

Banded Black Oystercatchers re-sighted in Laskeek Bay and northern Gwaii Haanas in 2010-2012.
(a) 2010

Band combination (Left - Right)[1]	Location seen / Nest site	Year Banded	Banded as Adult or Chick
W-LG/M	Low Island, non-territorial bird	2008	Chick
UB-M	Skedans Islands, non-territorial bird		
UB-M	SKE-6, both members of pair banded		
UB-M	SKE-6, both members of pair banded		
AL-BK/M	Cumshewa Island, not clearly associated with a territory	2000	Adult
UB-M	North side of Reef Island East of Camp		
UB-Or/M	LOS-2, one individual of 3 present in territory	2004	Chick
W-LG/M	In group of 6 non-territorial birds near REE-7	2008	Chick
M-UB	REE-11. New territory on S. Side of Reef Island. Both members of pair banded.		
UB-Br/M	REE-11. New territory on S. Side of Reef Island	2001	Chick
UB-M	REE-1. Band number 63028.	2000	Adult, REE-1
UB-Y/M	LOU-2. In group of three adults present at territory.	2007	Chick
UB-M	KNG-3		
UB-R/M	SLW-1. Both members of pair banded.	2003	Chick
UB-Bk/M	SLW-1. Both members of pair banded.	2000	?
UB-Y/M	East end of Reef Island (sealion haulout)	2007	

Survey	Band combination (Left - Right)[1]	Location seen / Nest site	Year Banded	Banded as Adult or Chick
1	UB-M	EM-560-4-1, may be from EM-560-4-2	unknown	Chick
1	W-W/M	E. side Ramsay Island in group of 7	2009	Chick
1	DB-DB/M	N. side Faraday Island in group of 6	2006	Chick
1	DB-DB/M	E. end House island, member of a pair	2006	Chick
2	UB-Or/M	EM-470-6-1 (last 4 digits of band: 6906.)	2004	Chick, 470-4-1
2	UB-DB/M	EM-560-4-1, may be from EM-560-9-1	2006	Chick
2	DB-DB/M	N. side Faraday Island in group of 7. May be same individual that was sighted on first survey – same location.	2006	Chick
2	W-W/M	E. side Ramsay Island in group of 8. May be same individual that was sighted on first survey – same location.	2009	Chick
2	UB-Or/M	N. shore Ramsay Island in group of 5	2004	Chick
2	UB-DB/M	EM 560-9-1, member of pair	2006	Chick

[1]Band codes: UB = unbanded (birds can lose bands), M = metal, Or = Orange, W = white, LG = Light Green, R = Red, Bk = Black, Br = Brown, Y = Yellow, DB = Dark blue

(b) 2011

Band combination (Left - Right)[1]	Location seen / Nest site	Year Banded	Banded as Adult or Chick
UB-DB/M	LOW-3	2006	Chick
W-W/M	Lookout Pt, ELI. In a group of 3 birds.	2009	Chick
UB-M	REE-1	2000	Likely as Adult, REE-1

Survey	Band combination (Left - Right)[1]	Location seen / Nest site	Year Banded	Banded as Adult or Chick
1	UB-DB/M	560-3-1, near scrape with 2 eggs but not alarmed.	2006	Chick
1	UB-OR/M	470-6-2, one member of pair banded.	2004	Chick
1	W-LG/M	Kunga shoreline, in a group of 11 non-territorial birds.	2008	Chick
1	W-W/M	Kunga shoreline, in a group of 11 non-territorial birds.	2009	Chick
1	UB-OR/M	LOS-11. New Territory. One member of pair banded.	2004	Chick
2	UB-DB/M	N. end Tuft Islets, one member of a non-territorial pair.	2006	Chick
2	DB-DB/M	560-4-3, one member of pair banded.	2006	Chick
2	UB-OR/M	470-6-2, one member of pair banded. Likely same individual sighted at same location on first survey.	2004	Chick
2	DB-DB/M	530-6-1, one member of pair banded.	2006	Chick
2	DB-DB/M	480-1-2, one member of pair banded.	2006	Chick
2	UB-OR/M	LOS-11, one member of pair banded. Likely same individual sighted at same location on first survey.	2004	Chick

[1]Band codes: UB = unbanded (birds can lose bands), M = metal, Or = Orange, W = white, LG = Light Green, R = Red, Bk = Black, Br = Brown, Y = Yellow, DB = Dark blue

(c) 2012

Band combination (Left - Right)[1]	**Location seen / Nest site**	**Year Banded**	**Banded as Adult or Chick**
UB-DB/M	LOW-2	2006	Chick
UB-UB/M	KNG-1	Unknown	-
AL-Bk/M	SKE-6	2000	Adult
UB-UB/M	SKE-6	Unknown	-
UB-Y/M	SKE-10	2007	Chick
UB-UB/M	REE-9	Unknown	-
W-?	Reef Island	Unknown	-
M-UB/UB	REE-11	Unknown	-
UB-Br/M	REE-11	2001	Chick
UB-UB/M	Reef Island	Unknown	-
W-UB/M	SLW-1	Unknown	-
UB-UB/M	SLW-4	Unknown	-
UB-UB/M	SLW-8	Unknown	-
W-LG/M	REE-3	2008	Chick
W-W/M	Reef Island	2009	Chick
UB-UB/M	Reef Island	Unknown	-
UB-UB/M	Reef Island	Unknown	-
UB-UB/M	LOW-1	Unknown	-
UB-UB/M	LOW-4	Unknown	-
UB-UB/M	Skedans Islands	Unknown	-
UB-UB/M	KNG-3	Unknown	-

Survey	**Band combination (Left - Right)[1]**	**Location seen / Nest site**	**Year Banded**	**Banded as Adult or Chick**
1	UB-DB/M	From 560-4-?	2006	Chick
1	UB-OR/M	470-6-2, band ends in 0695. Banded on Ramsay Island @ 470-4-1	2004	Chick
2	UB-DB/M	560-3-1	2006	Chick
2	UB-UB/M	560-4-1	Unknown	-
2	UB-OR/M	470-6-2	2004	Chick
2	W-W/M	Kunga Island, in group of 19	2009	Chick
2	UB-OR/M	LOS-11	2004	Chick

[1]Band codes: UB = unbanded (birds can lose bands), M = metal, Or = Orange, W = white, LG = Light Green, R = Red, Bk = Black, Br = Brown, Y = Yellow, DB = Dark blue

ANCIENT MURRELET SOCIAL ATTRACTION EXPERIMENT ON EAST LIMESTONE ISLAND 2011

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Megaphone used for social attraction, Photo: LBCS

INTRODUCTION

The Ancient Murrelet population on East Limestone Island (ELI) has been in decline since 1990. The colony census completed in 2006 estimated ± (SE) 509 ± 132 breeding pairs compared to 1273 ± 254 pairs estimated in 1995. The most likely cause of this decline is predation of murrelets in the breeding colony by raccoons (an introduced predator).

There has been either confirmed or suspected raccoon presence on ELI in nine years since 1990 (see following report "History of Raccoons on East Limestone Island 1990-2012). Based on predation rates observed during earlier visits to the island, it is also reasonable to assume high levels of predation for the period of 1983-1989 (see LBCS Science Report #3 for further discussion). During 1990 and 1991 there was considerable raccoon presence on the island and very high rates of predation. Raccoons were removed from the colony in the fall of 1991 and predation rates dropped dramatically. Raccoons were again present in 1993, 1994 and were suspected in 1995 and 2001. More recently a raccoon was removed from the island in 2007, and raccoon presence was confirmed again in 2009. There were no raccoon sightings in 2010 or 2011.

Because of continued declines in the colony in 2011 the Laskeek Bay Conservation Society decided to begin a restoration project aimed at increasing the recruitment of Ancient Murrelets to the breeding colony, while at the same time increasing efforts to keep raccoons off the island. To attract prospecting murrelets to the colony we used "vocalization broadcasting as a means of social attraction", based on work done by Heather Major on Langara Island in 2007 and 2008. There, she used megaphones broadcasting Ancient Murrelet vocalizations to simulate a busy colony to attract prospecting birds. On Langara Island, Ancient Murrelet prospector activity increased by 271% over background levels during playback trials (Major & Jones 2011).

Our objectives were: (1) To attract potential breeders to the colony and (2)To measure the effect of broadcasting vocalizations on prospecting activity in the colony area near the broadcast locations.

METHODS

We placed two megaphones (TOA model ER2230) in separate locations within the Ancient Murrelet colony and broadcast murrelet colony sounds during the part of the breeding season corresponding to chick departures and peak prospecting activity using 2 Sony Diskman CD players. The broadcast calls were recorded at Langara Island in 2006. This work was carried out in conjunction with our night-time monitoring work involving the capture of chicks from the colony to assess population trends.

Calls were broadcast between 0:00 and 2:30 on 17 nights between 7 May and 3 June. They were not played on nights with high winds or heavy rain as this decreased the effective range of the broadcast and prospecting activity is typically lower on these nights. Megaphones were located in Spring Valley (Station 1: N52.90889, W131.61024) and behind camp (Station 2: N52.90760, W131.61069). They were positioned 3-4 ft off the ground and pointed towards the ocean and up at a slight angle from the horizontal in order to project the sound into the forest canopy. The megaphones and CD players were kept at 75% volume. This is likely much louder than natural audio levels but ensures calls are audible over other ambient noise (e.g., wind and waves).

We monitored knockdown activity at 25 potential burrows area surrounding each megaphone. The burrows were numbered and the distance from megaphone to burrow was measured with a measuring tape. (Tables 1 & 2). Knockdown sticks were set-up and checked daily to determine if birds were entering the burrows. Between 11-May and 19-May knockdowns were checked at first light and just before dark to determine if burrows were being used by diurnal animals such as squirrels.

RESULTS

Knockdown activity at the burrows that we monitored is displayed in Tables 1 and 2 below. The amount of knockdown activity at the monitored burrows was very low, averaging 0.105 (plot 1) and 0.133 (plot 2) knockdowns per 24 hr period (Tables 1, 2). The overall average proportion of knockdowns during the day in plots 1 and 2 was 0.04 and 0.071, respectively, and 0.035 and 0.057 during the night

We plotted the relationship between distance from the megaphone and knock-down activity for nights when megaphones were played and for nights when they were not played (Figs 1 and 2). Relationships between distance and knockdown activity were very weak in all cases, and megaphone broadcasts do not appear to be of any influence on this relationship.

Table 1. The average proportion of knockdowns per night at Plot 1 (megaphone on and off)

		Proportion of knockdowns (# knockdowns / 27 days)		
Burrow #	Distance from Megaphone (m)	Nights with Megaphone ON	Nights with Megaphone OFF	Total nights Megaphone ON + OFF
1	1.3	0.00	0.00	0.00
2	3	0.00	0.00	0.00
3	7.2	0.24	0.00	0.15
4	10.4	0.06	0.00	0.04
5	4.9	0.12	0.00	0.07
6	10.8	0.12	0.20	0.15

7	5.8	0.00	0.10	0.04
8	3.6	0.06	0.00	0.04
9	8.6	0.06	0.00	0.04
10	19.9	0.00	0.00	0.00
11	14.5	0.06	0.00	0.04
12	12	0.41	0.40	0.41
13	10.6	0.00	0.00	0.00
14	13.2	0.59	0.20	0.44
15	13	0.53	0.20	0.41
16	7	0.12	0.00	0.07
17	10.4	0.12	0.00	0.07
18	22.4	0.00	0.10	0.04
19	18.8	0.24	0.00	0.15
20	22.3	0.18	0.10	0.15
21	18.1	0.12	0.10	0.11
22	21.8	0.06	0.00	0.04
23	30.7	0.18	0.10	0.15
24	34	0.00	0.00	0.00
25	39.2	0.00	0.10	0.04

Table 2. The average proportion of knockdowns per night at Plot 2 (megaphone on and off)

		Proportion of knockdowns (# knockdowns / 27 days)		
Burrow #	Distance from Megaphone (m)	Nights with Megaphone ON	Nights with Megaphone OFF	Total nights Megaphone ON + OFF
1	7.8	0.12	0.30	0.19
2	13.3	0.71	0.70	0.70
3	17.5	0.18	0.10	0.15
4	20	0.35	0.10	0.26
5	21	0.00	0.00	0.00
6	21.5	0.12	0.00	0.07
7	17.8	0.00	0.00	0.00
8	19	0.00	0.10	0.04
9	20.5	0.06	0.00	0.04
10	20.5	0.12	0.00	0.07
11	24.5	0.18	0.10	0.15
12	22.5	0.06	0.00	0.04
13	21.4	0.00	0.00	0.00
14	27	0.71	0.50	0.63
15	33.5	0.06	0.00	0.04
16	30	0.18	0.10	0.15
17	35	0.18	0.00	0.11
18	32.1	0.00	0.00	0.00
19	9.6	0.06	0.00	0.04
20	17.4	0.47	0.20	0.37
21	28	0.12	0.10	0.11
22	21	0.06	0.00	0.04
23	38.8	0.12	0.00	0.07
24	52.4	0.12	0.00	0.07
25	56	0.00	0.00	0.00

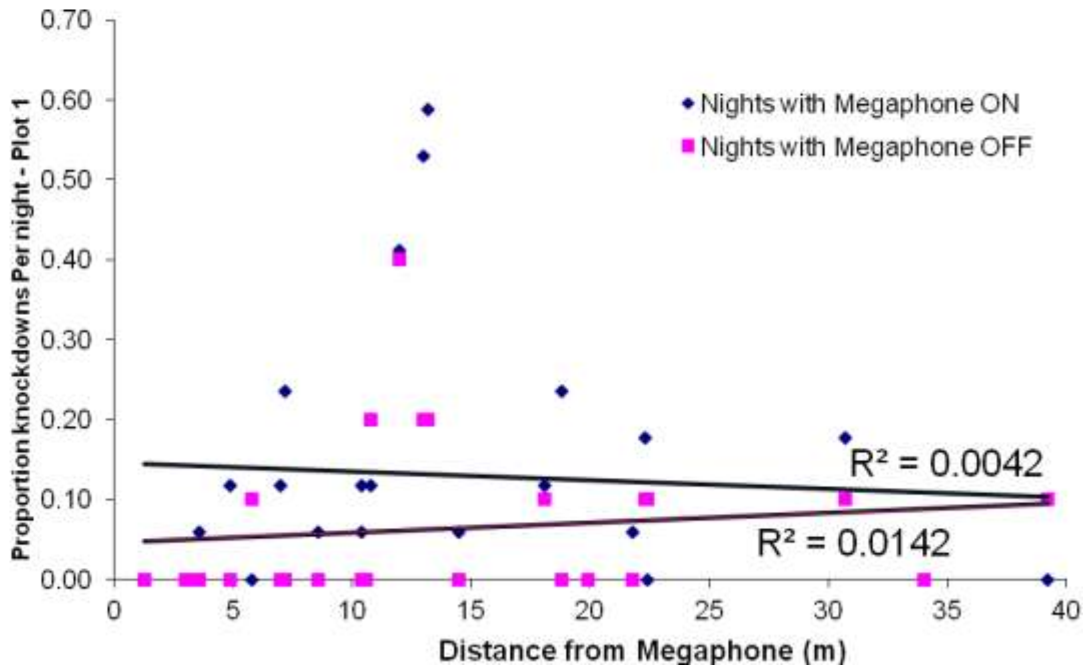

Figure 1. Proportion of knockdowns versus distance from the megaphone for, Plot 1.

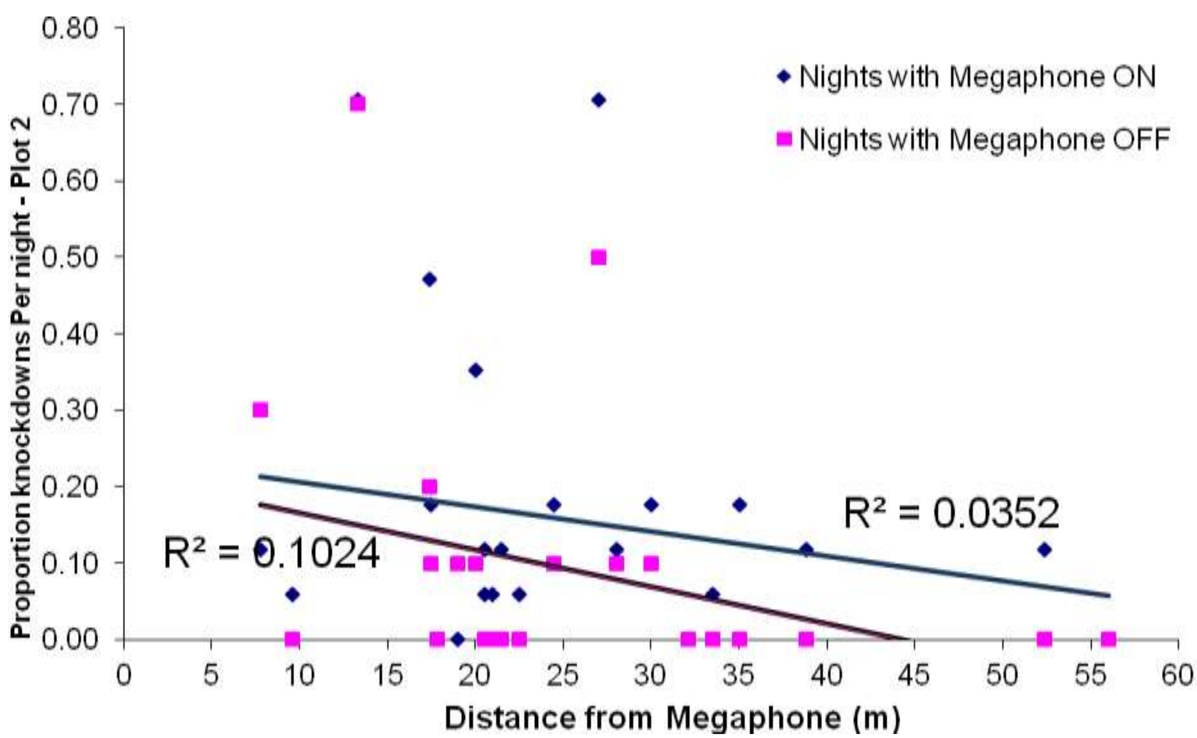

Figure 2. Proportion of knockdowns versus distance from the megaphone, Plot 2

DISCUSSION

Megaphones appeared to be successful in attracting murrelets, as birds were seen sitting next to the megaphone on several occasions. However, there was no apparent increase in knockdown activity close to the broadcast stations on nights when the megaphones were playing, suggesting that the amount of prospecting activity near the megaphones was not elevated on those nights. Inspection of the relationships showed a very low level of correlation with distance. The overall low proportion of knockdowns, and the fact that somewhat more than half of the observed knockdowns were shown to be occurring during the day (attributed to squirrels) limited the effectiveness of this approach to a large extent. This approach also makes the assumption that prospecting activity would be highest at points closest to the location of broadcast, however this may not be the case.

Due to the large blow-down events of winter 2010, there is relatively little colony area left intact on ELI, and this natural disturbance is also a confounding factor in testing the effectiveness of megaphone broadcasts. The true test of the social attraction method would have been to see if broadcasts translated, over a period of several years, to an increase in the number of departing chicks compared to those areas that did not have megaphones. Unfortunately, this is not likely to be possible given the limited remaining colony area and loss of ability to make comparisons to previous years.

This project was similar to work done on Langara Island in 2007 and 2008 (Major & Jones 2011. The main difference between these two projects is that work on Langara Island was conducted in an abandoned colony area, with no breeding Ancient Murrelets. This approach has not yet been tested on a declining, yet still active, colony. Further work is needed to determine whether social attraction can translate into population increase in existing low density colony areas.

When continuing this project in future years it is essential that effective raccoon control measures are in place to protect the remaining breeding population and allow new breeders to become established. Social attraction methods should not be used if racoons are present or suspected to be present in the colony area.

References

Major, H. L., and I. Jones. 2011. An experimental study of the use of social information by nocturnal burrow-nesting seabird prospectors. Doctor of Philosophy Thesis. Simon Fraser University, British Columbia.

HISTORY OF RACCOONS ON EAST LIMESTONE ISLAND 1990 – 2012

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SUMMARY

Raccoons *Procyon lotor* were present on East Limestone island during the Ancient Murrelet breeding period in at least six years during 1990-2012. Their presence was suspected, but not proven in another three years. They were present every year from 1990-1995, except for 1992, after very intensive culling of raccoons on East Limestone Island and adjacent part of Louis Island at the end of the 1991 season. Subsequently, they recurred only in 2001 (probably), 2007 and 2009. Counts of predation remains found on transects through the area of the Ancient Murrelet colony were much higher in years when raccoons were known to be present than in those when they were thought to be absent.

INTRODUCTION

The following information was compiled to provide a complete history of raccoon presence on East Limestone Island (ELI). The information was collected from a variety of sources, including Field Season Summaries, Science Reports, and email correspondence. The most important aim was to determine in which years raccoons were present on ELI (See Table 1). In addition, efforts made to control raccoons before and during the field season are catalogued. Many of the documents referenced were difficult to locate and they are therefore included as appendices to the web version of this document.

Background

Raccoons were introduced to Haida Gwaii in the early 1940s to provide local trappers with a source of employment. Raccoons (as well as rats) are one of the largest threats to ground and burrow nesting seabirds on Haida Gwaii. With few defences against mammalian predators, birds such as Ancient Murrelets, Cassin's Auklets and Fork-tailed Storm Petrels are very vulnerable to raccoon predation and are likely to experience rapid decline where these predators become established on colonies (Gaston and Masselink 1997, Hartman et al. 1997).

Raccoon predation is an ongoing concern on the Limestone Islands. In 1989 the presence of raccoons on East Limestone Island was strongly suspected on the basis of burrow excavations and dead adults (AJG and M.J.F. Lemon unpubl.). During 1990 and 1991 there was considerable raccoon presence on the island and very high rates of predation. Based on predation rates observed during earlier visits to the island, it is reasonable to assume high levels of predation for the period of 1983-1989 as well (see LBCS Science Report #3 for further discussion). Raccoons were removed from the colony in 1992 and predation rates dropped dramatically. Raccoons were again present in 1993, 1994 and were suspected in 1995 and 2001. More recently a raccoon was removed from the island in 2007, and raccoon presence was confirmed again in 2009.

Due to the large raccoon population on Louise Island it seems likely that raccoons will continue to disperse to Limestone Island in future years. It is therefore important to initiate spring surveys for raccoons to eliminate them on the breeding colony before birds begin breeding in early April. By the time field camp opens in early May raccoons, if present, can already have had considerable impact.

METHODS

The presence of raccoons on East Limestone Island was detected by several methods. Night time boat surveys, in which the shorelines were scanned with a 1 kW spotlight, were carried out periodically to detect raccoons foraging in the inter-tidal zone. Regular surveys for raccoon latrines were carried out along the coasts facing Louise Island, as well as opportunistically elsewhere. Latrines are usually situated close to the shore on small headlands just above high tide. In addition, regular surveys were carried out in the Ancient Murrelet colony area to detect predation remains and to assess, from the type of remains, the likely predator involved. The remains of Ancient Murrelets killed by predators are found on all murrelet colonies, but the abundance of signs and the type of predations found, depends on the suite of predators present in the area.

To obtain information on background levels of predation on East Limestone Island a series of fixed transects was established in 1990 to search for predation remains of Ancient Murrelets. Six 20m wide transects were marked on the ground and monitored at intervals during the Ancient Murrelet breeding period. The transects ranged from 120 to 200 m in length and covered 2.2 ha or approximately 15% of the total colony area. During surveys any predation remains found were removed or marked to avoid double-counting on subsequent surveys.

In addition to the transects, all casual encounters with Ancient Murrelet predations that were thought to be mammalian were recorded. When raccoons were thought to be present on the island various additional surveys were carried out.

Table 1. Summary of Raccoon Presence on ELI, 1989-2012

Year	Raccoons present?	Transect kills	Cull in previous season?
1989	Probably		No
1990	Confirmed	88	No
1991	Confirmed	127	No
1992	No evidence	18	Yes
1993	Confirmed	93	Yes
1994	Confirmed	58	Yes
1995	Suspected	45	Yes
1996	No evidence		No
1997	No evidence		Yes
1998	No evidence		No
1999	No evidence		No
2000	No evidence		No
2001	Probably		No
2002	No evidence		Yes
2003	No evidence		No
2004	No evidence		No
2005	No evidence		No
2006	No evidence		No
2007	Confirmed	40	No
2008	No evidence	30	Yes
2009	Confirmed	13	No
2010	No evidence	8	Yes
2011	No evidence		Yes
2012	No evidence		No

RESULTS

1989
During Ancient Murrelet census work, several excavated burrows were found of a type later identified with raccoon predation (AJG and M.J.F. Lemon).

1990
Intensive research on raccoons was carried out by Lisa Hartman and Derek Maselink, using radio collars to track animals trapped on Louise Island adjacent to East Limestone Island (Hartman et al. 1997). A type of

predation only once before previously encountered was observed on East Limestone Island. This included freshly broken and eaten eggs and Ancient Murrelet bodies from which the head had been cleanly severed. These remains were often associated with diggings into burrows. Of a total of 30 predations of this type found, 17 were fresh carcasses found undamaged except for a severed head. Three of these carcasses were adjacent to excavated burrows. Carcasses not found next to diggings may have been scavenged by birds. A raven was seen feeding on a fresh headless carcass and a flying crow was seen to drop an otherwise undamaged, fresh headless carcass. In some cases, headless carcasses and eaten eggs were found at a burrow entrance where no digging had occurred. Of the 30 atypical predations, 16 were incidences of eaten eggs and 13 of these were associated with diggings.

One radio-collared raccoon was definitely present on East Limestone Island throughout the breeding season except for brief forays onto West Limestone Island. Other raccoons may have been present, as an adult female with two young was sighted after the breeding season was over. An adult raccoon was sighted twice in the colony area.

Evidence from the telemetry fixes shows that the radio-collared raccoon frequently crossed the island at night, traversing the colony area. Raccoon scats were found containing crab shell and Ancient Murrelet eggshell, and hairs which appeared to be raccoon were found at several sites where burrows had been dug out. Both raccoon and otter tracks were seen in an interior wet area outside the colony where there was a high concentration of predation remains. The few otter scats observed contained only fish remains.

Transects were surveyed every 5 days from April 26 to June 13. A total of 88 murrelet predations were recorded on the transects, suggesting a predation rate of 50 birds/ha and a total of 700 predations over the 14 ha colony. Seventy-five per cent of the predations were typical avian predations as observed on other Ancient Murrelet colonies and included feather piles or wings. Twenty-five per cent of the predations included broken eggs, excavated burrows and/or decapitated, but otherwise untouched carcasses and were considered to be the work of mammalian predators. An additional 14 predations were recorded opportunistically. Some carcasses were marked to see if they were removed by other birds or animals. Circumstantial evidence pointed strongly to a raccoon as the source of mammalian predation.

1991

Intensive research continued on raccoons. At least three radio-collared raccoons were active on East Limestone Island during the murrelet breeding season, of which one was believed to be a very active bird-killer. On 11-13 June MOE Conservation Officers Mark West and Frank Guillon worked with Derek Masselink to eliminate the raccoons from the Limestone Islands. All three adult raccoons were sighted at different times in the intertidal at night, but only one was shot. Efforts to shoot the remaining two continue. During one nighttime circuit, a raccoon was seen taking a pigeon guillemot from the rocks south of the cabin, and a headless carcass was found soon after. This was the first visual observation of the raccoon's interaction with seabirds and the final evidence that all four species of nesting seabirds on the Limestone Islands (Ancient Murrelets, Cassins Auklets, Pigeon Guillemots and Fork-tailed Storm Petrels) may be killed by raccoons. On the early mornings of June 6, 7 and 8 a total of 14 fresh headless carcasses of nonbreeding Ancient Murrelets were found in site investigation after nighttime fixes on a raccoon. These were collected, measured and banded and then replaced at the site in the predawn the next morning. They were then watched until removed. They were generally taken by crows and eagles, often close to dawn. Bands were later recovered in Crow Valley.

1992

Evidence of Ancient Murrelet kills on the fixed transects was counted every six days, as in 1991 and 1990. Levels of predation were much lower than in the previous two years. Only 18 incidences of predation, mostly feather piles, were found, compared to 127 in 1991, many of which were headless carcasses. One fresh Ancient Murrelet carcass was found on 11 June, but subsequent shoreline surveys by boat and scat transects on land carried out by Michelle van den Brink and LBCS staff did not locate any raccoons on East Limestone Island. There was no sign of excavated burrows in 1992.

1993

The incidence of predation remains on transects was higher in 1993 than in 1992, with 93 predations found. One raccoon was seen on the island on 1 June. Fresh raccoon scat was found regularly, especially along shoreline areas and on West Limestone Island, where Ancient Murrelets also nest. In early June, Ministry of Environment staff killed four raccoons on Louise Island near Vertical Point. However, at least one raccoon continued to survive on East Limestone Island after 10 June.

1994

Four raccoons were killed by Ministry of Environment personnel at Vertical Point in early April.

Unfortunately, they missed at least one which arrived on East Limestone Island sometime in late April or early May. At least 5 burrows were excavated by a raccoon, all in the "C" plot. A raccoon hair was found at the entrance to one excavated burrow. Other diggings were found in the area although they did not appear to involve Ancient Murrelet burrows. Seven predation transect lines were monitored every 6 days, as in previous years. Transect 7, which passes through "C" plot, to the south of the cabin had the most signs of predation, including a headless adult, an inverted skin, a small digging (appeared to be raccoon) and assorted feather piles. Two carcasses with inverted skins were found along T4, and two raccoon diggings appeared on T6. A total of 58 predations were found, not counting egg shells, avian pellets or raccoon/otter scat. A collection of Murrelet parts (8 left wings, 6 right wings, 3 pairs of connected wings, 1 leg and assorted loose feathers), as well as shells and a fish head were found at the base of a limestone cliff in a water trickle, possibly the work of a raven.

1995

In mid-March, Ralph Stocker set out live traps and egg traps to catch any raccoons present on the Limestone Islands. He also conducted shoreline scat surveys but found no evidence of raccoons on either island. Shoreline scat surveys were continued throughout the season on both East and West Limestone Islands but no evidence suggested recent raccoon activity. The transect surveys were conducted once a week. As in 1994, transect 7, which passes through C plot, had the highest number of predations, including 4 headless, inverted carcasses. Three other headless carcasses were found, one on T1, one on T2, and one on T3. Forty-five predations, excluding failed and predated eggs, avian pellets, or raccoon/otter scats were recorded.

1996

The predation transects were not monitored this season, as no evidence of possible raccoon predation was observed. A spotlight survey was conducted on 9 May, sighting one raccoon in the intertidal at Vertical Point, but none was seen on the Limestone islands. Shoreline circumnavigations of East and West Limestone Islands were carried out on 26 March and 25 June.

1997

Spotlight surveys were carried out during low tide on 10 May, 31 May and 28 June. Three to four raccoons were observed each time foraging at Vertical Point, but none was seen on East Limestone Island. Nor was any other evidence of raccoons seen. With the permission of the Ministry of Environment, Lands and Parks, LBCS staff killed five of the raccoons and collected information from each carcass.

1998

No evidence of raccoons was found on East Limestone Island. A single midnight spotlight survey was done to scan the shores of Limestone and Louise Islands for raccoons. One raccoon was seen on Vertical Point.

1999

Shoreline surveys for raccoon sign were conducted on East Limestone Island throughout the season, as well as two spotlight surveys. No evidence of raccoon was found, although a raccoon was sighted in Louise Island and scat was found at nearby Vertical Point on several occasions.

2000

Several shoreline surveys for raccoon sign were conducted. While no evidence of raccoon was found on East Limestone Island, scats were found at Vertical Point.

2001

Unusual burrow excavations were found in three parts of the colony. The diggings first appeared on 23 April at the northern end of the island, then more diggings were found towards Lookout Point, in Spring Valley and in the northeast colony areas. Headless murrelet skins were found twice close to excavated burrows and once an inverted skin was found. Three excavated burrows were found with two eggs on the nest cup. During one search, a partially excavated burrow (the whole entrance and half the tunnel was gone) was found with an adult incubating two eggs; the nest was found abandoned the next day. We suspected that a raccoon was responsible for the diggings but as eggs were not taken from some of the burrows, it was possible that river otters were also involved. As noted by Michelle Masselink and others, the diggings were typical of raccoons. Michelle searched for raccoon latrines on Limestone and Louise Islands, finding none on Limestone but at least 40 on Louise. In total, 41 burrows were excavated, with no estimate of adult mortality. As well, two similar sized diggings were found on West Limestone Island. Despite a substantial search effort with two midnight spotlight surveys, several daytime shoreline surveys and numerous dawn searches in the colony, no raccoons were seen on East Limestone Island during the field season. Live animal traps were borrowed from Parks Canada and set for 60 trap days. We baited the traps with fresh chicken eggs. No raccoons were trapped. In October, a raccoon control crew shot and killed nine animals, probably killed two others, and saw two more, all on Vertical Point/Louise Island. A pair of eyes was seen on Limestone Island but a raccoon was never confirmed, despite one bait pile of fresh fish and two live traps with fresh fish (A. Edie, pers. comm.).

2002

Ten burrows were found excavated in 2002, most of them in the small Ancient Murrelet colony near the Look-out Point where an otter family has a play area and den within 200 m. Most of the diggings were found late April to mid-May, during the egg-laying and incubation period. Additional predation by birds of prey (eagles, falcons, hawks) was evident, with Ancient Murrelet wings and feather piles throughout the colony, and occasionally elsewhere. Twice, headless carcasses were found.

Two shoreline surveys were carried out, but the only raccoons seen were on Louise Island.

2003

The level of predation on Ancient Murrelets appeared normal this year, with no excessive burrow diggings, body parts or feather piles apparent (based on opportunistic surveys conducted as part of daily observations by staff and volunteers when moving around the colony). All burrow diggings appeared to be the work of river otters. One digging of interest was discovered on May 13 at Boat Cove near trail marker 510 on the main trail. A large and wide digging of a burrow was found at the base of a spruce tree, with an inverted carcass lying near-by. Upon investigation, two cold eggs were found in the burrow. This predation was believed to be the work of a raven.

2004

Predation levels on Ancient Murrelets, represented by the number of wings and feather piles found, were not unusual compared to past years: several feather piles and 38 wings were found in various locations around the island. Of interest, however, is that 11 of the wings were found in an area 5 m in radius behind the bird blind. They were suspected to be the result of Raven predations as a Raven family was often seen and heard nearby. Three headless carcasses were found in mid-June near Bald eagle nests BAEA-2, BAEA-4 and BAEA-7. It is suspected that river otters were responsible for the predations as a small burrow digging (too small for a raccoon) was also found in the same area. Spotlight surveys were conducted twice around the entire perimeter of East and West Limestone Islands, and on Louise Island from Vertical Point north to the point just south of Skedans Bay. On 16 May four raccoons were spotted on Louise Island: one opposite West Limestone, two on the rocks in the bay north of Vertical Point, and one just north of Vertical Point. On 31 May six raccoons were seen, all on Louise Island. No raccoons were seen on the Limestone Islands during either survey or throughout the rest of the season.

2005

We conducted two spotlight surveys at low tide: on 3 June we spotted four raccoons on Louise Island but on 18 June none was seen. No evidence of raccoon activity was found on East Limestone Island and no burrow diggings or headless murrelet carcasses were found. Feather piles and body parts left over from predators such as Common Ravens, Bald Eagles and Peregrine Falcons were found throughout the season.

2006

Only one spotlight survey for raccoons on Louise and Limestone Islands was possible, but we surveyed East Limestone Island regularly for signs of diggings, predation and raccoon latrines. No signs of raccoon activity were recorded and no raccoons were seen on either East or West Limestone islands. Two racoons were spotted on Louise Island, both in the intertidal zone opposite of West Limestone Island.

2007

On 29 April an Ancient Murrelet head was found on East Limestone Island. Over the following two weeks 11 excavated burrows were found. No raccoons were seen on East or West Limestone islands during a night time boat survey on 12 May but weekly transect surveys, starting 12 May, provided the first firm indication that a raccoon was active. On 19 May six headless ANMU carcasses were found consistent with raccoon predation. Altogether, we found 40 adult ANMU predations (feather piles, wings or headless carcasses) on the transects, five fresh diggings, six depredated eggs and three headless chicks. The frequency of adult predation remains was 29 ± 8.7 birds/ha, equivalent to 364 birds for the entire colony. Outside of the transects we found another 17 excavated burrows, six headless adult carcasses and one adult head.

Four raccoon traps were set up in area where carcasses were found. The traps were baited (marshmallows, canned fish, fresh fish, eggs, peanut butter) and checked throughout the remainder of the season but no raccoons were caught.

A raccoon was sighted in Boat Cove, East Limestone Island, during a spotlight survey on 27 May. This sighting prompted a visit on 6 June by provincial Conservation Officers who succeeded in removing several raccoons from Louise Island but none from the Limestone Islands. We continued to find decapitated adults and excavated burrows containing remains of predated adults and eggs. For the first time on record, we found two decapitated chicks, dug out from their burrow.

On 18 June a Conservation Officer returned to direct two night hunts for raccoons by boat. During this visit the CO helped ELI staff improve the raccoon traps by making them more camouflaged. Despite unfavourable weather conditions the crew succeeded in removing 2-3 raccoons from Louise Island, but none from East Limestone Island. On 20 June a survey was carried out around East Limestone Island just before dusk. A raccoon was sighted on top of the cliffs at Anemone Cove. The animal was treed, shot and killed. By that date the majority of Ancient Murrelets had left the colony. 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.

2008

In March Conservation Biologists (MoE, George Shultz) surveyed the Limestone Islands and Vertical Point on Louise Island seeing 7 raccoons, of which they killed six. No raccoons were seen on the Limestone Islands. There was no compelling evidence to suggest raccoons were active on in 2008 on East Limestone Island. A few excavated burrows were seen, evidence of predation on adult murrelets was found at many sites and a number of cold eggs were recovered. In no cases was there any evidence that eggs had been consumed. Many diggings were made from the burrow entrance rather than above the nest cup. A hair was collected from one of the digging sites which was later identified as belonging to a river otter. At this time we suspect that river otters and perhaps ravens were responsible for the diggings. We surveyed the predation transects weekly from 7 May for five weeks counting new additions of carcasses and feather piles. The minimum number of depredated Ancient Murrelet adults was estimated at 259 [extrapolating our estimates from the transect area (1.6 ha) to the colony area (12.55 ha)]. This number was slightly above the estimate for of 220 adults for 2007. Bald Eagles, Common Ravens, Peregrine Falcons and river otters are all possible contributors to the predations we recorded. We found no evidence to suggest that raccoons were active on the island this year.

2009

From 1-11 May East Limestone Island was surveyed for signs of digging and raccoon scat and the predation transects were have a night-hunting permit in place. However, the camp supervisor spent approximately 22 hours surveying shoreline and colony areas at night in an attempt to locate the raccoon and keep it up a tree until daylight. Four live traps were set (two in cabin cove, two in boat cove) and kept baited from 26 May until early July. As in past years, the traps did not prove to be effective, highlighting the difficulty in removing raccoons from even small islands such as East Limestone. Predation transects were cleared of remains on 5 May, and surveyed weekly until 9 June for a total of 5 surveys. On 12 May, fresh diggings were located and partly consumed carcasses characteristic of raccoon predation were identified. Over the 5 week period, at least 102 adult murrelets were killed by predators in the colony area, based on feather piles and carcasses. A hair sample was retrieved at one site, and was later positively identified as raccoon on 22 May by Len Morgan. Raccoon scat, containing Ancient Murrelet remains was also located in the same area on 1 June.

2010

George Schultz (Ministry of Environment, retired) culled raccoons on the shorelines of Louise Island opposite East Limestone and West Limestone Islands in March. Approximately ten raccoons were killed on the adjacent shorelines. This was apparently effective in keeping raccoons off Limestone in 2010. No night-time surveys for raccoons were completed. Transects were cleared of remains on 8 May and checked weekly until 30 May (three surveys). A minimum of 8 adult murrelets were estimated to have been killed by predators in the colony area over the 3 weeks period (2.7 birds per week). This estimate is dramatically lower than in previous years: the estimate in 2009 was 20.4 birds per week, and 70.6 per week in 2008. Field staff noted that there were very few predation remains in the forest this season in comparison with previous years. There were no signs of Raccoons on Limestone Island this season, perhaps accounting for a reduction in predation remains.

2011

There were no spring-time surveys or culls completed on Limestone or Louise Island this season, however the RGIS crew was based on Limestone in the first half of April and did not see any evidence of raccoons. Baited cameras were being used on the island during deer capture work and no raccoons were seen in any of the photos. Experience from testing these cameras in Skidegate Inlet in the winter 2010 indicated that raccoons were very attracted to the apples which were being used as bait. Based on this evidence we were confident that there were no raccoons present on Limestone in the early part of the season. Baited cameras were also deployed in May and no evidence of raccoons was detected.

2012

In March, director Jan Oord and trapper Len Morgan came to Limestone to monitor for raccoons. They spent seven nights (24 March to 31 March) searching the island by foot for signs of raccoons. They did not find any evidence of raccoons on Limestone, although they did see many on adjacent Vertical Point. They set traps on Vertical Point although none were successful. In April, Jake Pattison visited Vertical Point and successfully shot and killed one raccoon.

To continue monitoring for raccoons throughout the Ancient Murrelet season we set up two infrared cameras on Limestone, baited with sardines and cat food. One camera was stationed in Anemone Cove and one near the cache. These cameras, along with those from RGIS, were set for the majority of the field season and captured photos of deer, ravens, and deer mice, but no raccoons.

DISCUSSION

The heavy raccoon predation on adult Ancient Murrelets that took place on the East Limestone Island colony in 1990 and 1991 was associated with a sharp fall in the number of chicks captured in the funnels between 1990 and later years. Despite a significant cull of raccoons on East Limestone Island and adjacent parts of Louise Island after the Ancient Murrelet breeding season in 1991, and although there was no raccoon predation on the island in 1992, raccoons were again at work on the colony in 1993-1995. Following culls in every year from 1991-1995 there was a hiatus in raccoon predation that lasted until 2001 and during that period the number of chicks captured annually remained more or less stable. After that, there was another run of years without evidence of raccoon predation, followed by raccoon activity in 2007 and 2009. Numbers of predations on transects in the later years (40 in 2007, 13 in 2009) were much fewer than during the early 1990s, but the Ancient Murrelet population had by that time fallen to only about a third of its earlier size. With fewer burrows occupied and few non-breeders visiting the colony in June the island may have been less attractive to raccoons by 2007 than was the case in the early 1990s. However, the predation that took place in 2007 and 2009 may have contributed to the continued decline in numbers of chicks produced on the island. It is clear that, if the Ancient Murrelet population of East Limestone island is to be brought back to its former level, raccoons must be continuously controlled in the area to prevent them from re-colonizing the island.

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USING A VIDEO CAMERA TO STUDY COLONY ATTENDANCE AND FEEDING RATES OF CREVICE-NESTING PIGEON GUILLEMOTS

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It is difficult to study crevice-nesting seabirds, because colonies often occur on cliffs that are inaccessible or difficult to approach for researchers, making it hard to identify and count nest sites (Renner et al. 2010). There is no standardised monitoring method for studying crevice-nesting *Cepphus* and consequently little is known about their parental behaviour. Yet, *Cepphus* forms an important component of North Pacific and Atlantic marine ecosystems, and one species of this genus is considered *vulnerable* (Ministry of the Environment 2002).

In recent years, remote miniature video cameras have been used to observe avian breeding ecology and behaviour (Hoover et al. 2004, Kross and Nelson 2010). Using video cameras for avian research provide benefits for researchers as video monitoring systems can record continuously throughout nesting cycle of breeding adults without frequently approaching, and therefore potentially disturbing, nest sites. Moreover, recorded data can be stored permanently, allow a high ability to determine each activity and by using several cameras it may be possible to simultaneously monitor several nests.

To study nest-attendance patterns and chick feeding rates of the crevice-nesting Pigeon Guillemot *Cepphus columba*, our teacm initiated a preliminary study at East Limestone Island, Haida Gwaii, British Columbia. Between June and July 2010, we used three video cameras (Weatherproof Motion Activated Battery Powered DVR Package, SSC-773V2B/W Low LUX DVR System. http://www.surveillance-spy-cameras.com/) to record six Pigeon Guillemot pairs using birds occupying artificial nest boxes that had been put in place in 2000. We placed cameras to film the nest entrance (Fig. 1, 2) round the clock for three days at each nest during the incubation and chick-rearing period.

The time of activity in the colony was restricted to daylight, and was greatest in the morning (n = 3, Fig. 3). First nest visits by guillemot parents during incubation was earlier (range: 04:30 - 05:55, n = 3) than during chick-rearing (range: 06:09 - 10:17, n = 3). Nest visits by parents varied among nests (range: 5-11 times, n = 3, Fig. 3). A previous study showed that incubation shift length of Pigeon Guillemots varied between 30 min and 17 h (Drent 1975). The short shifts in this study may result from territorial behaviour without change-over of the incubation duty between pair members. In 2010, we did not tag individuals in order to reduce the intensity of human disturbance. However, in future it would be important to tag and identify the birds in order to measure shift length of guillemots.

The video camera recorded guillemots delivering 2-5 fishes per day, averaging 3.3 ± 1.5 times (n = 3). Prey species were difficult to identify from the video, as our test cameras were inexpensive black-and-white models. In order to identify prey species, I suggest the use of a colour video camera. Additionally, a high-speed camera should help capture fast moving objects. I conclude that the video camera system can provide researchers with valuable information about nest-attendance patterns and prey delivery rate when studying crevice-nesting seabirds such as guillemots. Moreover, the video camera can be used to detect the cause of certain nest activities, such as interruptions made by other birds, and to monitor incubation behaviour (e.g. copulation or reinforcing the pair bond). With further analysis, this monitoring system should also allow us to determine prey size so that we can estimate energy contents of preys, and therefore parental effort and chick's energy requirements for growth. This simple and relatively low-cost system could be useful for monitoring the reproductive behaviour of species that are susceptible to human disturbance and hence allow the development of long-term monitoring systems.

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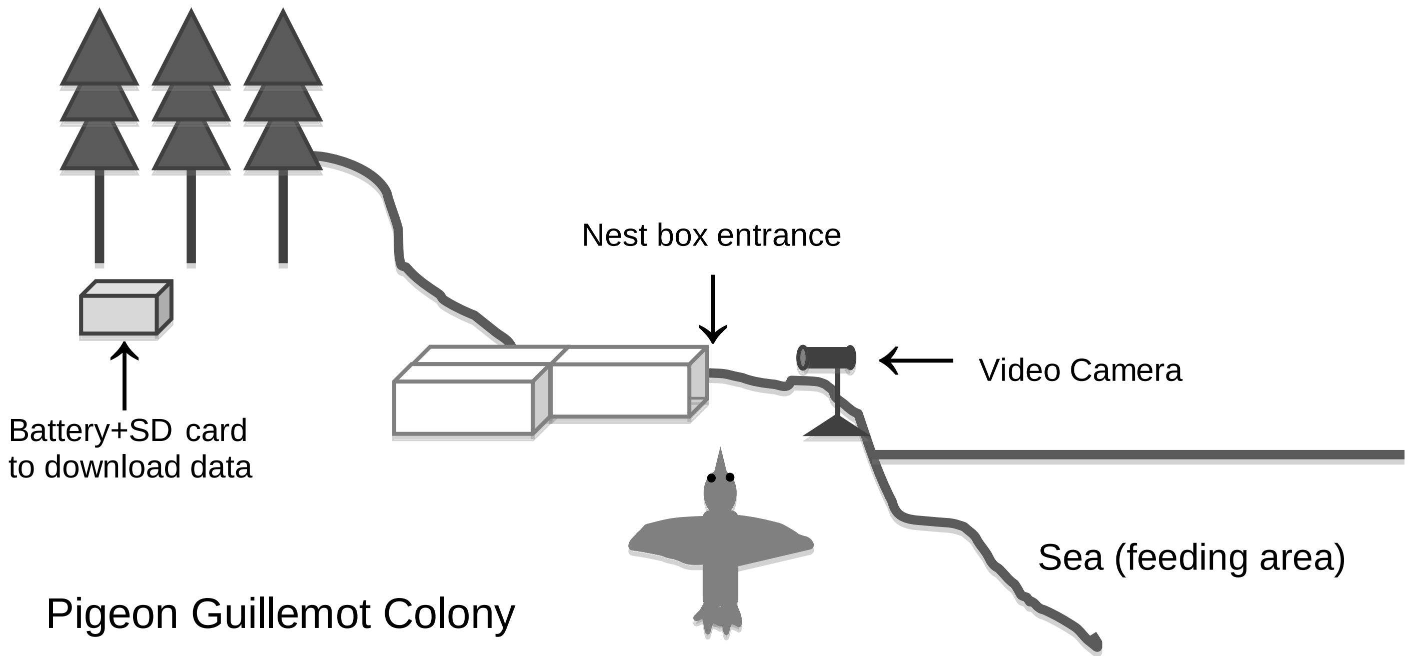

Figure 1. An illustration of the recording camera system to monitor nest attendance and feeding rates to their chicks of Pigeon Guillemots using by a small camera.

Figure 2. The view of an incubation change-over occuring between pair members.

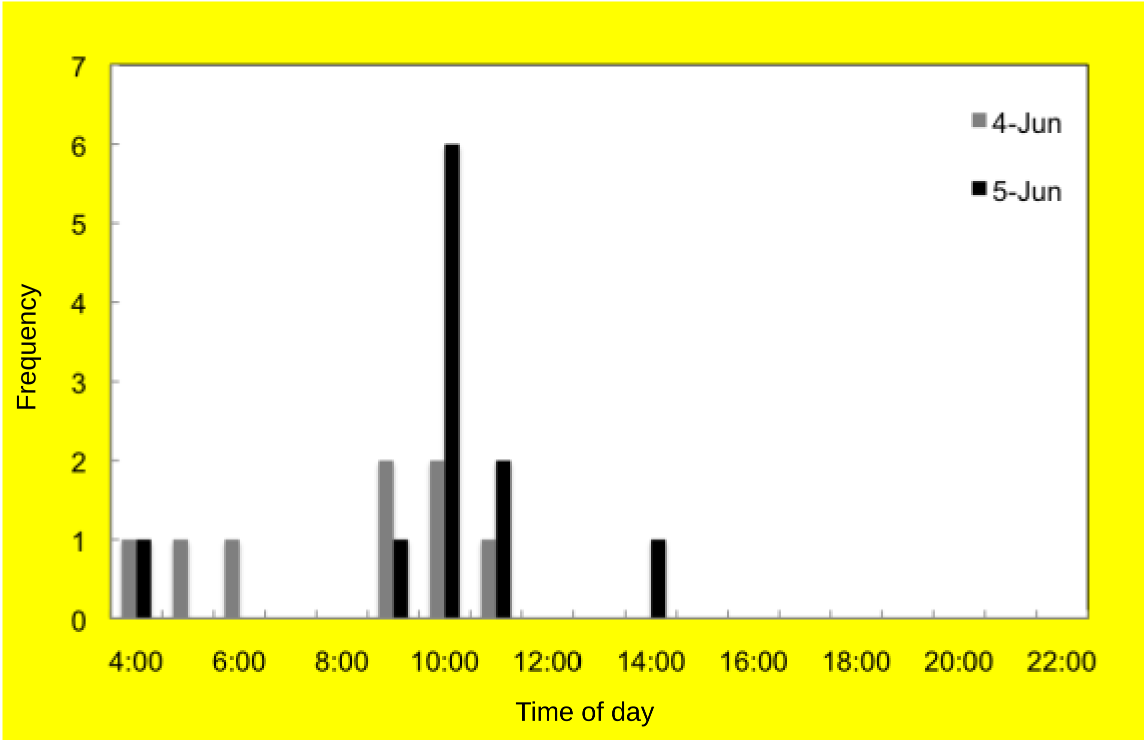

Figure 3. An example of nest visits by Pigeon Guillemots at the nest box No. 7.

SURVEYS OF PERMANENT SEABIRD MONITORING PLOTS ON RAMSAY ISLAND, GWAII HAANAS NATIONAL PARK RESERVE AND HAIDA HERITAGE SITE, JUNE 2012

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SUMMARY

A team of 6 field workers from the Canadian Wildlife Service visited Ramsay Island from 13 to 28 June, 2012, to resurvey standardized plots to assess the status of Cassin's Auklets and Ancient Murrelets breeding on the island. The number of Cassin's Auklet burrows counted on the series of 9 plots had an average of 59 burrows per plot (range 32-111), and has increased over time from 1984 to 2012 at an annual rate of 1% per year. The occupancy rate of these burrows in 2012 was estimated as 71.9% based on a sample of 32 burrows, and was comparable to other years. The number of Ancient Murrelet burrows counted on the series of 12 plots averaged 32 burrows per plot (range: 13-51). The average number of Ancient Murrelet burrows in the permanent plots has increased over time since 1984 at an annual rate of 2% per year. Occupancy rate of Ancient Murrelets in 2012 was estimated at 32.5% from a sample of 40 burrows, which was considerably lower than other years. The current plan is to resurvey the plots in 2017.

INTRODUCTION

The Canadian Wildlife Service (CWS) established a series of permanent plots on selected seabird colonies in the 1980s as part of a program to monitor seabird populations along the B.C. coast. Within Gwaii Haanas National Park Reserve and Haida Heritage Site, the seabird colonies at Ramsay, George, East Copper, and Rankine islands were selected as long-term monitoring sites for Ancient Murrelets and Cassin's Auklets. On Ramsay Island, twelve 20×20 m plots were established within the Ancient Murrelet colony, and within the Cassin's Auklet colony, eight 15×15 m and one 20×24 m plot were set up in 1984. These plots were surveyed opportunistically in 1990s, and on a 5-yr rotation since 2002 according to the schedule outlined in The Management Plan for Seabird Conservation, Pacific and Yukon Region. In 2012, a team of 6 field workers from the Canadian Wildlife Service visited Ramsay Island from 13 to 28 June to resurvey the permanent plots using standardized methods.

METHODS

Plots were located and surveyed using methods described in detail in Rodway and Lemon (2011). Briefly, plot boundaries are established using a system of colored aluminum posts, and all burrows within plots are examined for evidence of breeding activity by seabirds within an arm's reach of the burrow entrance. Burrows are not excavated to minimize disturbance in permanent plots. A sample of burrows is excavated at other locations within breeding colonies to determine burrow occupancy rates and to obtain morphological measures of Cassin's Auklet chicks found in the burrows.

Trends in total burrow counts from 1984 to 2012 were estimated using a mixed-effects model (Zuur et al 2009), that included ln-transformed burrow count at each plot as the response variable, year as the explanatory fixed effect, and year within plot ID as a random effect. This model then allowed us to calculate trend as proportional change over the years, and accounted for the repeated measures design where the same locations were visited over the years.

RESULTS

Cassin's Auklet

Overall, the number of Cassin's Auklet burrows counted on the series of 9 plots ranged between 34 and 111 burrows, with a mean of 59 burrows. The number of Cassin's Auklet burrows in the permanent plots on Ramsay Island has increased over time from 1984 to 2012 at an annual rate of 1% per year ($\beta = 0.01$, SE = 0.003, t = 4.10; Figure 2). The greatest increases over this time period occurred at plots 5 and 9 (Table 3), two coastal plots which may reflect distributional changes of occurrence within the colony rather than rapid growth of the entire population on Ramsay Island, and increases at most of other plots was more modest. We measured burrow occupancy rates of Cassin's Auklets nesting on a knoll west of the boat landing on Andrew Point. Overall occupancy in 2012 was estimated as 71.9% based on a sample of 32 burrows with known contents. This occupancy rate was comparable to other years; occupancy was estimated to be 71.4**%** in 1984 (n = 21), 63% in 2002 (n =24), and 83% in 2007 (n = 52).

Morphometric measurements of a sample of 12 chicks from the Ramsay Island colony were acquired for comparison with measurements of chicks on other Cassin's Auklet colonies obtained in the same study year. These measurements are presented in Table 5. Most chicks were very large and close to fledging at this time.

Ancient Murrelet

The number of Ancient Murrelet burrows counted on the series of 12 plots varied between 13 and 51, with a mean of 32 burrows per plot. The number of Ancient Murrelet burrows in the permanent plots on Ramsay Island has increased over time since 1984 at an annual rate of 2% per year ($\beta = 0.02$, SE = 0.005, t = 4.28; Figure 2). We measured burrow occupancy rates after departure of most or all Ancient Murrelets from the colony, in two areas near plots A1-3. Overall occupancy rate in 2012 was estimated at 32.5% from a sample of 40 burrows with known contents (Table 2). This occupancy rate was very low relative to other years; occupancy was estimated to be 64.5**%** in 1984 (n = 31), 40% (n = 30) in 2002, and 65% in 2007 (n = 43).

Table 1. Total counts of nesting burrows in 20x20m Ancient Murrelet permanent monitoring plots, Ramsay Island, Gwaii Haanas National Park, 1984 – 2012.

Year/Plot	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL Burrows
1984	20	7	11	35	22	28	7	24	12	14	24	14	**218**
1992	21	10	13	42	29	32	9	34		23	33	9	**N/A**
2002	22	12	10	47	34	36	13	45	13	29	47	16	**324**
2007	21	16	11	45	37	29	18	34	18	29	47	15	**320**
2012	39	19	19	47	39	23	42	33	24	31	51	13	**380**

Table 2. Ancient Murrelet burrow occupancy (current year's breeding effort) on Ramsay Island in 2012.

Location	Date	Burrows checked	Unknown	Empty	Hatched membrane	Total occupied	Total known	Percent occupied (%)
Hill north of boat landing near plots A1-3	24 June	53	19	15	9	9	24	37.5
Up slope from bay near A1-3	26 June	32	16	12	4	4	16	25.0
	Total	85	35	27	13	13	40	32.5

Table 3. Counts of burrows in 15x15m (plots 1-8) and 20x24m (plot 9) Cassin's Auklet (CAAU) permanent monitoring plots on Ramsay Island, Gwaii Haanas National Park, 1984 – 2012. Ancient murrelets (ANMU) are occasionally found in these plots.

Species	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL Burrows**
CAAU	1984	40	45	34	40	58	28	18	26	56	**345**
CAAU	1992			33	37				25		
CAAU	1993	43	47	37	41	56					
CAAU	2002	40	55	33	40	58	41	25	27	41	**360**
CAAU	2007	40	52	30	39	51	31	30	29	60	**362**
CAAU	2012	56	57	43	60	82	43	42	34	111	**528**
ANMU	1984	0	0	0	0	0	0	2	0	0	**2**
ANMU	1992			0	0				0		
ANMU	1993	0	0	0	0	0					
ANMU	2002	0	0	0	0	0	2	2	0	0	**4**
ANMU	2007	0	0	0	0	10	1	0	0	0	**11**
ANMU	2012	0	0	0	0	0	0	0	0	0	**0**

Table 4. Cassin's Auklet burrow occupancy (current year's breeding effort) on Ramsay Island in 2012.

Location	Date	Burrows checked	Unknown	Empty	Chick	Cold egg	Warm egg	Hatched membrane	Total occupied	Total known	Percent occupied (%)
Knoll west of boat landing on Andrew Pt	25 June	60	28	9	16	1	2	5	23	32	71.9

Table 5. Measurements of 12 Cassin’s Auklet chicks pulled from burrows near Andrew Point on Ramsay Island, June 2012.

Burrow	Date	Weight (g)	Tarsus (mm)	Wing Chord (mm)	Ticks
1	25-Jun-12	43	20.3	21	0
2	25-Jun-12	135	24.5	104	0
3	25-Jun-12	124	25.1	111	0
4	25-Jun-12	171	24.2	115	0
5	25-Jun-12	139	25.8	100	2
6	25-Jun-12	142	24.5	117	0
7	25-Jun-12	161	25.4	121	1
8	25-Jun-12	145	26.3	105	0
9	25-Jun-12	156	25.6	128	0
10	25-Jun-12	155	25	114	0
11	25-Jun-12	159	25.1	119	0
12	25-Jun-12	149	25.1	123	0

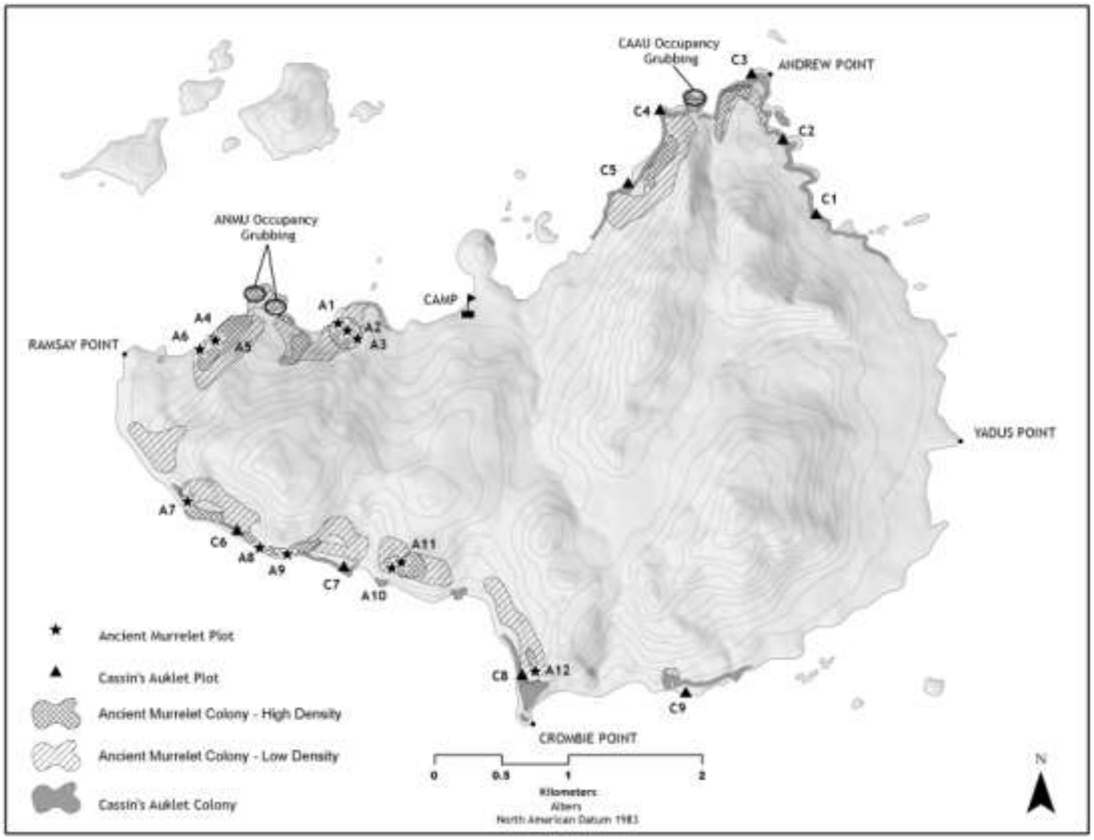

Figure 1. Map of Ramsay Island, Haida Gwaii, with locations of permanent plots and other features.

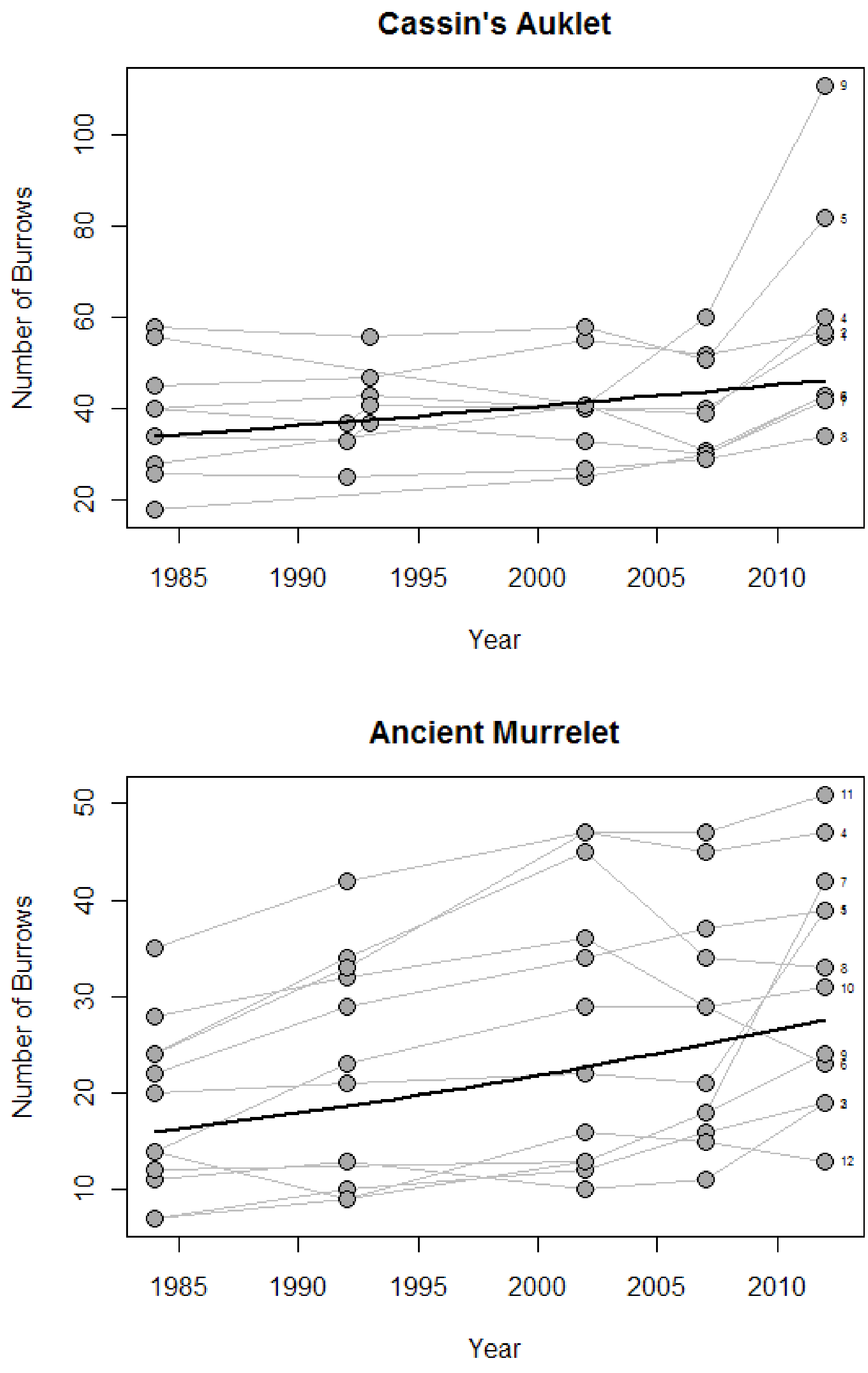

Figure 2. Number of burrows counted at permanent plots on Ramsay Island, 1984 to 2012. Number beside 2012 data indicates plot ID number

DISCUSSION

The islands of Gwaii Haanas National Park Reserve support several small but important populations of Cassin's Auklets. These results from the permanent monitoring plots indicate populations on Ramsay Island are relatively stable. For other islands in Gwaii Haanas National Park Reserve, a decline of 32% was detected on Rankine Island between 1984 and 2000, followed by a weak recovery between 2000 and 2010 (Rodway and Lemon 2011), and an overall negative trend of 1.4% per year in total burrow numbers. On East Copper Island, burrow numbers decreased by 16% over the period 1985-2003, with all the recorded decrease occurring between 1991 and 2003 and a potential leveling of the trend between 2003 and 2009 (Rodway and Lemon 2011). These trends contrast the strong negative trends in burrow counts observed on Triangle Island, which holds the majority of the world's population of Cassin's Auklets, prompting conservation concern for this species.

British Columbia supports an estimated 50% of the world population of Ancient Murrelets, all occurring in Haida Gwaii. With an estimated 44% of the BC population nesting on islands along the east coast of Moresby Island, most of them situated within Gwaii Haanas National Park, this is an important area for Ancient Murrelets. Results of monitoring plot surveys on 3 island colonies in the area indicated that populations are stable or increasing (Rodway and Lemon 2011). The number of burrows at the permanent plots on Ramsay Island increased over time between 1984 and 2012 (Figure 2). The colony on George Island also increased rapidly between 1985 and 1996 then experienced only a slight increase between 1996 and 2008. Both these colonies have undergone a similar annual rate of increase, and the burrow counts on Rankine Island were stable between 1984 and 2010.

ACKNOWLEDGMENTS

Field work in 2012 was carried out by Glen Keddie, Laurie Wilson, Yuriko Hashimoto, Ailish Murphy, Anurahda Rao, and Mark Drever. We are deeply indebted to staff of Parks Canada for supporting our work and providing assistance to the project. In particular we thank Carita Bergman for issuing research permits to work in Gwaii Haanas National Park; and to Nadine Wilson and Parks Canada wardens for providing boat transportation to some of the more inaccessible areas of the island. Moresby Explorers provided transport down to Ramsay Island.

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Appendix 1

Locations of bearing points and associated Ancient Murrelet plots on Ramsay Island, Gwaii Haanas National Park.

Bearing point Identifier	**Location**	**Marker**	**Plot Identifier**	**Directions to plot**
RAMS-A	N 52.56675° W 131.41680°	On cedar tree	ANMU-1 ANMU-2 ANMU-3	124° from RAMS-A, 35 m from shore 124° from RAMS-A, 105 m from shore 124° from RAMS-A, 195 m from shore
RAMS-B	N 52.56508° W 131.43014°	On spruce tree	ANMU-4 ANMU-5	At RAMS-B, 0 m from shore 134° from RAMS-B, 50 m from shore
RAMS-C	N 52.56422° W 131.43153°	On spruce tree	ANMU-6	124° from RAMS-C, 50 m from shore
RAMS-D	N 52.55514° W 131.43420°	On spruce tree	ANMU-7	50° from RAMS-D, 30 m from shore
RAMS-E	N 52.55136° W 131.42397°	On diseased spruce tree	ANMU-8	39° from RAMS-E, 75 m from shore
RAMS-F	N 52.53408° W 131.41819°	On alder tree	ANMU-9	350° from RAMS-F, 45 m from shore
RAMS-G	N 52.55170° W 131.40719°	On spruce tree	ANMU-10 ANMU-11	150 m at 221° from RAMS-G 55 m at 190° from RAMS-G
RAMS-H	N 52.54411° W 131.39330°	On spruce tree	ANMU-12	64° from RAMS-H, 110 m from shore

Appendix 2

Locations of Cassin's Auklet monitoring plots on Ramsay Island, Gwaii Haanas National Park

Plot number	GPS location	Markers (2007)	Location and directions to plot
CAAU – 1	N 52.57641° W 131.36478 °	Corner aluminum stakes; metal marker on shore spruce tree at yellow corner	east coast south of Andrew Point. orientation 234° from R to B corner
CAAU - 2	N 52.58125° W 131.36903 °	Corner aluminum stakes; Metal tag on large spruce near center of plot.	east coast halfway between Andrews Point and CAAU Plot # 1; orientation 306° from R to B corner
CAAU - 3	N 52.58547° W 131.37306 °	Corner aluminum stakes; metal tag on spruce 4m. seaward of red corner.	west side of Andrews Point. orientation 158° from R to B corner.
CAAU - 4	N 52.58258° W 131.38283 °	Corner aluminum stakes; metal tag on large spruce	On a headland southwest of Andrew Point. Orientation 220° R to B corner.
CAAU - 5	N 52.57753° W 131.38575 °	Corner aluminum stakes; metal on spruce in plot, 4.5m at 160° from R corner	northwest shore of Ramsay Island southwest of Andrew Point Red corner post is on the vegetation edge on a rock bluff. Orientation 105° R to B corner.
CAAU - 6	N 52.55233° W 131.42589 °	Corner aluminum stakes; metal tag on spruce tree in center of plot, 11.2m at 78° from R corner	southwest coast about 300 m SE from rounded point near ANMU Bearing Point D. orientation 29° R to Blue. Landslide prior to 2002 took out part of Yellow corner
CAAU - 7	N 52.55045° W 131.41381°	Corner aluminum stakes; marker tag on spruce on the ridge crest. Blue corner on downslope side of marker tree	southwest coast between ANMU Bearing Points F and G. Just below crest of ridge forming NW side of bay, where ridge joins island's main slope. Red corner is 15m at 57° from marker tree
CAAU - 8	N 52.54411° W 131.39330°	Corner aluminum stakes; ANMU BP H marker in plot	At ANMU bearing point H, 4m from shore. Orientation 176o dR to B.
CAAU - 9	N 52.54380° W 131.37511°	Corner aluminum stakes; metal tag on Spruce at G corner, and tag on Spruce at seaward pt of plot	SE coast, east of Crombie Pt. Irregular shaped plot on a grassy knoll surrounded on 3 sides by bare rock or beach. Orientation 258° from G to B corner on inland side, 24m long.

A STUDY OF INVASIVE ALIEN PLANT DISTRIBUTION IN LASKEEK BAY Part II

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INTRODUCTION

The following report outlines the Invasive Alien Plant Project for Laskeek Bay conducted in 2010, a continuation of a project started in 2009. This report includes a brief background and description of the project, the methodology and results from 15 site surveys, and a discussion of a management plan for future years. The project was funded by the Northwest Invasive Species Plant Council (NWIPC) and conducted by Laskeek Bay Conservation Society staff Christine Pansino (Executive Director), Jake Pattison (Camp supervisor / biologist), and Ainsley Brown (Biologist / interpreter).

Background

In 2009 an initial study of invasive plants in Laskeek Bay was conducted, focusing on four main species: wall lettuce *Lactuca muralis*, Canada thistle *Cirsium arvense*, bull thistle *Cirsium vulgare*, and prickly sow thistle *Sonchus asper*.

East Limestone Island, West Limestone Island, Reef Island, the Low Islands, the Skedans Islands, Haswell Island and Vertical Point were visited to determine the presence or absence of the invasive plants of interest. Due to lack of time, only East Limestone Island was completely inventoried and treated (where possible). Visits to the other islands provided general information on the invasive plants present although no treatment was conducted. The work conducted in 2010 was a continuation of this project, focusing on the change in distribution and density for the sites.

Goals/Objectives

There were four objectives to this project: (1) identify new sites of infestation of the four key invasive species, (2) re-survey the 15 known sites and update BC IAPP database, (3) mechanically treat where required and (4) develop a management plan for IAP in Laskeek Bay in coordination with Gwaii Haanas National Park Reserve and Haida Heritage Site standards.

METHODS

No new sites were identified this year as the work was focused on East Limestone Island – which was thoroughly surveyed in 2009.

Fourteen of the 15 sites identified in 2009 were revisited and re-surveyed to determine the effectiveness of 2009 treatments. The distribution and density for each species was recorded, assuming the same area recorded in 2009.

All invasive plants that could be pulled were removed for each site, except for those that were located in areas that could not be safely reached. Plants without flowers were pulled and left to decompose on the rocks. Plants with flowers were deposited in the ocean. All data were then entered into the IAPP database. Site 10 contained mainly *Cirsium arvense* and was treated by covering the entire area (0.05 Ha) with thick black plastic. The plastic was secured over the plants with logs and rocks with the goal of suffocating the plants and exhausting the root system.

Suggestions for a management plan are included in the discussion section of this report and will be expanded upon the completion of Gwaii Haanas National Park Reserve and Haida Heritage Site standards.

RESULTS

Both the distribution and density for the 14 sites visited were recorded and added to the IAPP database. These results were compared to the 2009 results to determine if our treatment methods were successful. Figures 1 through 8 show the difference of distribution and density between 2009 and 2010.

Figure 1 and 2 show the difference of distribution and density of *Cirsium vulgare* between 2009 and 2010. The distribution codes did not change between years for sites 2, 3, 4, 5, 6, 7, 10, 12 and 14, decreased greatly for sites 1 and 13, and increased for sites 8 and 9. The density codes did not change for sites 3, 4, 5, 6 and 14, decreased for sites 1, 2, 7, 10, 12 and 13, and increased for sites 8 and 9. Figure 3 and 4 show the difference of distribution and density of *Cirsium arvense.* The distribution codes did not change between years for sites 8, 11 and 14, decreased for sites 5, 9, 12 and 13 and increased for site 10. The density codes did not change for sites 8, 13 and 14, decreased for sites 5, 9 and 12, and increased for site 10. Figure 5 and 6 show the difference of distribution and density of *Lactuca muralis.* Neither the distribution nor density codes changed between years for sites 2 and 4 although increased for site 8. Figure 7 and 8 show the difference of distribution and density of *Sonchus spp.* Neither the distribution or density codes changed between years for sites 11, 12 and 13 although increased for site 6.

See Appendix 1 for a list of site identification numbers provided by NWIPC, site coordinates as well as the slope, aspect and elevation. A complete list of the area, distribution and density for each invasive plant site can be found in Appendix 2.

DISCUSSION

The treatment methods applied in 2009 had varied results depending on the species being treated. Looking at the results for *Cirsium vulgare* there was little change in distribution between the two years. The density did however decrease in six of the sites and only increased in two. Because *Cirsium vulgare* is a biennial results are not expected to occur for two years after treatment. Our results do show an improvement and are expected to show an even greater decrease in subsequent years. The results for *Cirsium arvense* also show a decrease in both density and distribution in more sites than increased. This invasive plant is a perennial which spreads by a horizontal creeping root system. This species is not easily controlled with mechanically methods of pulling do to its underground root system. Site 10, which was covered in black plastic, will act as a test plot to determine if this is a viable technique of treatment.

The treatment methods applied on *Lactuca muralis* did not prove effective. This species grows mainly on rocks and has roots embedded deep within crevices, making them hard to remove. Pulling did not appear to be a useful method for control of this species. *Sonchus spp.* did not respond to our methods of treatment. The roots of these plants were fragile and broke easily when pulled, most likely allowing for the regeneration in 2010.

Although most plants were removed within the 15 sites in 2009, some of the sites showed an increase in distribution and density in 2010. This could have been due in part to disturbance to the soil caused by digging up the plants, which would encourage dormant seeds to grow. Looking at the results for site 1 it appears that the invasive plant identified as *Cirsium vulgare* in 2009 may have been incorrectly identified. Many of these individual plants were quite small when the survey was conducted in 2009 and may have actually been *Cirsium arvense*, not *Cirsium vulgare. Cirsium arvense* was not recorded for sites 1 and 3 until the 2010 survey.

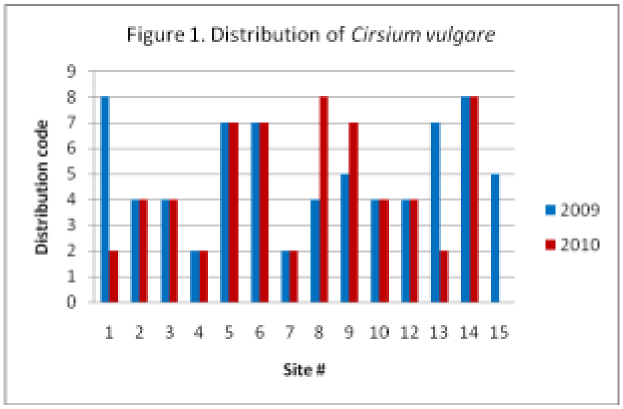

Figure 1. Distribution of *Cirsium vulgare*

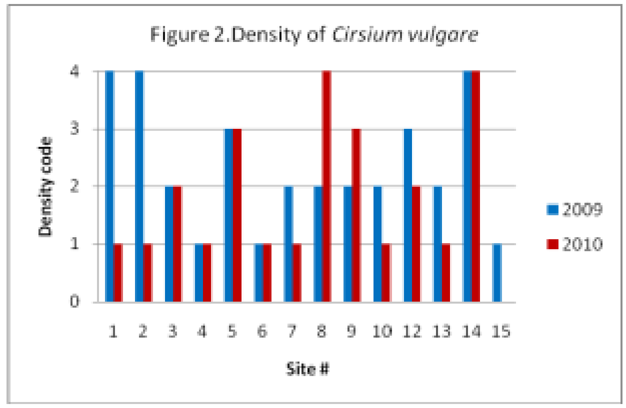

Figure 2.Density of *Cirsium vulgare*

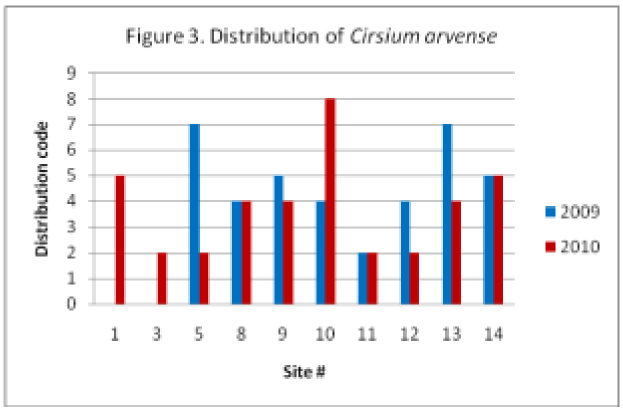

Figure 3. Distribution of *Cirsium arvense*

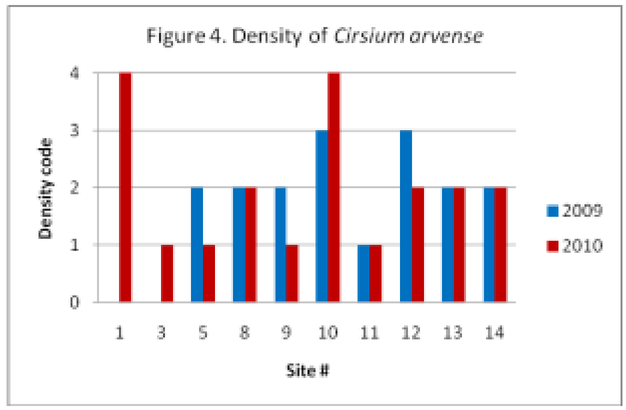

Figure 4. Density of *Cirsium arvense*

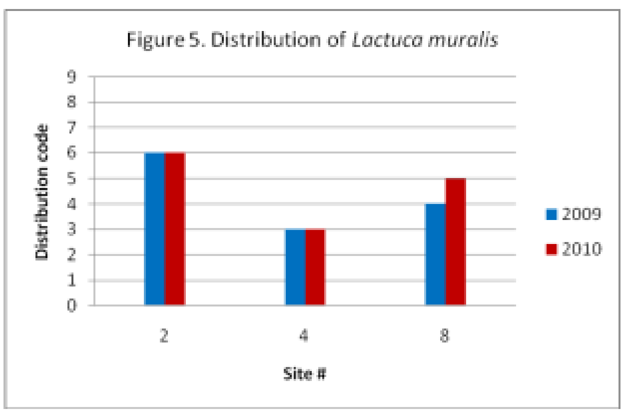

Figure 5. Distribution of *Lactuca muralis*

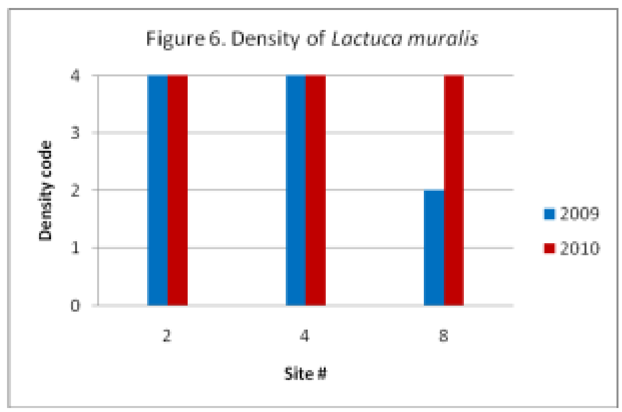

Figure 6. Density of *Lactuca muralis*

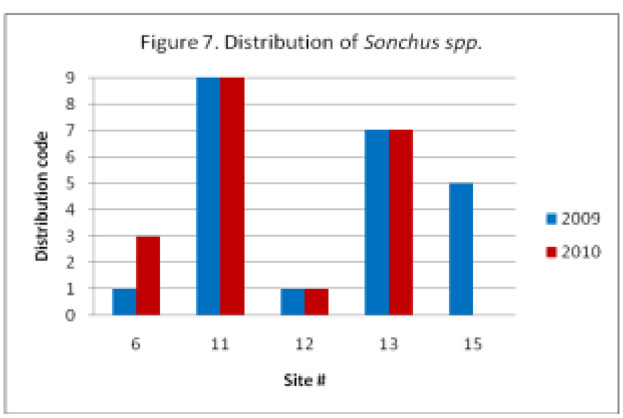

Figure 7. Distribution of *Sonchus spp.*

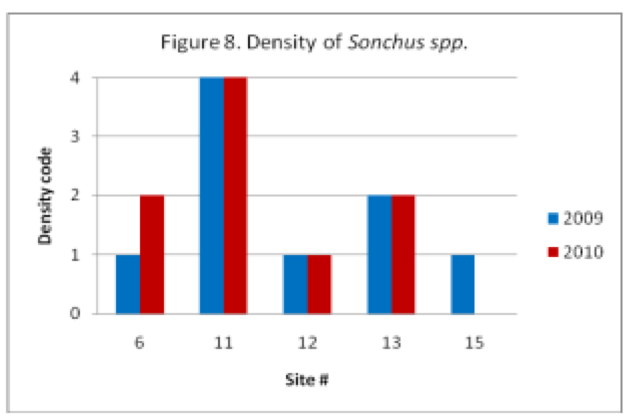

Figure 8. Density of *Sonchus spp.*

CONCLUSIONS

The results from this study show that mechanical treatment methods of the invasive species of concern have only a minor impact over a one year period. A more substantial impact may be evident after two years for sites with *Cirsium vulgare.* If the treatment of *Cirsium arvense* with black plastic proves successful, this could be a useful technique to apply to other areas with extensive *Cirsium arvense.*

It is important to monitor the distribution and density of invasive plant species in Laskeek Bay in order to study the effectiveness of manual removal and to mark any significant changes. Due to the presence of deer it is questionable whether native plants will be able to re-establish once invasive plants are removed.

In order to have a more significant impact other methods need to be applied. Removal of the deer would have a significant impact on the native plants as well as native fauna such as songbirds. Since the deer browse on the native vegetation, removing the invasive plants will not allow for native plants to recolonize the area. However, effective deer culling combined with invasive plant management would enable native plants to re-establish.

Public education continues to be an important outcome of this project. Thirty two volunteers have participated in the project to date, and learned identification techniques as well as methods of removal.

It will be important to revisit the sites in subsequent years to determine the impacts of the treatments. It will also be useful to fully survey the other island in Laskeek Bay in subsequent years. A comprehensive management plan will also be necessary and will be completed in coordination with Gwaii Haanas National Park Reserve and Haida Heritage Site standards. This plan will help direct and focus our efforts in future years.

Photo: Site 10 Treatment – *Cirsium arvense* patch covered in black plastic

Appendix 1

Site Coordinates, Slope, Aspect and Elevation

Site #	Site ID (IAPP Database)	Location - description	UTM Coordinates		Slope (%)	Aspect (degrees)	Elevation (m asl)
			Easting	Northing			
1	254988	ELI – Cabin cove	0324596	5865253	60	180	12
2	254998	ELI – Cabin cove	0324492	5865217	5	0	9
3	255000	ELI – End of Ridge trail	0324425	5864767	100	180	38
4	255001	ELI – Cabin cove	0324543	5865302	10	90	20
5	255002	ELI – Cabin cove	0324559	5865315	85	180	23
6	255003	ELI – North shore Cassin's	0324579	5865332	5	180	35
7	255004	ELI – North Cove	0324354	5865549	50	90	12
8	255005	ELI – Crow Valley	0324523	5864906	1	120	2
9	255006	ELI – Lookout Point	0324676	5865039	5	90	20
10	255007	ELI – South Cliffs	0324057	5864974	100	210	5
11	255009	ELI – South Cliffs	0324190	5864891	100	210	2
12	255010	ELI – South Cliffs	0324266	5864844	100	210	10
13	255011	ELI – South Cliffs	0324256	5864848	10	210	5
14	255012	ELI – South Cliffs	0324308	5864837	100	210	15
15	255013	Haswell – Southeast side	0319127	5860124	66	140	5

Appendix 2

Invasive Species Area, Distribution and Density for Each Site in 2009 and 2010

Site #	Invasive Species	Area (Ha)	Distribution (see App 3)		Density (plants/m^2)	
			2009	2010	2009	2010
1	*Cirsium vulgare*	0.001	8	2	>10	<=1
	Cirsium arvense	0.001	n/a	5	n/a	>10
2	*Lactuca muralis*	0.0012	6	6	>10	>10
	Cirsium vulgare	0.0012	4	4	>10	<=1
3	*Cirsium vulgare*	0.04	4	4	2-5	2-5
	Cirsium arvense	0.04	n/a	2	n/a	<=1
4	*Lactuca muralis*	0.0002	3	3	>10	>10
	Cirsium vulgare	0.0001	2	2	<=1	<=1
5	*Cirsium arvense*	0.001	7	2	2-5	<=1
	Cirsium vulgare	0.005	7	7	6-10	6-10
6	*Cirsium vulgare*	0.01	7	7	<=1	<=1
	Sonchus species	0.0001	1	3	<=1	2-5
7	*Cirsium vulgare*	0.001	2	2	2-5	<=1
8	*Lactuca muralis*	0.4	4	5	2-5	>10
	Cirsium arvense	0.4	4	4	2-5	2-5
	Cirsium vulgare	0.4	4	8	2-5	>10
9	*Cirsium vulgare*	0.05	5	7	2-5	6-10
	Cirsium arvense	0.05	5	4	2-5	<=1
10	*Cirsium vulgare*	0.05	4	4	2-5	<=1
	Cirsium arvense	0.05	4	8	6-10	>10
11	*Sonchus* species	0.002	9	8	>10	>10
	Cirsium arvense	0.002	2	2	<=1	<=1
12	*Cirsium vulgare*	0.04	4	4	6-10	2-5
	Cirsium arvense	0.04	4	2	6-10	2-5
	Sonchus species	0.04	1	1	<=1	<=1
13	*Cirsium vulgare*	0.016	7	2	2-5	<=1
	Cirsium arvense	0.016	7	4	2-5	2-5
	Sonchus species	0.016	7	7	2-5	2-5
14	*Cirsium vulgare*	0.04	8	8	>10	>10
	Cirsium arvense	0.04	5	5	2-5	2-5
15	*Cirsium vulgare*	0.2	5	n/a	<=1	n/a
	Sonchus species	0.05	5	n/a	<=1	n/a
	Senecio vulgaris	0.01	4	n/a	<=1	n/a

Appendix 3

Distribution Codes (used in Appendix 2)

Code	Description
1	Rare individual, a single occurrence
2	Few sporadically occurring individuals
3	Single patch or clump of a species
4	Several sporadically occurring individuals
5	A few patches or clumps of a species
6	Several well-spaced patches or clumps
7	Continuous uniform occurrence of well-spaced individuals
8	Continuous occurrence of a species with a few gaps in the distribution
9	Continuous dense occurrence of a species

NEW PLANT SPECIES FOUND IN LASKEEK BAY BETWEEN 2010 AND 2012

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INTRODUCTION / METHODS

The previous list of vascular plant of Laskeek Bay resulted from observations on the islands between 1990 and 2005 (Gaston et al. 2005, 2006). The present paper reports new observations made subsequent to 2005, and includes comments on the distribution of native and introduced species. For a comprehensive description of the ecology of studied islands see: Stockton et al. (2005) and Gaston et al. (2005, 2006).

Systematic surveys of five islands (Haswell, East Limestone, West Limestone, Low and Lost) were carried out 2010 to 2012 in the context of an evaluation of deer impacts on forest understory and shoreline plant communities (Chollet et al. 2013). Observations on Reef, Kunga and South Low were more opportunistic. The islands of South and West Skedans, which were investigated in the previous survey, were not visited during this one.

RESULTS / DISCUSSION

Four new species for Laskeek Bay were found during the 2010-2012 investigation: *Bellis perenis*, *Potentilla anserina* (=*P. pacifica*), *Viola biflora spp. carlotae* and *Viola glabella*, increasing the total number of vascular species to 174. New species were found on all islands surveyed (Table 1), but West Limestone, Haswell and Kunga showed the highest increase in species numbers (18, 22 and 17 respectively). A new analysis of species richness in relation to island area yielded the relationship: species recorded = $2.02 + 0.18 * \log_{10}$ island area (Fig. 1).

With 157 native species, Laskeek Bay is home to 31% of the native species described on Haida Gwaii (522, Cheney et al. 2007). This is a surprisingly high proportion of species because of the small area of the islands and of the relatively few ecosystem types present in Laskeek Bay (alpine, subalpine and bogs ecosystem are totally absent).

In comparison to the whole archipelago, the islands of Laskeek Bay support fewer introduced species (202 species, 28% for Haida Gwaii versus 17 species, 10% for Laskeek Bay). This result may be explained by the relative isolation of the area from major historical settlement. However, among the new species found in 2010-2012, one introduced species was totally new for Laskeek Bay (*Bellis perenis*) and six introduced species were found at new locations (*Cirsium arvense* , *Cirsium vulgare, Sonchus asper*, *Senecio sylvaticus, Taraxacum officinale* and *Vicia cracca*). In the case of *Bellis perenis*, large populations of the species exist in the two Haida village site within Laskeek Bay (Tanu and Skedans) suggesting a potential way of introduction.

The identification of two new species of *Viola* is probably due to the early time of the field season in 2012. In fact *Viola* species were previously mentioned but were not identified. It is interesting to note that one of the species, *Viola biflora spp. carlotae*, which has been identified at several locations on Kunga (in the forest interior, close to the top), is usually described as an alpine species (Calder & Taylor 1968).

The quite big increase in species number on all islands could be explained by at least two factors: long duration of field season and investigation in not easily accessible habitats. In fact, the cumulative three years of survey correspond to field work that has been conducted from early April to mid August, covering the full blooming period, allowing the possibility to record early and late flowering species. Previous botanical field work was carried out mainly in May and June. In addition, to evaluate the potential role that rocky places play as refuges from deer herbivory we systemically evaluated the plants growing in such areas during 2010-2012, on five islands (Haswell, East Limestone, West Limestone, Low and Lost; Chollet et al. 2013). These inaccessible habitats were probably under-investigated before, and this may account for the discovery of numerous new species, particularly on islands with deer.

An interesting record is the presence of *Chimaphila menziesii* on two more islands, West Limestone and Kunga. This species was before known only in four sites in Haida Gwaii (Stockton & Bobechko 2001)

Finally, my results suggest than even after 15 years of research on the islands flora of Laskeek Bay (and much more on East Limestone), it is still possible to discover previously unidentified species!

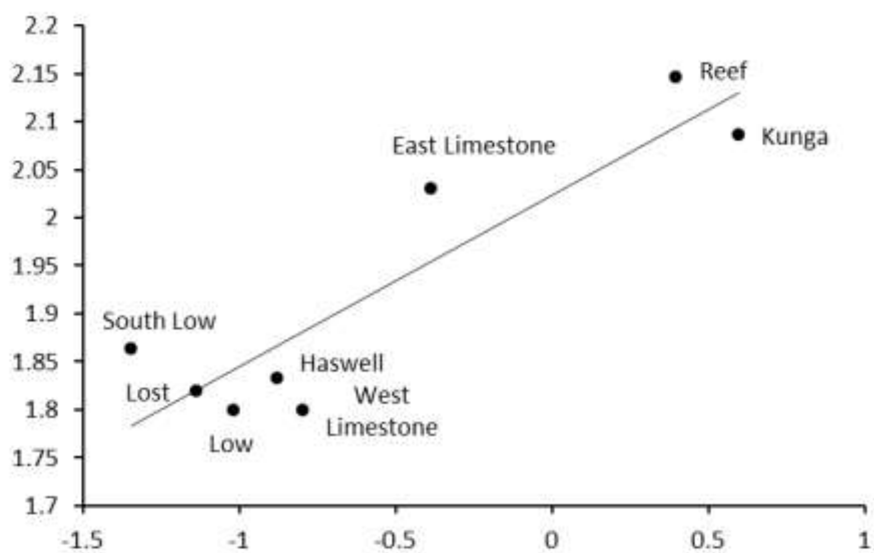

Figure 1. Relationship of species richness ($\log_{10}$ number of spp.) to island area ($\log_{10}$ km²) for the study islands. Species recorded = 2.02 + 0.18 * $\log_{10}$ island area.

Table 1. Complement to the list of plants of Laskeek Bay islands of Gaston et al. (2006). RE: Reef, EL: East Limestone, KU: Kunga, HA: Haswell, WL: West Limestone, SL: South Low, LO: Low, LT: Lost. Species with * in front of the name are introduced on Haida Gwaii (according to Cheney et al. 2007).

	RE	EL	KU	HA	WL	SL	LO	LT
Adiantum pedatum				1	1			
Ambrosia chamissonis					1			
Anaphalis margaritacea		1	1	1	1			
Aquilegia Formosa				1				
Arctostaphylos uva-ursi					1		1	
Asplenium trichomanes	1		1					
**Bellis perenis*	1		1					
Blechnum spicant				1				
Calypso bulbosa				1	1			
Campanula rotundifolia				1				
Cardamine oligosperma					1	1		
Castilleja unalaschcensis				1	1			1
Cerastium arvense								1
Chimaphila menziesii			1		1			
**Cirsium arvense*					1			
Cirsium edule					1			
**Cirsium vulgare*								1
Corallorhiza maculata					1			
Cornus canadensis			1					
Epilobium angustifolium				1				
Epilobium ciliatum				1	1			
Fragaria chiloensis				1	1			
Fritillaria camschatcensis					1			
Galium aparine				1				
Goodyera oblongifolia			1	1				
Heracleum lanatum			1					
Honckenya peploides			1				1	
Hypopitys monotropa		1	1	1				
Juncus falcatus								1
Lathyrus japonicus								1
Lycopodium clavatum	1							
Lycopodium selago			1	1				
Menziesia ferruginea					1			
Mimulus guttatus				1				
Moneses uniflora				1	1			
Pinus contorta			1					
Polypodium glycyrrhiza				1	1	1		1
Potentilla anserine (=P. pacifica)						1	1	1
Ranunculus occidentalis				1				
Ranunculus uncinatus			1					
Ribes lacustre				1	1			1
Rosa nutkana				1				
Saxifraga cespitosa		1						
Selaginella wallacei		1		1		1	1	1
**Senecio sylvaticus*						1		
Sisyrinchium littorale			1					
**Sonchus asper*		1		1	1			
Stachys cooleyae			1					
**Taraxacum officinale*			1					
Tiarella trifoliate					1			
Vaccinium alaskaense						1		
**Vicia cracca*	1			1				1
Viola biflora spp carlotae			1					
Viola glabella	1		1					
New species	5	5	17	23	20	6	4	10
New total	139	109	122	69	65	73	63	67

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LICHENS OF EAST LIMESTONE ISLAND

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Lichens are fascinating organisms that are a symbiosis between a fungus and a photosynthetic partner. They are the agriculturalists of the fungus kingdom, having discovered how to cultivate algae and/or photosynthetic bacteria. Lichens are not only important for documenting biodiversity, in many areas they also provide essential ecological services (like nitrogen cycling) and have important cultural uses (food, dye, medicine). Lichens respond to small environmental changes that go unnoticed by many other lifeforms, and thus can tell a detailed ecological story to the observant naturalist.

I conducted a preliminary survey of the lichens of East Limestone Island from May 11–18, 2012. The primary purpose of this survey was to prepare an educational resource on lichens for the Laskeek Bay Conservation Society. East Limestone Island supports a rich lichen flora. This report documents the majority of the lichens that an interested observer will be able to find and recognize after a reasonable effort. It focuses on the macrolichens, and only lists a few of the more obvious microlichens. Several of the more tricky genera are not differentiated to the species level.

Most of the lichen flora of Limestone Island is similar to elsewhere in Haida Gwaii. Many lichens are restricted to a specific microhabitat, but they are usually not limited by dispersal. This means that you can expect to see the same lichens growing across Haida Gwaii, wherever you find the same microhabitat. However, the limestone cliffs of East Limestone Island are an uncommon habitat on Haida Gwaii.

Haida Gwaii has two types of rocky shores: calcareous (eg. limestone) and siliceous (eg. granite, basalt, sandstone). Along much of Haida Gwaii's rocky shores, the spray zone is dominated by a distinct band of black lichen (*Verrucaria* spp.), with a band of white lichen (*Coccotrema maritimum*) above it. East Limestone Island is an exception — it has the band of black *Verrucaria* spp., but without the white lichen above it. This is because *Coccotrema maritimum* only grows on siliceous rocks. The limestone cliffs of Limestone Island also support different species of *Verrucaria*, *Caloplaca*, and *Collema* from the nearby siliceous shores.

For further information on identifying lichens, Brodo et al. (2001) "Lichens of North America", is an excellent resource with hundreds of beautiful pictures. If you wish to learn more about the traditional uses of lichens, my (2007) M.Sc. thesis "Ethnolichenology of *Bryoria fremontii*: wisdom of elders, population ecology, and nutritional chemistry" is available online from the University of Victoria library.

PLATISMATIA

Crumpled, messy-looking, medium-sized foliose lichens. This is a small genus, but the Pacific Northwest is a center of diversity for this genus. Out of the six species of *Platismatia* in North America, five are from the Pacific Northwest, and four are found in Haida Gwaii, including Limestone Island. Some species can be used to make a yellow-brown to orange-brown dye.

Platismatia norvegica

It has large ridges or wrinkles on its surface. These ridges are covered in soredia or isidia, particularly close to the edges of the lobes. In the interior, it is restricted to old growth forests. It is less fussy in coastal rainforests, and on Limestone Island it is the most abundant species of *Platismatia*. The other three species are frequently encountered, but are significantly less abundant.

***Platismatia lacunosa* (Wrinkled rag lichen)**
Similar to *P. norvegica* with large wrinkles on its surface, but it doesn't have soredia or isidia on top of these ridges. Instead, it has tiny black dots along the edges of its lobes which produce spores. It is also usually whiter than *P. norvegica*. Frequent on Limestone Island, but less abundant than *P. norvegica*.

***Platismatia glauca* (Ragbag lichen)**
Not wrinkled like *P. norvegica* or *P. lacunosa*. It has soredia or isidia along the edges of its lobes, but not on the upper surface like *P. norvegica*. This is the most common species of *Platismatia* in BC, and the only species that is widespread, but although it is frequently encountered on Limestone Island, it is not exceptionally abundant.

***Platismatia herrei* (Tattered rag lichen)**
Similar to *P. glauca* in having isidia or soredia only along the edges of its lobes, instead of on wrinkles on the upper surface like *P. norvegica*. However, its lobes are much narrower than *P. glauca*, giving it a more tattered appearance. Frequent on Limestone Island, but less abundant than *P. norvegica*.

LOBARIA

This is a genus of large foliose lichens. The two common species of *Lobaria* (*L. pulmonaria* and *L. oregana*) are three-way symbiosis between fungi, algae, and cyanobacteria. The cyanobacteria fix nitrogen, and these lichens are important sources of nitrogen. In some temperate rainforests, *Lobaria* species can be the single largest source of nitrogen to the system, even more important than salmon. They are also important forage for deer. They usually grow high in the canopy, but are accessible when they blow off in winter storms.

***Lobaria pulmonaria* (Lungwort)**
Brighter green than *L. oregana*, and with soredia on its upper surface. It contains norstictic acid, which is bright orange, and makes a good orange dye if you boil it in water. It is tasty eaten in soups, deep fried, or roasted in the oven and was once used for brewing beer. It is important in many traditional medicines, often for lung ailments. . It is widespread across the world in relatively undisturbed forests, and is abundant on Limestone Island.

Figure 1. *Lobaria pulmonaria*

***Lobaria oregana* (Lettuce lichen)**
More yellowish-green than *L. pulmonaria*, and with lobules along its edges which make it look frilly;no soredia. It prefers slightly moister habitats than *L. pulmonaria*. Both are abundant on Limestone Island. It does not contain norstictic acid, so would not make a good dye.

Lobaria scrobiculata
This species is grey in colour because it does not contain algae, only a cyanobacterium. It is infrequent on Limestone Island. Some Yup'ik in Alaska eat this lichen raw. They call it *Qelquaq*.

PSEUDOCYPHELLARIA

This genus of lichens looks like *Lobaria*, but is differentiated by pseudocyphellae on their lower surface. The pseudocyphellae are small holes in the lower cortex that allow the medulla to poke out, which look like small white pimples on the underside of the lichen.

This is the diagnostic feature of the genus, and the reason behind their common name of specklebelly lichen. Most species of *Pseudocyphellaria* are less common than *Lobaria.* They are dependent on undisturbed, old growth forests, and thus make good indicator species. There are four species of *Pseudocyphellaria* in Haida Gwaii, one of which is red listed. Two species have been found on Limestone Island, and can sometimes be seen on branches blown down from the tops of trees.

Pseudocyphellaria anthraspis
This species looks similar to *Lobaria pulmonaria*, but has a cyanobacteria symbiont instead of an algae, and is brown instead of green. It does not have any soredia on the ridges on its upper surface, instead it has brown apothecia. Infrequent on Limestone Island.

Pseudocyphellaria anomala
This species is less frequent than *P. anthraspis* on Limestone Island. It looks very similar to *P. anthraspis*, but it does not have apothecia. Instead, it has bright white soredia on the ridges on its upper surface.

STICTA

This genus is similar to *Lobaria* and *Pseudocyphellaria*. It is differentiated by the cyphellae on its lower surface. These structures are similar to the pseudocyphellae on the underside of *Pseudocyphellaria*. However, the cyphellae on *Sticta* are larger and are concave instead of convex (i.e. a larger crater instead of a smaller pimple). The cyphellae have a distinct border around the opening, while the pseudocyphellae do not, but this is only apparent under a dissecting scope.

Sticta fuliginosa (Peppered moon lichen)
Dark brown with a cyanobacteria symbiont. The upper surface of the lobes are covered with isidia. It is the only species of *Sticta* recorded on Limestone Island, where it is rare.

NEPHROMA

Foliose lichens with kidney-shaped apothecia on the underside of the lobes,which usually curl upwards so the apothecia are visible from above, although they are still obviously on the underside of the lobes, the diagnostic feature of this genus. Most *Nephroma* have a cyanobacteria symbiont.

***Nephroma resupinatum* (Pimpled kidney lichen)**
A white fuzz on its upper surface makes it look dull coloured. The underside has small white pimples, the diagnostic feature of this species. It is frequently found growing on branches of apples and other trees on Limestone Island.

Figure 2. *Nephroma resupinatum*

***Nephroma helveticum* (Fringed kidney lichen)**
This lichen has a shiny upper surface, unlike *N. resupinatum*. It also has isidia and lobules along the edges of its lobes, giving it a frilly appearance. On Limestone Island frequently found growing on the branches of apple trees.

PELTIGERA (dog pelt lichens)

Common growing on moss on Limestone Island, and also on the mossy twigs of stunted spruce trees. Most dog pelt lichens have a cyanobacteria symbiont, and so they fix nitrogen. Most species have distinct veins on the underside, and large rhizines. The apothecia are on the upper surface of the lobe, and curl upwards. This distinguishes them from *Nephroma* species, which have the apothecia on the lower surface. They are tasty to eat, and have many essential amino acids. They are used in traditional medicines of cultures across the world, and have been used to cure tuberculosis, liver ailments, and rabies, as well as a poultice for wounds, and as a love charm. There are many species of *Peltigera*, I have listed four of the species more frequently found on Limestone Island.

Peltigera membranaceae **(Membrane pelt)**
Greyish, with an orange-ish hue if it is exposed to a lot of light. The upper surface is often covered with white fuzz, making it look dull coloured. This white fuzz can cover the entire upper surface, be restricted to the edges of the lobes, or be entirely absent. The underside is white with white veins, it is not darkened in the center like other species. The entire thallus is much thinner than other species. It is frequently encountered on Limestone Island and can be abundant in some areas.

Peltigera malacea **(Veinless pelt)**
Greenish whenwet, even though it does not contain algae. No distinct veins on the underside, but the underside is darker in the center, and white along the edges. Frequently encountered on Limestone Island.

Peltigera neopolydactyla
Greyish, with a smooth upper surface and dark veins on a white undersurface. The apothecia are smaller than on other species, and protrude upwards on short lobes. Frequently encountered on Limestone Island.

Peltigera britannica **(Flaky freckle pelt)**
Bright green with brown freckles which contain cyanobacteria: the rest of the lichen contains green algae, making this a three-way symbiosis. It is a fickle lichen, and can change its mind as to which symbiont it wants to associate with. You can find individuals only using a cyanobacterium (grey), ones that just have an alga (green), and ones that have both (green with freckles). Less frequent on Limestone Island than the previous three species, but there is a nice specimen on a mossy log behind the fuel barrels.

PARMELIA

These lichens are called crottle in Scotland, and used to make a deep red-brown dye for wool. Socks dyed with crottle will protect your feet on a long journey. Various species of *Parmelia* have had a variety of medicinal, culinary, and recreational uses: used for curing epilepsy (if collected from a human skull), warts, coughs, stomach aches, and venereal diseases, and as a poultice for wounds. Some species are smoked as tobacco, and others are used in some curry spices. *Parmelia* species are very common globally, but not particularly abundant on Limestone Island. However, they are still frequently found on crab apple and spruce branches around the island. They have a black underside that is densely covered with little rhizines, which distinguishes them from similar leafy lichens found on Limestone Island.

Parmelia sulcata **(Waxpaper lichen)**
Incredibly common world-wide, it is the closest thing there is to a lichen weed, and is the species that you are likely to find on a picnic table. Found growing on trees on Limestone Island, but not particularly abundant. It has a network of white-ish, raised ridges on its surface that make it look like crinkled wax paper. It has soredia along these ridges, and no isidia.

Parmelia squarrosa
Similar to *P. sulcata*, but has isidia instead of soredia. Found on trees around the island.

MELANELIA

Similar in structure to *Parmelia*, but dark brown in colour. It also grows on bark, and can be seen on apple branches. Occasionally found on Limestone Island, but easy to overlook because it is relatively flat to the branch and brown. Because of this, their common name is camouflage lichens. There are numerous species, and a couple of related genera, that all look similar and are difficult to tell apart.

PARMOTREMA

These lichens have marginal cilia – long black hairs that project outwards from the edges of the lobes. No other lichen here has this feature, making *Parmotrema* very distinctive. They are important lichens in India, where they are sold as Charilla. This is an important drug that is used for a variety of ailments, as well as a recreational snuff. It is also supposed to be a powerful aphrodisiac, and some people use it in curry.

Parmotrema arnoldii
The only species of *Parmotrema* that I saw on Limestone Island. It has long marginal cilia, and marginal soredia. Abundant on freshly blown down spruce at Boat Cove, but not seen elsewhere.

***TUCKERMANNOPSIS* (ruffle lichens)**

They are green-brown, ruffly, and grow on trees.

Tuckermannopsis chlorophylla
This pretty lichen is the only species of *Tuckermannopsis* that I saw on Limestone Island. It is also the only species with marginal soredia, which makes it distinctive. Frequent, but not abundant, on tree branches.

HYPOGYMNIA

Distinctive for its hollow, inflated lobes.

***Hypogymnia enteromorpha* (Intestine lichen)**
Several species of *Hypogymnia* are found on Limestone Island, but this is the most abundant. It grows on trees and is relatively closely attached to the bark. It has little lobules along the sides of the lobes, and often has gigantic apothecia. It can be used to make a bright yellow-brown dye.

***DERMATOCARPON MINIATUM* (Leather lichen)**

This grey-brown foliose lichen is frequently found on the limestone cliffs high above the spray zone. The tiny black dots on its surface are the openings to its reproductive structures.

Figure 3. *Dermatocarpon miniatum*

***COLLEMA* spp.**

Small black foliose lichens abundant on the limestone cliffs, above the spray zone. They are jelly lichens, with a cyanobacterium symbiont and no internal structure. Externally, however, they can form rather odd shapes. Three species are known on Haida Gwaii's rocky shores. The limestone cliffs of Limestone Island have different species than the siliceous rocks of nearby islands.

SPHAEROPHORUS TUCKERMANII
(Coral lichen)

A distinctive, shrubby lichen that looks like miniature coral growing on tree tree trunks and larger diameter branches. Moderately frequent, but not abundant, on Limestone Island. This is the most common species of *Sphaerophorus* on Haida Gwaii. A second species with more sparse branches has been found on the archipelago, but I did not see it on Limestone Island.

***CLADONIA* (Pixie cup lichens)**

A very large and distinctive genus of lichens that are frequently encountered on Limestone Island. They have a primary thallus of small scales, and podetia grow up from them. The podetia can be shaped like little trumpets (hence the name pixie cup), spikes, or clubs. The clubs can have bright red balls on them. There are numerous species found on Limestone Island, telling them apart can be difficult. Various species are used medicinally for coughs or sores.

HAIR LICHENS

There are several species of hair lichens on Limestone Island that grow hanging off the trees. They look similar at a distance, but on closer inspection they are actually quite different, and not at all related.

***Alectoria sarmentosa* (Witch's hair)**
A yellow-green hair lichen that is dichotomously branched and does not have a central cord. If you break it open, it is hollow. It is an important forage for deer. It contains usnic acid, which is an antibiotic and mildly toxic. Frequently encountered on Limestone Island, and abundant in some areas.

Figure 4. *Alectoria sarmentosa*

***Usnea* spp. (Old man's beard)**
Another yellow-green hair lichen, but structurally quite different from *Alectoria*. It has one central stem with many smaller side branches coming off of that branch. If you pull apart a main stem, you will see that it has a central cord. It is quite high in usnic acid, an antibiotic, and is used as a medicine in many parts of the world, often as a bandage, or to treat urinary tract infections. There are many species of *Usnea*and differentiating them is a frustrating affair that should not be attempted without a dissecting scope. They are frequently encountered on Limestone Island, and abundant in some areas.

Ramalina farinacea
A shrubby pendant lichen that never grows as long as *Alectoria* or *Usnea*. It is the same yellow-green colour as *Usnea* and *Alectoria*, and is dichotomously branched, but the branches are more angular and grooved than *Alectoria*. It is also covered with large soredia, which are visible to the naked eye. A common food for people in some parts of Nepal. It is frequently encountered on Limestone Island abundant in some areas.

***Bryoria* spp. (Horsehair lichen)**
Similar to *Alectoria* in structure, but dark brown in colour. Frequently encountered on tree branches on Limestone Island, but they are always small, brown, and not particularly abundant, so easily overlooked. In the interior of BC, their growth can be much more spectacular, completely covering trees. In these areas they are important food for animals, and in the past they were an important food for people as well. They make a tasty gelatinous treat if cooked for a long time. Haida Gwaii has several different species of *Bryoria* that are endemic to Haida Gwaii and southeast Alaska.

CRUST/DUST LICHENS

There are many species of crust lichen, and most are very difficult to differentiate without a microscope. A few of the more distinctive ones are listed here.

***Ochrolechia* spp. (Cudbear)**
Frequently found on the bark of deciduous trees. It is a white crust with distinctive orange apothecia with white rims. If you cut open the thallus and drop bleach on it, it will turn bright red – this chemical test is one of the ways of differentiating difficult lichens. Traditionally used as a red dye in England, which was called cudbear.

***Pyrenula occidentalis* (Pox lichen)**
A very distinctive lichen, abundant on the bark of alders at the end of Ridge Trail. Numerous species of crust lichens grow on alder bark, visible as different coloured blotches all over the trunk. This species is one of the more distinctive. It has a shiny orangish-green thallus with small black pimples all over it. The tops of the pimples are bright orange-red.

***Icmadophila ericetorum* (Fairy puke)**
A green dust lichen with bright orange-pink apothecia, frequently seen on rotting logs on Limestone Island.

Figure 5. *Icamadophila ericetorum*

Lepraria
This is a light green dust that covers stuff, with no redeeming features to differentiate it from anything else. It is just fungal hyphae intertwined with algae. Recent genetic work has shown that different *Lepraria* aren't actually related to each other. It appears that this is what you get when a lichen decides to not produce any recognizable structures.

***Chrysothrix candelaris* (gold dust lichen)**
A brilliant yellow dust lichen that is abundant on spruce bark at a couple locations on Limestone Island. Don't eat it, it's poisonous. It usually only grows on one side of the tree, and moss grows on the other, probably because the moss enjoys liquid water in the form of rain, whereas dust lichens like *Chrysothrix* absorb humidity directly from the air.

Verrucaria
The black crust lichen that is very abundant in the spray zone on the limestone cliffs all around Limestone Island. There are about a dozen species known to live on the rocky shores of Haida Gwaii (including several which have recently been moved to the related genera *Hydropunctaria* and *Wahlenbergiella*). Several *Verrucaria* species were described new to science from Haida Gwaii. Some *Verrucaria* species form a black crust over the rock, with black pimples that are their reproductive structures. Others live entirely within the rock, and are only visible as tiny holes in the rock where their black reproductive structures bulge out.

The limestone cliffs of Limestone Island support different species of *Verrucaria* from the siliceous rocks that dominate most of the coast of Haida Gwaii.

Caloplaca
These crust lichens have bright orange apothecia, and the rest of them is often bright orange too. On Limestone Island, they are frequently found on the cliffs above the *Verrucaria*. There are seven species of *Caloplaca* known from Haida Gwaii's rocky shores. The species of *Caloplaca* growing on the limestone cliffs of Limestone Island are differentfrom those on the siliceous rocks of nearby islands. One species prefers to grow where there are lots of birds defecating.

LICHENOMPHALINA

Almost all lichens are ascomycetes, which is a phylum of fungi that also includes morels and many species of mycorrhizal fungi. Mushrooms belong to the other major phylum of fungi, the basidiomycetes. However, there are a couple species of mushrooms that have also adapted to farm algae. One of these lives on Limestone Island. It grows on rotten logs, and looks like small green scales with a mushroom sticking out. It is closely related to the mushroom *Omphalina*, which is not a lichen. It is rare on Limestone Island.