

LASKEEK BAY RESEARCH

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LASKEEK BAY CONSERVATION SOCIETY ANNUAL SCIENTIFIC REPORTS, 1999 and 2000

December 2000

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**LASKEEK BAY CONSERVATION SOCIETY
SCIENTIFIC REPORT, 1999 and 2000**

Edited by

ANTHONY J. GASTON

December 2000

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LASKEEK BAY CONSERVATION SOCIETY

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

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

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

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

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

BACKGROUND

The goals and objectives of the Society are:

1. *To undertake and support research and long term monitoring of wildlife populations, including nesting seabirds and other marine birds, forest birds, marine mammals and introduced species of the Laskeek Bay area (roughly coastal waters of Hecate Strait from Cumshewa Inlet to Lyell Island) of Haida Gwaii, the Queen Charlotte islands.*
2. *To provide information on all aspects of the biology of the Laskeek Bay area for residents of Haida Gwaii, the Queen Charlotte islands, and visitors to the area.*
3. *To encourage students and residents of the area to participate in field programs and to undertake and assist in presentations and other activities that promote better understanding and improved conservation of marine birds and forested and marine ecosystems throughout Haida Gwaii, the Queen Charlotte Islands.*

INTRODUCTION

In July 1998, the Laskeek Bay Conservation Society completed 9 years of volunteer field work in the Haida Gwaii archipelago. Based at a field camp on East Limestone Island, and concentrating mainly within the Laskeek Bay area, the Society's programme includes biological monitoring and research, interpretation for visitors, and learning opportunities for students and volunteers.

The scientific work of the Society is carried out in collaboration with several researchers who have ongoing interests in the ecology and conservation of Haida Gwaii. The research programme is 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 marine bird and marine mammals population monitoring, studies of intertidal invertebrates, plants, and forest birds. In addition, 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. This research focuses especially on the impact of introduced mammals, including deer, raccoons and squirrels on island ecosystems.

The overall aim of the Society's research programme is to provide long term information on the biology and ecology of Haida Gwaii ecosystems. Ongoing monitoring, using simple standardized techniques that allow 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 pertinent in the context of global climate change.

ACKNOWLEDGEMENTS

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

We received generous contributions from the following:

- W. Alton Jones Foundation for their continued financial assistance to our interpretive programme and in-town administration;
- Canadian Wildlife Service (National Research Centre, Ottawa, and Pacific and Yukon Region, Delta) for financial assistance and long-term equipment loans;
- Ministry of Environment, Lands and Parks, Skeena Region, for permission to conduct research and in the Wildlife Management Area;
- South Moresby Forest Renewal Account (SMFRA) and Forest Renewal British Columbia for financial assistance to our core programme and;
- Gwaii Trust for assistance with *Project Limestone*, our programme for Haida Gwaii secondary students.

We also thank the following individuals or groups who gave generously of their time to the Society, making life easier for us in the field:

- Tony Gaston for his valuable advice and guidance throughout the field season.
- Greg Wiggins, SMRFA coordinator.
- Graeme Ellis for providing us with a camera and film to document killer whales.
- Bev McBride for volunteer banding three weeks during songbird season.
- Crew and guests of the vessels Island Roamer and Maple Leaf for generously supporting our project with their visits and t-shirt purchases.
- Nathalie Macfarlane at the Haida Gwaii Museum, for continuing to provide a venue to promote the Society's work.
- Greg Martin for numerous hours of volunteer time to keep the Society going.
- Barb Rowsell, RGIS coordinator for generous help whenever required.
- LBCS directors for their time and efforts in maintaining and developing funding, the field camp, and the scientific and educational projects.
- All of the volunteers who participated in the Limestone Island camp, purchased t-shirts, made donations, or helped out in town.

Finally, thanks goes to the owners, staff and crew of South Moresby Air Charters, s/v Anvil Cove, and m/v Akko Chan for their professional services in transporting gear and people from Queen Charlotte City to Limestone Island.

SCIENCE ADVISORY COMMITTEE, 1998

Dr. Anthony Gaston (Chair, marine birds)

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

Dr. Jean-Louis Martin (introduced species, terrestrial birds)

*Centre National de Recherche Scientifique, CEPE, Route de Mende, BP 5051-34033,
Montpellier-Cedex, France*

Kathy Heise (marine mammals)

*Department of Zoology, University of British Columbia, 6270 University Blvd., Vancouver, BC,
V6T 1Z4*

Dr. Tom Reimchen (Haida Gwai ecosystems, fish)

Dept. of Biology, University of Victoria, Victoria, BC, V8W 3N5

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EAST LIMESTONE ISLAND CAMP: REPORT ON THE 1999 FIELD SEASON

Janet Gray

Laskeek Bay Conservation Society, Box 867, Queen Charlotte BC, V0T 1S0

SUMMARY

This report summarizes research and monitoring activities carried out in Laskeek Bay in 1999 and compares them to results from previous years. All of the ongoing monitoring programmes, such as seabird banding, burrow monitoring and sea surveys were continued. The spring and summer of 1999 were unusually cold, with mean daily temperatures for may lower than in any year since 1980. This resulted in a very poor breeding season for land birds, especially warblers. The other unusual feature of 1999 was the very large number of Humpback Whales seen, with a group of 25-30 being by far the largest recorded in Laskeek Bay since 1984. For the Laskeek Bay Conservation Society, this season marked the second year of the student apprentice program, designed to give local post secondary students experience with field biology. Several high school groups visited the field camp through Project Limestone to participate in the chick banding program and one student came to Limestone Island for his work experience project. In addition to these activities, the society continued its partnership with the Research Group on Introduced Species (RGIS), to study the effects of introduced species on Haida Gwaii.

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EAST LIMESTONE ISLAND FIELD PROGRAM

Laskeek Bay Conservation Society enables interested people to participate in ongoing ecological research at East Limestone Island. Volunteers stay on island with the staff for a minimum of one week. The volunteers are given an orientation to the field camp and field training so that they can aid in all aspects of camp life from the biological monitoring to cabin maintenance. Local school groups, tour boats, and other visitors come to the island for usually less than 24 hours. These parties learn about Ancient Murrelet life history, coastal forest ecology, and bird banding.

Limestone Island Field Station

The cabin on East Limestone Island underwent an addition this year. The existing north wall was removed, and the porch was enclosed. The old screen door was installed on the west side of the porch and a glass door was installed on the east side. The addition provides a lot more

interior space for staff and volunteers to work and relax.

Volunteer Program

This year 24 volunteers contributed 190 days at Limestone Island. Most people volunteered for one week; six people came for two weeks and four people came for less than a week to help pack up camp. Eight volunteers were from Haida Gwaii, fourteen were from the rest of Canada, and there was one volunteer from Argentina and one from England. Clayton Uliana, a Queen Charlotte City grade 11 student, was the work-experience student this year, volunteering on Limestone for one week during chick banding. He was a great help with the research, data collection and camp maintenance. The resident staff, Janet Gray and Joelle Fournier, worked for 14 weeks in camp.

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Student Apprenticeship Program

This was the second year of the Student Apprenticeship Program, designed to provide local post-secondary students with

skills and experience in biological monitoring and conservation. Carla Russ from Skidegate was the first apprentice this year, her work experience taking place from April 30th to June 11th. The second apprentice this year was Christine Bentley, also from Skidegate. Christine participated on Limestone from June 18th to July 25th. Both student apprentices took part in the biological monitoring, collation of data, natural history interpretation, and volunteer training.

Project Limestone

Initially set up in 1991 by Kevin Borserio and Sheila Douglas, Project Limestone consists of small groups of local students coming to East Limestone Island to gain hands on experience with research and conservation. Project Limestone students camp with their teachers at nearby Vertical Point on Louise Island. During the afternoon of their first day, the group visits Limestone Island and is given an orientation to become familiar with the procedures involved in chick banding, and the life history of Ancient Murrelets. The students return to Limestone later that night, catching the chicks and helping with the recording of data. Five school groups came this year: 2 from Queen Charlotte Secondary, 2 from George M Dawson Secondary, and one from the Living Learning School.

Tour Groups and Other Visitors

Visiting East Limestone Island is a highlight for tour boat operators, as guests are able to take part in seabird research and see Ancient Murrelet chicks depart. The sailing vessels Island Roamer and Maple Leaf have brought groups to East Limestone Island for many years and in 1999, they brought 40 visitors ashore. Guests and crew are given a guided tour of the island in the afternoon, to learn about the old growth forest that supports the

Ancient Murrelet colony. The groups return to the island later the same day and walk to the banding area on the North Cove to help catch and weigh chicks. We also had a visit this year from the Northwest Community College Eco-tourism Class that was camping on Vertical Point for an extended period.

Collaborating Scientists

Laskeek Bay continues to be a research partner with the Research Group on Introduced Species (RGIS). Drs Sean Sharpe, Jean-Louis Martin, and Tony Gaston are the primary researchers. This five year project focuses on the impact of introduced species on the ecology of the Queen Charlotte Islands. The RGIS field camp on Reef Island ran from 4 May to 25 July, with 2 to 18 people in camp. RGIS researchers worked on many islands in Laskeek Bay during the research season, including East Limestone Island.

ANCIENT MURRELET RESEARCH

Haida Gwaii contains about half of the world's Ancient Murrelet breeding population, nesting sites on the archipelago are at risk due to introduced racoons and rats. Ancient Murrelets are blue-listed in British Columbia and designated as vulnerable by the Council on the Status of Endangered Wildlife in Canada (COSEWIC). This means that the populations are thought to be declining throughout their range and may become endangered unless the factors responsible for their decline (such as introduced species) are addressed.

Adult Banding

Adult Ancient Murrelet survivorship is measured with a yearly banding program during the breeding season. Large knockdown nets are used in three locations, two on the east side of the island and one on

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the north. Adults were caught from 6-9 April, and then from 15 May to 11 June, when nesting was almost over. Banding is stopped in mid-April to minimize disturbance during egg laying and

incubation. We caught a total of 323 murrelets in 12 nights, comparable to numbers trapped in the past 2 years (Table 1).

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Table 1. Comparison of adult banding totals and breeding status for 1997-1999.

Year	Banding # nights	New		Retraps		Total	Breeder	Non-breeder	Unknown
		Net	Burrow	Net	Burrow				
1999	12	158	9	148	8	323	175	115	37
1998	13	162	5	120	9	296	160	120	16
1997	18	201	8	118	13	340	89	209	42

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NB. Birds are considered breeders if they are caught before 15 April, if they have a brood patch >19mm, or if they are in burrows with eggs or chicks. Breeding status is unknown if birds are caught from April 15th -20th or when brood patches are 10-19mm.

Valuable information such as survivorship, fecundity, mate fidelity and site fidelity can be determined from recapturing previously banded birds. In 1999, we recaptured 156 birds, of which 135 were banded as adults and 21 were banded as chicks (Table 2). Note that 3 birds from Reef Island were captured this year. One from Reef Island was banded in 1987 as an adult, which

means that it is 14 or 15 years old. It is difficult to age adults, but the bird was at least 2 when banded because typically Ancient Murrelets return to breed at two or three years of age. Still no chicks banded in 1993 have been recovered, and only a few have been recaptured from 1991 and 1992 (El Nino years).

Table 2. Numbers of Ancient Murrelet adults recaptured in 1997, 1998 and 1999 as well as the year of banding and the life stage when banded.

YEAR BANDED	1999			1998			1997		
	Banded as ADULT	Banded as CHICK	TOTAL RETRAPS	Banded as ADULT	Banded as CHICK	TOTAL RETRAPS	Banded as ADULT	Banded as CHICK	TOTAL RETRAPS
1987 (Reef)	1	1	2						
1988	-	-	-	-	-	-	-	-	-
1989	6	-	6	3	-	3	7	-	7
1990	4	3	7	10	3	13	12	2	14
1991	5	0	5	6	1	7	12	1	13
1992	5	0	5	5	0	5	12	1	13
1993	6	0	6	7	0	7	7	0	7
1994	5	3	8	6	2	8	7	7	14
1995	0	6 (1Reef)	6	9	2	11	7	2	9
1996	41	4	45	37	3	40	54	0	54
1997	20	4	24	32	0	32	-	-	-
1998	26	0	26	-	-	-	-	-	-
TOTAL	119	21	140	115	11	126	119	13	131

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Chick Banding

In 1999, chicks were banded with either a black stainless steel band or a blue plastic band. The two bands were used alternately throughout the banding period so that equal numbers of stainless steel and plastic bands

were used. Funnels were monitored from 9 May to 12 June and the first chicks appeared on 11 May. Numbers peaked on 21 May, when 54 chicks were captured, and the last 2 chicks were caught on 11 June, a spread of 32 days, during which 567 chicks were

banded at the funnels (Table 3). Another 23 adult flight nets. chicks were banded in burrows or at the

Table 3. A comparison of chick banding variables and dates including all monitoring years, note that 3 different time protocols have been used.

Variable	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Start monitoring	12 May	7 May	7 May	9 May	7 May	7 May	10 May	8 May	7 May	9 May
End monitoring	15 June	9 June	5 June	15 June	8 June	11 June	10 June	12 June	23 June	12 June
Period of observations	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200	2300 - 0230	2300 - 0230	2300 - 0230
Total days	35	30	23	38	33	36	31	35	48	34
1st night of chicks	12 May	10 May	13 May	10 May	7 May	10 May	11 May	11 May	11 May	11 May
Peak date & #	May 22 (65)	27 May (50)	22 May (85)	May 18 (70)	May 22 (52)	May 22 (64)	May 19 (48)	May 24 (41)	May 20 (55)	May 21 (54)
Last chick night	15 June	8 June	4 June	15 June	8 June	11 June	9 June	11 June	22 June	11 June
Days with chicks	35	30	23	37	33	33	29	31	43	31
Total chicks	873	562	674	653	618	617	588	527	495	567
Total chicks, 2300-2000 only	743	478	627	559	588	463	598	520	447	xxx

Burrow Monitoring

Monitoring of burrows began on 7 April, when one egg was present. The last was found on 18 May. Seventeen burrows were occupied this year and 3 nests were

abandoned during incubation. Although the occupancy rate this year was low, fledging success was quite high and there were few nest abandonments compared with 1998 (Table 4).

Table 4. Occupancy and fledging success of Ancient Murrelet chicks from burrows on East Limestone Island 1996-1999.

	1996		1997		1998		1999	
Burrows monitored	89		72		62		86	
Burrows occupied	28	(31%)	21	(29%)	17	(27%)	17	(20%)
Burrows fledged 2 chicks	22	(79%)	14	(67%)	6	(35%)	14	(82%)
Burrows fledged 1 chick	4	(14%)	1	(5%)	3	(18%)	0	(0%)
Nest abandonment 1 egg	2	(7%)	6	(28%)	6	(35%)	0	(0%)
Nest abandonment 2 eggs	0	(0%)	0	(0%)	2	(12%)	3	(18%)

Of the 17 breeders captured in monitored burrows, 8 were recaptures and 9 were new. One pair has successfully bred in C21 for 3 years, one of the pair having bred in the same burrow for 4 years. Another pair has successfully bred in C43 for two years, one adult having bred in the burrow for 4 years. An adult has successfully bred in S12 for 6 years with no consistent mate. We made 10

recordings of vocalizations by departing Ancient Murrelet families.

Gathering Ground Counts

Counts of birds assembled on the Gathering Grounds between East Limestone and Low islands were made at approximately 2 h before sunset from 11 April to 25 June, using a spotting scope focused on the water in front of Low Island. The highest monthly

counts were 129 on 20 April, 299 on 28 May, and 238 on 14 June. Seventeen counts were missed because of rough seas.

MARINE SURVEYS

Surveys for marine birds and mammals continued as part of the monitoring efforts in the Laskeek Bay area. During these surveys, seabirds are counted along established transects, seals and sea lions are counted at seasonal haul-outs.

Seabird Surveys

Due to poor weather conditions, 4 inshore and no offshore surveys were completed. Large rafts of Ancient Murrelets were seen off of Skedans Islands during 2 of the surveys. Twenty-one species of birds were counted: six auks, three gulls, two loons, two cormorants, two grebes, and one species each of duck, phalarope, eagle, oystercatcher, turnstone and crow.

Particular attention is paid to Marbled Murrelets because they are provincially red-listed and designated as threatened in Canada by COSEWIC. Marbled Murrelet numbers in past years have peaked in the hundreds, however due to the lack of surveys this year, our peak count was only 38 on 7 June.

Marine Mammal Surveys

Marine Mammal watches were conducted from a set location at Lookout Point. A total of 19 surveys were made between 13 April and 18 July, adding up to 20.5 h of sea watch effort.

Steller's Sea Lions were counted at the Skedans and Reef Island haul-outs. Peak numbers for Skedans occurred on 2 May, with 112 individuals counted, and peak numbers for the Reef Island rocks occurred on 22 June, with 511 individuals counted. The peak count for 1998 was 735 on 26 May; for 1997 it was 300 on 18 June. No California Sea Lions were seen this year.

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Killer whales were seen in Laskeek Bay on three occasions. One pod was photographed for later identification by Graeme Ellis at Pacific Biological Station, Nanaimo. A large group of humpback whales consisting of 25-30 individuals was also photographed for Kathy Heise, a marine mammal biologist.

Black Oystercatcher Census and Banding

Eight islands in the Laskeek Bay area are surveyed for breeding oystercatchers each year. Nest checks began on 22 May and finished on 23 July. Initially, 35 active nests with eggs were found, but many were later predated. Eleven chicks were banded, with many adults still sitting on eggs (replacement clutches) when camp closed.

Glaucous-winged Gull Colony Census

Glaucous-winged Gull nests were counted at five islands, 102 nests contained 1-3 eggs. In comparison to last year, nest counts decreased at Skedans, stayed the same on Low Island and increased on Kingsway Rock (Table 5). Trends for Lost island could not be assessed because only a partial count was made at that colony.

Table 5. Counts of Glaucous-winged Gull nests in the Laskeek Bay area since 1992.

Colony	1992	1993	1994	1995	1996	1997	1998	1999
Lost	120	140	165	145	175	226	293	[96]
Kingsway	94	79	82	56	46	36	22	32
Skedans	18	20	12	11	1	8	5	0
Low	1	4	2	1	6	0	9	9
TOTAL	233	234	261	213	228	270	329	[137]
Cumshewa	-	-	7	4	2	6	2	0
Reef	-	-	-	-	-	-	-	2

TERRESTRIAL PLANTS AND ANIMALS

Songbird Banding and Species Counts

Songbird trapping and banding took place again this year on East Limestone Island, Reef Island, Vertical Point, Louise Island and Low Island. The trapping is performed using mist-nets situated at fixed sites and opened for specified periods of time every few days, rotating among different islands. The main aim is to monitor juvenile/ adult ratios as a measure of reproduction on islands with and without introduced species. We also hope to establish a marked population for long-term monitoring and survival estimates. In 1998, 749 birds were caught in total, including 269 birds of 12 species on East Limestone Island, and 64 birds of 14 species at Vertical Point. This year 410 birds were caught in total, including 100 birds of 14 species on East Limestone Island, and 109 birds of 15 species at Vertical Point.

A daily checklist of bird species continued again this year, with 72 different species being recorded in the Laskeek Bay area. The maximum species counted for any one day was 35 on 20 April. Peregrine Falcons were absent from their nest on the south cliff most times it was viewed and there were no fledglings seen. A Sharp-shinned Hawk carcass was found in April, and there appeared to be no nesting activity at the

main trail site. On Cassin's Tower one burrow was occupied by a Fork-tailed Storm Petrels incubating an egg, but the nest was later abandoned. Two burrows were found with Cassin's Auklets adults incubating eggs, one nest was abandoned and the other fledged a chick. Northern Saw-whet Owls were heard and seen on both the west and east sides of Limestone Island.

Wildlife tree surveys

There were 16 active wildlife trees this year on East Limestone Island. Red-breasted Sapsuckers were found breeding in 15 trees. Chestnut-backed Chickadees nested in two, and two Hairy Woodpecker nests were also found. Two wildlife trees were found to have 2 species nesting. Tree #61 had active sapsucker and chickadee nests, and tree #33 had active sapsucker and woodpecker nests. The sapsuckers began nest excavation on 13 April, the first chicks were heard on 27 May, and chicks fledged from 6 June to 8 July.

Introduced Animals

Ten squirrel surveys were done from 3 May to 23 June to examine the distribution of squirrels on East Limestone Island, in the various habitat types. It total there were 85 records of squirrels, 27 of which occurred in the 20m radius study plots. Observations of squirrels varied over the season, with the high count of 15 on 24 May. As in previous years, the majority of squirrels noted were on the Main Trail.

Several shoreline surveys for racoon sign were conducted, as well as two spotlight surveys at night. No evidence of racoon was found on East Limestone Island, but one racoon was sighted on Louise Island and a scat was found at Vertical Point.

Plant Inventory

The total number of plants inventoried for East Limestone Island (including some mosses and lichens) remains at 120. Ten

species were added to the list of marine algae in 1999.

CONCLUSION

The 1999 field season went well, despite cold and rather inclement weather. Data comparable with earlier years was obtained for most monitoring projects, extending the series to ten years. Our results demonstrate that perseverance with simple, low-tech and environmentally friendly biological monitoring can yield important information on changes in environmental conditions over time. The student apprentices and hard working volunteers contribute immensely to the success of the camp, as do the in town staff, scientific advisors and Board of Directors. We look forward to another field season filled with shared experiences of staff, volunteers, school groups and other visitors.

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**EAST LIMESTONE ISLAND CAMP:
REPORT ON THE 2000 FIELD SEASON**

Janet Gray

Laskeek Bay Conservation Society, Box 867, Queen Charlotte BC, V0T 1S0

SUMMARY

In 2000, Laskeek Bay Conservation Society conducted its 11th field season of research, monitoring and education at East Limestone Island. All of the monitoring and research programs, such as seabird monitoring, boat surveys at sea, observations of wildlife trees and introduced species surveys were continued. Compared with 1999, this year was warmer and weather, especially in May and June, was generally good. The season was noteworthy for a continuing increase in the numbers of Ancient Murrelet chicks trapped on East Limestone Island: the highest total since 1995. This season marked the third year of the science intern program, designed to give local post-secondary students experience with biology work. Several high school groups visited the field camp through Project Limestone to participate in the chick banding program. In addition to these activities, the society continues its partnership with the Research Group on Introduced Species (RGIS) with its field camp located on near by Reef Island. LBSC welcomed a number of international scientists and grad students associated with RGIS to Limestone Island this year.

**EAST LIMESTONE ISLAND
FIELD PROGRAM**

Laskeek Bay Conservation Society enables interested people participate in ongoing environmental monitoring and research at East Limestone Island. Volunteers stay on the island with the staff for a minimum of one week. They are given an orientation to the field camp and field training so that they can fully engage in all aspects of camp life from biological monitoring to camp maintenance. Local school groups, tour groups, and other visitors come to the island for shorter stays, usually less than 24 hours. These parties learn about coastal forest ecosystems and the work of the society on Limestone Island.

Volunteer Program

This year 31 volunteers contributed 240 days at Limestone Island through our weekly volunteer program. The average length of stay was 7.7 days. Most people volunteered for one week; 2 people came for two weeks, 2 people came for 10 days, and 1 person came for only 3 days due to health problems. 13 volunteers were from Haida Gwaii, 16

were from the rest of Canada, and there was one volunteer from Germany and one from Tasmania. In addition, Beverly McBride from Canadian Wildlife Service, Hull, Quebec, volunteered for 25 days to help with the songbird banding work. Field Camp Supervisor Janet Gray returned for a 15 week season and research assistant/interpreter Chris Lindberg worked for 10 weeks in camp.

Science Intern Program

The Science Intern Program is designed to assist Haida Gwaii post-secondary students to gain biological and conservation skills and experience. In this third year of the program operation, Dana Nyeholt from Port Clements who attends University of Victoria, worked on Limestone Island from 5 May to 16 June. She took part in biological monitoring, collation of data, natural history interpretation, and volunteer training. Her main interests were wildlife tree monitoring and Ancient Murrelet chick banding.

Project Limestone

This program has been running for ten years, and is designed to give local students hands on experience with research and conservation. This year three school groups participated: two from Queen Charlotte Secondary (fourteen students total), and one from George M Dawson Secondary (six students).

Tour Groups and Other Visitors

Visiting East Limestone Island is a highlight of a South Moresby trip for many tour boat operators, as guests are able to take part in seabird research and see Ancient Murrelet chicks depart. The sailing vessels Island Roamer and Maple Leaf have brought groups to East Limestone Island for many years. This year, the Island Roamer brought 91 visitors ashore on 6 trips, while the Maple Leaf visited twice bringing 26 visitors. An additional tour boat, Copper Sky also came ashore twice this year, bringing 18 visitors. We also had a visit from a private vessel with a crew of four from Prince Rupert. Guests and crew were given guided tours of the island in the afternoon or evening, to learn about the old growth forest that supports the Ancient Murrelet colony. The groups returned to the island later the same day and walked to the banding area on the North Cove to help catch chicks and record data. In total, 139 people visited Limestone this year via tour boat, and 49 t-shirts were sold.

Collaborating Scientists

Laskeek Bay continues to be a partner with the Research Group on Introduced Species

(RGIS). Sean Sharpe, Dr. Jean-Louis Martin, and Dr. Tony Gaston are the primary researchers. This five year project focuses on the impact of introduced species on the ecology of the Queen Charlotte Islands. The RGIS field camp on Reef Island this year ran from May 6th to July 28th, with 2 to 8 staff in camp at various times through the season. Limestone staff and volunteers assist in number of their field projects that include work on Limestone Island and Laskeek Bay. Twenty-six people converged on Reef Island for the Summit 2000 weekend May 26-28.

RESEARCH AND MONITORING

Monitoring and research of seabirds, marine mammals, flora and fauna continued on East Limestone Island, extending what is one of the longest continuously run data sets for seabird research in British Columbia. The LBCS Scientific Advisory Panel has established research questions and protocols, putting the annual monitoring program on a sound scientific footing as well as providing valuable hands-on education for volunteers.

ANCIENT MURRELET RESEARCH

Adult Banding

Adult Ancient Murrelet survivorship is measured with a yearly banding program during the breeding season. In 2000, adults were caught from 6-9 April, and again from 15 May - 11 June, by which time nesting was almost over. Table 1 shows that total number caught was 260 in 15 nights, slightly more effort for fewer birds compared to the past three years.

Table 1. Comparison of adult banding totals and breeding status for 1997-2000.

Year	Banding # nights	New		Retraps		Total	Breeder	Non- breeder	Unknown
		Net	Burrow	Net	Burrow				
2000	15	129	8	117	6	260	130	93	37
1999	12	158	9	148	8	323	175	115	37
1998	13	162	5	120	9	296	160	120	16
1997	18	201	8	118	13	340	89	209	42

We recaptured 99 birds in 2000, of which 81 were banded as adults and 18 as chicks. Note the consistency in high numbers of recaptures banded as adults versus those banded as chicks. This reflects the fact that chicks have a much higher mortality rate than adults. Additionally adults are likely to return to the same area of a colony to breed year after year, in the vicinity of the net in which they were originally banded. Chicks

are much less likely to return to the same area of the colony from where they departed, and may choose to breed on another colony entirely. Still no chicks banded in 1993 have been recovered, and only a few have been recaptured from 1991 and 1992 (years that were marked by prolonged war-water conditions).

Table 2. Numbers and age at banding of Ancient Murrelet adults recaptured in 1997, 1998, 1999 and 2000.

Year banded	2000 Retraps			1999 Retraps			1998 Retraps			1997 Retraps		
	Banded as Adult	Banded as Chick	Total Retraps									
Total	81	18	99	135	21	156	115	11	126	119	13	131

Chick Banding

This year chicks were banded with either a black stainless steel band or a white plastic band. The two bands were used alternately throughout the banding period. Funnels were monitored from 11 May to 12 June, with the first two chicks appearing on 11 May. Numbers peaked on 20 May (Table 3) with 62 chicks; the first night with 0 chicks was 12 June, a spread of 32 days, during which 595 chicks were banded at the funnels. Another 25 chicks were banded in burrows, outside the funnels, or at the adult flight nets.

Burrow Monitoring

Monitoring of burrows at East Limestone Island began on 2 April. The first eggs were

found on 6 April and the last ones were found on 9 May. Eighteen burrows were occupied this year. Fledging success in 2000 was lower than in any year except the major El Nino year of 1998 (Table 4). Five nests were abandoned after only one egg had been laid, suggesting that conditions for feeding were poor and females were unable to complete their clutches. Two of the 20 eggs incubated to full term failed to hatch: a rather high rate of infertility. In both cases the unhatched eggs were found to be totally undeveloped. One single-egg clutch was deserted after it had been incubated to "full term"; the embryo was found to be fully developed with down, and a hard bill. The remainder of those abandoned either were

not incubated at all, or only incubated for a short time before abandonment.

Table 3. A comparison of chick banding variables and dates among years; note that there are 3 different time protocols involved.

Variable	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Start date	May 12	7 May	7 May	May 9	May 7	May 7	May 10	May 8	May 7	May 9	May 11
End date	June 15	9 June	5 June	June 15	June 8	June 11	June 10	June 12	June 23	June 12	June 12
Monitoring period	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200+	2300 - 0200	2300 - 0230	2300 - 0230	2300 - 0230	2300 - 0230
Total days	35	30	23	38	33	36	31	35	48	34	32
1st night of chicks	May 12	10 May	13 May	May 10	May 7	May 10	May 11				
Peak date & (#)	May 22 (65)	27 May (50)	22 May (85)	May 18 (70)	May 22 (52)	May 22 (64)	May 19 (48)	May 24 (41)	May 20 (55)	May 21 (54)	May 20 (62)
Last night	June 15	8 June	4 June	June 15	June 8	June 11	June 9	June 11	June 22	June 11	June 11
Days with chicks	35	30	23	37	33	33	29	31	43	31	31
Total chicks	873	562	674	653	618	617	588	527	495	567	595

Table 4. Occupancy and hatching success of Ancient Murrelet chicks from monitored burrows on East Limestone Island 1996-2000.

Burrows	1996	1997	1998	1999	2000
Monitored	89	72	62	86	75
Occupied	28 (31%)	21(29%)	17(27%)	17 (20%)	18 (24%)
Fledged 2 chicks	22 (79%)	14(67%)	6 (35%)	14 (82%)	8 (44%)
Fledged 1 chick	4 (14%)	1(5%)	3 (18%)	0 (0%)	2 (11%)
Abandoned 1 egg	2 (7%)	6 (28%)	6 (35%)	0 (0%)	5(39%)
Abandoned 2 eggs	0 (0%)	0 (0%)	2 (12%)	3 (18%)	3(17%)

No eggs laid after 22 April hatched. The burrow in which the first egg was laid, was also one of the last to successfully hatch two chicks, which departed on 30 May. Incubation in this burrow began on 19 April; hence it took 42 days from incubation to departure (normal duration 31-33 days). The total time between when the first egg was laid and the date of departure was 55 days compared to the normal 38-44 days. Altogether, this seems to have been a difficult year for breeding, although not as bad as 1998.

Gathering Ground Counts

Gathering Ground Counts were performed from 2 April to 20 June, using a spotting

scope focused on the water in front of Low Island. The highest monthly counts were 186 on 8 April, 511 on 19 May, and 127 on 4 June. Eight counts were missed due to rough weather. The peak count of 511 stands as the highest count recorded from Limestone since the project began. As birds on the staging area are believed to be mainly pre-breeders, this high count augurs well for future recruitment to the colony.

MARINE SURVEYS

Seabird Surveys

Five inshore surveys were completed. No offshore surveys were completed due to sea conditions and mechanical problems with

the boat. Large rafts of Ancient Murrelets were seen close to Skedans Islands during two of the surveys. On a separate boat trip to Lost Islands a family party of Ancient Murrelets, comprising two parents and two chicks, was observed up close, feeding and travelling together. Twenty-six species of birds were counted: seven auks, four gulls, three loons, two cormorants, five ducks, and one species each of shearwater, phalarope, eagle, oystercatcher, and crow. The peak count of Marbled Murrelets this year was 167 on 25 June, a relatively low number compared to counts of several hundreds in past years. However, the difference is partly accounted for by the lack of offshore surveys.

Marine Mammal Surveys

Marine Mammal watches were conducted from a set location on Lookout Point. A total of 29 surveys were done between April and July, adding up to 28 h of effort. Highlights for volunteers were the occasions when humpback whales were sighted in groups of 2 and 3 actively jumping and lunge feeding. Also of interest, was one decomposing Grey Whale carcass (male), marked with orange spray paint, floating into the kelp at Cabin Cove where it stayed for approximately 18 h before the current took it northward. Orcas were sighted on a few occasions, small groups travelling quickly and therefore not allowing us photo identification opportunities.

Steller Sea Lions were counted at the Skedans and Reef Island haul-outs. Peak numbers for Skedans occurred in May with 120 individuals counted (Table 5). Peak numbers for Reef also occurred in May with 400 individuals counted. No California Sea Lions or marked individuals were recorded this season.

Table 5. Peak counts from the two main sea lion haul out sites in Laskeek Bay 1997-2000

Sea lion haul out	1997	1998	1999	2000
Skedans Islands	180	72	112	120
Reef Island	300	735	511	400

Black Oystercatchers

It is important to monitor Black Oystercatchers because BC and Alaska together support 80-85 % of the world's population. By banding both adults and chicks it is possible to determine site fidelity, mate fidelity, individual breeding success, and adult survivorship. Eight islands in the Laskeek Bay area are surveyed for breeding pairs and their success each year. This year nest checks began in May and finished in July. Our surveys found 34 active nest sites this year with approximately 30% of those sites later experiencing some degree of predation/unsuccesful chick rearing. A total of 16 chicks were banded and 3 previously banded individuals were sighted at the same locations as last year. This year an adult banding program was begun by Stephanie Hazlitt of Bird Studies Canada. A total of 8 adults were marked in the Laskeek Bay Area.

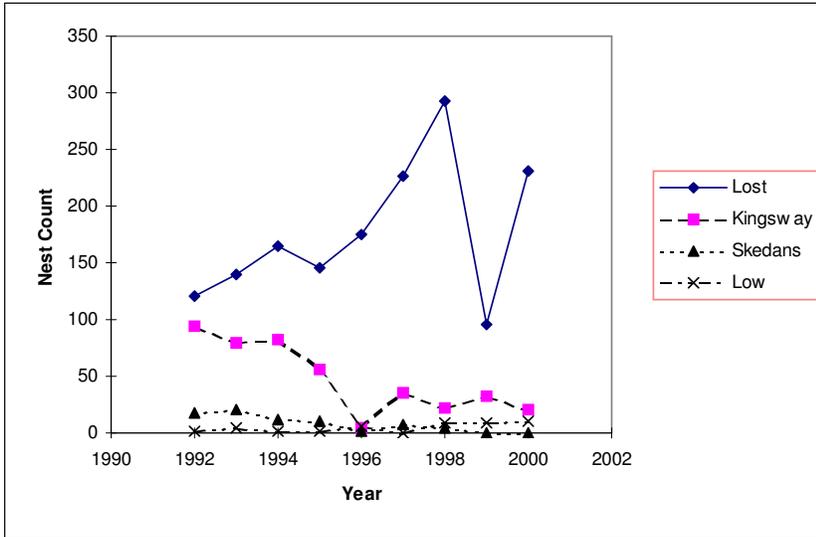
Glaucous-winged Gull

Glaucous-winged Gull nests were counted on five islands and 244 nests containing 1-3 eggs each were found. In comparison to last year, nest counts increased on Low island, and decreased on Kingsway Rock (Table 6). The total number of nests this year is equal to the count in 1994, but lower than those in 1997 and 1998. Comparisons with 1999 are not possible because counts at Lost Island in 1999 were incomplete. This year large congregations of 50-80 Bald Eagles were seen at Low Island, which may account for the low numbers of nesting sites in the area. On Skedans, Kingsway and Cumshewa, fresh

otter scat and prints were found through the gull colonies. Figure 1. Indicates that over the 8 years of surveys, Lost Islands nest counts are rising while those on Kingsway are declining. The low number of nests

counted in 1999 on Lost Islands are likely a reflection of the inability to count all colony locations due to prevailing weather conditions.

Figure1. Chart of Glaucous-winged Gull colony censuses in Laskeek Bay 1992-2000.



TERRESTRIAL PLANTS AND ANIMALS

Songbird Banding and Species Counts

Songbird banding is carried out primarily to determine differences in juvenile/adult ratios on islands with and without introduced species, and to establish a marked population for long-term monitoring and survival estimates. Banding took place at six stations:

East Limestone Island, Reef Island camp area (site13), Reef Island south shore

(site16), Vertical Point, Low Island and West Skedans, with the Limestone Island crew being responsible for East Limestone, Vertical Point and West Skedans. Table 6 shows the number of birds banded by the Laskeek Bay Conservation Society field crew over the last three years, as well as the species totals. An interesting recapture in 2000 was a Hermit Thrush originally banded on Vertical Point in 1999 and recaptured at the Limestone Island station. Numbers of juveniles this year were much higher than in 1999, though not as high as in 1998, suggesting a breeding season more successful than last year, but not as successful as the very warm summer of 1998.

Table 6. Songbird banding totals from 3 monitored islands in Laskeek Bay 1998-2000.

Year	East Limestone		Vertical Point		West Skedans	
	Species	Total	Species	Total	Species	Total
1998	12	269	14	64	-	-
1999	14	100	15	109	-	-
2000	12	234	14	91	12	315

The daily checklist of birds recorded 74 different species. The maximum species counted on a single day was 34 on both 11 April and 8 May. As in 1999, the Peregrine Falcons were absent from their nest on the south cliff most times it was viewed and there were no fledglings seen. A Sharp-shinned Hawk was seen several times near Boat Cove, however for the second year there appeared to be no nesting activity at the main trail site. A new Bald Eagle's nest was constructed on Cassin's Tower this year, successfully fledging two young. Because the nest was located in the spruce right on Cassin's Tower, surveys of Cassin's Auklet and Fork-tailed Storm Petrel burrows on the tower were not done. Northern Saw-whet Owls were heard and seen on both the west and east sides of Limestone Island.

Wildlife tree surveys

There were 23 active wildlife trees this year on East Limestone Island, 10 of which were previously unused for cavity nesting. Red-Breasted Sapsuckers were found breeding in 22 of trees and Hairy Woodpeckers were found using one tree. The sapsuckers began nest excavation in April, the first chicks were heard in early May, and chicks fledged from 13-23 June.

Introduced animals

Ten squirrel surveys were carried out between 21 April - 23 June to examine the distribution of squirrels on East Limestone Island, in the various habitat types. There were 27 records of squirrel presence, 10 of which occurred in the 20m-radius study plots. Observations of squirrels varied over the season, with the high count of 6 on 13

May. As in previous years, the majority of squirrels noted were along the Main Trail. On several occasions squirrels were seen chasing sapsuckers away from sap wells and then feeding on the sap.

A deer collared with a radio transmitter by RGIS researchers on Limestone in July 1999 was seen several times at the field camp this year. The deer was also tracked over last winter in various locations on Louise Island and Limestone Islands. On one occasion, two deer without collars were seen swimming from the south side of Limestone to nearby Vertical Point.

Several shoreline surveys for racoon sign were conducted. No evidence of racoons was found on East Limestone Island, however the participants of Project Limestone found scat at Vertical Point.

Plant inventory

The total number of plants inventoried for East Limestone Island (including some mosses and lichens) remains at 120, with no new plant species found in 2000. Dr. Erwin Brodo of the Canadian Museum of Nature, visited Limestone Island to make a lichen collection of the island. We hope to have a comprehensive lichen inventory for the 2001 report. Algal collections and presses were also made this season to aid Parks Canada in species occurrence and distribution within the Laskeek Bay area.

ADULT BLACK OYSTERCATCHER BANDING IN LASKEEK BAY: REPORT ON A PILOT PROJECT

Stephanie L. Hazlitt

Bird Studies Canada, 5421 Robertson Rd., RR1, Delta, B.C. V4K 3N2

and

Joanna L. Smith

101-1001 W. Broadway Ave. Box 623, Vancouver, B.C. V6H 4E4

ABSTRACT

Black Oystercatchers, rocky intertidal residents of the BC coastline, are considered a shorebird species of high national and regional conservation concern. Long-term monitoring and adult and chick banding programs, such as the one delivered by the Laskeek Bay Conservation Society (LBCS), provide an excellent opportunity to investigate the breeding biology, annual survival and other population parameters of Black Oystercatchers. The pilot project objectives were to establish a marked population of adult oystercatchers in Laskeek Bay, complimenting the LBCS chick-banding program, and to pass on the adult trapping technique to LBCS staff and volunteers. In total, eight adult Black Oystercatchers were trapped on five islands; one adult was previously banded and seven were unbanded. Three previously banded birds were also observed, bringing the total number of marked birds to ten individuals in 2000. The adult trapping technique was demonstrated to LBCS camp manager Janet Gray and scientific advisor Tony Gaston, both of whom successfully used the method. The LBCS chick-banding program has provided the first known-age Black Oystercatcher breeders in BC and the first evidence of philopatry for this species. However, Black Oystercatcher chick survival and recruitment into the breeding population is low. Adult banding increases the number of marked birds in the breeding population each season, and will provide information on breeding site fidelity, pair longevity, adult survival and nesting success.

INTRODUCTION

Black Oystercatchers (*Haematopus bachmani*) are resident shorebirds that live in rocky intertidal habitats along the Pacific Coast of North America. More than 80% of the world's 11,000 Black Oystercatchers are found in Alaska and British Columbia (Andres & Falxa 1995, Campbell *et al.* 1990). Hence, this species is of high national and regional concern (Canadian Shorebird Conservation Plan 1999, Pacific & Yukon Regional Shorebird Conservation Plan 2000). Throughout their range, Black Oystercatchers occur at relatively low densities, presumably limited by the availability of their specialized breeding habitat. In addition to natural hazards, oil spills, introduced predators, beach debris covering nesting sites and human disturbances are significant threats to both adult and chick survival.

In British Columbia, Black Oystercatcher populations are considered stable. Studies in the southern Gulf Islands (Strait of Georgia) and Laskeek Bay (Haida Gwaii) show that there have been a relatively stable number of breeding pairs over the past decade (Vermeer *et al.* 1989, Hazlitt 1999, Laskeek Bay Conservation Society (LBCS) field reports 1992-99). However, threats to adult and chick survival occur throughout their range and information on annual survival rates and the importance of specific nest sites is still lacking for this species. Chick banding in the aforementioned areas has provided some information on juvenile survival. However, adult banding may yield more information despite working with birds of unknown age. Individually marked adults, with unique band combinations, can

provide information on nest site fidelity, pair longevity, adult survival and individual nesting success.

Long-term studies of Black Oystercatchers can be hampered by logistical difficulties because this species often breeds in remote places. The Laskeek Bay area offers an excellent opportunity to investigate the breeding biology, annual survival and other population parameters of Black Oystercatchers for several reasons. First, the offshore islands of Laskeek Bay support a population of 34 breeding pairs (1% of the global population), a relatively high density of oystercatchers that are accessible by boat. Second, LBCS, the Research Group on Introduced Species (RGIS) and the Canadian Wildlife Service (CWS) operate seasonal research camps on East Limestone Island and Reef Island and monitor Black Oystercatcher nests annually.

The objectives of the pilot project were to (1) establish a marked population of adult Black Oystercatchers in Laskeek Bay using an adult trapping technique that was successful in the southern Gulf Islands (Hazlitt 1999) and (2) train LBCS staff and volunteers to use the Black Oystercatcher trapping technique for use in future seasons.

The long-term objectives of the project are to establish a marked population of approximately 30 breeding pairs of Black Oystercatchers for population monitoring purposes, and to obtain biological information on adult survival rate, nest site fidelity, pair-bond longevity, breeding success, juvenile survival and philopatry.

METHODS

A heart shaped (50cm by 80cm) walk-in nest trap was constructed of 1 cm galvanized mesh wire with a soft mesh ceiling to capture a single incubating adult (see Hazlitt

1999). Birds entered through a 15cm opening in the side of the trap and were allowed to settle on the eggs. After about 2 minutes, they were flushed away from the eggs toward the rear of the trap where they were captured by hand. This technique requires two people: one hides close to the nest, ready to approach and bag the trapped bird, while the other retreats to a vantage point watching the activity at the nest and signaling the other person when the adult has entered the trap. The nest trap was placed over the eggs and secured with rocks from the surrounding area. The nest trap technique was demonstrated to LBCS camp manager Janet Gray and scientific advisor Tony Gaston, both of whom successfully used the method.

A noose carpet design was tested to investigate whether the second bird could be captured near the nest after the first was caught in the nest trap. A noose carpet was made from an approximately 1m x 3m piece of used, dark green fishing net (trawl type) and noose knots tied with 100 lb test fishing line. Approximately 20 nooses were tied to the carpet at intervals to maximize the possibility of capturing an adult's leg.

Between 28 May and 5 July 2000, islands were surveyed for Black Oystercatcher occupancy and the presence of eggs. A territory was considered occupied if a pair was present; whether or not we found a nest scrape. Attempts to band adults at nest sites with eggs were made only between 28 May and 11 June 2000 during the second half of incubation and before hatching.

Captured adults were weighed with Pesola spring scales (± 1 g) and bill length, depth and width measured, as well as tarsus and wing length. Adults were banded with three bands: on the right leg, a black darvic band

was placed above a stainless steel U.S. Fish and Wildlife band and an anodized alpha-numeric aluminum band (turquoise) was placed on the left leg. Time to capture was recorded from the moment that the trap was set over the nest until capture. A cut-off time of 60 minutes was chosen so that adults could return to the nest and incubate their eggs and we minimized habituating the birds to the nest trap. Total time was recorded and the mean calculated (\pm SD) for successful and unsuccessful trapping attempts. The total number of islands surveyed, the number of trapping attempts and the numbers of adults marked are summarized by island in Table 1.

RESULTS

Table 1. A summary of Black Oystercatcher adult trapping and banding in Laskeek Bay, 2000.

Island	No. of occupied nests	No. of trapping attempts	No. of adults banded this year	No. of previously banded birds
Reef	2	3	2	0
E. Limestone	3	2	2	0
South Skedans	3	3	1	0
Finger (Skedans)	1	1	0	0
South Low	5	5	2	1
Lost Islands	4	1	1	1*
Kingsway	2	0	0	1*
TOTAL	20	15	8	3

*not trapped; band was read with binoculars

The mean time to capture using the nest trap was 40 (\pm 16) min ($n=7$) and the mean time we waited but were not successful was 62 (\pm 20) min ($n=8$). Adults weighed 575 \pm 30 g ($n=7$).

Known-Aged Breeders

The observed marked population of adult Black Oystercatchers in 2000 was 11 individuals, four of known age. All known-aged birds were banded as chicks in Laskeek Bay by LBCS.

Adult trapping

Between 28 May and 11 June, 20 nests were found occupied on seven islands in Laskeek Bay, and 15 attempts were made to trap adults (Table 1). In total, eight adult oystercatchers were trapped on five islands: one adult was previously banded and seven were unbanded. Three previously banded birds were also observed on the Lost Islands, on Skedans Islands and at Kingsway Rock, bringing the total number of marked birds to 11 in 2000. All trapped adults were caught using the nest trap. The noose trap was used once without success. We concluded that the noose trap was too visible to the birds to successfully trap an adult.

The previously banded adults observed on South Low Island and at Skedans Islands were 6 years old and the banded birds on Kingsway and Lost Islands were 5 years old or less. The adult on South Low Island was banded in 1994 as a chick using the banding scheme of white plastic on the left leg and white plastic over metal on the right leg (stainless steel US Fish and Wildlife band); we replaced the white plastic bands because they had degraded. The other birds were marked with a white plastic spiral band with black alpha-numeric codes engraved for

individual identification, but because of wear, the codes were illegible.

Census of Oystercatcher Breeding Population In Laskeek Bay

Throughout the entire season (28 May – 5 July), 28 known oystercatcher breeding territories were visited and 24 sites were occupied (see definition in Methods). The occupancy rate of 83% is similar to previous years in Laskeek Bay (88% in 1999).

DISCUSSION

Adult trapping

We caught 8 individuals in 7 days of effort, although other camp activities meant that we could not devote full time to the work. Trapping success may be dependent on age of the clutch, weather or disturbance at the breeding site. The nest trapping technique is fairly simple, and is an easily transferable skill to staff and volunteers of the Laskeek Bay Conservation Society. The noose carpet technique was unsuccessful, most likely due to the materials used for the carpet construction. Future trapping attempts could be made using less visible materials.

Known-Aged Breeders

The chick-banding program conducted by LBCS, now in its ninth year, has provided the first known-age Black Oystercatcher breeders in BC and the first evidence of philopatry for this species. Unfortunately, the alpha-numeric spiral bands used to individually mark chicks (1992-1999) have poor longevity, as seen in other studies (Hazlitt 1999) and will eventually fall off the birds. Observations of birds with only the metal band on the right leg indicate plastic band loss and birds with a black plastic band on the left leg are typical when the outer layer of the spiral band breaks off, leaving

only the black inner layer (Hazlitt 1999). A more durable band material must be used when marking Black Oystercatchers. This year, LBCS used anodized aluminum bands to mark adults in the hope of an increased band life; plastic darvic bands were used simultaneously for comparison purposes. Chicks were marked with plain darvic bands using a unique combination for the year 2000.

Recommendations for marking adults and chicks

Each year, the LBCS staff and volunteers could dedicate a few days in late May and early June to trap and mark adult oystercatchers, slowly increasing the marked population. It is clear that band materials need to be robust for this species, therefore we recommend the use of anodized aluminum bands on adults. However, anodized aluminum bands are expensive and chick survival to first year is low. Therefore we recommend banding chicks with plain plastic darvic bands using unique combinations each year in place of the plastic alpha-numeric engraved spiral bands. Unique combinations are easy to view with binoculars, the plain bands have longer longevity and will provide information on individual age. Naturally, if this programme is to be of value, it requires that effort also be devoted to recording bands on adult oystercatchers every year. Ideally, we should have a record for all pairs in Laskeek Bay of whether or not they were banded and what the combination was. Although this information may not be of immediate value, over several years it could allow us to determine the annual survival of adults, an important factor in understanding population dynamics.

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**SECOND RECORD OF MENZIES' PIPSISSEWA, *CHIMAPHILA MENZIESII*, ON
HAIDA GWAI**

Stephen Stockton

Research Group on Introduced Species, Queen Charlotte City, BC, V0T 1S0.

sstock@science.uottawa.ca

and

Isabel Buttler

Dept. of Geography, University of Victoria, Victoria, BC, V8W 3N5.

eib@uvic.ca

On June 22, 1999, *Chimaphila menziesii* (Menzies' pipsissewa) was recorded blooming in several locations in the forest interior of Haswell Island. The occurrence is the second record of this species for the Laskeek Bay area. *C. menziesii* was previously recorded on East Limestone Island in 1997, misidentified as *Vaccinium alaskense*, and again in 1998, correctly identified as *C. menziesii* (Smith and Butler 1999). The eight individuals detected on Haswell Island effectively doubles the total number of individuals detected on Haida Gwaii thus far. The location of Haswell Island, 6.5 km SSW of East Limestone expands the known range on Haida Gwaii.

The habitat in which *C. menziesii* was found on Haswell Island is mostly consistent with that on Limestone Island; a thick bed of moss, primarily *Rhytidiadelphus squarrosus*, beneath *Tsuga heterophylla* (western hemlock) and *Thuja plicata* (western redcedar). The volcanic basalt substrate of Haswell Island is the only significant departure from the previously record. Given the ubiquitous nature of this habitat, the occurrence of this species on islands other than East Limestone was expected (Smith and Butler 1999), and given the occurrence on a non-limestone substrate

the species' presence on further islands in the archipelago is also expected.

Vegetation on Haswell Island as well as Limestone Island is radically modified by Sitka Black-tailed Deer (*Odocoileus hemionus sitkensis*) (Daufresne and Martin 1997). Browsing of *C. menziesii* may constitute a major impediment to the successful identification of this small and inconspicuous plant species.

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THE POPULATION AND EVOLUTIONARY GENETICS OF THE ANCIENT MURRELET (*SYNTHLIBORAMPHUS ANTIQUUS*): A SUMMARY

R.L. Pearce

Department of Biology, McMaster University, Hamilton, Ontario L8S 4L8, Canada
pearcerl@mcmaster.ca

J.J. Wood

Department of Natural Resource Management, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada

Y. Artukhin

Kamchatka Institute of Ecology and Nature Management, Petropavlovsk, Kamchatka, Russia.

T.P. Birt, M. Damus and V.L. Friesen

Department of Biology, Queen's University, Kingston, Ontario K7L 3N6, Canada

ABSTRACT

Genetic data can help answer questions about the basis of the contemporary population structure and evolutionary history of a species. Ancient Murrelets (*Synthliboramphus antiquus*) are north-Pacific seabirds that breed in a 9,000 km subarctic range from China to British Columbia. In this study, DNA sequence variation data from the cytochrome *b* gene and the mitochondrial control region are used to both estimate the extent of genetic differentiation, or structure, among current populations of the Ancient Murrelet, and to infer the evolutionary events responsible for this structure. Neither genotype frequencies nor sequence variation revealed any large-scale population structuring, suggesting that contemporary Ancient Murrelets form a single, panmictic population. Estimated rates of gene flow between colonies and regions are high enough to counter genetic drift. Genetic distances between haplotypes are small. Mismatch distribution and phylogenetic analysis are not consistent with an expanding population. Thus the null hypothesis that Ancient Murrelets are in genetic equilibrium with respect to mutation, migration and genetic drift cannot be rejected.

INTRODUCTION

ANCIENT Murrelets (*Synthliboramphus antiquus*) are small, migratory seabirds that breed in a 9,000 km arc around the northern rim of the Pacific Ocean (Fig. 1), becoming increasingly abundant from China to British Columbia (Gaston 1992). British Columbia supports about half of the world's breeding population of Ancient Murrelets, while the majority of the remaining 50% nest in Alaska. Over the past several decades, dramatic population declines have been reported worldwide for Ancient Murrelets, and the species has been designated as

“Vulnerable” by the Committee on the Status of Endangered Wildlife in Canada (Gaston 1994). Much of this population decline has been attributed to the introduction of mammalian predators, including rats (*Rattus rattus* and *R. norvegicus*) and raccoons (*Procyon lotor*).

Little is known about the movements of Ancient Murrelets among different colonies, and there is no information about their global population genetic structure. Aspects of this population structure include gene flow (the loss or gain of genetic information

from a population due to the immigration or emigration of fertile individuals) and effective population sizes (the number of breeding individuals in a particular area). Analysis of genetic population structure can also indicate whether populations from different geographic areas are genetically different from each other, and if so, how different. Banding studies have suggested that either Ancient Murrelets do not exhibit strong natal philopatry (birds do not necessarily return to the geographic location where they were hatched), or that they suffer high mortality (Gaston 1992).

Asian Ancient Murrelets remain close to Asia, which suggests that while gene flow may be high within Asia and North America, significant gene flow may not occur between North American and Asian Ancient Murrelets (Piatt and Gould 1994). Also, few Ancient Murrelets nest in the Aleutians, so Asian and North American populations are essentially geographically disjunct, or separate.

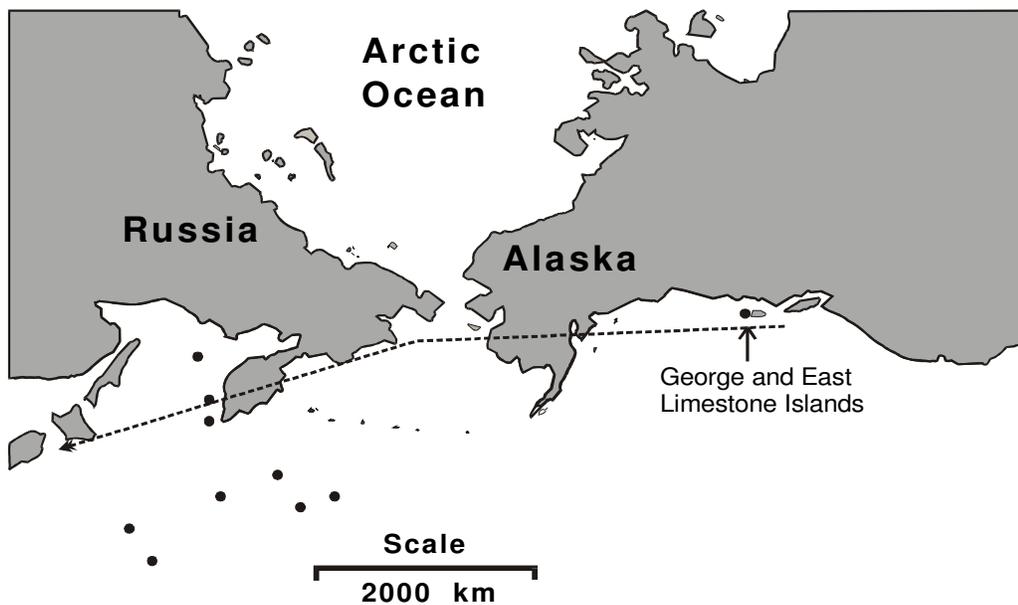


Figure 1. Ancient Murrelet breeding range (dotted line) and sampling sites (dots).

The goal of this study was to apply various statistical methods, including coalescent theory, to sequence variation data from the mitochondrial control region and cytochrome *b* gene in order to estimate gene flow between North American colonies of Ancient Murrelets on George Island and East Limestone Island, and between North American and Asian populations. Mitochondrial DNA (mtDNA), found in mitochondria (a cellular organelle), is useful in population genetics studies because it is maternally inherited, haploid (single-copy), and has a higher mutation rate than most nuclear DNA.

The coalescent theory is a novel population genetics model that relates evolutionary processes to DNA sequence variation represented as a genealogy, or tree (Harding 1996). It can be used to infer population genetics quantities, such as gene flow and effective population size (e.g. Slatkin and Maddison 1989, Beerli 1998, Beerli and Felsenstein 1999). Estimators of migration rates based on the coalescent are potentially more accurate than traditional estimators, as they accommodate possible asymmetries in migration rates (for example, if two populations are considered, more individuals could be migrating from population A to population B than from population B to population A), and differences in population sizes (Beerli 1998, Beerli and Felsenstein 1999). From the large distance between North American and Asian breeding sites and the likelihood that these populations have separate wintering grounds, we predicted that little gene flow would occur between North America and Asian Ancient Murrelets. However, given evidence from banding encounters and the proximity of the two islands, we expected to find significant gene flow between the two North

American colonies, in the Queen Charlotte Islands.

METHODS

Forty-five blood and tissue samples were taken from adult Ancient Murrelets caught in drift nets off the coast of the Kamchatka Peninsula during the spring of 1995 and 1996 (Fig.1). Birds were in breeding condition, so were probably near their breeding sites, however they could not be associated with any particular colony. Fourteen tissue samples were taken from adult Ancient Murrelets predated by rats and raccoons on East Limestone Island during the spring of 1996 (Fig.1), and eleven tissue samples were taken from eggs and predated Adult Ancient Murrelets on George Island during the spring of 1997 (Fig.1). These islands are located 70 km apart within the Queen Charlotte Islands. East Limestone Island is 48 ha and supports about 1,150 pairs of Ancient Murrelets, while George Island has an Ancient Murrelet population of approximately 11,600 pairs (Gaston 1992).

Laboratory methods

DNA was extracted from the samples. Parts of the mitochondrial DNA were amplified, including a portion of the cytochrome *b* gene, which codes for a protein involved in the electron transport chain, and the mitochondrial control region, which is a non-coding region of the mitochondrial DNA. The DNA of individuals with variation in these regions was sequenced.

Data analysis

Genetic differentiation among populations was indexed using gamma (γ), the mutational divergence, or difference, between populations. Gene flow and effective population size (N_e) were

calculated using the program MIGRATE (Beerli and Felsenstein 1998), which uses the coalescent theory to estimate gene flow and population size.

The possibility that Ancient Murrelets underwent a recent population expansion, estimates of population sizes before and after the expansion, and time since population expansion were estimated using a mismatch distribution (Rogers and Harpending 1992, Rogers 1995). An expansion is when a population increases in size over a period of time. A maximum-likelihood tree was also compiled for mtDNA sequences with the program PHYLIP (Felsenstein 1995). For more specific materials and methods, please see Pearce et. al. (unpublished data).

RESULTS AND DISCUSSION

Structure and variability of the mtDNA sequence

Altogether, 1153 base pairs (bp) of the mitochondrial genome were analyzed. A total of 21 mtDNA haplotypes, or different sequences, defined by 21 variable sites and one 9 bp insertion, were found among 59 individuals. The structure and base composition of the Ancient Murrelet mtDNA sequenced in this study is similar to that found in other avian mtDNA genes (Wenink et al. 1994, Baker and Marshall 1997). Similar control region composition has also been found in non-avian species, such as the Humpback Whale (Baker et al. 1993).

Genetic structure between colonies and regions

No significant difference from a random distribution of variation was found either between colonies or between regions (Table

1). This means that the populations interbreed sufficiently frequently that there are no significant genetic differences between them.

Results from Migrate suggest that, with the possible exception of gene flow from Asia to East Limestone Island, gene flow both between George Island and East Limestone Island and between Asia and North America is high (Table 2, Fig. 2). Gene flow out of East Limestone Island greatly exceeds gene flow into this colony (Fig. 2). The effective population size at East Limestone appears to be much lower than at George Island. Estimates of effective population sizes were 1500 individuals for George Island, 70 individuals for East Limestone Island, and 15 000 individuals for Asia (Table 2).

There is no strong evidence to support a recent population expansion. Neither mismatch distribution analysis nor the maximum-likelihood tree fit the patterns expected for expanding populations. Rather than expanding, Ancient Murrelet population are likely in genetic equilibrium.

Evolutionary inferences

No evidence was found to support population genetic structure in Ancient Murrelets. This is not surprising given the high migration rates found in this study, and in light of Wright's (1931) theory that one migrant per generation is sufficient to prevent genetic divergence of populations through genetic drift (chance changes in the gene pool of populations). Gene flow both within British Columbia and Asia appears to be sufficient to counteract drift, and suggests that East Limestone Island is acting as a net source of recruits for both George Island and Asia.

Table 1. Results of analysis of genotype frequencies and analysis of molecular variance for mtDNA haplotypes.

Haplotypes		
	North American Colonies	Regions
G_{st}	0.032	0.009
γ	0.320	0.231
$N_e m (G_{st})$	15	55
v_{st}	0	-
v_{sc}	0	-
v_{ct}	-	0.021*
$N_e m (v_{sc})$	NA/EI	-
$N_e m (v_{ct})$	-	23

* $P < 0.01$

NA/EI = not available but effectively infinite.

 $N_e m$ given in number of females per generation G_{st} —among-population genotype variation γ —mutational divergence between populations $N_e m (G_{st})$ —estimation of gene flow using G_{st} in the equation $N_e m = (1/G_{st} - 1) / 2$ (Crow and Aoki 1982) v_{st} —sequence variation among populations relative to variation from the whole species v_{sc} —sequence variation among populations within a region v_{ct} —sequence variation among groupings of populations relative to the entire species $N_e m (v_{sc})$ —estimation of gene flow using v_{sc} $N_e m (v_{ct})$ —estimation of gene flow using v_{ct} **Table 2. Estimates of N_e (effective population size) derived from θ values from Migrate for three different values of μ ($N_e = \theta / 4\mu$).**

	George Island	East Limestone Island	Asia
θ	0.0078 (0.0027-0.042)	0.00016 (0.00011-0.00024)	0.039 (0.019-0.1)
N_e ($\mu=0.10/\text{My}$)	19,500 (6800-105,000)	400 (275-600)	98,000 (48,000-250,000)
N_e ($\mu=0.05/\text{My}$)	9,800 (3400-53,000)	200 (140-300)	49,000 (24,000-130,000)
N_e ($\mu=0.02/\text{My}$)	3,900 (1400-21,000)	80 (55-120)	20,000 (9,500-50,000)

Values of μ (mutation rate) given in bases per million years

Ancient Murrelets probably underwent a population expansion in the past, possibly from a glacial refugium which could have arisen during the late Pleistocene, approximately 10,000 years ago. Studying a region of DNA with a slower mutation rate than mtDNA (e.g. nuclear introns) could provide more information about this historical expansion, such as when it may have occurred. However, as the mismatch distribution and maximum-likelihood tree do not fit the model of an expanding population, the assumption that Ancient Murrelets are now in genetic equilibrium cannot be discounted. Genetic equilibrium occurs when the same allelic frequencies (the relative numbers of different forms of a gene) persist over a series of generations. Genetic equilibrium infers that populations are in balance with respect to genetic mutation, migration rates, and genetic drift. If the populations are in equilibrium, estimates of migration rates determined from MIGRATE can be taken as contemporary, rather than historical.

Conservation Implications

When conservation biology is considered from a genetic perspective, two of its major goals are to preserve genetic diversity and evolutionary potential (Avice 1994). For this reason, studies of the population and evolutionary genetics of a particular species are useful in that they can provide information about the genetic diversity and evolutionary processes of the species (Avice 1994). By looking at the way genetic diversity is partitioned among populations of a threatened species, the genetic resources that conservation biology attempts to preserve can be assessed and characterized (Avice 1994). For example, if one population is significantly genetically different than three other populations which

are not genetically different, it could be suggested that this population should have conservation priority over the other three populations. As there was no genetic structuring found in this study among Ancient Murrelet populations, from a genetic perspective it is likely that no real conservation priority can be assigned to any one Ancient Murrelet population.

Caveats

There are number of factors that may confound the results that were found in this study. In particular, the statistical methods used have several assumptions that may have been violated by the data used. However, violation of these assumptions does not undermine the general conclusions of this study. As several different types of analyses suggest high gene flow and no global population structuring among Ancient Murrelet populations, the inferences made in this paper are sound. Finally, in the future, data from more loci (DNA regions) could be used to obtain a better estimate of gene flow within the Queen Charlotte Islands.

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Figure 2. Migration rates among North American colonies and Asian populations of Ancient Murrelets, and estimates of effective population sizes.

