Alaska Department of Fish and Game
State Wildlife Grant
ANNUAL INTERIM PERFORMANCE REPORT

Grant Number: T-1 **Segment Number:** 6
Project Number: 14
Project Title: Current population and decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay, Alaska
Project Duration: July 1, 2004 – June 30, 2007
Report Period: July 1, 2004 – June 30, 2005
Report Due Date: September 30, 2005

Objectives (*as submitted in grant project statement*):

1. Obtain population estimates for Kittlitz's and marbled murrelets in Kachemak Bay.
2. Determine decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay.
3. Track annual and seasonal patterns of abundance and distribution of adult and juvenile Kittlitz's and marbled murrelets in Kachemak Bay.
4. Identify critical habitats for Kittlitz's and marbled murrelets within Kachemak Bay.

Summary of Accomplishments

The following accomplishments are related to Objectives 1-3:

1. At-sea surveys were conducted on 24 April 2005 to obtain information on early migration of *Brachyramphus* murrelets into Kachemak Bay. Eight transects covering 6.92 km^2 were surveyed along the south shore, following historic transects (Fig. 1). Twenty-one bird species and three marine mammal species were recorded. Only two Kittlitz's murrelets in winter plumage were observed, and six marbled murrelets, indicating that most birds must arrive later in spring. Biologists with URS, Inc. assisted in data collection.

2. At-sea surveys were conducted from 16 to 19 June 2005 to repeat surveys conducted by U.S. Fish and Wildlife Service (USFWS) during the same period in June 1993 (Fig. 2). This survey covered 46 transects for a total of 161.7 km (32.2 km^2). Thirty-six species of birds and three species of marine mammals were encountered. No Kittlitz's murrelets were observed on these transects. Marbled murrelets were observed on 20 transects, with an average density on these 20 transects of 2.56 birds/km^2. Highest densities of marbled murrelets were encountered in Eldridge Passage and the mouth of Tutka Bay (Fig. 3). These data will be used to examine decadal trends in murrelet densities. We were assisted in all surveys by URS biologists, Cook Inlet Keeper, and Alaska Center for Coastal Studies.

3. At-sea surveys were conducted on 20 June 2005 to repeat surveys conducted by USFWS and USGS during the same period in 1988, 1989, and 1996-1999 along the south side of the bay (Fig. 4). Three transects totaling 13.5 km (2.7 km^2) were surveyed. Three Kittlitz's murrelets were observed on transect in the region normally occupied by this species, between Aurora Lagoon and Glacier Spit (Fig. 4). Also on transect were 35 marbled murrelets and 4 unidentified *Brachyramphus* murrelets (Fig. 4). The only other species observed on transect were black-legged kittiwakes, glaucous-winged gulls, and a minke whale. These data will be used to examine trends in murrelet densities since 1988.

Because these same transects will be surveyed again in July and August, they will also be used to describe seasonal changes in murrelet abundance and distribution.

4. A systematic survey design was decided on to obtain a current population estimate for marbled and Kittlitz's murrelets in Kachemak Bay. Previous track lines only allowed us to compare densities of birds in the bay. The survey track lines were based on the grid used in the random selection of transects for the 1993 USFWS survey, but connected all block lines for more complete coverage of the bay (Fig. 5). This will ensure that areas occupied by Kittlitz's murrelets, and all types of habitats, will be sampled. These transects were to be surveyed in July 2005, when murrelet numbers should be at their peak.

The following accomplishments are related to Objective 4:

5. Environmental variables were collected at the start of each transect, including sea surface temperature and salinity (with digital meter), water clarity (with sechi disk), wind speed and direction (Kestrel wind gauge), air temperature, and sea state. Sea state was also changed during the surveys as conditions changed, since continuous plotting by GPS provided track lines and location data for every recorded observation. In addition, we collected data on water column structure using a CTD probe (Fig. 2; see below).
6. Investigation and data compilation for long-term environmental factors were initiated with the assistance of the Homer Soil and Water Conservation District (HSWCD) and the Spruce Bark Beetle Mitigation Program of the Kenai Peninsula Borough (KPB). D. Lehner (HSWCD) began compiling and summarizing plant community data and NRCS snow survey data to determine seasonal averages and long-term trends in snow depth and snow water equivalent around Kachemak Bay. M. Fastabend and M. Rude (KPB) provided technical information, maps, and unpublished data on the spread of spruce bark beetle on the southern Kenai Peninsula. These data will assist in identifying important habitats for marbled and Kittlitz's murrelets in Kachemak Bay, and they will be used to investigate factors that may be associated with changes in murrelet populations or habitat use.

Significant Deviations*:*

None

Actual Costs during this Report Period *(personnel plus all operating expense totals)*:

Federal (from ADF&G):	Partner (nonfederal share):
$11,506.67	$3,835.56

Project Leader *(or Report Contact Person)*: Kathy Kuletz

Additional Information: *See attached figures. Data tables and figures showing distribution of other species recorded during at-sea surveys of Kachemak Bay can be provided on request.*

1. Because the cooperative agreement with ADF&G was not finalized until September 2004, we used USFWS funds ($12,000) to conduct at-sea surveys in Kachemak Bay in August 2004, over a period of 18 days (Fig. 6). These data will be incorporated into the decadal trends analyses for the final report, although the federal contribution was not

indicated in the budget of the final agreement. During this time, we also used ArcGIS to incorporate historic track lines into DLOG software (R.G. Ford, Inc., Portland OR), to enable us to follow historic transects during subsequent surveys. Numbers of all birds, including both *Brachyramphus* murrelets, were higher in August than during the June 2004 surveys. During these surveys we counted 4,434 murrelets on transect, comprised of 85 % marbled (Fig. 7), 11 % Kittlitz's (Fig. 8) and 4 % unidentified. We observed juveniles of both murrelet species during the August surveys (Fig. 9), indicating local breeding of both species.

2. Because water column structure may be an important determinant of murrelet distribution at sea, we added additional environmental factors to our data collection. We used a CTD (Conductivity-Temperature-Depth) probe (Seabird Electronics Inc., SBE 19 SEACAT), fitted with an additional sensor to measure turbidity, to determine the vertical profile of the water column. Water structure can vary considerably throughout Kachemak Bay, due to the bathymetry of inner and outer bay regions, and the influence of clear, saline water from the Alaska Coastal Current entering from the southwest, and turbid, fresher water entering the northwest region of Kachemak from upper Cook Inlet. Therefore, we conducted 11 CTD casts along the middle of the bay (Fig. 2). Preliminary results show well mixed outer bay waters and highly stratified inner bay waters. A more extensive grid of CTD casts was also sampled in July 2005. This data will be important in defining critical marine habitats for each murrelet species. The CTD (a $10,000 instrument) was donated by Auk Bay Laboratory, Juneau, Alaska, which was not in the original proposal as part of the federal contribution.

3. Our at-sea surveys were conducted from a 25 ft. whaler, which had difficulty accessing some shallow areas. In addition, we had to complete the 1993 transects during the same time frame in which they were conducted in 1993, but we had only one vessel whereas the USFWS used two in 1993. Because of extreme tides in June 2005 and limited time, we relied on Cook Inlet Keeper (Bob Shavelson and his assistants) to conduct surveys of selected transects using their vessel. This effort was beyond what was anticipated in the proposal, and is reflected in the invoiced budget submitted June 30, 2005.

Alaska Department of Fish and Game
State Wildlife Grant
ANNUAL INTERIM PERFORMANCE REPORT

Grant Number: T-1 **Segment Number:** 6
Project Number: 14
Project Title: Current population and decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay, Alaska
Project Duration: July 1, 2004 – June 30, 2007
Report Period: July 1, 2005 – June 30, 2006
Report Due Date: September 30, 2006
Partner: U. S. Fish & Wildlife Service

Objectives

1. Obtain population estimates for Kittlitz's and marbled murrelets in Kachemak Bay.
2. Determine decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay.
3. Track annual and seasonal patterns of abundance and distribution of adult and juvenile Kittlitz's and marbled murrelets in Kachemak Bay.
4. Identify critical habitats for Kittlitz's and marbled murrelets within Kachemak Bay.

Summary of Accomplishments

The following accomplishments are related to Objectives 1-3:

1. At-sea surveys were conducted from 18 to 23 July, 2005 for a comprehensive survey of Kachemak Bay. These were not historic transects, but were the first effort to obtain complete coverage of the bay during a period of peak murrelet at-sea attendance (mid to late July). Transects were systematically spaced, north-south lines approximately 4 km apart (Fig. 1). Transects totaled 188 km in length, and 37.6 km^2 (at a transect width of 0.2 km^2), over a total area of 634 km^2. Based on murrelets counted on transect (558 marbled and 93 Kittlitz's), the preliminary population estimates were 9,400 (± 3,478 95% CI) marbled murrelets and 1,567 (± 1,910) Kittlitz's murrelets. Population estimates and distribution maps will also be available for other marine birds and marine mammals observed and recorded during this survey.

2. We conducted at-sea surveys over a period of 19 days from 3 - 22 August 2005. During the August 2005 surveys, we recorded a total of 2,291 murrelets, of which 85% were marbled murrelets, 7% were Kittlitz's murrelets, and 8% were unidentified Brachyramphus murrelets. The data will be incorporated into the decadal trends analyses for the final report. These surveys repeated historic transects (1988, 1989, 1993-1996) during the murrelet fledging period. As in 2004, we observed juveniles of both murrelet species during the August surveys (Fig. 2), indicating local breeding of both species. However, juvenile densities and ratios of both murrelet species were lower in 2005.

3. We conducted at-sea surveys from 16 to 20 June 2006, to repeat surveys conducted by U.S. Fish and Wildlife Service (USFWS) during the same period in June 1993 and 2005. This survey covered 46 transects for a total of 166 km (33.3 km^2). During the June 2006 survey, 8 Kittlitz's murrelets were observed on transect, as well as 146 marbled murrelets (Fig. 3). No Kittlitz's had been observed on transect during the June 2005 surveys.

Marbled murrelet densities in June 2006 were also higher than in June 2005. We were assisted during June surveys by URS biologists and by Cook Inlet Keeper.

<u>The following accomplishments are related to Objective 4:</u>

4. Environmental variables were collected at the start of each transect, including sea surface temperature and salinity (with digital meter), water clarity (with sechi disk), wind speed and direction (Kestrel wind gauge), air temperature, and sea state. Continuous plotting by GPS provided track lines and location data for every recorded observation. In addition, we collected data on water column structure using a CTD sampler (Fig. 4; see below).
5. We used a CTD (Conductivity-Temperature-Depth) probe (Seabird Electronics Inc., SBE 19 SEACAT), fitted with an additional sensor to measure turbidity, to determine the vertical profile of the water column. A series of 11 CTD sites was sampled immediately following the June survey (21 June 2006). A larger grid of 22 sites was sampled on 22 - 23 July 2005 (Fig. 4). These will provide information on water column characteristics (temperature, salinity, density), which will be used to describe marine habitats associated with each murrelet species. We will be assisted in analysis of the CTD data by Dr. Scott Pegau, of the Kachemak Bay Research Reserve. The CTD (a $10,000 instrument) was donated by Auke Bay Laboratory, Juneau, Alaska, which was not in the original proposal as part of the federal contribution.

Significant Deviations*:*
None

Actual Costs during this Report Period *(personnel plus all operating expense totals)*:
(Reported costs included ADF&G indirect calculated at 13.5%)

Federal (from ADF&G):	Partner (nonfederal share):
$37,013	$12,338

Project Leader *(or Report Contact Person)*: Kathy Kuletz

Additional Information: *See attached figures. Data tables and figures showing distribution of other species recorded during at-sea surveys of Kachemak Bay can be provided on request.*

1. During July 25-26, 2005, we conducted a recognizance survey of Grewingk Glacier Lake, 4 km above the Grewingk Glacier outflow into Kachemak Bay. The waters adjoining the glacier outflow are where most of the Kittlitz's murrelet are typically found in Kachemak Bay (Fig. 1). Because Russian scientists have indicated that newly fledged Kittlitz's murrelets spend time in the upland glacial lakes, we hiked to the most likely and accessible lake in Kachemak Bay during a time when fledging should have occurred. We were delivered and picked up at the drop-off site on Glacier Spit by our partner, Cook Inlet Keeper, and spent two days canvassing the area with spotting scopes and binoculars. We did not observe any Kittlitz's murrelets in the lake, but estimated there were approximately 2,000 – 3,000 glaucous-winged gulls on rocky islands in the lake. There were also small numbers of arctic terns nesting along the lake edges.

2. We submitted a request for, and received, additional funding ($6,000) from ADF&G. This allowed us to conduct the June 2006 surveys, which had not been originally scheduled. It will also allow us to increase survey effort during the fledging period, when we attempt to locate newly fledged murrelets of both species.
3. Upon request, we provided Angela Doroff (USFWS/Marine Mammals Management) with our historic and recent data sets for sea otters. She will analyze the Kachemak data to determine if there have been population changes in this area, and will compare population trends in Kachemak to other areas of Alaska.
4. Upon request, we provided Ellen Lance (USFWS/Ecological Services) with data on the distribution and abundance of Kittlitz's murrelets, marbled murrelets, pigeon guillemots, and sea otters. This was to assist an assessment of a local proposed development.
5. We have been collaborating with Dr. Scott Pegau (ADF&G) of the Kachemak Bay Research Reserve by providing our CTD data to assist in his analyses of currents in lower Cook Inlet. In addition, Dr. Pegau will be co-authoring a paper with us on murrelet use of marine habitats relative to water column structure. On two of Dr. Pegau's oceanographic surveys of lower Cook Inlet, we were able to collect seabird data. These additional surveys (personnel costs covered by USFWS) will add to our understanding of murrelet distribution in the outer regions of Kachemak Bay and lower Cook Inlet.
6. During this reporting period (July 2005 – June 2006), results from this study were presented at the Alaska Marine Science Symposium, the Alaska Bird Conference, the Pacific Seabird Group meeting, and at a special presentation for the Audubon Society in Cordova. We also submitted an abstract that was accepted for presentation in September 2006 at The Wildlife Society National Conference.

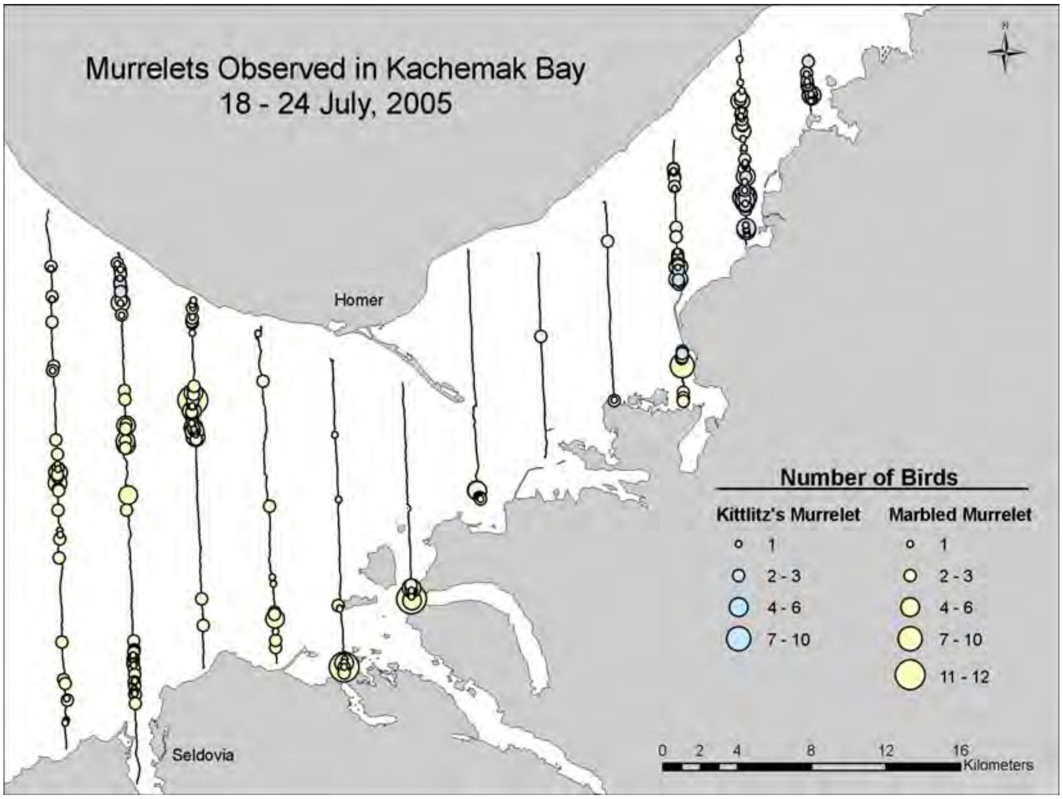

Figure 1. Distribution of marbled and Kittlitz's murrelets during July 2005

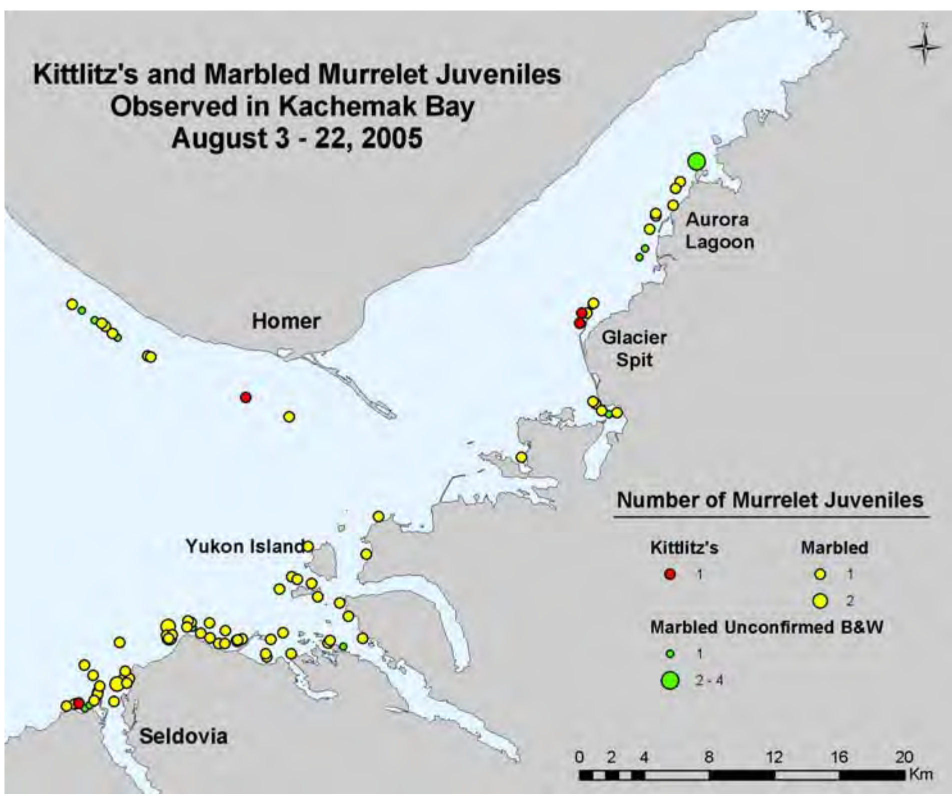

Figure 2. Distribution of juvenile murrelets in August 2005. 'Unconfirmed B&W' refers to black-and-white plumaged birds not identified to age class.

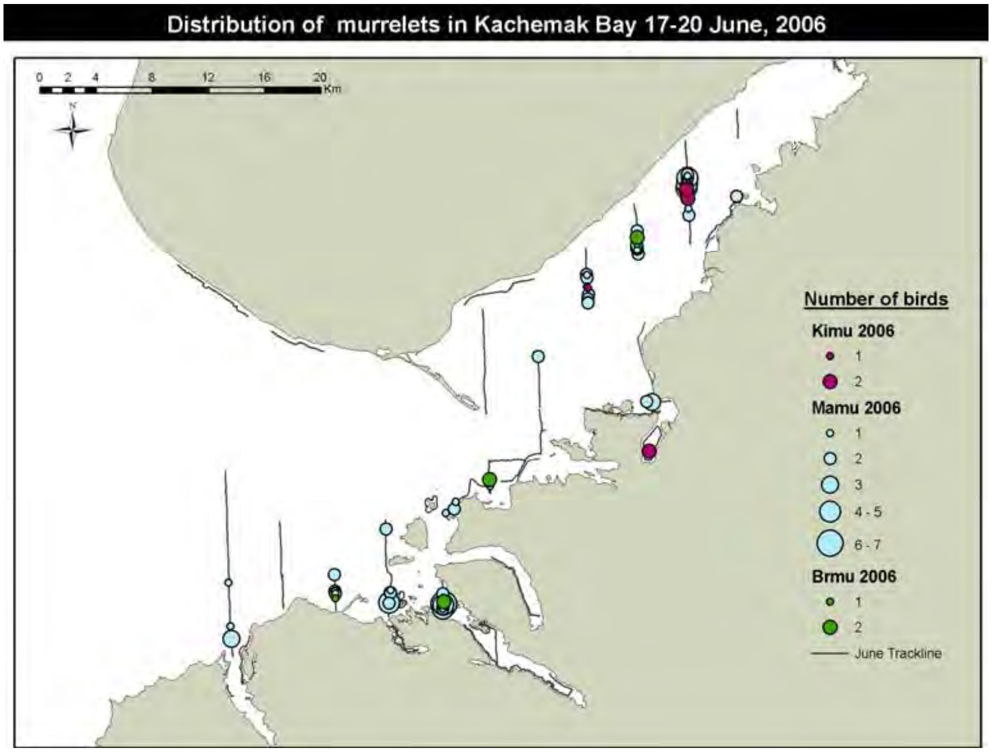

Figure 3. Distribution of Brachyramphus murrelets in Kachemak Bay in June 2006.

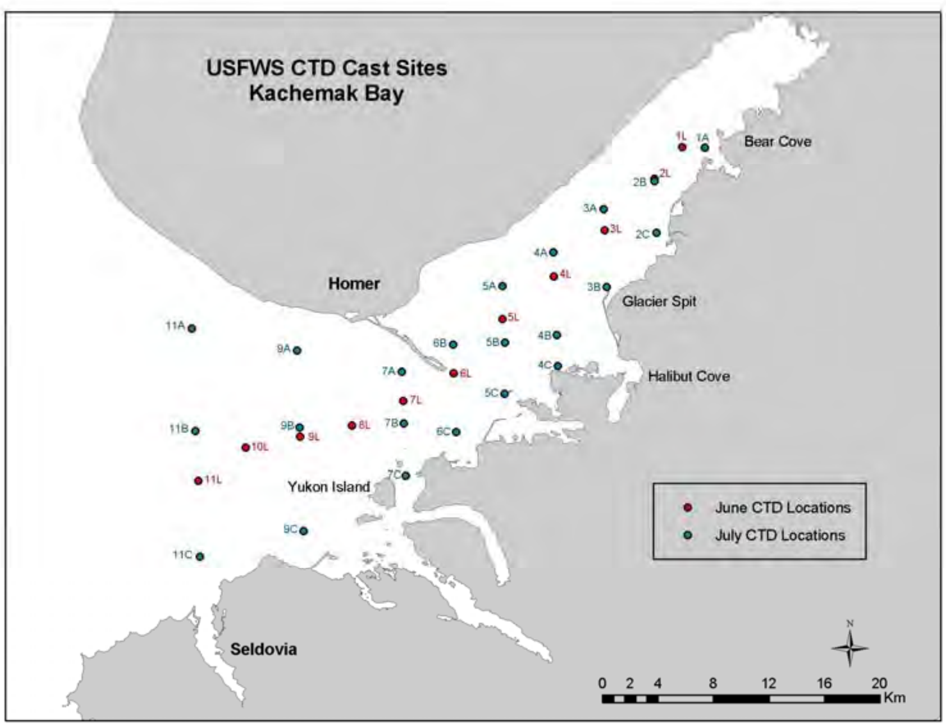

Figure 4. CTD locations in Kachemak Bay in July 2005 (blue dots) and June 2006 (red dots).

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number:** **6**

Project Number: **14**

Project Title: Current population and decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay, Alaska

Project Duration: July 1, 2004 – June 30, 2007

Report Period: July 1, 2006 – June 30, 2007

Report Due Date: September 30, 2007

Partner: U. S. Fish & Wildlife Service

Project Objectives

1. Obtain population estimates for Kittlitz's and marbled murrelets in Kachemak Bay.
2. Determine decadal trends of Kittlitz's and marbled murrelets in Kachemak Bay.
3. Track annual and seasonal patterns of abundance and distribution of adult and juvenile Kittlitz's and marbled murrelets in Kachemak Bay.
4. Identify critical habitats for Kittlitz's and marbled murrelets within Kachemak Bay.

Summary of Project Accomplishments for entire project

Objective 1: We obtained current population estimates during mid June and late July for Kittlitz's and marbled murrelets in Kachemak Bay. The June survey (conducted in 2005 and 2006) repeated randomly selected transects that had been surveyed in 1993 by USFWS. The July surveys (2005 and 2006) used a systematic design to provide comprehensive coverage of all habitats. We received funding from USFWS to conduct late July surveys in 2007, and this data will be incorporated into the final report. Population estimates will also be available for other marine species encountered during our surveys.

Objective 2: To determine decadal trends we replicated survey track lines that had been surveyed between 1988 and 1996. The two survey periods were mid June (re-surveyed during this project in 2005 and 2006) and from late July to late August (2004, 2005, 2006). We will incorporate the late July 2007 surveys which were funded by USFWS.

Objective 3: Our surveys will provide data on inter-annual variation in abundance and distribution of murrelets for 2004-2007. Seasonal patterns will be examined for the entire breeding period (June – August) for 2005 and 2006. Adult and juvenile abundance during the fledging and post breeding period (August) will be examined for 2004, 2005, and 2006. August surveys provide data on the timing of juvenile fledging, and juvenile densities and juvenile:adult ratios during the post-fledging period, as an index of productivity.

Objective 4: We have identified critical habitats for Kittlitz's and marbled murrelets in Kachemak Bay by combining at sea surveys with GIS coverages and concurrent CTD sampling of the water column. Areas of high murrelet density will be mapped for the final report, and a multivariate analyses will describe water column characteristics associated with murrelets. We also have data on distribution of other marine species, of which maps for selected species will be included in the report. A complete data set will be available via the North Pacific Pelagic Seabird Database.

Project Accomplishments during last segment period only (July 1, 2006 – June 30, 2007)

Objectives 1-3:

1. At-sea surveys were conducted from 18 to 24 July 2006 for a comprehensive survey of Kachemak Bay. This survey repeated the 2005 July survey, and provided complete coverage of the bay during a period of peak murrelet at-sea attendance (mid to late July). Transects (total 188 km) were systematically spaced, 4 km apart. Preliminary population estimates were 8754 (± 5450 95% CI) marbled murrelets and 2592 (± 2470) Kittlitz's murrelets.
2. We conducted at-sea surveys from 1 to 17 August 2006. These surveys repeated historic transects (1988 - 1996) during the murrelet fledging period, and were also surveyed in 2004 and 2005. For both murrelet species, juvenile densities and ratios were higher in 2006 than in 2005, and comparable to 2004 results.
3. All June and July survey data were prepared and formatted for entry into the North Pacific Pelagic Seabird Database. To complete this task, we contracted with a programmer familiar with the DLOG data entry program.

Objective 4:

1. Environmental variables were collected at the start of each transect, including sea surface temperature and salinity, water clarity (with sechi disk), wind speed and direction, air temperature, and sea state. Continuous plotting by GPS provided track lines and location data for every recorded observation.
2. In addition to the surface conditions sampled (above), we used a CTD (Conductivity-Temperature-Depth) probe (Seabird Electronics Inc., SBE 19 SEACAT), fitted with an additional sensor to measure turbidity, to determine the vertical profile of the water column. Thirty-two CTD sites were sampled 24-26 July 2006. These will provide information on water column characteristics (temperature, salinity, density), which will be used to describe marine habitats used by each murrelet species. We will be assisted in analysis of the CTD data by Dr. Scott Pegau, of the Kachemak Bay Research Reserve. The CTD (a $10,000 instrument) was donated by Auke Bay Laboratory, Juneau, Alaska, which was not in the original proposal as part of the federal contribution.

Significant Deviations: none

Project Leader: Kathy Kuletz

Alaska Department of Fish and Game
State Wildlife Grant
ANNUAL INTERIM PERFORMANCE REPORT

Grant Number: **T-1** **Segment Number:** **16**
Project Number: **1**
Project Title: Marbled Murrelet Activity Patterns and Health at Port Snettisham, Alaska
Project Duration: 20 May 2005 – 30 June 2008
Report Period: 20 May 2005 – 20 May 2006
Report Due Date: August 20, 2006

Objectives

Activity Patterns and Habitat Use

1. Determine daily flight and foraging patterns of radio-marked Marbled Murrelets (*Brachyramphus marmoratus*, MAMU) during nesting, chick rearing, and post-fledging periods (2005 and 2006);
2. Determine initial post-breeding dispersal movements as best as possible based on battery signal strength, flight time costs, and distances birds move from Port Snettisham (2005);
3. Identify nesting habitat and potentially locate nests (2006);

Health Assessment

4. Conduct health evaluations for 30-35 MAMU/year using hematologic and biochemical testing (2005 and 2006);
5. Establish blood-based reference ranges for Southeastern Alaska MAMU;
6. Compare health indices inter-annually;
7. Conduct geographic health comparison between MAMU from Southeast Alaska and MAMU from central California (samples previously collected and analyzed);
8. Archive blood samples for future DNA analyses, disease testing, and isotope research.

Summary of Accomplishments

The following accomplishment relates to Objectives 1-8:

1. We captured and radio-marked 72 MAMU (32 in June of 2005 and 40 in May of 2006). An additional 13 murrelets were captured in June and July 2005 for banding and blood analyses. Twenty-five research team members and volunteers spent 38 hours over 7 nights capturing, banding, and releasing 75 murrelets. An additional 5 hours were spent over 2 nights to catch 10 birds.

The following accomplishment relates to Objectives 1-3:

2. Radio-marked murrelets were tracked by aircraft, boat, and data logger (2 in 2005 and 3 in 2006). Aerial, boat, and data-logger surveys of radio-marked murrelets occurred on 55, 38 and 70-99 days, respectively (15, 27, and 59 days in 2005; 40, 11, and 11-40 days in 2006). More than 145 hours of flight time was logged in tracking birds from Sullivan Island in Lynn Canal in the north to Wrangell in Sumner Strait and the southeast tip of Baranoff Island in Chatham Strait in the south.

The following accomplishment relates to Objectives 1 and 2:

3. Surveys of daily movements and activity patterns in both years indicated that radio-marked murrelets departed Port Snettisham in the evening and usually returned in the early to mid-morning hours (00:00-06:00). In 2005, 22 radio-marked murrelets stayed within a 50 km radius of Port Snettisham until mid-July and returned to the inlet at least every 1-9 days. In

2006, 12 murrelets left the area soon after marking (by 22 May), and 5 remained in the Port Snettisham area until at least 26 June.

The following relates to Objective 2:

4. In 2005, when our objective was to look at post-breeding dispersal, the number of radio-marked murrelets attending Port Snettisham declined steadily throughout the season, with half the birds leaving the inlet by 15 July, and all but 2 gone by 31 July. Dispersing radio-marked murrelets were found throughout the inner passages of SE Alaska; over 200 km (over water distance) into Glacier Bay in the north and 160 km in the direction of Chatham Strait in the south.

The following accomplishment relates to Objective 3:

5. In 2006, when our objective was to identify nesting habitat, 4 birds were detected inland and two active nests were found. One nest failed during incubation and the other was presumed successful. Remote habitat limited actual discovery of the nests. Both nests were located on steep cliffs with 25-75% vegetation cover along river valleys that drain into Port Snettisham (Prospect and Tease creeks). These sites were near but not in forested habitat (western hemlock *Tsuga heterophylla* Sitka spruce *Picea sitchensis* forest type). Aerial photographs were taken to document each nest area. Additional habitat details are forthcoming.

The following accomplishments relate to Objectives 4-8:

6. To our knowledge no murrelets died in 2005 as a result of our captures. In 2006, however, we lost 15 birds; at least 4 were taken by Bald Eagles (*Haliaeetus leucocephalus*) and the others died of unknown causes. This level of mortality has not been documented in previous MAMU telemetry studies despite capturing and marking hundreds of birds. Mortality was also high in other bird radio-telemetry projects in SE Alaska in 2006, indicating that environmental conditions (e.g., prey abundance, weather) could be contributing factors. An analysis of this high mortality is ongoing.
7. Analysis of blood samples is ongoing. Health assessments are forthcoming.

Significant Deviations:

1. In 2006, 2 of the 3 data loggers were not deployed until early June. We had planned to conduct boat surveys in the evening at the mouth of Port Snettisham, but when that proved dangerous, we ordered two new data loggers to collect similar data.
2. More money was spent on aerial telemetry flights and supplies than originally anticipated. Less money will be spent on these items in FY08, so we anticipate an offsetting cost-savings.

Actual Costs during this Report Period *(personnel plus all operating expense totals)*:

Federal (from ADF&G):	Partner (nonfederal share):	Total:
$ 64,361	$ 21,454	$ 85,815

Project Leader *(or Report Contact Person)*: _S. Kim Nelson or Scott Newman___________

Additional Information:

1. Is this project contributing samples to the Alaska Avian Influenza detection effort? Several fecal samples were collected by veterinarian Katherine Savage (Juneau) during captures in 2006. These will be contributed to the Avian Influenza detection effort. We would be happy to contribute future samples if provided with the standardized protocols.

FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number:** **16**

Project Number: **1**

Project Title: Marbled Murrelet activity patterns and health at Port Snettisham, Alaska

Project Duration: 20 May 2005 – 30 June 2008

Report Period: 21 May 2006 – 20 May 2007

Report Due Date: August 20, 2007

Partners: Wildlife Trust and Oregon State University

Project Objectives

Activity Patterns and Habitat Use

1. Determine daily flight and foraging patterns of radio-marked Marbled Murrelets (*Brachyramphus marmoratus,* MAMU) during nesting, chick rearing, and post-fledging periods (2005-2007);
2. Determine initial post-breeding dispersal movements as best as possible based on battery signal strength, flight time costs, and distances birds move from Port Snettisham (PS; 2005);
3. Identify nesting habitat and potentially locate nests (2006);

Health Assessment

4. Conduct health evaluations for 30-35 MAMU/year using hematologic and biochemical testing (2005-2007);
5. Establish blood-based reference ranges for Southeastern Alaska MAMU;
6. Compare health indices inter-annually;
7. Conduct geographic health comparison between MAMU from Southeast Alaska and MAMU from central California (samples previously collected and analyzed); and
8. Archive blood samples for future DNA analyses, disease testing, and isotope research.

Summary of Accomplishments

Objectives 1-8:

We captured and radio-marked 79 MAMU (40 in May 2006 and 39 in May 2007) in or at the mouth of PS. Twenty-five research team members and volunteers spent 28 hours over 6 nights capturing, banding, and releasing 81 murrelets.

Objectives 1-3:

Radio-marked murrelets were tracked by aircraft, boat, and data logger (3 in 2006 and 6 in 2007). Aerial, boat, and data-logger surveys of radio-marked murrelets occurred on 35, 13, and 11-29 days in 2006. These surveys were just beginning as of 16 May 2007. More than 94 hours of flight time was logged in 2006 tracking birds throughout the inner passages of Southeast Alaska from Glacier Bay and Lynn Canal south to Kuiu and Wrangell islands.

Objectives 1 and 2:

Surveys of daily movements and activity patterns in 2006 indicated that most radio-marked murrelets were located near the mouth of PS during the late night-early morning period (20:00 – 06:00 h) and located inside PS in the mid morning–late afternoon period (08:00h – 18:00 h). This pattern is opposite of that observed in mid-summer 2005.

We observed a steady decline in the number of radio-marked murrelets attending PS on a daily basis in 2006. Ten birds disappeared from the PS area within 22 days of marking. Fifteen radio-marked murrelets were repeatedly tracked in the same area along or near a shoreline in PS and were determined to have died before the flight on 30 May. By 6 June, 5 weeks post-capture, 6 of the radio-marked murrelets were still located in the PS area and the fate of 19 was unknown. Only 4 (10%) radio-marked birds were still remaining inside PS by the final aerial survey in PS on 26 June 2006.

Objective 3:

In 2006, four radio-marked murrelets were detected flying inland in PS and two active nests were located. The first nest, found on 12 May, was located on a rock cliff in the extreme northeast corner of the Prospect Creek drainage in northern PS. This nest was active for 31 days and was determined to have failed soon after the egg hatched. The characteristic on/off incubation behavior was detected at the second nest on 12 June. This nest was located on the upper portion of a large rock cliff along the northeast side of the Tease Lake drainage at the northern end of Speel Arm. After 9 days of incubation monitoring the nest failed.

Objectives 4-8:

In 2006, we began to notice irregular patterns by some of the radio-marked murrelets in PS during the first week of post-capture aerial surveys (5 May – 12 May). By the end of May we had documented a total of 15 (37%) radio-marked murrelet mortalities in PS. This level of mortality of radio-marked murrelets is unprecedented; hundreds of murrelets have been captured and marked in numerous projects throughout the murrelets range using the same techniques with only a few mortalities. No correlation was found between handling time, use of anesthesia, weight, or overall health and murrelet mortality. We speculate that our radio-marked murrelets were compromised by the late, cold spring and the unusually high numbers of Bald Eagles (*Haliaeetus leucocephalus*) present in the capture area.

Analysis of blood samples is ongoing. Health assessments are forthcoming.

Significant Deviations

In 2006, 2 of our 3 data loggers were not deployed until early June. We had planned to conduct boat surveys in the evening at the mouth of PS, but when that proved dangerous, we ordered two new data loggers to collect similar data.

Project Leader: S. Kim Nelson or Scott Newman

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Alaska Department of Fish and Game
State Wildlife Grant

GRANT AND SEGMENT NR: **T-1-16**

PROJECT NUMBER: **1**

PROJECT TITLE: Marbled Murrelet activity patterns and health at Port Snettisham, Alaska

PARTNER: Wildlife Trust and Oregon State University

PRINCIPAL INVESTIGATORS: S. Kim Nelson and Scott Newman

PROJECT DURATION: May 20, 2005 – December 31, 2008

REPORT PERIOD: May 20, 2007 – May 19, 2008

Project Objectives

Activity Patterns and Habitat Use

1. Determine daily flight and foraging patterns of radio-marked Marbled Murrelets (*Brachyramphus marmoratus*, MAMU) during nesting, chick rearing, and post-fledging periods (2005-2007);
2. Determine initial post-breeding dispersal movements as best as possible based on battery signal strength, flight time costs, and distances birds move from Port Snettisham (PS; 2005);
3. Identify nesting habitat and potentially locate nests (2006-2007);

Health Assessment

4. Conduct health evaluations for 30-35 MAMU/year using hematologic and biochemical testing (2005-2007);
5. Establish blood-based reference ranges for Southeastern Alaska MAMU;
6. Compare health indices inter-annually;
7. Conduct geographic health comparison between MAMU from Southeast Alaska and MAMU from central California (samples previously collected and analyzed); and
8. Archive blood samples for future DNA analyses, disease testing, and isotope research.

Summary of Accomplishments:

We captured 40 and radio-marked 39 MAMU in mid-May 2007. We tracked radio-marked MAMU using aerial and boat surveys, and six fixed data logger stations located within Port Snettisham (PS) from mid-May through the end of July.

JOB/ACTIVITY 1: Determine daily flight and foraging patterns of radio-marked Marbled Murrelets (*Brachyramphus marmoratus*, MAMU) during nesting, chick rearing, and post-fledging periods.

The combination of boat surveys and data logger stations allowed us to determine daily and seasonal activity patterns for murrelets foraging inside PS. The Mist Is. and South Shore data loggers and boat-based surveys near the mouth of PS showed significantly higher nighttime detection totals than daytime detection totals, demonstrating that many MAMU exit interior PS during the late evening hours where they congregate at the mouth of PS. MAMU return to interior PS early in the morning hours and many are found foraging and loafing near the juncture of the Whiting and Speel arms of PS. However, other than the Whiting River data logger no differences were found in the numbers of MAMU present during the day compared to night.

JOB/ACTIVITY 2: Determine initial post-breeding dispersal movements as best as possible based on battery signal strength, flight time costs, and distances birds move from Port Snettisham.

Although determining post-breeding dispersal was not a research focus in 2007, we documented dispersal dates for 17 (44%) radio-marked murrelets, of which, 5 (13%) were known breeders. Post-breeding dispersal dates ranged from 25 June to 24 July with a mean departure date of 12 July (± 9 d). We did not track dispersal locations in 2007, but in 2005 birds moved to areas at least 150 km from PS, including as far north as Glacier Bay and Icy Strait and as far south as Chatham Strait off Kuiu Island.

JOB/ACTIVITY 3: Identify nesting habitat and potentially locate nests.

A total of 16 active inland nest sites were located via aerial telemetry, including three nests for radio-marked pairs and one second nest attempt. Eight of the nests were located in trees, three on cliffs, and five on either cliffs or trees. Half of the nests were located more than 15km inland, and two were along the Whiting River in Canada, more than 50km inland. One murrelet nested above the Bridge Glacier (off Speel Arm) in habitat more characteristic of the Kittlitz's Murrelet (*B. brevirostris*).

One additional murrelet was later determined to have attended an active nest using the "on/off" incubation pattern detected by combined data logger and boat survey information. Also, we identified two potentially inactive nesting areas where individual murrelets sporadically attended inland sites.

JOB/ACTIVITY 4: Conduct health evaluations for 30-35 MAMU/year using hematologic and biochemical testing.

During captures from 2005 to 2007, blood samples were taken from 101 MAMU in PS (42, 36 and 23 in each year, respectively). Blood samples were analyzed for hematological and biochemical parameters, screened for diseases, and used to determine sex. In addition, in 2007, fecal samples were analyzed for Avian Influenza and Exotic Newcastle Disease. Plasma from Alaska MAMU collected in 2005 and 2006 was analyzed for biochemical parameters and compared to biochemical data collected from California MAMU between 1997 and 2000.

JOB/ACTIVITY 5: Establish blood-based reference ranges for Southeastern Alaska MAMU.

By collecting the blood samples over three years and analyzing them for hematological and biochemical parameters, and screening them for diseases, we have established baseline reference ranges that can be used in future studies to look at changes in the health of MAMU in Southeast Alaska.

JOB/ACTIVITY 6: Compare health indices inter-annually.

Of the three years of this study, the average total white blood cells (WBC) for 2007 birds was approximately five times higher than the previous two years. Birds were sampled in June 2005, in April 2006, and in May 2007. Because May is the height of the breeding season, physiological stress from breeding may be playing a role in the increased WBC count for 2007. Also egg production during this period may cause antigen stimulation in females, causing increased WBC production. This is supported by our results from the comparison of 2006 females to 2007 females. WBC for May 2007 females was significantly higher than WBC for April 2006 females.

JOB/ACTIVITY 7: Conduct geographic health comparison between MAMU from Southeast Alaska and MAMU from central California (samples previously collected and analyzed).

Hematological parameters (e.g., white blood cells), the immune response parameter total protein (TP), phosphorous (and indicator of electrolyte activity and acid), and lactate dehydrogenase (an indicator of muscle function) were lower for CA MAMU than for AK MAMU. However, hematological and biochemical values for AK MAMU were similar to reference ranges established for MAMU from the Aleutian Islands (Newman *et al.* 1997) and XAMU from California (Newman *et al.* 2005). Such low WBC, differential leukocyte counts, and TP values may suggest that the immune systems of CA MAMU may be compromised.

Monocytes were an order of magnitude higher for PS MAMU (2005 and 2006) compared to MAMU from the Aleutian Islands and XAMU from California (both radio-marked and non-radio-marked). Monocytes are responsible for phagocytosis of foreign substances in the body, and thus high monocyte values may reflect the presence of blood-borne pathogens in the PS population. Because monocyte values did not differ between MAMU with blood parasites and those without blood parasites, monocyte response is likely due to other pathogens that we could not readily detect.

JOB/ACTIVITY 8: Archive blood samples for future DNA analyses, disease testing, and isotope research.

All of the blood samples have been archived or are currently undergoing DNA and stable isotope analyses.

Significant Deviations:

We have no significant deviations to report for the Activity Patterns and Habitat Use portion of the study. However, for the health analyses, we collected fewer blood samples in 2007 than originally proposed as we felt we already had enough blood to conduct sufficient analyses of all our hematological and biochemical parameters.

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PARTNER: Wildlife Trust and Oregon State University

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PROJECT DURATION: May 20, 2005 – December 31, 2008

REPORT PERIOD: May 20, 2008 – December 31, 2008

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

We proposed to study the health, activity patterns, foraging ranges and habitat use of Marbled Murrelets (*Brachyramphus marmoratus*) in the Port Snettisham (PS) area of Southeast Alaska over 3 years beginning in 2005. This project was, in part, a continuation of work begun by Matt Kirchhoff (ADFG) on murrelet activity patterns at Port Snettisham in 2004.

The Marbled Murrelet (hereafter murrelet) is a small diving seabird in family Alcidae that breeds in coastal older-aged forests from Alaska to central California (Nelson 1997). This species generally occurs near shore and is the most common alcid in the sheltered waters of its range. Murrelets are unique among alcids in flying long distances inland to their solitary nests (generally within 40 km; Nelson and Hamer 1995). Because breeding birds are cryptic, secretive, and primarily crepuscular in their flights and at nest sites, relatively little is know about their activity patterns and few active nests have been found. Murrelets are currently listed as threatened or are thought to be declining over much of their range primarily because of breeding habitat loss (USFWS 1992, McShane *et al*. 2004, Huff *et al*. 2006, Piatt *et al*. 2006).

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Southeast Alaska is generally considered the center of abundance for murrelets in North America (Piatt and Naslund 1995). Surveys at inland sites in this area have provided us with some information on murrelet activity patterns in the forest (e.g., Brown *et al*. 1999). In addition, observations made during shipboard surveys in Southeast Alaska have indicated that local murrelet numbers fluctuated seasonally (Agler *et al*. 1998, Speckman *et al*. 2000), and suggested that murrelets fly long distances between nesting and foraging areas during the breeding season (DeGange 1996; G. van Vliet, M. McAllister, unpubl. data). With the advancement of murrelet capture and radio-marking techniques in the late 1990s (Newman *et al*. 1999a, 1999b), these long distance at-sea movements were verified in Southeast Alaska (Whitworth *et al*. 2000) and California (Peery *et al*. 2003) by tracking marked individuals. Murrelets were also successfully tracked to nest sites in many areas of their range providing detailed information on inland activity patterns and nesting habitat selection (Kuletz *et al*. 1995, Burkett *et al*. 1999, Lougheed 2000, Hull *et al*. 2001, Bradley 2002). While these data have provided us with a more complete picture of murrelet ecology, most of these studies were conducted outside of Southeast Alaska; we still know very little about murrelet activity patterns and habitat use in this area. Determining specific flight patterns and habitat preferences in Southeast Alaska will be crucial for understanding the marine and inland ecology of murrelets, and for future management efforts.

Concurrent with murrelet telemetry studies in central California (Burkett *et al*. 1999), blood samples were collected to evaluate the health and physiological condition of the nesting murrelets. Baseline health indices were established for murrelets inhabiting this geographic range, and we now have a better understanding of the murrelets' hematologic parameters, immune function, liver enzymes, kidney function, and electrolyte balance (Newman and Zinkl 1998, Newman 2000). Establishing baseline health indices for murrelets in central CA enable future comparisons to be made; either among years when environmental conditions differ, or among different geographic areas where ecological conditions and threats to murrelet health differ. Furthermore, baseline health indices can play a vital role in helping veterinarians assess the health of oil injured or diseased murrelet receiving care. To date, no blood-based health assessments have been conducted on murrelets from Alaska and it is unknown if birds from Southeast Alaska are physiologically healthy or have conditions that would place them at a survival disadvantage.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

Activity Patterns and Habitat Use

OBJECTIVE 1: Determine daily flight and foraging patterns of radio-marked Marbled Murrelets during nesting, chick rearing, and post-fledging periods.

We captured 126 and radio-marked 111 murrelets in PS from 2005 to 2007. Individual radio-marked murrelets were tracked for periods of 3 to 74 days during the late (2005), early (2006), and peak (2007) portions of the breeding season: mean = 25 ± 12 d (n = 32) for 2005, 26 ± 10 d (n = 40) for 2006, and 61 ± 17 d (n = 39) for 2007. The dramatic increase in mean tracking periods during 2007 compared to 2005 (t = 10.0878, $p <$ 0.0001) and 2006 (t = 11.1875, $p < 0.0001$) was mostly due to longer transmitter battery life, relatively calm weather, and an extended field season. Also, annual variations in food availability are potentially a factor affecting murrelet population levels in PS during the late breeding season.

The combination of boat survey and data logger radio-telemetry techniques allowed us to determine daily and seasonal activity patterns for murrelets foraging inside PS. During all three years of our study we observed murrelets exiting interior PS during the late evening hours and returning early the next morning. We also documented a steady decline in attendance in PS by radio-marked murrelets as each season progressed.

At Auke Bay, AK (Speckman *et al.* 2000 and Whitworth *et al.* 2000), Clayoquot Sound, BC (Tranquilla *et al.* 2005), and Desolation Sound, BC (Lougheed 2000), murrelets also moved out of inlets at night and returned in the early morning hours. While daily activity patterns for murrelets differ somewhat among areas, little is understood about the factors that affect a local murrelet population's daily movements. Our work on murrelet at-sea habitat use (Haynes *et al.* 2008) suggests that murrelets are not redistributing themselves in response to a change in prey abundance. Theories as to why most murrelets would leave PS at night include predator avoidance, social behavior, weather patterns, and marine conditions (sea surface temperature, salinity, etc.). Certainly, more research is needed to determine the mechanisms that drive murrelet offshore at night in Southeast Alaska.

We expected seasonal declines in numbers of radio-marked murrelets attending PS as murrelets dispersed post-breeding. The rate at which attendance declined varied each year and was likely affected by individual breeding status.

OBJECTIVE 2: Determine initial post-breeding dispersal movements as best as possible based on battery signal strength, flight time costs, and distances birds move from Port Snettisham.

Post-breeding dispersal for an individual radio-marked murrelet was considered to have begun after the last detection (using any survey method) inside PS or a surrounding area. Although efforts to identify post-breeding sites in 2006 failed due to radio failure, data collected during 2005 and 2007 gave us an idea of the immediate directions and general timing of post-breeding dispersal.

We obtained post-breeding dispersal locations for 17 (53%) radio-marked murrelets during 2005. Radio-marked murrelets began post-breeding dispersal as early as 30 June, with a mean departure date of 17 July (± 12 d), although one murrelet attended PS until at least 26 August. The number of dispersal locations for individual radio-marked murrelets ranged from 1 to 8, over periods ranging from 1 to 30 days after departure from PS. All detections of dispersed murrelets were within a 150 km radius of PS. Locations occurred as far north as Glacier Bay and Icy Strait and as far south as Chatham Strait off Kuiu Island. In 2007, we documented post-breeding dispersal dates for 17 (44%) radio-marked murrelets, of which 5 (13%) were known breeders. Considering our final aerial survey was 26 July, only dispersal dates prior to 25 July, were examined. Post-breeding dispersal dates ranged from 25 June to 24 July with a mean departure date of 12 July (± 9 d, n = 17). The mean departure date for murrelets with a documented breeding attempt was 11 July (± 8 d, n = 5). We also found current breeding status to be an important factor in determining timing of post-breeding dispersal from PS and surrounding areas. During our final aerial survey on 26 July 2007, 80% (12 of 15) of murrelets detected were known breeders with 67% (10 of 15) thought to have an active nest at that time. On the last two days of data logger monitoring (27-28 July), 71% (10 of 14) of murrelets detected inside PS were known breeders while 57% were thought to still have an active nest. Similar results from 2005 and 2007 show that mid-July is the peak of post-breeding dispersal from PS for non-breeding murrelets and murrelets with failed nest attempts.

No particular dispersal direction or destination was evident in movements of individual murrelets after leaving PS. Timing of post-breeding dispersal was previously unknown for most of southeast Alaska and was slightly later than dates observed in studies to the south (*e.g.,* Peery *et al*. 2004). This period of dispersal from PS coincided with previously mentioned peaks in flyway counts in PS (M. Kirhhoff, unpubl. data) suggesting that the observed influx of murrelets was due to dispersal to PS from other areas in southeast Alaska. Further research is required to gain an understanding of this fairly nomadic annual period for most murrelets.

OBJECTIVE 3: Identify nesting habitat and potentially locate nests.

We captured murrelets early in the breeding season during 2006 and 2007 allowing us to focus intensely on identifying breeding activity of radio-marked murrelets in PS. A total of 19 active nest sites were located (8 tree, 5 cliff, 6 either) via aerial telemetry, including three nests for radio-marked pairs and one second nesting attempt. Two additional murrelets were later determined to have attended an active nest using the “on/off” incubation pattern (henceforth, the incubation pattern) detected by combined data logger and boat survey information. Also, we identified three potentially inactive nesting areas where individual murrelets sporadically attended inland sites.

Most incubation patterns were first documented during aerial surveys with an inland location or the presence then absence of an individual murrelet from the waters of PS during consecutive aerial surveys. Later, all detections (aerial survey and data logger) were combined and analyzed for incubation success, chick feedings, overall nest success, and previously undetected incubation patterns. Nest initiation dates ranged from 12 May to 11 July and peaked during late May and early June. Incubation at individual nests ranged from 9 to 41 days. Chick feeding flights were recorded for 5 to 34 days. Thirteen eggs successfully hatched (6 failed to hatch) and of those only 3 successfully fledged (6 failed and 3 outcomes were unknown).

We found that radio-marked murrelets nested in a variety of inland habitats within river or creek drainages associated with PS. While most nest sites were inaccessible by foot, we were able to visually locate and document three tree nesting locations using hand-held telemetry as well as confirming one nest location on a cliff. All other nest-site locations were determined from repeated low-elevation aerial telemetry and examination of low elevation aerial photographs of the nest area. We determined nest-site characteristics for 16 of the 19 nesting areas using approximate nest location coordinates from aerial surveys and mapping software. Nesting areas occurred in older-aged forests or steep cliff areas with various aspects, elevations, and distances from the coastline. Elevations ranged from 42 to 986 m (0 = 374 ± 268 m; n = 19) and distance from the coast ranged from 1.2 to 52.3 km (0 = 15.1 ± 15.0 km). Two nests were found in Canada >50 km inland. The use of habitat so distant from the coast was surprising considering the vast amount of available nesting habitat (tree and cliff) near the coastline in most areas of PS.

We examined our active and inactive nesting areas relative to predicted murrelet nesting habitat from the Southeast Alaska Core Areas of Biological Value Database (Schoen and

Dovichin 2007). This database characterizes most terrestrial habitat types and forms of land cover, including different forest types and productivity levels (annual gross volume ft^3 growth per acre). The database also predicts the suitability of an area for important wildlife species, including murrelet nesting habitat. In this model, a productive old-growth forest is considered suitable for murrelet nesting habitat while non-forest areas are considered not suitable. After overlaying our nesting areas on the predicted murrelet nesting habitat, we found that nests were located in all levels of predicted murrelet habitat. All tree nests were inside or along the edge of the moderate to predicted murrelet habitat, while most cliff nests were outside the predicted murrelet habitat. Nests of unknown nest type (tree or cliff) were located nearby or within low to moderately suitable predicted murrelet nesting habitat. Overall, the amount of predicted murrelet nesting habitat in PS was relatively low compared to many nearby areas but no murrelets captured at the mouth of PS were found to breed in other areas despite aerial searches.

Health Assessment

OBJECTIVE 4: Conduct health evaluations for 30-35 murrelets/year using hematologic and biochemical testing.

We captured and collected blood from 101 murrelet in PS from 2005 to 2007 (2005 n = 42, 2006 n = 36, and 2007 n = 23). We analyzed blood samples for hematological parameters, plasma samples for biochemical parameters, and cloacal samples in 2007 to determine Avian Influenza Virus (AIV) and Newcastle Disease Virus (vNDV) status, all to establish baseline health reference intervals for this population.

For the hematological analysis, blood samples were analyzed for the white blood cell count (WBC) differential by counting 100 white blood cells on each blood smear and categorizing the following cell types: eosinophils, heterophils, lymphocytes, monocytes and basophils. Blood smears were examined for the presence of blood parasites. For the biochemical analysis, we sent frozen plasma samples on dry ice to the Division of Comparative Pathology at the University of Miami, Miller School of Medicine for a summary of alanine amino transferase (ALT), lactate dehydrogenase (LDH), aspartate amino transferase (AST), creatine phosphokinase (CK), calcium (CAL), phosphorus (PHOS), glucose (GLU), total protein (TP), and uric acid (URIC) using an Ortho Vitros 250 (Ortho Diagnostics, Rochester, NY). For the disease analysis, we sent cloacal swab samples taken in 2007 (n = 40) to the Alaska State Veterinarian in Anchorage, AK, to be analyzed for AIV and vNDV.

OBJECTIVE 5: Establish blood-based reference ranges for Southeastern Alaska murrelets.

In this study, we not only established reference ranges for baseline blood health indices for murrelets in AK, but also identified significant differences between these parameters spatially, temporally, and with respect to gender and parasite presence. See other objectives for a summary of reference ranges.

OBJECTIVE 6: Compare health indices inter-annually.

We compared hematological and biochemical parameters among years.

We found significant differences among years for WBC, eosinophil, heterophil, monocyte, and lymphocyte counts, and *post-hoc* tests revealed that mean WBC count was significantly larger in 2007 than 2005 and 2006, and the eosinophil count was significantly smaller in 2005 than 2006 and 2007. The monocyte and lymphocyte counts were significantly smaller in 2006 than 2005 and 2007. H/L values were significantly different for all 3 years, with the largest ratio in 2006, followed by 2005 and 2007. CAL, URIC, TP, ALT, and CK were significantly smaller in 2005 than in 2006 and 2007. Blood parasites (*Haemoproteus* spp. and *Plasmodium* spp.) were present on 23%, 47%, and 36% of blood smears in 2005, 2006, and 2007, respectively. Eosinophil counts were significantly larger for birds with blood parasites than for birds without blood parasites, and monocyte counts were significantly larger for birds without blood parasites than for birds with blood parasites. When biochemical parameters were compared, CAL, TP, ALT, and CK were significantly higher for birds with blood parasites than for birds without blood parasites. In 2007, there were no significant differences between birds that nested and those that did not nest, and all 2007 cloacal swab samples were negative for AIV and vNDV.

Total WBC, an indicator of immune system function, reflects the balance between supply and need for white blood cells, or leukocytes, to defend the body against pathogens upon exposure and infection (Amand 1986). Mean WBC for birds in 2007 was about twice that of the previous two years. Varying environmental conditions and the timing of sampling in all three years may have influenced WBC. In 2006, PS murrelets experienced high mortality (Nelson *et al*. 2008), likely due to poor environmental factors that also limited breeding success. Conversely, we captured birds during the height of their breeding season in May 2007 (Nelson 1997) and normal physiological processes associated with egg production in females, particularly antigen stimulation, may have been associated with increased WBC count for 2007 murrelets. Additionally, 2007 eosinophil counts were significantly larger than 2005, and monocyte and lymphocyte counts were larger than 2006. These results may be linked to the same breeding issues as WBC.

H/L values for 2006 were significantly larger than those in 2005 and 2007. The cause of this large H/L ratio was a relatively low lymphocyte count despite an overall higher WBC for that year. In 2006, PS birds with high H/L ratios experienced high mortality. Increased H/L ratios can result from a variety of stressors including handling (Vleck *et al.* 2000), however, a transient elevation in H/L ratios would not lead to increased mortality in murrelets. Therefore, we believe that true ecological stressors (lack of food, unusual temperatures, inclement weather, etc.) were contributing to the high mortality observed. Ecological conditions may be part of the reason that breeding success of murrelets was so low (13%; Nelson *et al*. 2008).

Activity levels for CK were highest for murrelets in 2006. CK is an enzyme associated with muscle function (Newman *et al.* 2007) and may be elevated due to physical exertion, traumatic restraint, or muscle atrophy secondary to poor environmental conditions, leading to starvation and emaciation. The 2006 spring was particularly wet and cold and may have added atypical environmental stress, or increased metabolic demands. Consequently, CK levels following capture and sampling may have been elevated. The average daily temperature recorded at the Juneau weather station in May 2006 was colder (9.4˚ C [48.9˚ F]), and wetter (21.59 cm [8.50 in] precipitation) than 20-yr averages (9.7˚

C [49.5˚ F] and 12.75 cm [5.02 in] precipitation) (Nelson *et al*. 2008). The extreme weather conditions and potentially poor prey availability, coupled with increased metabolic demands in 2006 also could have played a role in the poor breeding effort, failed nesting attempts, and high number of mortalities recorded by radio-marked PS murrelets that year (Nelson *et al.* 2008). Other less likely causes of increased CK in PS murrelets include Vitamin E/ Se deficiency and lead toxicity but we did not have the opportunity to evaluate these parameters.

OBJECTIVE 7: Conduct geographic health comparison between murrelets from Southeast Alaska and murrelets from central California (samples previously collected and analyzed).

We compared hematological and/or biochemical parameters between California (CA) and Alaska (PS) birds using Mann-Whitney U tests. Total WBC, monocytes, eosinophils, lymphocytes, PHOS, LDH, and TP were higher for AK murrelets than for CA birds. Basophils and H/L were higher for CA murrelets, although the differences are not as striking or thought to be of clinical significance. However, hematological and biochemical values for AK birds were similar to reference ranges established for murrelets from the Aleutian Islands (Newman *et al.* 1997) and Xantus' Murrelets (*Synthliboramphus hypoleucus*) from CA (Newman *et al.* 2005).

Hematological and biochemical profiles have been used in other studies to reveal the geographic differences among stable and declining populations of seabirds (Hollmen *et al.* 2001). Thus, geographic comparisons of hematology and biochemistry may be useful in revealing differences between murrelet populations in PS, which are thought to have remained relatively stable (although see Piatt *et al*. 2006 about SE AK populations), and murrelet populations in Año Nuevo Bay, CA which are steadily declining. The CA population of murrelets has been on the threatened species list in California since 1992 (USFWS 1992; Ralph *et al.* 1995), and the most recent survey has determined the CA population to still be in decline (Henkel and Peery 2008).

Overall, LDH activity for PS birds was elevated in comparison to murrelets from CA and the Aleutian Islands or Xantus' Murrelets from CA. It has been determined that LDH rises and declines more rapidly upon muscle exertion in birds, followed by rising CK and AST activity. Therefore, the high LDH activity serves as an indicator of physical exertion associated with a specific temporal marker of sampling approximately 30 min after capture. On the other hand, CK activity was lower for PS birds in comparison to murrelets from CA and the Aleutian Islands. CK is an enzyme associated with muscle function (Newman et al. 2007) and may be elevated due to physical exertion, traumatic restraint, or muscle atrophy secondary to poor environmental conditions leading to starvation and emaciation. The CK activity for CA murrelets was almost twice that of AK murrelets, suggesting that CA birds may have experienced more stress as a result of capture and handling, in addition to potentially poor environmental conditions. Activity levels of CK and AST were relatively low in PS birds and this suggests little, if any, prolonged muscle associated exertion due to capture or restraint.

One factor that can compromise the avian immune system is pollution. The marine environment along the CA coast may be affected by organic contaminants from agricultural run-off, trace elements discharged as waste from industrial areas, and oil pollution, and as a result, the health of murrelet populations in this area may be threatened. Further study to carefully evaluate murrelet health concurrent with contaminant levels in water, prey, and murrelets in central CA is necessary to draw such conclusions.

OBJECTIVE 8: Archive blood samples for future DNA analyses, disease testing, and isotope research.

Blood samples have been archived at Wildlife Trust and the Division of Comparative Pathology at the University of Miami, Miller School of Medicine. Some samples are currently undergoing DNA and stable isotope analyses.

IV. MANAGEMENT IMPLICATIONS

Activity Patterns and Habitat Use Study – Important and unexpected information about Marbled Murrelets in the PS area, Southeast Alaska, was obtained during each year of our study from 2005 to 2007. Highlights were the: (1) identification of PS as an important regional breeding and foraging area between April and August; (2) discovery of 19 nesting areas with at least 8 nests in trees and 5 nests located on rock cliffs; (3) details from our stationary data loggers which documented nest success, several cases of egg neglect, and revealed the exact timing of incubation and chick feeding flights in PS; (4) determination of the daily and seasonal activity patterns for murrelets attending the PS area during the breeding season; (5) documentation of long-distance movements of murrelets from PS during the post-breeding dispersal period; (6) evaluation of different telemetry tracking techniques for the PS area, including identification of stationary data loggers as a viable method for monitoring activity patterns and nest success; (7) documentation of high transmitter failure rates and potential environmental effects in 2006 resulting in few breeding attempts and high mortality; and (8) identification of varied seasonal weather patterns over the years and related affects on murrelet breeding and mortality rates.

Additional research in needed in Southeast Alaska to determine the range of conditions in murrelet activity patterns, post-breeding dispersal, breeding behavior, and nesting habitat use. Port Snettisham is located on the Alaska mainland where tree and cliff nesting habitat are abundant and tidewater glaciers are present. An investigation of murrelet behavior and habitat use is needed on the islands of Southeast Alaska, which comprise a majority of the land base in the region and where available habitats are significantly different. Without further exploration of the preferences of this unique seabird on and adjacent to the islands, murrelet management options will remain limited.

Health Study – In this study, we not only establish reference ranges for baseline blood health indices for murrelets in AK, but also identified significant differences between these parameters spatially, temporally, and with respect to gender and parasite presence. These results will provide future AK murrelet health assessments with information for comparative purposes and allow for continued monitoring of avian populations and ecosystem health over time. Currently, the birds sampled in our study appear to be physiologically healthy based on blood hematological and biochemical parameters measured. However, they often face unpredictable environmental conditions during both their over-wintering and breeding seasons which can result in chronic stress and increased metabolic demands. Severe environmental conditions may result in poor nesting effort, low nest initiation rates, failed nesting attempts, and greater mortalities as supported by our 2006 results. As animals are programmed to survive and maintain their own homeostasis and physiological health, if environmental conditions are not favorable, reproductive efforts would be compromised in an attempt to maintain their own health. However, in extraordinary conditions, despite efforts to maintain health, severe nutritional stressors and environmental conditions result in increased mortality rates. Our data supports a combination of both of these effects in PS as well as in central CA.

Other threats to murrelet health in PS include compromised water quality, contaminated prey items due to oil pollution, cruise ship and industry discharges, and changes in prey availability and abundance. However, this project provided an opportunity to assess health of murrelets in PS at a time when no obvious oil pollution or discharge threats existed. This type of assessment, conducted before a problem or disaster occurs, is an excellent way to ensure proper health assessments without complicating factors affecting interpretation of results and should be conducted more frequently to evaluate the health of populations of marine birds and other wildlife species.

If environmental conditions and food resources are compromised, the health of murrelets and other organisms in Southeast Alaskan ecosystems could be affected. Detrimental effects would, in turn, be indicated by changes in blood health indices (Newman *et al*. 2007). Should changes in blood health indices be seen in the future, a study of contaminants in prey items may help elucidate underlying pollution problems.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY (May 20, 2008 – December 31, 2008)

During this last period, we analyzed data and completed reports on the T-1-16-1 project. Fieldwork on the T-8-1 project (Marbled Murrelet Habitat Use and Activity Patterns at Port Snettisham, Alaska), with an effective date May 8, 2008, began where this project left off.

JOB/ACTIVITY 8: Archive blood samples for future DNA analyses, disease testing, and isotope research.

All of the blood samples have been archived or are currently undergoing DNA and stable isotope analyses.

VI. PUBLICATIONS

Reports

Nelson, S.K., B.A. Barbaree, S.H. Newman, H.R. Carter, and D.L. Whitworth. 2008. Marbled Murrelet (*Brachyramphus marmoratus*) Breeding Ecology, Terrestrial Habitat Use, and Activity Patterns in Port Snettisham, Southeast Alaska, 2005-2007. Unpublished report prepared for the Alaska Department of Fish and Game by Wildlife Trust, New York, NY.

Newman, S. H., V.M. Padula, S.K. Nelson, and T.B. Haynes. 2008. Health Assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska. Unpublished report

prepared for the Alaska Department of Fish and Game by Wildlife Trust, New York, NY. 41pp.

Publications in Review

Padula, V.M., S.H. Newman, S.K. Nelson, T.B. Haynes, and C. Cray. In review. Health assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska. Journal of Wildlife Diseases.

Haynes, T.B., S.K. Nelson, F. Poulsen, and V.M. Padula. In review. At-sea habitat use and patterns in spatial distribution of Marbled Murrelets in Port Snettisham, Southeast Alaska. Marine Ornithology.

Presentations

Newman, S.H., S.K. Nelson, D.L. Whitworth, H.R. Carter, and M. Kirchhoff. Marbled Murrelet activity patterns and health at Port Snettisham, Alaska. Poster, 2006 Pacific Seabird Group Annual Meeting.

Nelson, S.K., S.H. Newman, D.L. Whitworth, H.R. Carter, and M. Kirchhoff. Marbled Murrelet activity patterns and health at Port Snettisham, Alaska. Poster, 2006 North American Ornithological Conference.

Nelson, S.K., S.H. Newman, B.A. Barbaree, T.B. Haynes, D.L. Whitworth, and H.R. Carter. Nesting habitat, activity patterns, and distribution of Marbled Murrelets at Port Snettisham, Southeast Alaska. Paper, 2008 Pacific Seabird Group Annual Meeting and 2008 Oregon Chapter of the Wildlife Society Annual Meeting.

Haynes, T.B., S.K. Nelson, F. Poulsen, and V.M. Padula. At-sea habitat use and patterns in spatial distribution of Marbled Murrelets in Port Snettisham, Southeast Alaska. Poster, 2009 Pacific Seabird Group Annual Meeting.

LITERATURE CITED

Agler, B.A., S.J. Kendall, and D.B. Irons. 1998. Abundance and distribution of Marbled and Kittlitz's Murrelets in southcentral and southeast Alaska. Condor 100:254-265.

Amand, W.B. 1986. Avian clinical hematology and blood chemistry. Pages 264-276 i*n* Fowler, M.B., ed. Zoo and Wild Animal Medicine, W. B. Saunders Co, Philadelphia, Pennsylvania.

Brown, M., J.G. Doerr, J. Fowler, A. Russel, and P.J. Walsh. 1999. Marbled Murrelet activity patterns and survey efficiency at inland sites in southeastern Alaska. Northwestern Naturalist 80:44-50.

Bradley, R.W. 2002. Breeding ecology of radio-marked Marbled Murrelets *(Brachyramphus marmoratus*) in Desolation Sound, British Columbia. M.S. Thesis, Simon Fraser University, Burnaby, BC.

Burkett, E.E., H.R. Carter, J.Y. Takekawa, S.N. Newman, R.T. Golightly, and J.L. Lanser. 1999. Marbled Murrelet radio telemetry in central California in 1997 and 1998: a reduced effort noted in an El Nino year. Pacific Seabirds 26:32.

DeGange, A.R. 1996. A conservation assessment for the Marbled Murrelet in southeast Alaska. USDA Forest Service Gen. Tech. Rep. PNW-GTR-388, Portland, OR.

Haynes, T.B., S.K. Nelson, F. Poulsen, and V.M. Padula. 2008. At-sea habitat use and patterns in spatial distribution of Marbled Murrelets in Port Snettisham, SE Alaska. Unpublished report to the Alaska Department of Fish and Game by Wildlife Trust and Oregon State University. 57 pp.

Henkel, L.A., Peery, M.Z. 2008. Abundance and productivity of Marbled Murrelets off Central California during the 2007 breeding season. California State Parks, Moss Landing, CA.

Hollmen, T., Franson, J.C., Hario, M., Sankari, S., Kilpi, M., Lindstrom, K. 2001. Use of serum biochemistry to evaluate nutritional status and health of incubating Common Eiders (*Somateria mollissima*) in Finland. Physiological and Biochemical Zoology 74:333-342.

Huff, M.H., M.G. Raphael, S.L. Miller, S.K. Nelson, and J. Baldwin, tech. coords. 2006. Northwest Forest Plan—The first 10 years (1994-2003): status and trends of populations and nesting habitat for the Marbled Murrelet. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-650, Portland, OR. 149 pp.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of Marbled Murrelets (*Brachyramphus marmoratus*): Ecological and energetic consequences of nesting further inland. Auk 118:1036-1046.

Kuletz, K.J., D.K. Marks, D. Flint, R. Burns, and L. Prestash. 1995. Marbled Murrelet foraging patterns and a pilot productivity index for murrelets in Prince William Sound, Alaska. Exxon Valdez Oil Spill Restoration Project Final Rep. (Project 94102), U.S. Fish and Wildlife Service, Anchorage, AK.

Lougheed, C. 2000. Breeding chronology, breeding success, distribution and movements of Marbled Murrelets (*Brachyramphus marmoratus*) in Desolation Sound, British Columbia. Canadian Wildlife Service Tech. Rep. Series No. 352, Pacific and Yukon Region, BC.McShane, C., T. Hamer, H.R. Carter [et al.]. 2004. Evaluation report for the 5-year status review of the Marbled Murrelet in Washington, Oregon, and California. USDI Fish and Wildlife Service, Portland, OR.

Nelson, S.K. 1997. Marbled Murrelet (*Brachyramphus marmoratus*). Pages 1-32 *in* A. Poole and F. Gill, eds. Birds of North America, No. 276. The Academy of Natural Sciences, Philadelphia; The American Ornithologists Union, Washington, D.C.

Nelson, S.K. and T.E. Hamer. 1995. Nesting biology and behavior of the Marbled Murrelet. Pages 57-68 *in* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. Ecology and conservation of the Marbled Murrelet. USDA Forest Service Gen. Tech. Rep. PSW-GTR-152, Albany, CA.

Nelson, S.K., B.A. Barbaree, S.H. Newman, H.R. Carter, and D.L. Whitworth. 2008. Marbled Murrelet (*Brachyramphus marmoratus*) breeding ecology, terrestrial habitat use, and activity patterns in Port Snettisham, Southeast Alaska, 2005-2007. Wildlife Trust, New York, NY (prepared for the Alaska Department of Fish and Game).

Newman, S.H. 2000. Establishing Hematologic and Serum Biochemical Reference Ranges for Central California Marbled Murrelets and Evaluation of Individual Animal Health and Population Health. Final Report. California Department of Fish and Game, Resource Management Division, Sacramento, CA.

Newman, S.H., H.R. Carter, D.L. Whitworth, and J.G. Zinkl. 2005. Health assessments and stress response of Xantus' Murrelets to capture, handling and radio-marking. Marine Ornithology 33: 147-154.

Newman, S.H., S.K. Nelson, J.Y. Takekawa, E.E. Burkett, and R.T. Golightly. 1999a. An improved radio attachment technique for a variety of marine bird species. Pages 415-425 *in* J. H. Eiler, D. J. Alcorn, and M. R. Neuman, eds. Biotelemetry 15: Proceedings of the 15th Int. Symposium on Biotelemetry, Juneau, AK. International Society of Biotelemetry, Wageningen, The Netherlands.

Newman, S.H., V.M. Padula, C. Cray, and L.D. Kramer. 2007. Health assessment of Black-crowned Night-herons (*Nycticorax nycticorax*) of the New York Harbor estuary. Journal of Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 148: 363-374.

Newman, S.H., J.F. Piatt, and J. White. 1997. Hematological and Plasma Biochemical Reference Ranges of Alaskan Seabirds: Their Ecological Significance and Clinical Importance. Colonial Waterbirds 20: 492-504.

Newman, S.H., J.Y. Takekawa, D.L. Whitworth, and E.E. Burkett. 1999b. Subcutaneous anchor attachment increased retention of radio transmitters on Xantus' and Marbled Murrelets. Journal of Field Ornithology 70:520-534.

Newman, S.H. and J.G. Zinkl. 1998. Establishment of hematological, serum biochemical and electrophoretogram reference intervals for species of marine birds likely to be impacted by oil spill incidents in the state of California. Baseline Marine Bird Project, Contract FG 3460-OS Final Report submitted to California Department of Fish and Game, Office of Oil Spill Prevention and Response, Sacramento, CA. 28 pp.

Peery, M.Z., S.R. Beissinger, and S.N. Newman. 2003. Post-breeding movements and distribution of Marbled Murrelets in central California. Unpubl. Rep., Oiled Wildlife Care Network, Univ. California, Davis, CA and California Department of Fish and Game, Sacramento, CA.

Peery, M.Z., S.R. Beissinger, S.H. Newman, E. Burkett, and T.D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the Marbled Murrelet. Conservation Biology 18: 1088-1098.

Piatt, J.F. and N.L. Naslund. 1995. Abundance, distribution and population status of Marbled Murrelets in Alaska. Pages 285-294 *in* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. Ecology and conservation of the Marbled Murrelet. USDA Forest Service Gen. Tech. Rep. PSW-GTR-152, Albany, CA.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P. Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, K.S. Bixler. 2006. Status review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Alaska and British Columbia. U.S. Geological Survey Open-File Report 2006-1387. 258 pp.

Ralph, C.J., G.L. Hunt, J., Raphael, M.G., Piatt, J.F. 1995. Ecology and conservation of the Marbled Murrelet in North America: an overview. Pages 3-22 *in* Ralph, C.J., G. L. Hunt, J., Raphael, M.G., Piatt, J.F. (eds.). Ecology and conservation of the Marbled Murrelet. USDA Forest Service, General Technical Report PSW-GTR-152, Albany, CA.

Schoen, J. and E. Dovichin, eds. 2007. The coastal forests and mountain ecoregion of southeastern Alaska and the Tongass National Forest. Audubon Alaska and The Nature Conservancy, 715 L. Street, Anchorage, AK.

Speckman, S.G., A.M. Springer, J.F. Piatt, and D.L. Thomas. 2000. Temporal variability in abundance of Marbled Murrelets at sea in southeast Alaska. Waterbirds 23:364-377.

Tranquilla, L.M., N.R. Parker, R.W. Bradley, D.B. Lank, E.A. Krebs, L. Lougheed, and C. Lougheed. 2005. Breeding chronology of Marbled Murrelets varies between coastal and inshore sites in southern British Columbia. J. Field Ornithol. 76:357-367.

U. S. Fish and Wildlife Service. 1992. Endangered and threatened wildlife and plants; determination of threatened status for the Washington, Oregon and California population of the Marbled Murrelet. USDI Fish and Wildlife Service Fed. Reg. 57: 45328-45337.

Vleck, C.M., Vertalino, N., Vleck, D. and Bucher, T.L. 2000. Stress, corticosterone, and heterophil to lymphocyte ratios in free-living Adelie Penguins. Condor 102: 392-400.

Whitworth, D.L., S.K. Nelson, S.H. Newman, G.B. Van Vliet, and W.P. Smith. 2000. Foraging distances of radio-marked Marbled Murrelets from inland areas in southeast Alaska. Condor 102: 452-456.

FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number: 16**

Project Number: **5**

Project Title: Detecting trends in marbled murrelet populations in Southeast Alaska

Project Duration: May 25, 2006 – December 31, 2007

Report Period: May 25, 2006 – May 24, 2007

Report Due Date: August 20, 2007

Partner: University of Washington

Project Objective: Develop a statistically reliable survey protocol for estimating marbled murrelet population trends in Southeast Alaska based on an assessment of available data and existing survey protocols.

1. Collect existing datasets and summarize methodological details on each.
2. Collect additional marbled murrelet at-sea protocols from British Columbia, Washington, and Oregon and summarize methods.
3. Determine the statistical power of existing survey data to detect significant trends
4. Prepare final reports and publications.

Summary of Accomplishments

Objective 1: COMPLETED. All the original at-sea data for SE Alaska, including where necessary raw data sheets, maps (including GIS data), and notes have been collected, collated, and cleaned for use in data analysis. These include 12 unique datasets from several different sources, including the FWS surveys of SEAK by Agler in 1994, Hodges in 1997-2001, and Lindell in SEAK, Glacier Bay and Icy Strait in 1993-1999; the USGS surveys in Glacier Bay and Icy Strait in 1999-2003; the USFS surveys of 7 different forest districts of SEAK; and finally surveys from four different sites in British Columbia in 1994-2006. Methodological details on each of these surveys have also been compiled.

Objective 2: COMPLETED. Sampling protocols from British Columbia, Washington, Oregon and California have been compiled and summarized.

Objective 3: IN PROGRESS. All data have been compiled and turned over to a statistical consultant (WEST Inc.) for the power analysis and evaluation of different sampling protocols. This work is delayed, and will be completed during August-November.

Objective 4: NOT COMPLETED. With concurrence of ADF&G (Mary Rabe), the deadline for completion of the final report has been changed to December 2007.

Significant Deviations: We were unable to complete the project by the deadline of May 31, 2007 owing to difficulty in staffing; the need to complete an urgent Status Assessment on the marbled murrelet last winter; consecutive illnesses of the PIs during spring; and delay in establishing a contract with the statistical consultant. The final report due date has therefore been revised to December 31, 2007 (see above).

Project Leaders

Dr. Julia Parrish, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195. jparrish@u.washington.edu.

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ALASKA DEPARTMENT OF FISH AND GAME
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Alaska Department of Fish and Game
State Wildlife Grant

GRANT AND SEGMENT NR: T-1-16

PROJECT NUMBER: 5

PROJECT TITLE: Detecting trends in marbled murrelet populations in Southeast Alaska

PARTNER: School of Aquatic and Fishery Sciences, University of Washington

PRINCIPAL INVESTIGATORS: Dr. Julia Parrish, University of Washington & Dr. John Piatt, USGS Alaska Science Center

COOPERATORS: US Fish and Wildlife Service, Alaska Department of Fish & Game, US Forest Service

PROJECT DURATION: May 25, 2006 – December 31, 2007

REPORT PERIOD: May 24, 2007 – December 31, 2007

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small seabird that inhabits near-shore marine waters from central California to the Bering Sea of Alaska. Its distribution is closely tied to that of the Pacific Coast Temperate Rainforest, where it nests primarily on natural moss platforms in the canopy of old-growth trees. The loss of nesting habitat, especially in the southern portions of its range outside of Alaska, and increased mortality from anthropogenic factors such as oil spills and fishery by-catch, led to this species being listed as threatened in California, Oregon, Washington and British Columbia. Southeast Alaska is an important population center for the species, supporting an estimated 65% of the global population.

Recent surveys (see below) suggest that the number of Marbled Murrelets in southeast Alaska has declined precipitously. Declines in Prince William Sound were less extreme. Numbers of *Brachyramphus* murrelets along the Malaspina Forelands, in Kachemak Bay, and at Adak Island were all negative, and slightly positive at Kenai Fjords.

A number of these historical surveys for seabirds at sea in SE Alaska, including those conducted by the U.S. Forest Service (USFS) but not analyzed by Piatt et al. (2007), could be repeated in order to better evaluate population trends at local or regional scales. However, it is not entirely obvious which methods of surveying would be best to replicate in the future. These surveys have differed markedly with respect to data collection protocol and sampling design, and they have never been contrasted for their power to detect trends. The purpose of this project was to collate and analyze existing historical murrelet survey data to determine which offers the most efficient method for detecting trends, and to make recommendations for conducting region-wide population and trend surveys in Southeast Alaska.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

The original population estimate for Southeast Alaska is derived from a single region-wide survey conducted by the USFWS in the summer of 1994 (Agler et al. 1998; hereafter called the "Agler surveys"). Other agencies and individuals conducted surveys at various locations in the early 1990s for purposes of monitoring this species and detecting population trends. Except for the Glacier Bay/Icy Strait area, however, these surveys have never been repeated and population trends for the region are poorly known. Results of recent analyses (Piatt et al. 2007) suggest that there has been a rapid and widespread decline in *Brachyramphus* murrelet populations throughout most of their range in British Columbia and Alaska. The evidence for major declines in abundance is strongest from Southeast Alaska and Prince William Sound owing to time-series data in both locations. In Southeast Alaska, there is good agreement with rates of *Brachyramphus* murrelet decline estimated from Icy Strait and Glacier Bay (-12.7 vs. -11.8 percent per year), and these declines are corroborated by comparison of Agler's survey with a region-wide survey conducted by Hodges et al. (Piatt et al., 2007) 4-7 years later than Agler, although questions remain about their comparability.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Develop a statistically reliable survey protocol for estimating marbled murrelet population trends in Southeast Alaska based on an assessment of available data and existing survey protocols.

Analysis of datasets were performed to determine: *power* (what degree of change, assessed annually, can be detected with each data set. How do surveys measuring temporal variance (e.g., BC surveys) compare to those measuring spatial variance (e.g., Alaska surveys)? What is the relative power of surveys conducted with random sampling, opportunistic sampling, or systematic sampling; surveys conducted from small skiffs versus larger, slower vessels; transects conducted nearshore versus offshore, or data collected using line transect protocols?); *sample size* (what is the relationship between survey effort and power (specifically, degree of change that can be assessed annually)?); *superior method*(what transect method is the most efficacious, providing the highest degree of certainty with the lowest input of survey effort?); *interannual sampling rate* (assuming a necessity for determining 50% changes over different times intervals (say 10, 15 or 20 years) and assuming that survey effort is limited by personnel and financial resources, which is the superior method for surveying murrelets: annual surveys or surveys every n years?); *survey design* (what is the most efficacious geographic design for surveys (selected from a continuum of a single survey, repeated within seasons, to multiple surveys, each conducted once annually). In other words, from the point of view of power to detect change, but also given that the population is dispersed widely over all of SE Alaska (ca. 30,000 square km), and that resources for monitoring in the future will only ever permit sampling the entire area infrequently (e.g., once every 10 years) or to sample a much smaller area annually (and perhaps repeatedly within season), but not both, which is the superior strategy for monitoring populations? Should we move towards a i) spatially comprehensive survey, or, ii) a (random or core?) selection of several sub-areas to survey, perhaps repeatedly within year?)

Given that 10 to 20 years of sample data will be collected, our professional judgment is that strip transect surveys of the same spatial sample over the entire SE Alaska area should be conducted under the assumption that more species than murrelets will be surveyed. Our analysis suggests that for assessing population trends of murrelets it makes little difference which counting protocol (line versus strip), platform (skiff versus ship), or sampling layout (random versus systematic) one employs, but methods should be standardized in any case. Having said that, we note that line transect methods are more accurate for estimating absolute population size of individual species. Since they can be employed for *Brachyramphus* murrelets while conducting strip transects for everything else, and since they are widely used for murrelet surveys elsewhere, they are recommended. In contrast to protocol issues, sampling effort (sample unit area, frequency of sampling) and total area being sampled are very important issues to sort out in advance.

We make the weak recommendation that segments/transects be of size comparable to the Icy Strait segments (ca. 1 km^2) which were determined in previous analyses to be largely uncorrelated (Piatt et al. 2007). Segments/transects should be well interspersed throughout the study area by the GRTS procedure or a systematic sampling procedure. Surveys every third year with total effort comparable to that in the Icy Strait surveys should give 80% power to detect a 50% decline in population density in 20 years (at the $\alpha = 5\%$ level of testing and under the assumption that the decline is relatively smooth). Minimum total effort should be at least 44 km^2 of surveyed area with the survey effort in the Icy Strait study (ca. 70 km^2) as a more reasonable minimum target.

From a practical standpoint, it may not be possible to sample the entire Southeast Alaska area every third year. Our simulations indicate that surveys conducted every 5 years with sampling effort between that of the Icy Strait and Glacier Bay surveys will meet the same criterion of 80% power to detect a 50% decline in population density in 20 years. Similar power to detect trends could be obtained by conducting repeated surveys of a small area (for example, 7 repetitions of a 10 km^2 survey). We recommend this kind of sampling to assess local-scale trends in different areas of SE Alaska and provide more “real-time” information on annual variability.

IV. MANAGEMENT IMPLICATIONS

These findings and recommendations provide a framework for establishing a long-term monitoring program for marbled murrelets in Southeast Alaska; surveys that might be conducted and/or funded by various wildlife management agencies including the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Park Service and National Forest Service. Southeast Alaska is the most important area for populations of marbled murrelets throughout its range. Populations in Washington, Oregon and California are declining and will likely be extirpated in this century without intervention

(McShane and others, 2004). The status of populations in Alaska and BC is less clear, but possibly declining rapidly in most areas, especially Southeast Alaska (Piatt et al. 2007). The USFWS is currently re-reviewing the status of the murrelet and considering whether it should be listed throughout its range. The results of this study will help with establishing and interpreting new population surveys in Southeast, and contribute to conservation of the species in Alaska and the North Pacific.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY *(*July 1, 2007 – December 31, 2007)

JOB/ACTIVITY A: Collect existing datasets and summarize methodological details on each.

Completed. See Appendices 1 and 2 of full final report. Funds spent on an hourly biologist.

JOB/ACTIVITY B: Collect additional marbled murrelet at-sea protocols from British Columbia, Washington, and Oregon and summarize methods.

Protocols (and data) for British Columbia were collected and summarized (see Appendix 2). Protocols for Washington and Oregon were not specifically summarized, although additional eneral strip transect protocols were collected and summarized (e.g., Gould and Forsell Balance; see Appendix 2). Funds spent on an hourly biologist.

JOB/ACTIVITY C: Determine the statistical power of existing survey data to detect significant trends.

Completed. See final report. Funds spent on statistical consultant.

JOB/ACTIVITY D: Prepare final reports and publications.

Completed. Funds spent on statistical consultant. Matching funds (Parrish) and in-kind personnel (Piatt) also used.

VI. PUBLICATIONS

No peer-reviewed publication has resulted from this work. A final report has been submitted:

Nations, C., McDonald, L., and Parrish, J. 2008. Power to Detect Trends in Brachyramphus Murrelet Populations in Southeast Alaska. Final Report for the Alaska Department of Fish and Game. 70p.

ALASKA DEPARTMENT OF FISH AND GAME
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PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number: 3**

Project Number: **2.10**

Project Title: Field testing alternative survey methods for monitoring Marbled Murrelet populations in Southeast Alaska

Project Duration: 1 September 2006 – 30 June 2009

Report Period: 1 July 2006 – 30 June 2007

Report Due Date: September 30, 2007

Partner: Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Evaluate the strengths and weaknesses of alternative survey protocols to monitor trends in Marbled Murrelet populations in Southeast Alaska. Merit shall be reflected in statistical power to detect trends versus relative cost, including equipment, manpower, and time.

JOB/ACTIVITY A: Assess sources of variability in flyway count data, including temporal patterns (daily and seasonal), environmental effects (weather, visibility), equipment-related (optics quality) and observer.

JOB/ACTIVITY B: Assess error in distance estimation for strip and line transects

JOB/ACTIVITY C: Compare line-transect and strip-transect survey methods for measuring Marbled Murrelet densities at sea.

OBJECTIVE 2: **Assess** spatial variation in Marbled Murrelet numbers between watersheds and across the region and relate to upland and marine habitat attributes.

JOB/ACTIVITY A: Survey murrelets using different methods at multiple watersheds in Southeast Alaska.

Summary of Project Accomplishments

OBJECTIVE 1:

JOB/ACTIVITY A: During this report period, we completed 362 flyway surveys, including 102 flyway surveys to compare simultaneous counts among scopes and observers, 53 surveys to compare counts against time of day, 74 surveys to assess proportion of murrelets counted, and 133 surveys to compare spatial variation (5 sites). For the final analyses (depending on objective and methods) certain of these data sets have been pooled.

JOB/ACTIVITY B: We assessed accuracy and precision of distance estimates over 455 trials covering 7 observers, 3 targets (bouys, decoys, and murrelets), and varying light and sea conditions. Estimated distance and true distance at distances from 10-300 m were recorded. Error was expressed as mean distance error (m), mean percent error, absolute distance error (m), and absolute percent error. Effect of observer, target type, testing experience, and viewing conditions were tested.

JOB/ACTIVITY C: The boat we purchased and intended to use during this report period was not delivered until 9 September 06 (after the 2006 field season) and was inoperable (engine problems) during most of the first half of the 07 season (13 May – 30 June 2007). Consequently few at-sea surveys were completed. We surveyed Port Snettisham 3 times during this report period, running 15 standardized tracks in each survey. On one of those surveys, we conducted simultaneous strip and line counts using independent observers. The other two surveys employed strip transects only. We compared density estimates over time (3 surveys), between years (06 and 07), and between methods (one survey). More work on this Job/Activity is planned for next fiscal year.

OBJECTIVE 2:

JOB/ACTIVITY A: This job involved comparing survey results from 3 main methods (flyway counts, at-sea surveys, and boat-based radar) across a range of locations in Southeast Alaska. Because the ADF&G vessel I had planned to use was unavailable (or broken down) during this report period, no progress was made on this objective. This job will need to be extended a 1 year to satisfactorily complete this objective.

Prepared By: Matthew Kirchhoff

ALASKA DEPARTMENT OF FISH AND GAME
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Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number: 3**

Project Number: **2.10**

Project Title: Field testing alternative survey methods for monitoring marbled murrelet populations in Southeast Alaska

Project Duration: July 1, 2006 – June 30, 2009

Report Period: July 1, 2007 – June 30, 2008

Report Due Date: September 30, 2008

Partner: Alaska Department of Fish and Game

Project Objectives:

OBJECTIVE 1: Evaluate the strengths and weaknesses of alternative survey protocols to monitor trends in marbled murrelet populations in Southeast Alaska. Merit shall be reflected in statistical power to detect trends versus relative cost, including equipment, manpower, and time.

JOB/ACTIVITY 1A: Assess sources of variability in flyway count data, including temporal patterns (daily and seasonal), environmental effects (weather, visibility), equipment-related (optics quality) and observer.

JOB/ACTIVITY 1B: Assess error in distance estimation for strip and line transects.

JOB/ACTIVITY 1C: Compare line-transect and strip-transect survey methods for measuring marbled murrelet densities at sea.

OBJECTIVE 2: Assess spatial variation in marbled murrelet numbers between watersheds and across the region and relate to upland and marine habitat attributes.

JOB/ACTIVITY 2A: Survey murrelets using different methods at multiple watersheds in Southeast Alaska.

Summary of Project Accomplishments

OBJECTIVE 1: We conducted surveys using flyway counts, strip transects, and line transects in Glacier Bay and Icy Strait during this reporting period. We documented temporal and spatial patterns of abundance and variability, and used that information to recommend survey protocols that yielded the highest power to detect population trends. For at-sea surveys, line transects are superior to strip transects; and surveys conducted in July have lower variability, and higher power to detect trends, than surveys conducted in June or August. Observer bias with respect to distance estimation was low. For flyway surveys, activity appears closely tied to time of day and stage of tide. Surveys conducted between 0500 and 0900, and between 1800 and 2200, capture the peaks of Murrelet flyway activity. More detail on methods and results are included under the Job/Activity statements that follow. A progress report is in review.

JOB/ACTIVITY 1A: Assess sources of variability in flyway count data, including temporal patterns (daily and seasonal), environmental effects (weather, visibility), equipment-related (optics quality) and observer.

Accomplishments: From 9-13 July, 2007, flyway surveys were conducted from the western shore of Young Island, at Sitakaday Narrows in lower Glacier Bay. Alternating 2-person crews conducted 15 minute flyway surveys every half hour from sunrise to sunset. At the start of each survey, the observer recorded his or her name, the date, time of day, stage of tide, scope and power setting, cloud cover (%), ceiling height, precipitation, sea state, and visibility. A digital timer/alarm was used to mark the 15 minute survey period. A multiple tally counter was used to keep count of *Brachyramphus* murrelets going in (northbound) and going out (southbound) through the narrows. Surveys were discontinued when visibility declined to “poor” (half or more of the distance not viewable) due to fog, rain, shimmer, or low light.

Over 108 surveys, we counted an average of 331 murrelets per 15 minute survey (SE = 32.8) flying North into Glacier Bay. Birds arrived in two main pulses, mid morning and mid day, with the highest peak at mid-day (1300 hrs) averaging over 700 birds per 15 minute survey. The lulls between those two incoming pulses were balanced by two pulses of birds flying south, out of the Bay. Over 108 surveys, the mean number of birds counted (in plus out) was 521 per survey (SE = 30.13). The coefficient of variation for total number of birds (north and south) was low, at 0.06.

Tides appear to strongly influence the timing of these pulses. Birds moved in and out of the Bay counter to the direction of tidal flow. The daily peak count of incoming birds occurred 1.5 hours after high tide (x = 97 minutes, SE=6.6, N=4). As the tide ebbs, large volumes of water from Glacier Bay flow through this constriction, creating strong currents and tide rips. It was not uncommon to see many murrelets, and other seabirds (including thousands of Northern Phalaropes [*Phalaropus lobatus*]) actively foraging there.

The maximum number of birds coming into the Bay occurred during moderate stages of ebbing tides (1.5-2 hours past high); and the maximum number of birds flying out of the Bay coincided with maximum flooding tidal volume (3-4 hours past low tide). Because significantly more murrelets are entering the Bay than leaving it during our daylight surveys, the difference is presumably leaving Glacier Bay sometime during the evening hours, after the last survey is conducted. Marbled Murrelets in Port Snettisham show a similar diurnal movement pattern (ADF&G, unpubl. data).

Between June 27 and June 30, 2008, we conducted 15-minute flyway surveys at Pt. Adolphus in Icy Strait. Surveys were conducted on the hour, every hour, starting at 0500 and ending at 2200. Similar weather and environmental variables were recorded as in Glacier Bay (see above). The temporal pattern of activity differed from Glacier Bay (in 2007) in that the highest counts occurred just after dawn, and tapered off through the morning. Incoming birds (flying westward) past Pt. Adolphus were much more numerous than eastbound birds in the evening hours, which suggests a significant proportion of the population is flying east after dusk.

We had insufficient replicates in either location to test for effect of scope, magnification, observer, and weather. The final report will combine surveys at point Adolphus from before July 1 with those after July 1 to examine effects of covariates on counts.

JOB/ACTIVITY 1B: Assess error in distance estimation for strip and line transects.

Accomplishments: We conducted 367 accuracy trials from 8-15 July 2007. A trial consisted of an observer making a distance estimate to a Marbled Murrelet sitting on the water, followed by a measurement of the true distance using a laser rangefinder. The true distance to the bird in these trials ranged from 15-242 m, with a mean of 94.8 m (SD = 46.3). We trained and tested 6 observers for this exercise. Mean error overall was -2.6 m, and mean percent error was -2.1%. The absolute error ranged from 9.4-15.8 m by observer, and averaged 13.9 m across observers. Although absolute error was relatively high, the under-estimates largely cancelled out the over-estimates, and a slight (2%) underestimate in distance estimation resulted. This will bias strip transects approximately 4% low because the underestimate applies to both sides of the strip. In contrast, if distances are underestimated in line transects, there will be a positive bias in the density estimate. The best way to control for this is to adjust distance estimates for individual observers, based on these trials, and re-compute the density estimates.

We conducted 293 accuracy trials with 4 observers from 30 May-30 June 2008. A trial consisted of an observer making a distance estimate to a Marbled Murrelet sitting on the water, followed by a measurement of the true distance using a laser rangefinder. The true distance to the bird in these trials ranged from 20-300 m, with a mean distance of 101.8 m (SD = 46.3). The mean error (for all observers) was 0.62 meters. The mean percent error was 3.0 percent. The mean absolute error (16.5 m). For individual observers, the mean error ranged from -1.59 to 4.50; the mean percent error ranged from 0.4 % to 7.4 %, and the mean absolute error ranged from 12.1 to 21.8 m. Although there was a degree of error in all the distance estimates, those errors tended to cancel one another out over time, with the net percent error being very low. On this basis we decided no adjustment were necessary in counts based on observer.

JOB/ACTIVITY 1C: Compare line-transect and strip-transect survey methods for measuring marbled murrelet densities at sea.

Accomplishments: From 9-15 July, 2007, we conducted simultaneous line and strip transects in Glacier Bay. We randomly selected 48 transect throughout the non-wilderness waters of the Bay, with lines running from mid-channel to the nearest shore. The observers switched duties after each transect, so observer effects were cancelled out. Line transects returned substantially higher population densities, and lower coefficients of variation, than strip transects. Line transects returned population estimates of 31, 318 Marbled Murrelets and 4,207 Kittlitz's Murrelets on the water. If both line and strip transects return unbiased estimates of murrelet abundance, simultaneous surveys of the same transect lines should yield similar results. In this study, line transects returned a population estimate for *Brachyramphus* murrelets that was 33 % higher than strip transects. Based on line transects, the number of *Brachyramphus* murrelets on the water was 36,627, with Marbled Murrelets numbering 31,318 and Kittlitz's Murrelets numbering 4,299. Coefficients of variation were 0.18 and 0.38 for the 2 species respectively

Although it is commonly assumed that no birds are missed within the width of a strip transect, some birds are inevitably missed, especially when seas are rough. The maximum detection distance from the centerline was 218 m, and the effective strip width was 97 m. The CV for the population *Brachyramphus* murrelet population estimate was 17 %, which is a little more than half the CV for strip counts on the same lines.

From May 30-June 31, 2008, we completed 3 surveys of the western half of Icy Strait. The survey consisted of 14 transect segments, and duplicated the survey tracks of John Lindell (USFWS 1993). Survey protocols were the same for these Icy Strait surveys in 2008 as they were for Glacier Bay in 2007. The data from these surveys has been entered and the strip transect data analyzed. The line transect data has not been analyzed, but will be in the next reporting period.

OBJECTIVE 2: There was no progress made on this Objective during this reporting period.

Prepared By: Matthew Kirchhoff

Date: 26 September 2008

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: T-3 **Segment Number:** 1

Project Number: 2.10

Project Title: Field testing alternative survey methods for monitoring marbled murrelet populations in Southeast Alaska

Project Duration: July 1, 2006 – June 30, 2009

Report Period: July 1, 2008 – 30 June 2009

Report Due Date: September 30, 2009

Partner: Alaska Department of Fish and Game

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The marbled murrelet (Brachyramphus marmoratus) is currently listed as a threatened species in California, Oregon, Washington, and British Columbia, but is relatively abundant in Alaska, where an estimated 91% of the world's population exists (McShane et al. 2004). Given the national spotlight on this species, and the obvious importance of Southeast Alaska to the bird's future, relatively few resources have been devoted to monitoring marbled murrelets in this region. Estimates of the Alaska population were driven in large part by a single at-sea survey conducted by the USFWS in 1994, which placed the population of Brachyramphus spp. in Southeast Alaska at 687,061 (+201,162) (Agler et al. 1998). By these estimates, Southeast Alaska alone contains approximately 65% of the world's marbled murrelets, making it the geographic and demographic center of the bird's range. It is worth noting, however, that the total population estimate was derived from a 0.8% sample of the bird's marine habitat (Agler at al. 1998). Additional localized at-sea surveys were conducted by the USFS and the USFWS in the early 1990's (ref. DeGange 1996), but few of these have been repeated. The only marbled murrelet dataset that spans >3 years is from Glacier Bay National Park, where marbled murrelets declined by 75% between 1991 and 1999/2000 – a rate of decline of 17.5% per year (Piatt and Kuletz 2005). We do not know if the broader population in Southeast Alaska has followed this Glacier Bay trend.

Although information on the current status and trend of marbled murrelets in Southeast Alaska is desperately needed, the best approach for surveying and monitoring this species has not been determined. A region-wide survey comparable to the 1994 USFWS at-sea survey would provide valuable management data, however large-scale randomized surveys are expensive, and funding has been lacking to conduct this work. The cost of marine survey efforts is only one consideration. Agencies must also consider whether to repeat prior survey protocols exactly, for maximum comparability, or switch to alternate methods which may be more accurate, more precise, and less costly. For example, new distance-sampling techniques model detectability as a function of distance, and generally return a more accurate, more precise estimate than the standard fixed-width strip surveys that were employed in Alaska in the past, with only minimal additional effort (Burnham et al. 1985, Thomson et al. 1998, Becker et al. 1997). Staying with old methods improves power retrospectively, while switching to more precise or more accurate techniques improves power prospectively. Management agencies in the Pacific Northwest deliberated for several years over this question before settling on new survey protocols (Beissinger et al. 1999, USDA 2001, Bentivoglio et al. 2002).

Alaska traditionally used fixed-width strip transects for vessel-based surveys. Other murrelet monitoring methods include vessel-based line transects, aerial strip transects, variable area transects (Parker 1979, Engeman et al 2005), “flyway counts” (VanVliet 1993) which are conducted in daylight without the aid of radar, and radar surveys (Burger 1997). It is worth emphasizing that neither radar counts nor flyway counts will provide an estimate of population size. Without knowing what proportion of the population we are counting, the sample counts can not be extrapolated to a larger population. The counts merely represent an index of activity which we assume is correlated with population size.

This study will determine which of the survey methods described above provide the greatest power to detect trends for a given amount of money, time, and effort. Since almost nothing is known about the types of habitats/landscapes favored by marbled murrelets for nesting, this study also will correlate marbled murrelets population indices with physiographic and vegetative attributes at the watershed scale.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Alaska has primarily used fixed-width strip transects for vessel-based surveys. This is partially due to historical precedence. It is also partially due to the fact that in Alaska, large-scale surveys often census all bird species encountered, as well as marine mammals. When populations are dense, as they sometimes are in Alaska, there is insufficient time to collect necessary distance measures (K. Kuletz, personal communication). Hamer (1997) found that multi-species surveys lead to a negative bias for Marbled Murrelets and other small birds.

High-frequency surveillance radar is a tool that allows birds to be reliably detected in darkness and other low-visibility conditions. Radar also provides the option to map flight path, flight speed, and if desired, save data from the CRT screen to CD or other storage media. Extensive testing in British Columbia and the Pacific Northwest has shown radar to be effective for detecting marbled murrelets, with higher detection rates and greater precision than audio-visual methods (Hamer et al 1995, Burger 1997, Cooper et al 2001). In addition to monitoring population trend, researchers have found useful correlations between marbled murrelet numbers and upland habitat attributes, such as forest area, forest type, tree size, fragmentation indices, and topography (e.g., Burger 2001, Cullen 2002, Steventon and Holmes, 2002).

If radar is to be used effectively as a monitoring tool, it should be located where topography funnels birds into narrow, discrete flight paths (Cooper and Hamer 2000), and ideally, where the birds from several watersheds funnel past the monitoring site (Drever and Kaiser 1999). As counts per unit time increase, and precision increases, we realize increased power to detect trends (Thompson et al. 1998). Our goal will be to situate radar stations where they will consistently track the largest possible number of birds per hour.

Flyway counts consist of 10-20 minute counts of marbled murrelets in flight over water (Kirchhoff, in prep). The counts, made with a spotting scope, are conducted during daylight hours, ideally between 5 and 10 AM. Flyway counts are most effective when terrain funnels large numbers of birds through waterways that are less than 3 km across. For waterways > 3 km, an unknown proportion of birds flying in the distant band likely go undetected. In Southeast Alaska, we know from radio-tagged birds that Marbled Murrelets can make long flights 1 or more times per day between nesting and foraging sites (x = 78 km, + 27 km) (Whitworth et al. 2000). Other observers in Southeast Alaska, conducting visual counts from stationary points in the post-dawn hours, have detected hundreds to > 1,000 murrelets per hour flying to and from foraging and nesting areas (Van Vliet 1993, McAllister, unpublished data). Such mass movements along predictable flyways provide an ideal opportunity for population monitoring. As with radar surveys, flyway surveys provide an index of abundance (not a population estimate). Depending on how stable and uniform these surveys are over time (within day and within season), they can be a useful tool for monitoring population trends in Marbled Murrelets.

The purpose of this study is to (1) compare line transects, strip transects, and variable area transects for measuring Marbled Murrelet densities, (2) assess variations in marbled murrelet numbers across the region and relate to upland habitat attributes, and (3) develop a protocol for future Marbled Murrelet monitoring surveys that will maximize the statistical power to detect trends while minimizing cost.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Evaluate the strengths and weaknesses of alternative survey protocols to monitor trends in marbled murrelet populations in Southeast Alaska. Merit shall be reflected in statistical power to detect trends versus relative cost, including equipment, manpower, and time.

We conducted surveys using flyway counts, strip transects, and line transects in Glacier Bay and Icy Strait during this reporting period. We documented temporal and spatial patterns of abundance and variability, and used that information to recommend survey protocols that yielded the highest power to detect population trends. For at-sea surveys, line transects are superior to strip transects; and surveys conducted in July have lower variability, and higher power to detect trends, than surveys conducted in June or August. Observer bias with respect to distance estimation was low. For flyway surveys, activity appears closely tied to time of day and stage of tide. Surveys conducted between 0500 and 0900, and between 1800 and 2200, capture the peaks of Murrelet flyway activity. More detail on methods and results are included under the Job/Activity statements that follow. A progress report is in review.

From 9-13 July, 2007, flyway surveys were conducted from the western shore of Young Island, at Sitakaday Narrows in lower Glacier Bay. Alternating 2-person crews conducted 15 minute flyway surveys every half hour from sunrise to sunset. At the start of each survey, the observer recorded his or her name, the date, time of day, stage of tide, scope and power setting, cloud cover (%), ceiling height, precipitation, sea state, and visibility. A digital timer/alarm was used to mark the 15 minute survey period. A multiple tally counter was used to keep count of *Brachyramphus* murrelets going in (northbound) and going out (southbound) through the narrows. Surveys were discontinued when visibility declined to “poor” (half or more of the distance not viewable) due to fog, rain, shimmer, or low light.

Over 108 surveys, we counted an average of 331 murrelets per 15 minute survey (SE = 32.8) flying North into Glacier Bay. Birds arrived in two main pulses, mid morning and mid day, with the highest peak at mid-day (1300 hrs) averaging over 700 birds per 15 minute survey. The lulls between those two incoming pulses were balanced by two pulses of birds flying south, out of the Bay. Over 108 surveys, the mean number of birds counted (in plus out) was 521 per survey (SE = 30.13). The coefficient of variation for total number of birds (north and south) was low, at 0.06.

Tides appear to strongly influence the timing of these pulses. Birds moved in and out of the Bay counter to the direction of tidal flow. The daily peak count of incoming birds occurred 1.5 hours after high tide (x = 97 minutes, SE=6.6, N=4). As the tide ebbs, large volumes of water from Glacier Bay flow through this constriction, creating strong currents and tide rips. It was not uncommon to see many murrelets, and other seabirds (including thousands of Northern Phalaropes [*Phalaropus lobatus*]) actively foraging there.

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We conducted 293 accuracy trials with 4 observers from 30 May-30 June 2008. A trial consisted of an observer making a distance estimate to a Marbled Murrelet sitting on the water, followed by a measurement of the true distance using a laser rangefinder. The true distance to the bird in these trials ranged from 20-300 m, with a mean distance of 101.8 m (SD = 46.3). The mean error (for all observers) was 0.62 meters. The mean percent error was 3.0 percent. The mean absolute error (16.5 m). For individual observers, the mean error ranged from -1.59 to 4.50; the mean percent error ranged from 0.4 % to 7.4 %, and the mean absolute error ranged from 12.1 to 21.8 m. Although there was a degree of error in all the distance estimates, those errors tended to cancel one another out over time, with the net percent error being very low. On this basis we decided no adjustment were necessary in counts based on observer.

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From May 30-June 31, 2008, we completed 3 surveys of the western half of Icy Strait. The survey consisted of 14 transect segments, and duplicated the survey tracks of John Lindell (USFWS 1993). Survey protocols were the same for these Icy Strait surveys in 2008 as they were for Glacier Bay in 2007. The data from these surveys has been entered and the strip transect data analyzed.

OBJECTIVE 2. Assess spatial variation in marbled murrelet numbers between watersheds and across the region and relate to upland and marine habitat attributes.

We underestimated the logistical difficulties, costs, and personnel required to accomplish this job as planned. We scaled this job back, and completed surveys in a smaller geographic area (Icy Strait). The distribution and abundance of murrelets was related to physiographic and oceanographic habitat features. The work was done with a single 8 person crew, working from the ADF&G research vessel, *Iyoukeen*. The results of this work are described in section V below.

IV. MANAGEMENT IMPLICATIONS

Evaluating the strengths and weaknesses of different monitoring methods will allow ADF&G or other agencies to design more accurate, more precise, and cost effective protocols. By understanding the inland distribution and habitat relationships of marbled murrelets, the US Forest Service will be able to target old-growth conservation measures effectively, both in Alaska and in the lower 48.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY (July 1, 2009 – June 30, 2009)

There was no activity on Objective 1 jobs during the last segment period.

JOB/ACTIVITY 2A: Survey murrelets using different methods at multiple watersheds in Southeast Alaska.

Study Area

Icy Strait is the major East-West waterway connecting offshore waters with inside waters in northern Southeast Alaska. It is bounded by Chatham Strait to the east, Cross Sound to the west, Chichagof Island to the south, and the mainland to the north. Of particular interest was the portion of Icy Strait that receives the cold, highly-mixed, nutrient-rich waters from Glacier Bay (C, in Figure 1). This marine area, bounded by Point Adolphus to the east and Lemesurier Island to the west, features a massive, v-shaped submarine sill, or moraine that was deposited by the Glacier Bay ice sheet centuries ago. This submarine sill figures prominently in the unique oceanography and productivity of this locale (Etherington et al 2007).

Methods

At-Sea Surveys

Surveys in 2008 were conducted in western Icy Strait (B in Figure 1). Surveys of the Icy Strait Sill area followed the same survey routes and protocols established by Lindell (2005) and referenced by Piatt et al (2007) (Figure 2). Two observers counted from the bow deck of a 26-foot aluminum vessel traveling 5-15 knots. We slowed the vessel when encountering large numbers of birds in order to satisfy the assumptions of the survey protocols (e.g., 100% of birds counted within the strip, or on the line). We would also slow when humpback whales were observed, and stop when our respective courses appeared likely to intersect.

One observer counted all murrelets detected on the water within a 100-m wide strip on either side of the vessel. The second observer recorded the angle and the estimated distance to every murrelet detected on the water (with no distance limit). A third observer recorded data, and collected GPS readings (some surveys). Observers rotated duties after each transect to eliminate observer-related bias. A fourth crewmember was dedicated to navigating and steering the vessel, and did not participate in the surveys. Surveys were discontinued when seas showed whitecaps (0.5-1.0 m), or rain and fog limited visibility. Data on time of day, stage of tide, and weather conditions were recorded for each transect segment.

If a bird was seen sitting on the water, or was observed o take off from the water, it was recorded as a sitting bird. Observers counted flying birds using a “snapshot” method. The area surveyed in each snapshot was the width of the transect (200 m), times the distance to the bird (or birds) when they entered the transect space. The distance forward was unconstrained, but in most cases < 500 m. Once that initial group of flying birds was counted, no other flying birds would be tallied until the vessel had reached the end of the prior snapshot area (i.e., that point on the water where the prior bird(s) entered). This method avoided the need to record zero counts, and keep track of a series of rolling survey ”windows” in front of the vessel.

Observers were trained to estimate distances accurately by periodic testing. This was done by having observers estimate distance to single murrelet sitting on the water, and having the true distance determined with a laser range finder. Observers were told the true distance after each test and their improvement on successive tests recorded. Differences were recorded as mean difference, mean absolute difference, and mean percent difference for the daily trials. Computed densities were not adjusted based on these tests.

Observers on the bow conducted strip and line transects independently for later comparison (e.g., Kirchhoff 2008). Earlier surveys did not use a snapshot technique for tallying flying birds, but instead, counted birds continuously whenever they passed over a moving window 200-300 meters in front of the boat. Because these flying birds are traveling very fast relative to the boat, continuous counts of this nature significantly overestimate the number of flying birds (Kirchhoff 2008). The densities cited in this report refer to birds sitting on the water.

In western Icy Strait (Figure 1, Area B), we surveyed 6 straight-line transects that ran from Elfin Cove to Point Adolphus. These segments are named for the waters they transit, including Cross Sound, South Inian Pass, Idaho Inlet Mouth, South Pass, Mud Bay, and Point Adolphus (Figure 3). Because we ran these transects at higher speed (20-25 knots), the strip width was reduced to 50 m on either side of the vessel to ensure the assumption of 100% detection. We only counted birds sitting on the water. Otherwise, protocols for these surveys were the same as strip surveys in eastern Icy Strait.

Results

<u>Distribution of Birds in Icy Strait</u>

The large majority of murrelets in Icy Strait are found over the Icy Strait sill, between Point Adolphus and Lemesurier Island. Over the course of 15 complete surveys between 1993 and 1999, the area between Point Adolphus and Lemesurier Island (representing 29.8% the sample area) contained 80 percent of all sitting birds counted (Lindell 2005).

Piatt et al. (2007) also noted high use of this area, but suggested it was a recent phenomenon, and that the bird’s distribution had contracted significantly over time. When one examines the proportion of bird using the Icy Bay sill area across all surveys, from 1993 to 1999, there is no evidence of the population contracting (Figure 4). With the exception of the June 1993 survey, no survey found less than 65% of the total *Brachyramphus* murrelet population on the waters between Lemesurier Island and Point Adolphus.

In 2008, we completed 7 surveys of the Icy Bay sill area between 31 May and 8 August. The first survey used the original transect lines from Lindell (2005). For subsequent surveys, we broke the longer north-south transects into smaller segments of approximately equal length (14 segments in all) (Figure 2). The highest densities in this area were recorded in the center (over the shallow sill), along the shore of Chichagof Island, and along the eastern shore of Lemesurier Island (Figure 5). These areas all experience upwelling and fronts that predictably attract foraging birds (as well as whales and sea lions). In comparison, the lowest densities were consistently in the northeast quadrant (segments 2 and 3), near Pleasant Island and the mainland. Thermographs of sea surface temperature show that Glacier Bay outflow has little influence on sea surface temperature in this area (Figure 1). All Kittlitz's Murrelets (*B. brevirostris*) identified in these surveys (19 birds) occurred in Icy Strait off Point Carolus, near the Mouth of Glacier Bay.

Between Cross Sound and Point Adolphus (Figure 1, Area B), we conducted 28 surveys between 27 June and 10 August. Due to conflicting demands, 11% of the 168 possible survey segments were not completed. In those cases, I substituted the segment mean (all surveys) for the corresponding missing value. These surveys reveal an increase in the density of *Brachyramphus* murrelets going from Cross Sound towards Point Adolphus (Table 1).

The results confirm there are substantially higher murrelet densities in western Icy Strait, especially between Lemesurier Island and Point Adlophus (the Icy Strait sill). The relatively high murrelet densities coincide very closely with the colder, nutrient-rich waters that are brought to the surface by the bathymetry at the mouth of Glacier Bay (Figure 6).

<u>Variation Within Summer</u>

Because the survey tracks and methods used in the central Icy Strait area in 2008 were identical to those used by Lindell (2005), I combined his 1993-1999 data with the 2008 data to analyze variation in murrelet attendance throughout the summer (N=22 surveys).

There was an apparent decrease in density during June (Figure 7), which would be expected, assuming some proportion of adult birds are off the water sitting on nests. The monthly means, however, were not significantly different (Anova, P = 0.59, df = 22). The monthly coefficients of variation showed July to be the least variable, and June to be the most variable month (Table 1). On this evidence, surveys conducted during July would have the greatest power to detect population trends in central Icy Strait.

Although monthly differences are convenient to reference, there is no reason to expect that months are biologically meaningful to the birds. It is more likely that if density changes over the summer, it changes based on some linear or curvilinear relationship. Accordingly, I looked at how bird densities changed in Icy Strait as a function of Julian Date throughout the summer, and found a weak curvilinear relationship that shows bird numbers in Icy Strait increase gradually through early summer, peak during the last 2 weeks of July, and then decrease through mid August (Figure 8).

Acknowledgements

Many people contributed to the success of this job. ADF&G staff working on the project included P. Harper, J. Koehler, M. Rabe, D. Rabe, and S. Wright. Volunteers working on the project included D. Albert, P. Kirchhoff, E. Hill, B. Koehler, R. Posey, Z. Posey. I thank the University of Alaska, Southeast, and ADF&G for allowing me to offer a 4-credit field course in Marine Ornithology that featured this field study. Students enrolled in that class were: J. Brown, K. Burkinshaw, T. Cullison, K. Jackson and C. Mounce. Jack Hodges (USFWS) provided valuable assistance with the data analysis, and G. Drew (USGS) generously provided data from USGS surveys in Icy Strait.

VI. PUBLICATIONS

The following manuscripts are in preparation by Matt Kirchhoff and will be submitted for publication by June, 2010:

Near-shore Distribution of Marbled Murrelets: Implications for Population Survey Design (Kirchhoff)

This paper will describe the population density gradient that exists in the near-shore (<1 km) marine environment. This pattern has implications for survey designs because meandering survey routes that “follow the shore” are difficult to replicate (imprecise) and susceptible to significant bias.

Status and Trends in Marbled Murrelet Populations in Southeast Alaska (Kirchhoff, Lindell, Kissling, and Hodges)

This paper will reanalyze historic survey data from Glacier Bay and Icy Strait, and update it with new data collected by ADF&G in 2007 and 2008. It will include an analysis of temporal variation throughout the breeding season, inter-annual variation in spatial distribution, and revise estimated rates of population change for both Marbled and Kittlitz’s Murrelets.

Large-scale Activity Patterns of Marbled Murrelets in Southeast Alaska (Kirchhoff and Koehler)

This paper will describe large-scale movements of Marbled Murrelets, in time and in space, as documented using flyway count data from Port Snettisham, Taku Inlet, and Icy Strait. These data describe regular long-distance movements of Murrelets on a daily, seasonal, and inter-annual basis. They have implications for the timing and spatial scale of future monitoring efforts.

Assessing Potential Causes of Declining Murrelet Populations in Southeast Alaska (Kirchhoff and Day) (Day’s involvement is not confirmed)

This paper will discuss how population trend data (job 1b) can provide insight into contributing sources of mortality, including juvenile versus adult mortality, and chronic versus episodic mortality. This analysis can sharpen our focus on the true drivers in Murrelet population declines, and eliminate others as trivial.

A Field Comparison of Fixed Strip and Line Transect Methods for Surveying *Brachyramphus* Murrelets (Kirchhoff)

This paper compares the accuracy and precision of two common at-sea survey methods that were employed simultaneously on surveys in Glacier Bay. The ease, efficiency, precision, and statistical power of the two methods will be compared.

<u>A Convenient, Unbiased Method for Tallying Flying Murrelets on At-sea Surveys</u> (Kirchhoff and Hodges) (Hodges involvement is not confirmed)

Murrelet surveys in Alaska have been inconsistent in how flying birds are tallied, with the fraction of flying birds ranging from 5-75%. Continuous counts of flying birds will result in estimates that are biased high. This paper proposes a new, unbiased method for estimating the density of flying birds that can be easily incorporated into existing protocols (either line or strip surveys).

Literature Cited

Etherington, L.L., P.N. Hooge, E.R. Hooge, and D.F. Hill. 2007. Oceanography of Glacier bay, Alaska: implications for biological patterns in a Glacial Fjord Estuary. Estuaries and Coasts 30:927-944.

Kirchhoff, M.D. 2008. Methodological Considerations for at-sea monitoring of Brachyramphus Murrelets in Glacier Bay, Alaska. Final Report. Alaska Department of Fish and Game, Nongame, Juneau AK. 72. pp

Lindell, J. 2005. Results of at-sea Brachyramphus murrelet surveys in Icy Strait and other selected areas of Southeast Alaska 1993-1999. Unpubl. Report, USFWS, Ecological Services, Juneau, AK.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P. Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, and K.S. Bixler. 2006. Status Review of the Marbled Murrelet (Brachyramphus marmoratus) in Alaska and British Columbia. U.S. Geological Survey Open-File Report 2006-1387.

VII. APPENDIX

Tables

Table 1. Mean density of Brachyramphus murrelets sitting on the water in Western Icy Strait, between Cross Sound and Point Adolphus, June 27-August 10, 2008.

AREA	N SURVEYS	MEAN BIRDS/KM2	STANDARD DEVIATION
Cross Sound	28	53.7	55.0
Inian Pass	28	39.7	44.8
Idaho Inlet	28	83.6	74.5
South Pass	28	89.0	87.6
Mud Bay	28	130.4	114.8
Point Adolphus	28	171.2	114.9
Total	168	94.6	90.5

Table 2. Mean monthly density of Brachyramphus murrelets on the water in central Icy Strait (Lemesurier Island to Point Adolphus) during all years (1993-99, 2008).

MONTH	N SURVEYS	MEAN BIRDS/KM^2	STANDARD DEVIATION	COEFF. OF VARIATION
May	1	57.7	na	na
June	8	49.0	25.4	0.518
July	4	63.5	18.8	0.296
August	10	62.9	21.2	0.337
Total	23	59.9	22.0	0.380

List of Figures

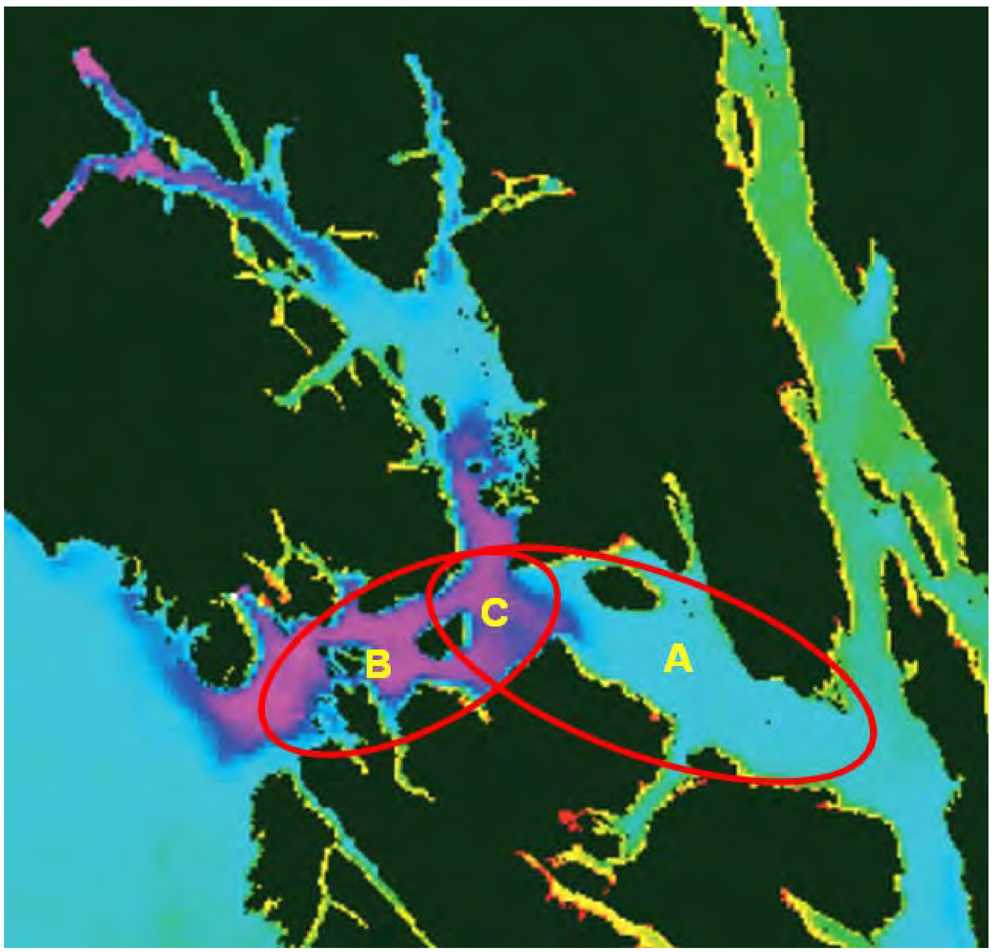

Figure 1. Cold, nutrient rich waters (shown in purple) from the deep basins of Glacier Bay flow are brought to the surface by submarine moraines in the lower Bay and Icy Strait. Eastern Icy Strait, marked as A, was surveyed 1993-2003. Western Icy Strait, marked as B, was surveyed in 2008. The overlapping central area, marked as C, was surveyed in all years. Base map shows mean sea surface temperatures from late May through mid September, 1985-2000 (N=26 images, flood stage) (Douglas 2001).

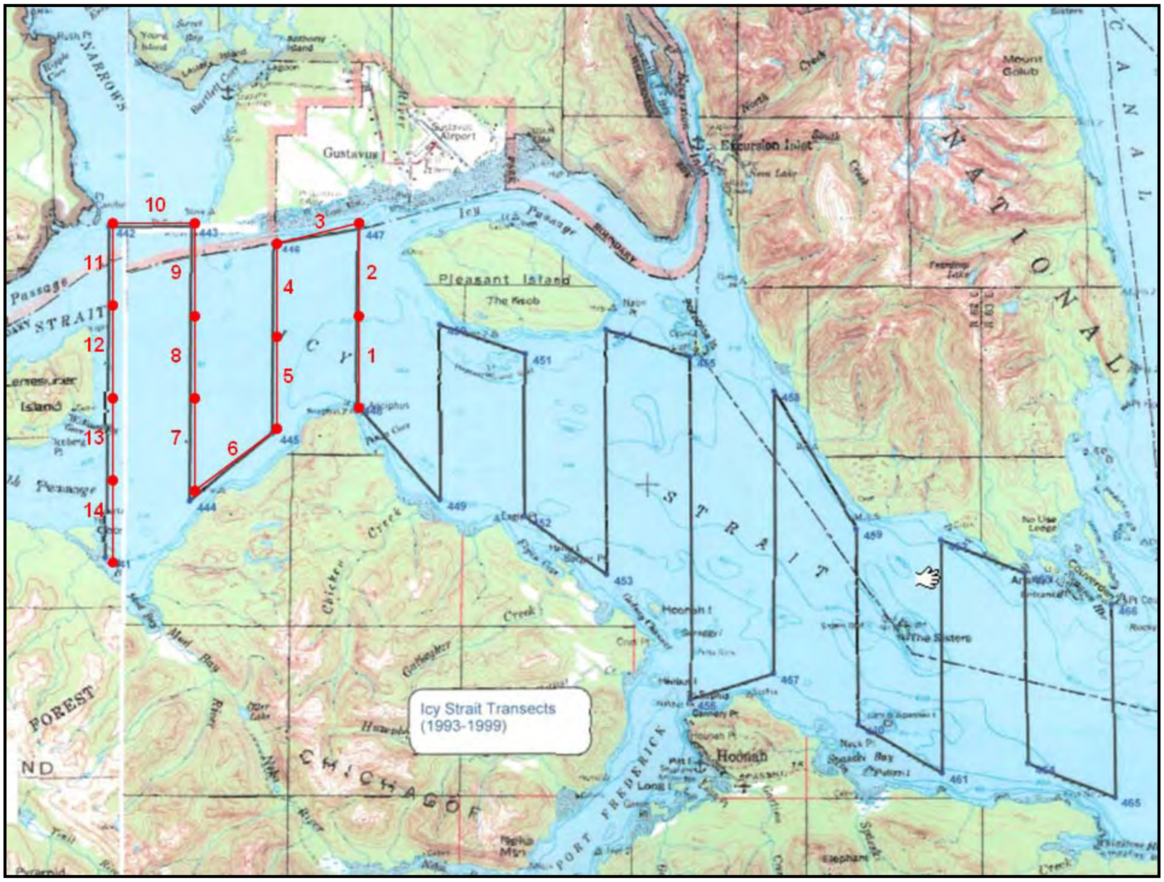

Figure 2. The transect routes surveyed by Lindell (2005) are shown in black. Overlain, in red, are the transect routes surveyed in this study. These red transects sample the productive Icy Strait Sill, an area of concentrated murrelet use. From 1993-1999, 80 % of all murrelets recorded in Icy Strait were found in this area.

Figure 3. Six survey segments in western Icy Strait, including 2 in the Icy Strait sill area (outlined in red).

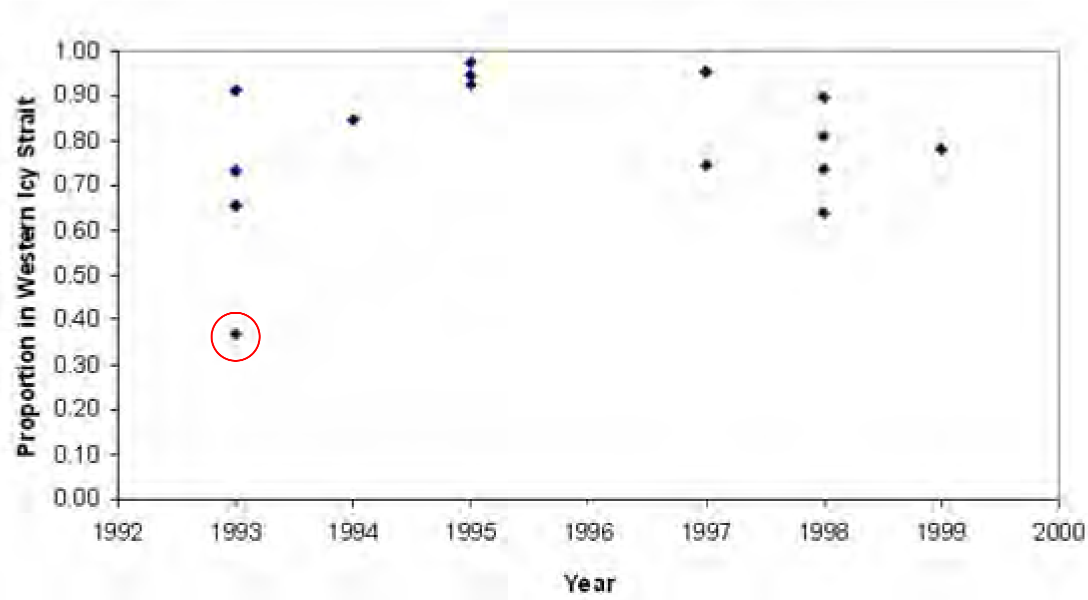

Figure 4. Eighty percent of birds observed in surveys of Icy Strait are found between Point Adolphus and Lemesurier Island. Although the proportion varies from survey to survey, there was no significant trend from 1993 to 1999. One survey in June, 1993, (circled) stands out as different.

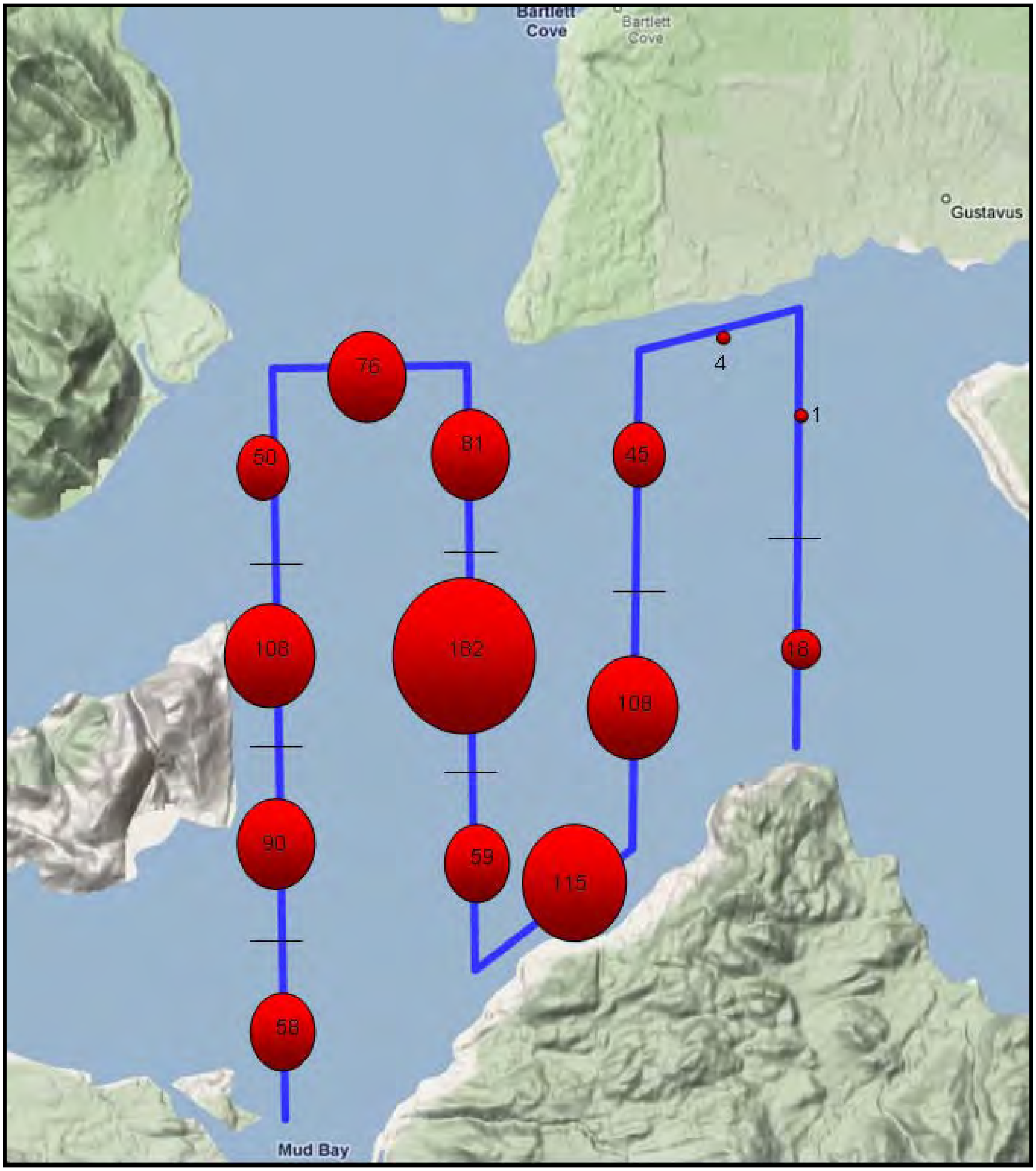

Figure 5. Distribution of Brachyramphus murrelets in central Icy Strait during summer, 2008. Numbers signify mean density in murrelets per km^2 on the water (N = 6 surveys, 12 June – 8 August).

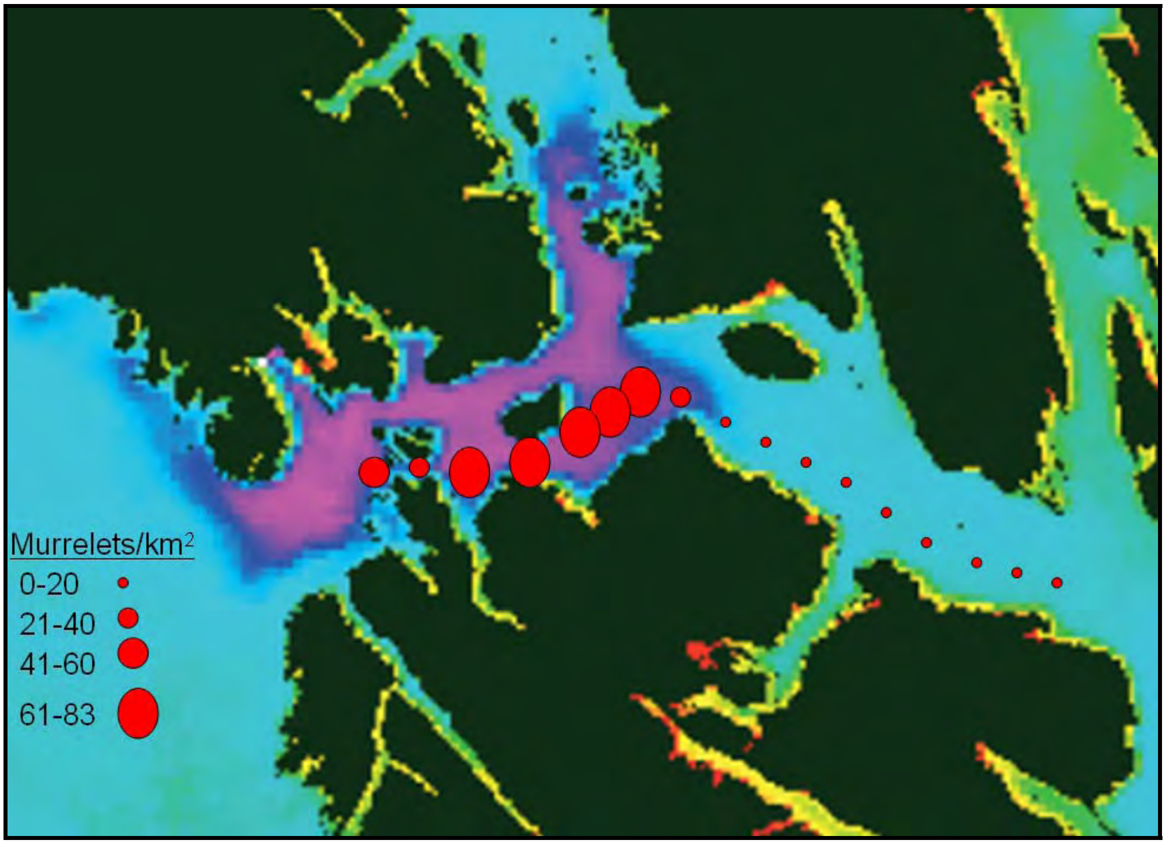

Figure 6.Relative density of Brachyramphus murrelets in Icy Strait, overlain on a base map showing mean Sea Surface Temperature (colder temperatures are purple) (Douglas 2001). Mean densities for all points, except the 4 westernmost, are calculated from north-south crossing transects. Density on the four western points (Cross Sound, S. Inian Pass, Idaho Inlet, South Pass) were adjusted for a methods difference (see text) to make this spatial comparison valid.

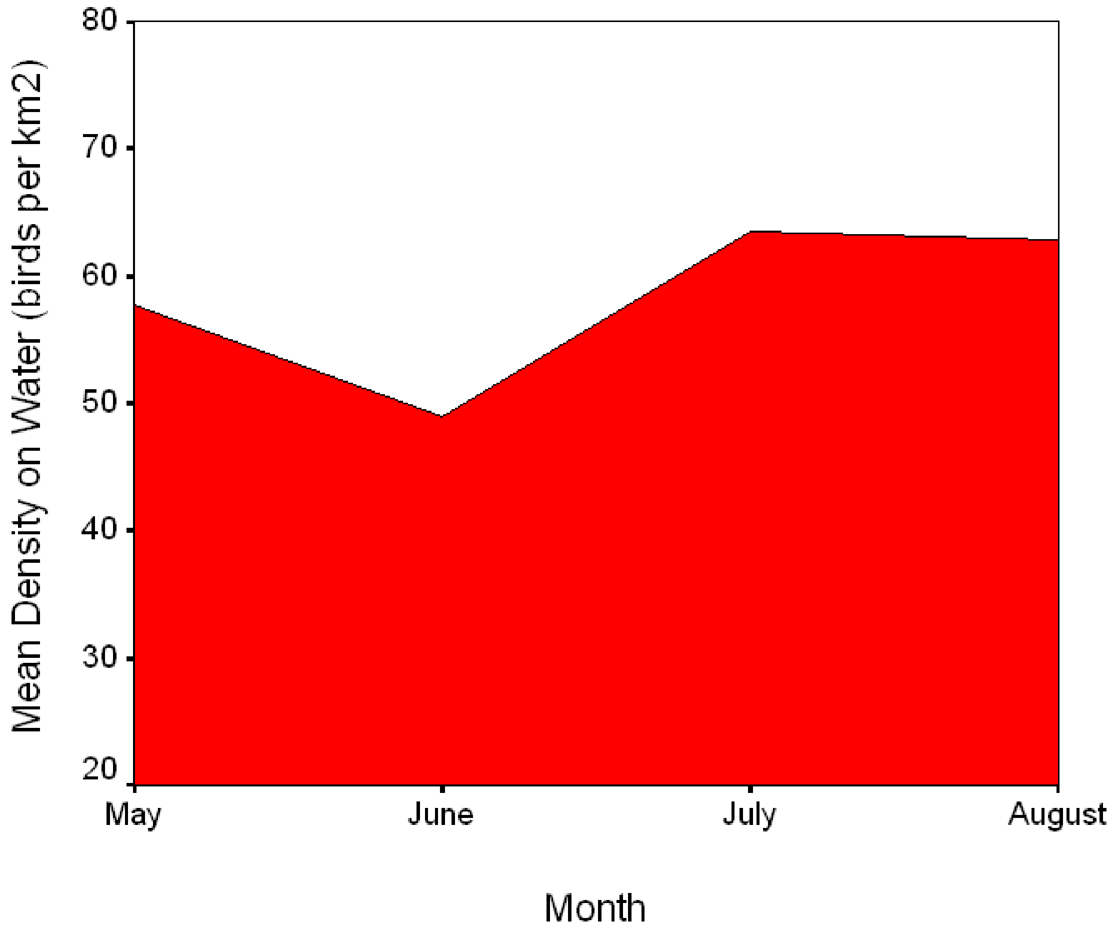

Figure 7. Mean density of Brachyramphus murrelets on the water in central Icy Strait , by month, during summer. The lower numbers in June probably reflect the absence of adult birds who are on the nest incubating eggs. The monthly means are not significantly different (ANOVA P = 0.59, df = 22).

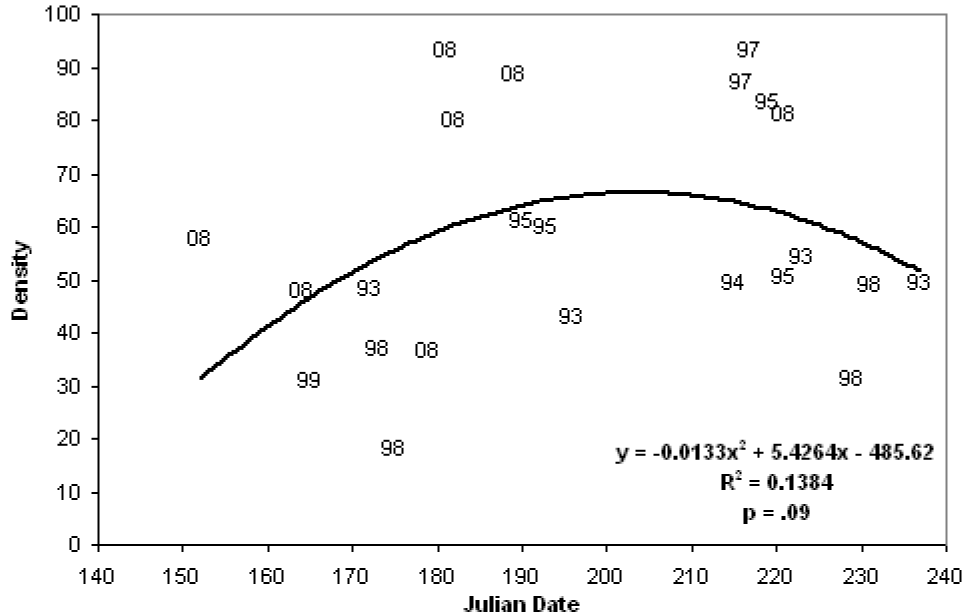

Figure 8. Change in density of Brachyramphus murrelets on the water (birds/km2) throughout the summer in central Icy Strait. The regression equation is marginally significant (P = 0.09).

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-1** **Segment Number: 3**

Project Number: **2.11**

Project Title: Northern Bristol Bay seabird survey

Project Duration: July 1, 2006 – June 30, 2008

Report Period: 1 July 2006 – 30 June 2007

Report Due Date: September 30, 2007

Partner: Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Conduct a population survey of select nesting seabirds in all of northern Bristol Bay including the Walrus Islands State Game Sanctuary and Togiak National Wildlife Refuge to:

JOB/ACTIVITY A: Assess changes in population levels over the past 20 years.

JOB/ACTIVITY B: Establish a reliable baseline level of nesting populations to assess future environmental impacts.

Summary of Project Accomplishments

OBJECTIVE 1: A boat-based survey of colonial ledge-nesting seabirds was conducted in July 2006. All previously documented colonies in the study area were surveyed as were all new colonies discovered. Field counts were made at the colonies for all individuals of the following species: black-legged kittiwakes, common murres, glaucous-winged gulls, pelagic cormorants and double-crested cormorants.

Digital photographs were also taken of all colonies. These photographs are being merged to create one comprehensive photograph of the colony and then each species of seabird is counted using ARC GIS software. Approximately half the colonies have been counted during this reporting period.

Preparations for a replicate survey to be conducted in July 2007 were made during this reporting period.

JOB/ACTIVITY A: This assessment will be made after data from the 2006 and 2007 surveys is compiled and analyzed.

JOB/ACTIVITY B: The 2006 and 2007 survey data will be added to the U.S. Fish and Wildlife Service Seabird Colony Catalog and will serve as a baseline of population levels to use for future comparisons.

Prepared By: Joe Meehan, September 10, 2007

FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-3** **Segment Number: 1**

Project Number: **2.11**

Project Title: Northern Bristol Bay seabird survey

Project Duration: July 1, 2006 – December 31, 2008

Report Period: July 1, 2007 – June 30, 2008

Report Due Date: September 30, 2008

Principal Investigator: Joe Meehan, Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Conduct a population survey of select nesting seabirds in all of northern Bristol Bay including the Walrus Islands State Game Sanctuary and Togiak National Wildlife Refuge to:

JOB/ACTIVITY 1A: Assess changes in population levels over the past 20 years.

JOB/ACTIVITY 1B: Establish a reliable baseline level of nesting populations to assess future environmental impacts.

Summary of Project Accomplishments

OBJECTIVE 1: A second boat-based survey of colonial ledge-nesting seabirds was conducted in July 2008. All previously documented colonies in the study area were surveyed as were all new colonies encountered. Digital photographs were taken at all colonies concentrating on the following species: black-legged kittiwakes, common murres, glaucous-winged gulls, pelagic cormorants and double-crested cormorants. In addition, field counts were made in colonies that consisted of only cormorant species.

The photographs were merged to create one comprehensive image of the colony and we counted each species of seabird in the digital photographs using ARC GIS software. During this reporting period, we finished the counts from the remaining 2006 survey colonies and completed approximately one-third of the colonies from the 2007 survey.

JOB/ACTIVITY 1A: This assessment will be made after data from the 2006 and 2007 surveys is compiled and analyzed.

JOB/ACTIVITY 1B: The 2006 and 2007 survey data will be added to the U.S. Fish and Wildlife Service Alaska Seabird Colony Catalog and will serve as a baseline of population levels to use for future comparisons.

Prepared by: Joe Meehan

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant
ANNUAL INTERIM PERFORMANCE REPORT

Grant Number: **T-1** **Segment Number: 3**

Project Number: **3.10**

Project Title: An integrated regional ecological assessment of the Black oystercatcher (*Haematopus bachmani*)

Project Duration: July 1, 2006 – June 30, 2008

Report Period: 1 July 2006 – 30 June 2007

Report Due Date: September 30, 2007

Partner: Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Determine the size and nesting density of several important local breeding populations throughout the range.

OBJECTIVE 2: Assess the overall population status and demographic parameters important in regulating population size (i.e., overwintering and adult survival, fledging success, recruitment age, breeding site fidelity, and natal philopatry).

OBJECTIVE 3: Assess regional differences in nesting effort, breeding success and productivity.

OBJECTIVE 4: Identify local threats or limitations to productivity.

OBJECTIVE 5: Elucidate levels of population structuring and the degree of connectivity between regional breeding populations.

OBJECTIVE 6: Identify locations of important wintering areas and the numbers of birds in those areas.

OBJECTIVE 7: Identify movement patterns between various breeding and wintering areas.

OBJECTIVE 8: Follow the movements of oystercatchers from their breeding areas to their wintering areas.

JOB/ACTIVITY A: Capture at least five adult oystercatchers at each of two important breeding areas in Alaska, and attach backpack mounted satellite transmitters to them.

OBJECTIVE 9: Analyze data, write reports, attend conferences, present papers and results.

Summary of Project Accomplishments

OBJECTIVE 1: For the most part, this objective was completed in summer 2006. We have surveyed breeding activity on Kodiak Island, Middleton Island, Kenai Fjords National Park, Harriman Fjord in Prince William Sound, the Beardslee Islands in Glacier Bay National Park, Sitka Sound, Baranof Island, the Necker Islands, the Myriad Islands, the Tebenkof Islands, and the Forester and Lowrie island complex. Collaborators have independently surveyed much of the Queen Charlotte Islands, as well as Barkley and Clayoquot Sounds in British Columbia, the San Juan Islands in Washington, and most of the Oregon Coast.

OBJECTIVE 2: In the summers of 2006 and 2007 we continued to monitor the fate of populations of oystercatcher we have banded on Middleton Island, Kenai Fjords National Park, Prince William Sound, and Glacier Bay National Park. 2005 was the final year of banding in Kenai Fjords and Middleton Island; 2006 was the last banding year in Prince William Sound and Glacier Bay. 2007 was the final year for active observation of banded populations because, A) the four years of data we have should be sufficient for determining adult survival, and B) band loss rates will make identification of a large proportion of individuals unlikely after 2007, C) it was the planned conclusion of the study, and we have expended our funds for this objective.

OBJECTIVE 3: The summer of 2006 was the third and final season for assessing productivity in Glacier Bay and Prince William Sound. Summer 2005 was the last of three years studying productivity at Kenai Fjords National Park, and the last of two years on Middleton Island. In 2007, independent colleagues began to assess productivity in Pacific Rim National Park and Gulf Islands national Park in British Columbia, and along the Oregon Coast.

OBJECTIVE 4: See Objective 3.

OBJECTIVE 5: In summer 2006 and 2007 we conducted genetics investigations in the Molecular Biology Laboratory at the USGS Alaska Science Center. We extracted DNA from all samples collected at our various study sites (Kodiak Island, Kenai Fjords, Prince William Sound, Middleton Island, Glacier Bay, Stephens Passage, and Laskeek Bay in BC. We acquired or developed all necessary primers to compare individuals and populations from these sites using both DNA microsatellite techniques and mitochondrial DNA. The majority of the microsatellite and mitochondrial DNA comparisons have been run, and we will be completing the population genetics analyses between September 2007 and January 2008. We also developed a new technique for accurately sexing oystercatchers in the field; a technique we validated through molecular genetic work.

OBJECTIVE 6: We surveyed Middleton Island on foot in February 2006, we used boats to survey Kodiak Island in February 2007, and Barkley and Clayoquot Sounds (BC) October 2006, and Prince William Sound in March 2007. For the third year running, inclement weather made planned aerial surveys impossible

OBJECTIVE 7: Resighting of oystercatchers banded on their breeding grounds provided some exciting and novel information about interseasonal movements. One chick banded in Glacier Bay and one adult banded on Middleton Island were sighted on Vancouver Island, BC in the winter of 2006-7. Another adult banded on Middleton was observed in Prince William Sound winter of 2006-7. Band resightings also began to provide information on natal philopatry. A chick banded in Kenai Fjords was found in a breeding are in BC in 2007, while three other chicks were found returning to breeding areas only 10 to 40km from their natal grounds.

OBJECTIVE 8:

JOB/ACTIVITY A: In May and June of 2007, we implanted satellite transmitters in 18 adult oystercatchers: six on Middleton Island, six in Prince William Sound, and six in Stephen's Passage near Juneau. We also attached VHF radio transmitters to 20 adult oystercatchers; 10 on Kodiak Island and 10 in Pacific Rim National Park, BC. Satellite and VHF transmitters were split evenly between genders at each location. We are already getting exciting information from this effort, but it falls outside this reporting period, so you'll have to stay tuned for the next one!

OBJECTIVE 9: Analyses of data is ongoing, and is estimated to be complete March 2008. Data from this work helped inform the recently completed Black Oystercatcher Conservation Action Plan (Tessler et al. 2007). Portions of this work have been presented as oral papers at the Shorebird Science in the Western Hemisphere conference in Boulder, CO February 2007, and at The Wildlife Society meetings in Juneau, AK April 2007.

Prepared By: David F. Tessler

Additional Information:

Tessler, D.F., J.A. Johnson, B.A. Andres, S. Thomas, and R.B. Lanctot. 2007. Black Oystercatcher (*Haematopus bachmani*) Conservation Action Plan. International Black Oystercatcher Working Group, Alaska Department of Fish and Game, Anchorage, Alaska, U.S. Fish and Wildlife Service, Anchorage, Alaska, and Manomet Center for Conservation Sciences, Manomet, Massachusetts. 115 pp. (http://www.whsrn.org/shorebirds/conservation_plans.html)

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FINAL PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-3** **Segment No. 1**

Project Number: **3.10**

Project Title: An integrated regional ecological assessment of the Black oystercatcher (*Haematopus bachmani*)

Project Duration: July 1, 2006 – June 30, 2008

Report Period: July 1, 2007 – June 30, 2008

Report Due Date: September 30, 2008

Principal Investigator: Dave Tessler, Alaska Department of Fish and Game

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I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The black oystercatcher (*Haematopus bachmani*) is a large, long-lived shorebird with a global population of roughly 10,000 individuals. Black oystercatchers occur uncommonly along the North American Pacific coast from the Aleutian Islands to Baja California, and are completely dependent upon these marine shorelines throughout their life cycle. The black oystercatcher is an intertidal obligate, spending its entire life history in this narrow ecological zone, and feeding exclusively on intertidal invertebrates. They are thought to be a particularly sensitive indicator of the overall health of this ecological community (USDA Forest Service 2002). Although they range from the Aleutian Islands to Baja California, the vast majority (about 70%) of the global population resides in Alaska, conferring a significant amount of the global stewardship responsibility for this species to our state.

The black oystercatcher is listed as a "species of high concern" within the United States, Canadian, Alaskan, and Northern and Southern Pacific shorebird conservation plans and is on the Audubon Society's Watch List (Donaldson et al. 2000, Drut and Buchanan 2000, Brown et al. 2001, Hickey, et. al. 2003, Alaska Shorebird Working Group 2000, National Audubon Society 2002). It is a management indicator species in the Chugach National Forest Plan, was selected as a U. S. Fish and Wildlife Service (USFWS) "Focal Species for Priority Conservation Action," and is a "featured species" in Alaska's Comprehensive Wildlife Conservation Strategy, as well as the strategies developed for Washington, Oregon, and California (U.S. Forest Service 2002, Tessler et al. 2007, Alaska Department of Fish and Game 2005, Washington Department of Fish and Wildlife 2005, Oregon Department of Fish and Wildlife 2005, California Department of Fish and Game, S. Blankenship, pers. comm.).

Conservation concerns for black oystercatchers are due to a number of factors, primarily the species' small population size and restricted range; threats to its obligatory shoreline habitat; susceptibility to human-related disturbances; and a suite of ongoing anthropogenic and natural factors that may potentially limit long-term viability. Yet, despite the mounting concern for this species, direct conservation efforts have been limited by a general lack of information on factors such as the overall population status and trend, the sizes of local breeding populations, population demographics, productivity, local and regional threats to survival and productivity, the locations of important wintering areas, migratory connectivity between breeding and wintering sites, and genetic population structure.

The Nongame Program at the Alaska Department of Fish and Game (ADF&G) initiated this ambitious project to address several key aspects of black oystercatcher ecology critical to the conservation of this poorly understood species. ADF&G took the lead in this cooperatively funded and administered project drawing together the efforts of the U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, U.S. Geologic Survey, the University of Alaska Fairbanks, Oregon State University, and ultimately the Canadian Wildlife Service, Parks Canada, and the Lakseek Bay Conservation Society in British Columbia. Initial project funding came through the federal State Wildlife Grant (SWG) Program administered by ADF&G, and was used to leverage hundreds of thousands of dollars of investment from participating partners.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Despite being gregarious and highly visible, this species remained relatively unknown – especially in Alaska. Research on black oystercatchers in Alaska has been largely limited to investigating the immediate effects of the *Exxon Valdez* oil spill, habitat selection and use, and potential human impacts on breeding birds (Andres 1997, 1998, 1999; Murphy and Mabee 2000; Meyers 2002; Poe 2003). Information on reproductive and demographic traits of this species is based on a hand full of birds banded in British Columbia (Andres and Falxa 1995). We completed a comprehensive review of all historical and contemporary research on black oystercatchers, including published and unpublished work, in the process of compiling the Black Oystercatcher Conservation Action Plan; see Tessler et al. 2007 for the complete review and citations.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Determine the size and nesting density of several important local breeding populations throughout the range.

We intensively surveyed breeding populations throughout the summer for four years at each of four core sites known for high densities of black oystercatchers: Middleton Island in the Gulf of Alaska, Aialik and Northwestern Fjords in Kenai Fjords National Park, Harriman Fjord in Prince William Sound, and the Beardslee Islands in Glacier Bay National Park. We conducted thorough one-time surveys of breeding activity at seven other breeding areas: Kodiak Island, Sitka Sound, Baranof Island, the Necker Islands, the Myriad Islands, the Tebenkof Islands, and the Forester and Lowrie island complex. Collaborators outside of Alaska surveyed breeding pair numbers across much of the Queen Charlotte Islands, Barkley and Clayoquot Sounds on Vancouver Island, the Straight of Georgia, and the Gulf Islands in British Columbia, the San Juan Islands in

Washington, and most of the Oregon Coast. See Tessler et al. 2007 for a complete listing of breeding population size by geographic area.

OBJECTIVE 2: Assess the overall population status and demographic parameters important in regulating population size (i.e., overwintering and adult survival, fledging success, recruitment age, breeding site fidelity, and natal philopatry).

Black oystercatcher population estimates have historically been based mainly on incidental observations made during seabird surveys. To date, there has been no systematic effort to census the entire population. Due to the lack of a systematic sampling effort, broad-scale population trends are unknown.

We established a common protocol for conducting surveys of breeding black oystercatchers, and used this methodology to conduct our surveys of the breeding areas outlined above; thus providing the first consistent, region-wide baseline against which to compare future changes. We were able to compare our results to historical surveys conducted using similar methodologies at three of our survey areas, Middleton Island surveyed in 1976 and 2002 (Gill et al. 2004), the Beardslee Islands in 1987 (Lentfer and Maier 1995), and Sitka Sound surveyed in 1941 (Webster 1941). We synthesized all published and unpublished local population estimates throughout the entire range, and compared gross numbers qualitatively when possible. From these spotty sources, we are tempted to conclude that the population is stable: However, evaluating the actual population size, status, and trend will require a coordinated, systematic, range-wide monitoring effort that is not yet in place.

To assess the demographic parameters that regulate population size, we established an intensive banding effort at our four core breeding sites. We banded adults and chicks at these sites for three breeding seasons, and monitored these banded populations for four summers. In addition, we banded adult breeding birds on Kodiak Island, in Stephens Passage south of Juneau, and in Clayoquot and Barclay Sounds in B.C. In all, we banded 475 black oystercatchers (4-6% of the global population); 261 adults and 214 chicks.

We still have to compile and calculate adult survival, but apparent overwintering survival of banded birds over the four years of continuous observation is 87%. Site fidelity; 92% of returning banded birds returned to their territory from the previous year. Mate fidelity; 91% of returning banded birds returned to their mate from the previous year. Only eight of the 214 chicks banded have ever been resighted anywhere near their natal area in succeeding years, and none were seen in more than one subsequent year. Two chicks banded in Alaska were sighted in subsequent years in British Columbia. The small number of chicks seen in following years clouds the question of philopatry, as it is not currently possible to distinguish between widespread dispersal of subadults and poor survival of juveniles to the age of recruitment. This lack of data also prevents any determination about age of first reproduction at this point.

Due to the historic lack of a systematic sampling effort, broad-scale population trends are unknown; evaluating the actual population size, status, and trend will require a coordinated, systematic, range-wide monitoring effort that is not yet in place.

OBJECTIVE 3: Assess regional differences in nesting effort, breeding success and productivity.

We monitored productivity for three years at each of our four core research sites: Middleton Island in the Gulf of Alaska, Aialik and Northwestern Fjords in Kenai Fjords National Park, Harriman Fjord in Prince William Sound, and the Beardslee Islands in Glacier Bay National Park. In all, we monitored 177 individual breeding pairs for a total of 443 breeding pair seasons.

In our survey operations, we recorded the locations of all observed oystercatchers and identified territorial pairs via behavioral observation. Each actively defended territory was searched to locate nests, and a commercial GPS was used to record the locations of both territories and nests. We implemented a visitation schedule to insure that each black oystercatcher territory was revisited at least every seven days (within the average relaying period of nine days). When a nest was located, the size and number of eggs were recorded, the eggs were floated to estimate laying and hatching dates, and each was marked inconspicuously with a letter for individual identification. We determined breeding chronology and daily nest and chick survival rates using the Mayfield estimator. We plan to re-analyze the final data using program MARK. When a nest failed prior to hatch, territorial pairs were observed to determine if and when they initiated a second nest. Because black oystercatchers remain on their territories after successfully hatching young, we documented the survival of chicks by observing them on territories from a distance using spotting scopes (Andres 1999). We continued to monitor territories according to the visitation schedule until any chicks present fledged or until the end of field operations mid- August.

Clutch size, hatching percentage, fledging success, overall productivity, and causes of egg and chick loss vary widely both between study areas and between years. Average clutch size across all sites and years is 2.51 eggs per nest (range 2.18 – 2.80, n=572), with second and third replacement clutches progressively smaller. 572 clutches produced 1340 eggs, 479 chicks, and 175 fledglings. Average clutch size at Middleton Island was slightly higher (2.77 eggs, P-value < 0.0001) than the other three sites, which were statistically equivalent to one another. Overall hatching percentage (eggs hatched * eggs laid^{-1}) was 33% (range 13% - 72%), and again was significantly greater at Middleton Island (68%, P-value < 0.0001) than the other sites. Overall fledging (fledglings * eggs laid^{-1}) for the duration of the study was 13% (range 5%-25%); and overall productivity (fledglings * adult female^{-1} * season^{-1}) was 0.42 (range 0.15-0.89). Interestingly, there was no significant difference in productivity between any of the study areas. One particularly good year at two sites appears to have inflated our estimate of average productivity; if those unusually high years aren't included in the analysis, annual productivity across the region is about 0.30.

The low average productivity described by this study (0.43) puts the continued stability of this species at risk. Although this study will provide an estimate of adult survival, lifespan has not yet been determined, nor has age of recruitment, nor reproductive lifespan. In addition, survivorship curves for post fledging to senescence are not available and the variation in reproductive output over the fertile lifespan remains unknown. However, for illustration purposes, let us assume an average lifespan of 15 years, recruitment at 5 years, and a reproductive lifespan of 10 years; a very optimistic estimate. If we use the unrealistic assumption of 100% survival at all age classes and an average productivity of between 0.30 and 0.43, we can postulate that a breeding pair would successfully produce their own replacement value (2 breeding adults) in about five to seven years, yielding a total lifetime productivity of three to four adult birds. In reality, survival is not 100%, and both annual survival and fecundity will likely vary throughout reproductive life. A very small change in either adult survival or productivity, even for a single year or affecting a single local breeding population, could result in a declining trend for the species as a whole. Conservation and management of the black oystercatcher will require additional research to determine experimentally the lifetime variation in survivorship and reproductive output. Only then can the viability if the population be assessed.

OBJECTIVE 4: Identify local threats or limitations to productivity.

Over the three years of our intensive productivity monitoring, we made every effort to identify the causes of egg, nest, and chick loss at each of our four core research sites.

Over three years a total of 572 clutches produced 1340 eggs, of which 861 (64%) were lost. When considered together, causes of egg loss were: depredation 32%; tidal flooding 28%; unknown 28%; duds 8%; abandoned 5%; observer induced 0%. Causes of egg and chick loss varied among years and study sites, but a few patterns emerged. In the Beardslee Islands and Harriman Fjord, predation and flooding of nests during high tide events were the two dominant causes of explainable loss: predation accounted for 18% and 21% of losses respectively, while flooding made up 40% and 20% of losses at those sites. In Kenai Fjords, predation accounted for the majority of losses (65%) while tidal flooding made up a smaller proportion (6%) of explained losses. We hypothesize that a large number of the unexplained losses at Kenai Fjords were due to flooding. The most notable difference among study areas was Middleton Island which supports very high densities of nesting oystercatchers on “new” supra-tidal land uplifted in the Alaskan earthquake of 1964: Tidal flooding was virtually absent (3%), as was egg depredation due to the absence of mammalian predators on the island. These factors may explain why both clutch size and hatching success were significantly higher on Middleton Island. However, Middleton is home to a great many avian predators, and once eggs hatched, predation of young chicks by glaucous-winged gulls was largely responsible for reducing fledging success to 16%; statistically the same level found at the other sites. Also, Middleton Island had the greatest percentage of “dud” eggs reported (38%); this rather high proportion is believed to be a consequence of the unusually high nesting density of oystercatchers on that island (nearly 300 breeding pairs or 10 pairs km^{-1} of shoreline), and is due either to confusion on behalf of the incubating parents or interference from conspecifics.

We have photographic, video, visual, or spoor evidence for the following egg predators: mink (*Mustela vison*), marten (*Martes americana*), river otter (*Lutra canadensis)*, wolverine (*Gulo gulo*), red fox (*Vulpes vulpes*), brown bear (*Ursus arctos*), black bear (*Ursus americanus*), Glaucous-winged Gull (*Larus glaucenscens*), Northwestern Crow (*Corvus caurinus*), and Common Raven (*C. corax*).

Clutches on low sloping gravel beaches and wave cut platforms are regularly lost to high tides or wave action. Periods of particularly high tides, storm surges, tsunamis, and boat wakes may all contribute to nest flooding. In an area of high breeding density (e.g., Harriman Fjord in Prince William Sound), a single wave or wake event coincident with monthly high tides could destroy the majority of nests.

OBJECTIVE 5: Elucidate levels of population structuring and the degree of connectivity between regional breeding populations.

We collected 662 individual genetic samples in the form of blood or egg shell membrane from breeding sites throughout the range, including Kodiak Island, Prince William Sound, Middleton Island, Kenai Fjords National Park, Glacier Bay National Park, Stephens Passage, Gwaii Haanas National Park on Queen Charlotte Island, and Pacific Rim National Park on Vancouver Island.

We have analyzed the genetic structure of the species using both DNA microsatellite and mitochondrial DNA techniques. Our final analysis is not yet complete. However, preliminary analyses indicate that no breeding population examined is significantly differentiated from any other population, with the exception of Middleton Island, which is genetically distinct from all others. The genetic distinction of black oystercatchers on Middleton Island is likely the result of a founder effect. The 1964 earthquake resulted in tectonic uplift of the island creating a vast amount of newly available foraging and nesting habitat. The island was first colonized by oystercatchers in 1976, and as recently as 1994 there were just 37 breeding pairs on Middleton Island or just over one pair km^{-1}: in 2006 there were nearly 300 breeding pairs or 10 pairs km^{-1}. We detected no signature of a genetic bottleneck, but it appears that the current population does not recruit from outside at detectable levels.

Overall levels of heterozygosity were lowest at MDO and highest at Queen Charlotte Island; allelic richness was lowest in MDO and PWS, and highest in Kenai Fjords and Queen Charlotte Island. Lower observed levels of heterozygosity on MDO point to some level of inbreeding or a founder effect.

One would expect *a priori* that a long lived species, with such high mate and site fidelity would exhibit considerable genetic differentiation between geographic areas. Yet black oystercatchers appear to be thoroughly mixed. We hypothesize that the lack of genetic differentiation for the species as a whole, and the genetic distinction of the Middleton population are both consequences of the same interplay between habitat availability and behavior. In general, black oystercatcher populations appear to be ultimately regulated by the availability of high quality nesting and foraging habitat, and, with the exception of the 405 ha of newly minted habitat on Middleton Island, nesting habitat is patchily and sparsely distributed throughout the range. In most breeding areas, the suitable territories are already occupied by long lived, monogamous, highly site faithful and territorial breeding pairs, leaving few or no opportunities for newly recruited individuals to mate and establish themselves. If there are no available sites in their natal areas, the young must disperse to take advantage of opportunities in other areas as they arise. Thus, the dispersal of young is likely the primary mechanism for genetic mixing in this species. On Middleton Island, immediately following the initial colonization, because abundant habitat was available for additional territories, young recruits were not forced to disperse.

The fact that so few (3%) of the chicks we banded were ever seen in their natal areas, and then only for brief periods is consistent with this hypothesis. During the course of this project, the population of Middleton Island stopped expanding and began to stabilize at around 700 individuals. The population size appears to have peaked in 2004 at 781 birds and has since dropped off to 703 birds in 2006. The available habitat is apparently now saturated. Had we banded chicks on the island 20 years ago, we would likely have seen them return and establish their own territories.

OBJECTIVE 6: Identify locations of important wintering areas and the numbers of birds in those areas.

We surveyed a number of areas we believed might be important to wintering concentrations of oystercatchers: The Alaska Peninsula, Kodiak Island, Middleton Island, Prince William Sound conducted several winter time surveys of areas. We conducted aerial surveys of portions of the Alaska Peninsula near Izembeck National Wildlife Refuge in February 2005 in a Piper Super Cub at an altitude of 100-150 ft., and airspeed of 60-80 mph. Only 121 oystercatchers were observed, dispersed widely across the survey area, suggesting the area isn't a wintering "hotspot."

We conducted boat based surveys of the shoreline of Kodiak Island in January 2005 and observed a total of 1,716 birds in flocks of tens to hundreds of individuals. The majority (1,155) were found in Chiniak Bay. Adjacent Afognak Island was not surveyed due to inclement weather and sea state conditions, and its potential importance to oystercatchers remains unknown. That the winter estimate for Kodiak is similar to summer counts of between 1,350 and 1,750 (made during Harlequin Duck surveys 1994-2005) suggests Kodiak may be a year round residence for non-migratory oystercatchers. No banded individuals from other study areas were observed in Kodiak surveys. Kodiak Island supports a very large population of black oystercatchers year round, representing nearly 20% of the global population of the species.

We surveyed Middleton Island on foot in February and September 2005. No oystercatchers were seen in February 2005 and only two groups of oystercatchers, one group of four juveniles and a flock of 58 mixed adults and juveniles, were seen in September. The migration of all the 700+ individuals from the island stands in stark contrast to the large number of birds overwintering on Kodiak Island, and suggests differential migratory behavior; some individuals migrate while others remain in place.

We surveyed the ice free shorelines of Prince William Sound by boat in March 2007, and observed 203 oystercatchers in flocks numbering in the tens of individuals. Danger Island had the most with 105. A female banded on Middleton Island in June 2005 was seen on Green Island. The total number observed is less than half of the breeding population. Although the overall number is not as dramatically high as Kodiak, Prince William Sound supports just under 2% of the global population of this species in the winter.

We surveyed the shorelines of Clayoquot and Barclay Sounds on Vancouver Island by boat in October 2006, and detected approximately 300 oystercatchers; a number similar to previous breeding season estimates.

Oystercatchers concentrate in large groups of tens to hundreds of individuals during the winter months and therefore large segments of the population are more vulnerable to localized environmental perturbations at that time. Further efforts to map and define the locations of these important wintering concentrations are needed to assist in assessment and mitigation in the event of a shoreline catastrophe.

OBJECTIVE 7: Identify movement patterns between various breeding and wintering areas.

Our intensive banding efforts of juveniles and adults provided some tantalizing information on the seasonal movements of this species, but due to the fact that they reside in exceedingly remote locations year round, interseasonal band resightings were uncommon.

No clear patterns of movements emerged, but rather both seasonal movements and dispersal appear quite variable.

Chick Dispersal / Migration

Two chicks banded in Alaska were seen in subsequent years in British Columbia. One was banded in Glacier Bay in 2005, and was seen the following January on Vancouver Island, BC; the other was in Kenai Fjords in 2005 and was observed June 2006 in Masset Inlet, Graham Island, BC.

Three chicks banded in Alaska were later seen near their natal grounds: A chick banded in 2005 in Harriman Fjord, Prince William Sound, was sighted August 2007 at Green Island, about 100km southwest. A chick banded in Northwestern Fjord, Kenai Fjords in 2003, was documented back in Northwestern Fjord in May 2006, and another chick from Kenai Fjords banded in Aialik Fjord 2005, was observed in the same fjord July 2007.

Adult Winter Migration

An adult male bird banded on Middleton Island June 2004 was observed in Barklay Sound, Vancouver Island, BC in October 2006; while an adult female banded on Middleton June 2005 was seen on Green Island in Prince William Sound, March 2007.

Site fidelity

Despite variation in dispersal and seasonal movement patterns, site fidelity is strong in adults. In addition to the 92% site fidelity noted from our four intensive core sites, adults from non-intensive sites have been observed returning to the area of their capture: An adult male banded in Bay of Isles, Prince William Sound March in 2004, was seen at the same location in March 2008; and an adult banded on Green Island in 2004 was seen in the same spot again in 2008.

OBJECTIVE 8: Follow the movements of oystercatchers from their breeding areas to their wintering areas.

In 2007, we initiated a migration study utilizing both implanted satellite transmitters (N=18) and backpack harness VHF radio transmitters (N=19) to track black oystercatchers from five breeding sites (Vancouver Island, British Columbia; Kodiak Island, Prince William Sound, Middleton Island, and Juneau Alaska) to nonbreeding sites, and back again (2007-2008). Results of our winter surveys and banding efforts suggested that birds from some breeding areas likely undertake significant post-breeding migrations, while birds breeding in other locations remain relatively close to their breeding sites. We fit individuals from suspected resident populations on Kodiak and Vancouver Islands with conventional VHF transmitters (N = 20, 10/site). Birds from suspected migratory populations (Middleton Island, Prince William Sound, and Juneau Alaska) were implanted with satellite transmitters (N = 18, six/site). We observed variation in migration strategy among breeding populations. None of the oystercatchers fitted with conventional VHF transmitters have been documented more than 20 km from their nest sites. Preliminary results suggest long-distance migration in three populations (range of migration distances: Prince William Sound, 1218-1664 km; Middleton Island, 1031-1479 km; Juneau, 130-1033 km) and year-round residency in two others (Kodiak and Vancouver Islands). Preliminary findings indicate that the coasts of British Columbia and Southeast Alaska provide critical nonbreeding habitat for Black Oystercatchers, as all of the migratory birds we monitored wintered there. We are currently investigating which factors have the greatest effect on Black Oystercatcher space and habitat use throughout the annual cycle to better understand observed variation in migration strategy.

OBJECTIVE 9: Analyze data, write reports, attend conferences, and present papers and results.

We are currently in the midst of finalizing all the analyses for this project, but the data collected from this effort contributed immeasurably to the new Black Oystercatcher Conservation Action Plan (Tessler et al. 2007), the single strategic planning resource now in use for this species throughout its range.

A large number of publications are forthcoming from this body of work; and we expect work to be completed on the majority of these manuscripts over the autumn and winter 2008-2009. Two are already in print. This work has also resulted in a large number of reports to land management agencies.

Aspects of this work have been presented at a number of international, national, and local meetings, including: American Ornithologists Union, Portland, Oregon, August 2008. International Wader Study Group La Rochelle, France, October 2007; Shorebird Science in the Western Hemisphere, Boulder, Colorado, March 2006.

Please see Section VI: PUBLICATIONS for a complete formal list of publications, reports, oral presentations, and posters.

IV. MANAGEMENT IMPLICATIONS

Implications are included above with the sections on the various objectives.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY (July 1, 2007 – June 30, 2008)

JOB/ACTIVITY 1A: Determine the size and nesting density of several important local breeding populations throughout the range.

None.

JOB/ACTIVITY 2A: Assess the overall population status and demographic parameters important in regulating population size (i.e., overwintering and adult survival, fledging success, recruitment age, breeding site fidelity, and natal philopatry).

None.

JOB/ACTIVITY 3A: Assess regional differences in nesting effort, breeding success and productivity.

None.

JOB/ACTIVITY 4A: Identify local threats or limitations to productivity.

One area of particular importance to breeding black oystercatchers, Prince William Sound, experiences relatively high volumes of boat traffic, from both privately owned recreational vessels and tour boat operations. In these areas, should significant boat wake activity coincide with periods of particularly high tides, the potential exists for the majority of black oystercatcher nests on beaches in the area to be lost.

We developed an instrument, a small, unobtrusive salt water data logger, capable of recording the amount of time it is immersed in sea water. With the device we can detect the difference between tidal flooding and an overwash from a wave or boat wake. By combining the use of these devices with regular nest checks, we will be able to determine if a flooded nest was lost to the tide or to a wave. We placed of these salt water data loggers adjacent to all 11 black oystercatcher nests on beaches in Harriman Fjord in Prince William Sound, after the onset of egg laying and prior to the first major high tide cycle. We followed the fate of the eggs in each nest with nest visits at intervals between 5 and 8 days through five major high tide cycles between May 17 and July 17. We made every effort to determine the cause of nest loss and categorized as either due to predation, flooding, abandonment, or unknown causes. We will be analyzing these data through the autumn of 2008.

JOB/ACTIVITY 5A: Elucidate levels of population structuring and the degree of connectivity between regional breeding populations.

None.

JOB/ACTIVITY 6A: Identify locations of important wintering areas and the numbers of birds in those areas.

None.

JOB/ACTIVITY 7A: Identify movement patterns between various breeding and wintering areas.

None.

JOB/ACTIVITY 8A: Capture at least five adult oystercatchers at each of two important breeding areas in Alaska, and attach backpack mounted satellite transmitters to them.

In 2007, we initiated a migration study utilizing both implanted satellite transmitters (N=18) and backpack harness VHF radio transmitters (N=19) to track black oystercatchers from five breeding sites (Vancouver Island, British Columbia; Kodiak Island, Prince William Sound, Middleton Island, and Juneau Alaska) to nonbreeding sites, and back again (2007-2008). Results of our winter surveys and banding efforts suggested that birds from some breeding areas likely undertake significant post-breeding migrations, while birds breeding in other locations remain relatively close to their breeding sites. We fit individuals from suspected resident populations on Kodiak and

Vancouver Islands with conventional VHF transmitters (N = 20, 10/site). Birds from suspected migratory populations (Middleton Island, Prince William Sound, and Juneau Alaska) were implanted with satellite transmitters (N = 18, six/site). We observed variation in migration strategy among breeding populations. None of the oystercatchers fitted with conventional VHF transmitters have been documented more than 20 km from their nest sites. Preliminary results suggest long-distance migration in three populations (range of migration distances: Prince William Sound, 1218-1664 km; Middleton Island, 1031-1479 km; Juneau, 130-1033 km) and year-round residency in two others (Kodiak and Vancouver Islands). Preliminary findings indicate that the coasts of British Columbia and Southeast Alaska provide critical nonbreeding habitat for Black Oystercatchers, as all of the migratory birds we monitored wintered there. We are currently investigating which factors have the greatest effect on Black Oystercatcher space and habitat use throughout the annual cycle to better understand observed variation in migration strategy.

JOB/ACTIVITY 9A: Analyze data, write reports, attend conferences, and present papers and results.

We are currently in the midst of finalizing all the analyses for this project, but the data collected from this effort contributed immeasurably to the new Black Oystercatcher Conservation Action Plan (Tessler et al. 2007), the single strategic planning resource now in use for this species throughout its range.

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International Wader Study Group La Rochelle, France, October 2007; Shorebird Science in the Western Hemisphere, Boulder, Colorado, March 2006.

Please see Section VI. PUBLICATIONS for a complete formal list of publications, reports, oral presentations, and posters.

VI. PUBLICATIONS

Current Publications

Guzzetti, B. M., S.L. Talbot, **D.F. Tessler**, V.A. Gill, and E.C. Murphy. 2008. Secrets in the eyes of Black Oystercatchers: a new sexing technique. J. Field Ornithology 79(2):223–231

Tessler, D. F., J.A. Johnson, B.A. Andres, S. Thomas, and R.B. Lanctot. 2007. Black Oystercatcher (*Haematopus bachmani)* Conservation Action Plan. International Black Oystercatcher Working Group, U.S. Fish and Wildlife Service, Manomet Center for Conservation Sciences, Manomet, Massachussets. 115 pp. (see http:www.whsrn.org/shorebirds/conservation_plans.html)

Invited Presentations

Tessler, D.F., B.A. Andres, J.A. Johnson, S. Thomas, V.A. Gill, M.I. Goldstein, B.S. Guzzetti, R.B. Lanctot, J. Morse, E. Murphy, M. Johnson, S. Talbot, C. Speigel, P. Clarkson, T. Golumia, D. Nysewander, D. Zwiefelhofer, A.Gaston, M. Hipfner, M. Hahr, and S. Haig. 2007. Black Oystercatcher *(Haematopus bachmani)*: Ecology, status, conservation planning, and recent successes. Invited symposium presentation at the Wader Study Group annual meeting, University of La Rochelle, La Rochelle, France, October 2007.

Tessler, D.F., V.A. Gill, M.I. Goldstein, B. Guzzetti, R.B. Lanctot, J. Morse, S. Talbot, M. Tetreau, C. Speigel, and S. Haig. 2006. An Integrated Regional Ecological Assesment of the Black Oystercatcher (*Haematopus bachmani).* Invited Symposium presentation at the Shorebird Science in the Western Hemisphere conference, University of Colorado, Boulder, Colorado, March 2006.

Other Oral Presentations and Posters

Johnson, M., P. Clarkson**,** M.I. Goldstein, S.M. Haig, R.B. Lanctot, **D.F. Tessler**, D. Zwiefelhofer. Inter-seasonal Movements, Habitat Use and Migratory Connectivity of Black Oystercatchers. Oral Presentation at the American Ornithologists Union annual meeting, Portland, Oregon, August 2008.

Tessler, D.F., M. Johnson, S.M. Haig, R.B. Lanctot, D. Zwiefelhofer, M.I. Goldstein, and P. Clarkson. 2008. Inter-seasonal movements and migratory connectivity of Black Oystercatchers. Oral Presentation at the Alaska Bird Conference, Fairbanks, Alaska, March 2008.

Brian M. Guzzetti*, Verena A. Gill, Sandra L. Talbot, George K. Sage, **David F. Tessler**, Edward C. Murphy, and Eduardo Wilner. 2008. Structure and Dynamics of Black Oystercatchers on an isolated and rapidly changing island. Oral Presentation at the Alaska Bird Conference, Fairbanks, Alaska, March 2008.

Brian M. Guzzetti, Sandra L. Talbot, **David F. Tessler**, Verena A. Gill, Edward C. Murphy. 2007. Sexing Black Oystercatchers (Haematopus Bachmani) in the Field. Poster presented at the Wader Study Group annual meeting, University of La Rochelle, La Rochelle, France, October 2007.

Tessler, D.F., V. A. Gill, M.I. Goldstein, B. Guzzetti, R.B. Lanctot, J. Morse, S. Talbot, M. Tetreau, C. Speigel, and S. Haig. 2007. Black Oystercatcher Regional Ecological Assesment: Breeding Biology, demographics, productivity, interseasonal movements, and threats at four important breeding areas across Alaska. Oral presentation at The Wildlife Society annual meeting, Juneau, Alaska, April 2007.

Tessler, D.F., V.A. Gill, M.I. Goldstein, B. Guzzetti, R.B. Lanctot, J. Morse, J. Piatt, A. N. Powell, M.A. Romano, D.L. Schamel, and S. Talbot. 2004. A regional ecological assessment of the Black oystercatcher *(Haematopus bachmani).* Oral **p**resentation at the Alaska Shorebird Group annual meeting, Anchorage, Alaska, December 2004, included in Summaries of ongoing or new studies of Alaska shorebirds in 2004, R. Gill, editor.

Reports to Agencies

Spiegel, C.S., B.A. Brown, M.I. Goldstein, **D.F**. **Tessler**, and S.M. Haig. 2006. Population monitoring, video nesting documentation, and breeding success of Black Oystercatchers (*Haematopus bachmani*) in Harriman Fjord, Prince William Sound, AK 2006. Unpublished Report, USDA Forest Service, Chugach National Forest, Girdwood, AK. 28 pp.

Tessler, D.F., and L.S. Garding. 2006. Black Oystercatcher Distribution and Productivity in the Beardslee Islands, Glacier Bay National Park and Preserve, Alaska. Unpublished Report, National Park Service, Glacier Bay National Park and Preserve, Gustavus, Alaska. 33pp.

Spiegel, C.S., B.A. Brown, M.I. Goldstein, **D.F**. **Tessler.** 2005. Population monitoring, breeding success, and movement of Black Oystercatchers (*Haematopus bachmani*) in Harriman Fjord, Prince William Sound, AK 2005. Unpublished Report, USDA Forest Service, Chugach National Forest, Girdwood, AK. 25 pp.

B.A. Brown, A. Poe, and **D.F. Tessler**. 2004. Nesting and productivity of Black oystercatchers in Harriman Fjord, Prince William Sound, AK. Prepared for U.S.D.A. Forest Service, Chugach National Forest, Glacier Ranger District, AK. 22 pp.

Tessler, D.F. 2004. Black oystercatcher nesting and productivity in the Beardslee Islands in Glacier Bay National Park. Unpublished Report prepared for National Park Service, Glacier Bay National Park, Gustavus, AK. 17 pp.

Arimitsu M.L., M.D. Romano, J.F. Piatt, and **D.F. Tessler**. 2003. Ground nesting marine bird distribution and potential for human impacts in Glacier Bay. Unpublished Report prepared for National Park Service, Glacier Bay National Park, Gustavus, AK. 34 pp.

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-3** **Segment Number: 1**

Project Number: **10.11**

Project Title: Murrelet Watch – A Citizen-based Monitoring Program in SE Alaska

Project Duration: January 1, 2007 – June 30, 2009

Report Period: January 1, 2008 – December 31, 2008

Report Due Date: March 30, 2008

Partner: Alaska Department of Fish and Game

Project Objectives:

OBJECTIVE 1: Monitor long-term trends in Marbled Murrelet populations in Southeast Alaska, while building awareness and support for the conservation of nongame wildlife in the region.

JOB/ACTIVITY 1A: Train citizen volunteers to conduct monitoring surveys via a 3-day spring workshop in each community. Workshops will consist of presentations on the ecology of the bird, field trips to train volunteers in standard survey protocols, and a required practicum to qualify volunteers for this work.

JOB/ACTIVITY 1B: Maintain weekly contact with volunteers by reviewing the data they mail, fax or phone in to the regional office. Answer any questions and offer guidance as needed.

JOB/ACTIVITY 1C: Summarize data with a report at the end of the year. Return to each community to thank the volunteers and present a progress report showing the results of the monitoring to date.

JOB/ACTIVITY 1D: Provide publicity for the project by conducting interviews, contributing articles, and giving talks in participating communities.

Summary of Accomplishments:

OBJECTIVE 1:

JOB/ACTIVITY 1A: <u>Train citizen volunteers to conduct monitoring surveys via a 3-day spring workshop in each community.</u>

We gave public presentations and held training workshops in Juneau, Ketchikan, Wrangell and Sitka. From 28 May through 30 July, 30 trained observers conducted 365 flyway surveys, on 52 days, over 5 survey sites. On average, observers counted 9.7 marbled murrelets per flyway survey (SD=16.8, Max = 108). The highest numbers of birds were counted in Sitka, Juneau, and Ketchikan.

Lower numbers were counted in Wrangell and Funter Bay. Counts were generally highest in the morning hours. Overall variance was high.

JOB/ACTIVITY 1B: Maintain weekly contact with volunteers by reviewing the data they mail, fax or phone in to the regional office. Answer any questions and offer guidance as needed.

Survey teams faxed or mailed their survey results on a weekly basis to Kristen Romanoff, who answered their questions and offered guidance as needed.

JOB/ACTIVITY 1C: Summarize data with a report at the end of the year. Return to each community to thank the volunteers and present a progress report showing the results of the monitoring to date.

Data were summarized in a 24 page progress report at the end of the year, and mailed to all of the observers who participated in the program. Observers expressed a high level of satisfaction with the program, and were eager to continue as citizen science volunteers next year. A copy of the report is attached.

JOB/ACTIVITY 1D: Provide publicity for the project by conducting interviews, contributing articles, and giving talks in participating communities.

Radio announcements were aired throughout Southeast Alaska inviting community members to participate. An article about the program was distributed to the Juneau Empire and Ketchikan Daily News and also posted on ADF&G's website in the Wildlife News. We also developed a 45 minute slideshow presentation about Marbled Murrelets, their natural history, conservation, ADF&G research and information about Murrelet Watch and presented it in Juneau and Sitka. Murrelet Watch also reached a large audience at two Friday-night Fireside chats at the glacier visitor center in Juneau. We also created a tabletop display to be used at community events. at the World Oceans Day held out at the NOAA facility in Juneau the display helped to recruit half a dozen new volunteers. The display will be used at future events, where we are likely to find interested volunteers. We also sent out letters of all of our previous volunteers and encouraged them to invite friends to join the program. Certainly word of mouth was our best tool for promotion and recruitment.

Significant Deviations: The only significant deviation from the project statement was under Job/Activity 1C, which indicated we would return to the communities to personally thank volunteers. Given the regular contact throughout the season, we didn't think the time and expense of a personal visit was necessary. We will probably revisit the communities before the start of next summer's season to refresh them, and possibly recruit additional volunteers to survey added sites.

Additional Information: Coefficients of variation (CVs) were high, which reduces the power of this survey technique to detect population change over time. To reduce CV and boost power, surveys next year will be targeted at locations and times of day where counts are high. If necessary, we will transport crews for intensive survey work at some of these known sites.

Prepared By: Mathhew Kirchhoff, Nongame Biologist, Region 1

Murrelet Watch – Citizen-based Monitoring of Marbled Murrelets and Other Seabirds in Southeast Alaska

2007 Progress Report

Kristen Romanoff and Matthew Kirchhoff
Alaska Department of Fish and Game
PO Box 110024, Juneau, AK 99811
907-465-4292

Suggested citation:

Romanoff K, and M. Kirchhoff. 2007. Murrelet Watch—Citizen-based monitoring of Marbled Murrelets and other seabirds in southeast Alaska. Unpublished Report. Alaska Department of Fish and Game. Douglas, AK. State Wildlife Grant T-3, project 2.11. 24 pp.

Abstract

A citizen-based program for monitoring population trends of Marbled-Murrelets (*Brachyramphus marmoratus*) using land-based flyway surveys was initiated during summer, 2007. Volunteers in 5 communities completed 365 surveys, from 7 locations, over 52 individual survey days during the summer. Surveys were conducted mostly in the mornings, before 0900 hours. The average number of Marbled Murrelets counted per 15 minute survey was 9.7. Counts were higher in July than in June, and higher in early morning versus late morning and afternoon. Counts were significantly higher in the Juneau, Sitka and Ketchikan areas compared to the Funter Bay and Wrangell areas. To reduce noise in the data, we selected a subset of data for the trend analysis. We included surveys conducted between 0530 and 0830 hours during the month of July only. The Coefficient of Variation (CV) for this subset was 24% lower (CV = 1.3) than the CV for the entire data set. From these data we modeled the power to detect changes in the Marbled Murrelet population over time. The power was relatively low. Assuming 5 survey sites, 21 surveys per year per site, similar CV's to those measured in 2007, and a 10 year monitoring effort, we were 71% likely to detect a 5% per annum decline in the population. That likelihood could be increased by adding additional sites, conducting more surveys per site, extending the monitoring effort over more years, and/or selecting sites with higher flyway activity. We recommend this pilot program be continued, with the following changes: (1) conduct more intensive sampling in a narrower time frame (both daily and seasonally), and (2) add at least 2 high-activity sites elsewhere in the Archipelago. This will require locating volunteer crews in field camps for multi-day time periods as a compliment to the current road-based community approach.

Introduction

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small, diving seabird found in near-shore waters along the northwest coast of North America. The birds nest solitarily, often many kilometers inland on moss platforms in the canopy of tall old-growth trees. Their dispersed, secretive nesting behavior requires that population surveys be conducted when the birds are away from their nests, either sitting on, or flying over the water.

Surveys of birds on the water are typically conducted by boat or plane, with the observer either counting all of the birds within a fixed width strip (strip transects), or recording the distance of each bird from the transect centerline (line transects). A limitation of boat-based methods is the vessel requirement, and the time necessary to cover a representative area. Airplane surveys can cover large areas quickly, but reliable counts require flat calm ocean conditions, and those conditions are rare.

Birds flying to and from their nests at night, either to exchange incubation duties or to provision the young chick, can be counted using high-frequency radar (Burger 1997, 2001, Cooper et al. 2001). The radar system mounts on a boat or truck and is positioned near the mouth of an inlet or valley. Numbers of murrelets can be detected flying to and from the water and their nest site in the dark. This is believed a reliable index of population size (Burger et al. 2001).

Birds also fly during daylight hours as they move among productive foraging sites, or between foraging sites and their nests (VanVliet 1993, Whitworth et al. 2000). These birds fly low to the water, and can also be detected and counted using radar (ADF&G unpublished). During daylight hours, they can also be counted with a spotting scope trained across the water's surface. These flyway surveys require minimal training and equipment, and can be replicated widely in time and space by citizen volunteers. On some flyways, hundreds of Marbled Murrelets can be counted per survey for little cost (ADF&G unpublished data).

Flyway counts are most effective when terrain funnels large numbers of birds through waterways that are less than 3 km across. When waterways are very narrow (< 0.5 km), the field of view is small (vertically and horizontally). Birds flying above or below the field of view are missed, and birds flying through it pass quickly, which can make identification difficult. For waterways > 2 km, an unknown proportion of birds flying in the distant band are not detected. This percentage varies with viewing conditions (shimmer, rain, light, scope quality). Like radar surveys, flyway surveys provide an index of abundance (not a population estimate). The more abundant the population, the more birds will be detected during a standardized survey period.

This report analyzes data collected during the first year of a study using citizen volunteers to collect flyway count data. We examine variation in the counts within a day, within a season, and from site to site within the region. The study objectives are to determine the best times to conduct surveys (minimum variation), the number of survey replicates required, and the number of survey sites required to achieve acceptable power to detect population changes in the region.

Methods

Flyway Counts

Flyway counts were conducted from 7 locations in 5 communities in Southeast Alaska (Table 1). Potential volunteers were recruited from public talks given on Marbled Murrelets in each community. Interested persons attended a subsequent weekend training session where they were familiarized with the survey protocols, the survey equipment, and gained experience identifying flying birds.

Survey stations were typically set up on the beach, or adjoining roadway, with a variable zoom spotting scope trained across the water-body to the opposing shore. Distance to the opposing shore varied from site to site (Table 1, Appendix A). The eyepiece power was primarily set between 20 and 25 power, although observers were allowed to use other power settings if they felt it increased their ability to detect and identify birds. The scope was adjusted so the opposite shore line was in focus, and leveled so that the shoreline bisected the field of view.

Flyway Counts were generally conducted once per week, on weekends, usually in the morning. A survey consisted of 4 or more 15 minute “sample periods”. Pairs of observers alternated counting and recording duties on each 15 minute period. For each survey, we recorded date, time, weather, sea conditions, and tide information (Appendix 1).

Marbled Murrelets were counted flying either “in” or “out” based on flight direction through the field of view. These birds were tallied on a hand-held, double tally-counter. Other species counted included Loon spp., Common Murres, Pigeon Guillemots, Harlequin ducks, Scoter spp., “other” (e.g, Rhinocerous Auklets, or comorants), and “unidentified”. Counts of non-murrelet species were tallied by verbal communication between the observer and the recorder.

Focal Area Scans

Once per survey, the crews conducted a focal area scan, including number of birds seen, by species, sitting within their field of view on the water. These counts were done by unaided eye, except that binoculars and a spotting scope could be used to help identify individual birds to species, and to determine if birds were holding fish. In conjunction with each scan, the observers described weather, sea conditions, visibility, field of view or arc (degrees) and estimated maximum distance seaward that was surveyed. Counts were later converted to birds per km^2.

Results

From 28 May-30 July, crews conducted 365 flyway surveys, on 52 survey days, over 5 survey sites in southeast Alaska (Figure 1). Maps showing the scope locations and sight lines for each of the survey sites are included in Appendix A. In Juneau and Wrangell, different sightlines were surveyed by different crews. However, they were close enough in proximity to effectively sample the same population of birds. Thus, these sightlines were combined for reporting purposes.

Survey effort varied by site, with the largest number of surveys completed in Ketchikan (n = 131) and the fewest in Funter Bay (n = 32) (Figure 2). The number of surveys per day averaged 7.2 (SD = 4.6, range = 1-23).

On average, teams counted 9.7 Marbled Murrelets per 15 minute survey (SD=16.8, max = 108) (Table 1). Counts were highly variable among the 5 sites, with the higher numbers of birds in Sitka, Juneau and Ketchikan, and significantly lower numbers of birds in Wrangell and Funter Bay (Figure 3).

Most surveys were conducted in the mornings, with 69% of surveys occurring between 0530 and 0830 hours; however, some surveys were conducted as early as 0435 and as late as 2155 (Figure 4). There was a clear trend of higher counts on surveys conducted earlier in the day (Figure 5), and to a lesser degree, late in the day (Figure 6). These results are consistent with intensive flyway surveys conducted at Port Snettisham in 2005 and 2006 (ADF&G unpublished data), and reflect higher activity in early morning and late evening hours as birds apparently are flying to and from preferred foraging areas and nests (or resting sites).

In addition to variation within the day, there was also significant variation in counts throughout the summer. The number of birds increased over time, with significantly more birds counted after July 3rd, than before June 24th. The peak occurred in late July, consistent with patterns observed during intensive flyway surveys in Port Snettisham during 2005 and 2006 (ADF&G unpublished data). This overall pattern was largely determined by the survey results for Ketchikan and Sitka (Figure 8). The other communities showed weak or inconsistent patterns.

Other seabirds counted on the flyway surveys occurred in relatively small numbers compared to Marbled Murrelets (Appendix B). Of these, the most abundant species were scoters (in Juneau) and “Other species” (primarily Rhinocerous Auklets) in Sitka (Figure 9).

The results reveal a high level of noise in the data—that is, variation unrelated to the variable of interest- population size. The extraneous factors that influence the number of Marbled Murrelets counted include period of the day, period of the summer, and survey location. To control for those factors, we examined a subset of the data, looking for relatively high sample size, high means, and low variance. After examining multiple subsets of the data, the lowest coefficient of variation (CV) obtained was for surveys conducted in the early morning (between 0530 and 0730 hours) during the month of July (Table 2). The CV for this subset of data was 1.30, compared with a CV of 1.72 for the unfiltered dataset.

To compute power to detect change, we used the program Monitor (Gibbs and Arrelan 2007), and the parameters for the subset of data shown in Table 2. The run assumed an average of 21 surveys per site, on 5 sites. Surveys would be conducted during the month of July in the morning hours, between 0530 and 0830. The expected coefficients of variation (standard deviation / mean) would mimic those observed during the 2007 pilot study. For this prospective analysis, we weighted the CV from each survey site by its 2007 sample size. We assumed the sites would be monitored for 10 years, with no pre-supposition about the direction of population change. We assumed any observed change would be linear; and we accepted an alpha level of ≤ 0.10 (i.e., a < 10% chance of wrongly reporting an increase or decrease).

The results of the simulation indicate that this monitoring program over 10 years time could detect a 3% annual population increase with 66% likelihood. It would detect a 4% annual increase with 85% likelihood, and a 5% increase with 94% likelihood. The monitoring program is not as sensitive to population decreases. It could detect a 3% annual decrease with 45% likelihood, a 4% annual decrease with 56% likelihood, and a 5% annual decrease with 71% likelihood.

Discussion

The results show relatively high degree of variance, or noise, in the flyway count data, although not unlike that found in at-sea surveys conducted across similar daily and seasonal time intervals (ADF&G unpublished). Factors such as time of day, and date within the breeding season have a significant effect on the number of birds counted, quite apart from the size of the Marbled Murrelet population. Moreover, the covariates themselves are quite variable in their influence from area to area, and throughout the summer, which makes them difficult to model. Variation can be reduced by restricting the temporal window for surveys. We suggest morning hours, before 0830, during July, provide the optimal time for surveys. We recorded larger numbers of birds, and slightly lower variances, during these times.

The surveys can also be improved by selecting survey sites where relatively large numbers of Marbled Murrelets can be counted (increasing the mean), and/or by narrowing the sample frame temporally to reduce sample variance. It is also possible to increase the power of the surveys by increasing the number of survey sites, increasing the number of replicate surveys (within a site and year), and increasing the number of years surveyed.

Our goal is to have a > 90% likelihood of detecting a 3% annual decline in Marbled Murrelets over a 10 year period. We could reach that goal by doubling the number of sites surveyed to 10, by increasing the number of surveys on the existing 5 sites to 120, or by extending the monitoring period to 15 years. Rather than adopt any one of those changes in total, we recommend a combination of smaller changes and enhancements. Principle among these is a narrowing of the sampling time frame (both within the day and within the summer), increasing sample intensity (number of surveys per 10 days), and adding 2 or more high-activity sites to the sample frame. These changes should more than meet our monitoring objectives.

These power analyses assume there is no error in the counts themselves. That is, no birds are missed or misidentified during the counts. This is not likely true, which would mean the true power is probably lower than that reported here. There is also an issue of possible pseudo-replication in the current design. Because 15 minute surveys were conducted back to back at each site, they are likely auto-correlated. Future surveys can still be 15 minutes long to ensure alertness, but the results of 4 15-minute consecutive surveys might be summed, and reported as a tally for an 1 hour-long survey block. This will reduce the sample size by 75%, but should also stabilize the variance relative to the mean. The effect on the CV, and power, should not be dramatic.

Recommendations

We recommend continuing this exploratory project for one more year with the following recommended changes based on the results of work in 2007:

1) During the month of June, multiple sites should be scouted for marbled murrelet flyway activity. Only sites with > 3 MAMU detections per 15 minute survey should be considered as formal survey sites.
2) Add 2 or more survey sites from the following list of known or suspected high-activity areas:
    a. Port Snettisham (mainland)
    b. Strait Island (Sumner Strait)
    c. Sisters Island (Icy Strait)
    d. Point Adolphus (Icy Strait)
    e. Young Island, (Glacier Bay)
3) Conduct daily surveys during a 10-day time window, from 5-15 July.
4) Conduct surveys between 0530 and 0830 hours, and between 1930 and 2230 hours. Survey at least once in the morning, and once in the evening, each day.
5) Conduct all surveys in 4 consecutive 15 minute periods (alternating observers every 15 minutes) for a 1 hour "time block". If doing 2 or more time blocks in a morning/evening, separate the blocks by at least ½ hour.
6) When counting, record number of fish-holding birds flying in each direction separately from non-fish-holding birds. Fish-holding birds are likely breeders.
7) Maximize accuracy and precision by adhering to precise sight lines, using similar optics, and training/testing crews throughout the season.

Acknowledgements

We would like to thank the dedicated volunteers who generously contributed their time, talent, and energy to this study. They are: **Ketchikan:** Rosemarie Bengeron, Peter Dwyer, Cheryl Fultz, Debbie Gravel, Amanda Kiely, Drew Lindmer, Andy Piston, Jim Pomplun, Leslie Swada, **Sitka:** Kent Bovee, Erik Bahnsen, Kristina Calvin, Darlene Dehlin, Matt Goff, Kameron Perensovich, Joanne Kleis, John Kleis, Kitty Labounty, Natalie Sattler, Justin Schalon, **Juneau:,** Marge Hermans, Aleria Jensen, Laurie Lamm, Wayne Longacre, Beth Peluso, Pauline Strong, **Wrangell:** Bonnie Demerjian, David Rak, Paula Rak, and Carol Ross. We also thank Gus VanVliet for discussions and ideas that sparked this study, and for his assistance in identifying flyway monitoring areas.

Literature Cited

Burger A. E. 1997. Behavior and numbers of Marbled Murrelets measured with radar. *Journal of Field Ornithology*. 68:208-223.

Burger A. E. 2001. Using radar to estimate populations and assess habitat associations of Marbled Murrelets. *Journal of Wildlife Management* 65:696-715.

Cooper, B.A., M.G. Raphael, D. Evans-Mack. 2001. Radar-based monitoring of Marbled Murrelets. *Condor* 103:219-229.

van Vliet G. 1993. Flyways and the Marbled Murrelet: observations and long-distance foraging flights by thousands of *Brachyramphus Mamoratun* during the chick-rearing period in the Icy Strait-Glacier Bay National Park region of northern Southeast Alaska. *Unpubl. Report*. On file. Alaska Department of Fish and Game, Douglas, AK. 9pp.

Whitworth, D. L., S. K. Nelson, S. H. Newman, G. B. van Vliet, and W. P. Smith. 2000. Foraging distances of radio-marked Marbled Murrelets from inland areas in Southeast Alaska. *The Condor* 102:452-456.

Table 1. Mean number of Marbled Murrelets counted per 15 minute survey period in each of the 5 survey areas, May 28-July 30, 2007. Overall CV = 1.72

Survey Area	Mean	Std. Deviation	N
Ketchikan	10.50	15.06	131
Wrangell	1.30	2.51	60
Sitka	14.56	24.50	88
Juneau	14.09	14.45	54
Funter Bay	2.09	3.49	32
Total	**9.76**	**16.81**	**365**

Table 2. Mean number of Marbled Murrelets counted per 15 minute survey period in each of the 5 survey areas during July, on surveys between 0530 and 0830 hours. Overall CV = 1.30

Survey Area	Mean	Std. Deviation	N
Ketchikan	11.21	11.62	39
Wrangell	1.33	2.15	12
Sitka	15.68	19.40	28
Juneau	15.0	19.28	23
Funter Bay	10.0	6.08	3
Total	**12.07**	**15.70**	**105**

Figures

Figure 1. Location of 5 sites in Southeast Alaska where Marbled Murrelets were surveyed with flyway counts in 2007.

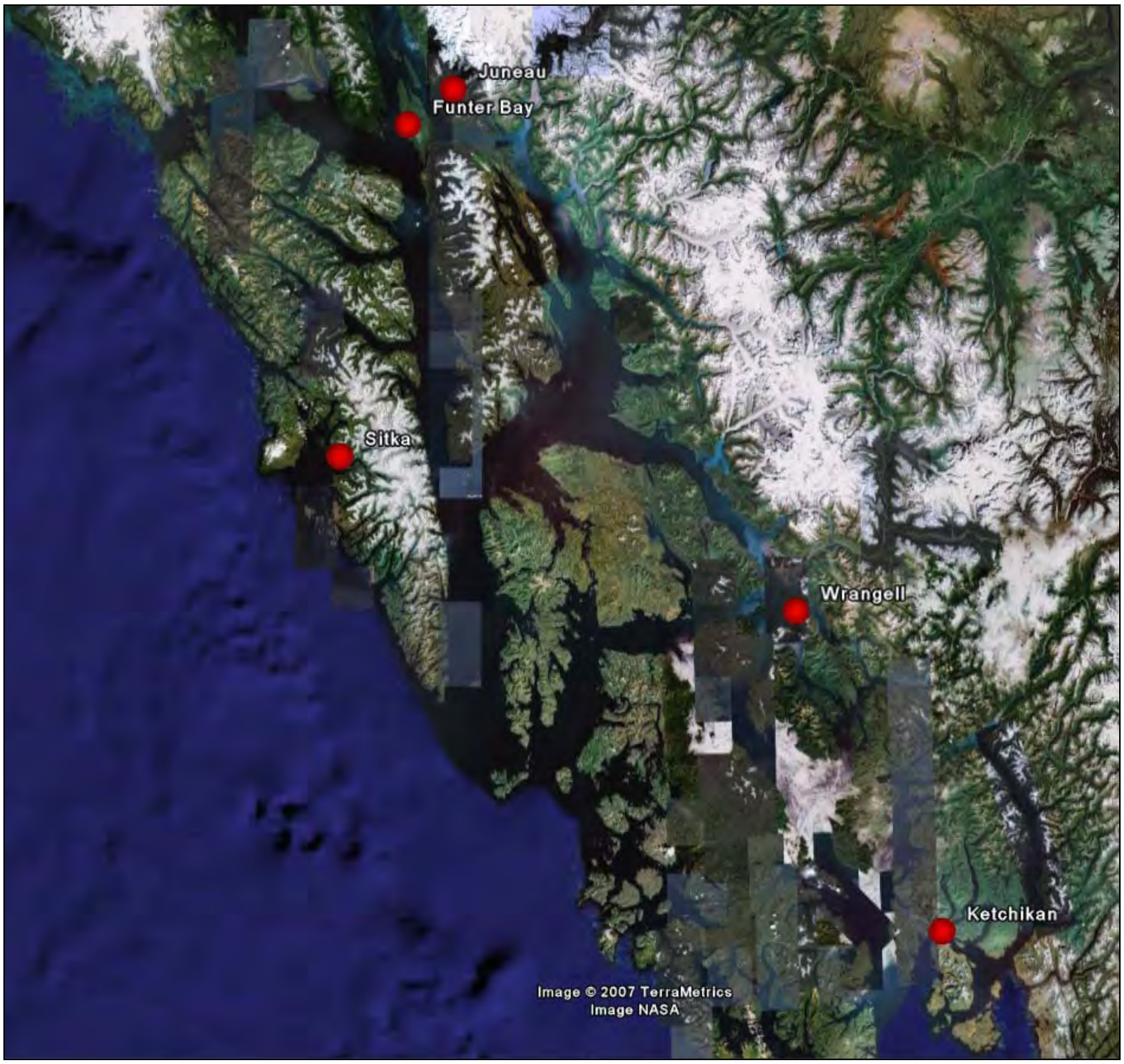

Figure 2. Relative survey effort by area (N surveys = 365)

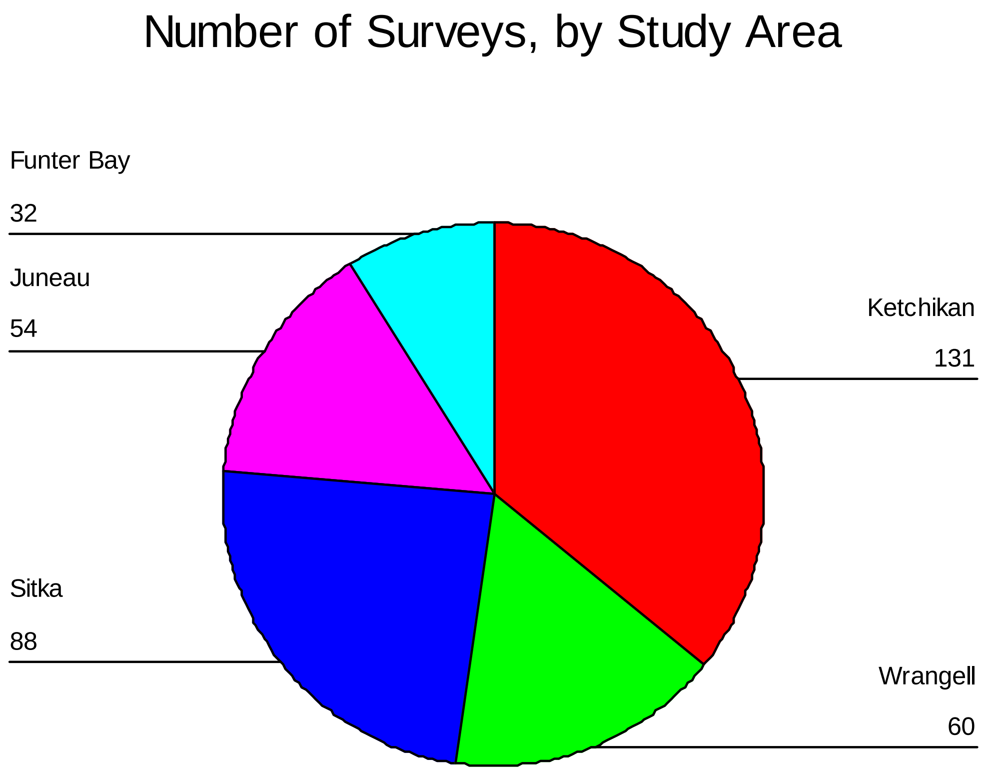

Figure 3. Mean Count of Marbled Murrelets per survey, by survey area. Counts reflect averages for the entire summer, over all times of day.

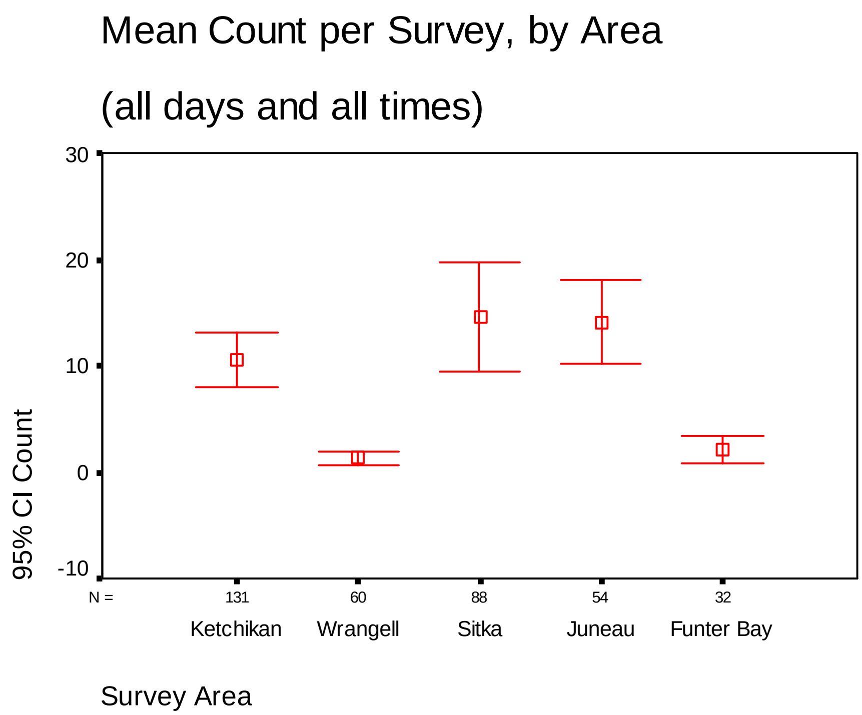

Figure 4. Sampling effort (percent of surveys) by hour of the day.

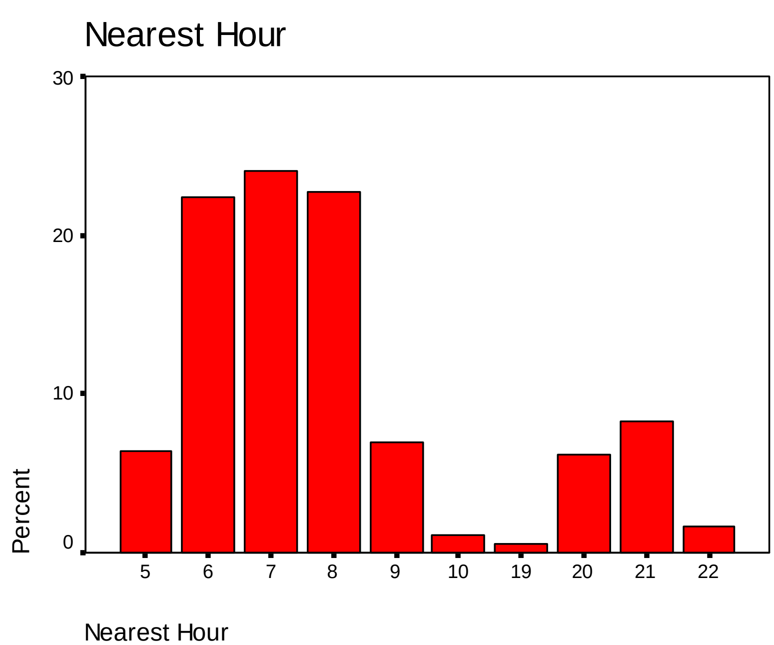

Figure 5. Mean number of Marbled Murrelets per 15 minute survey during the early morning hours.

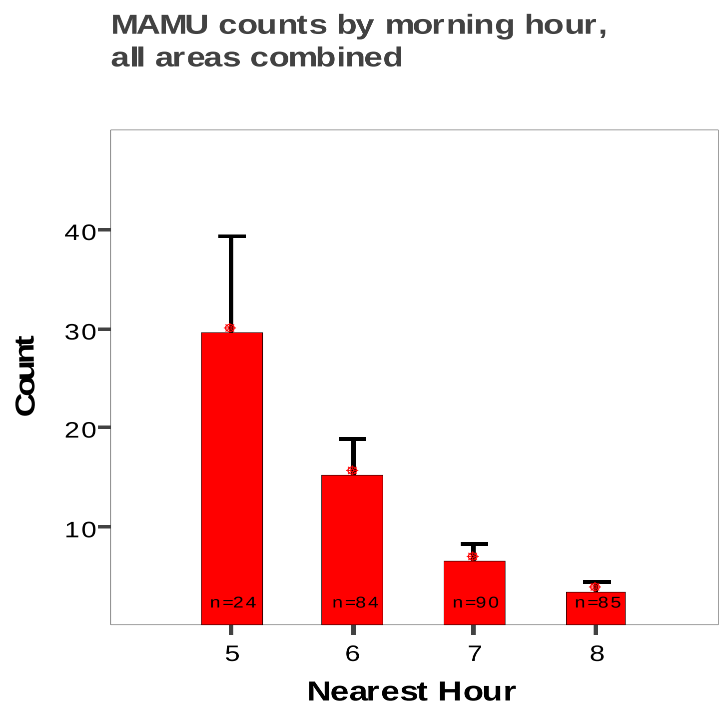

Figure 6. Mean number of Marbled Murrelets per 15 minute survey during the late evening hours.

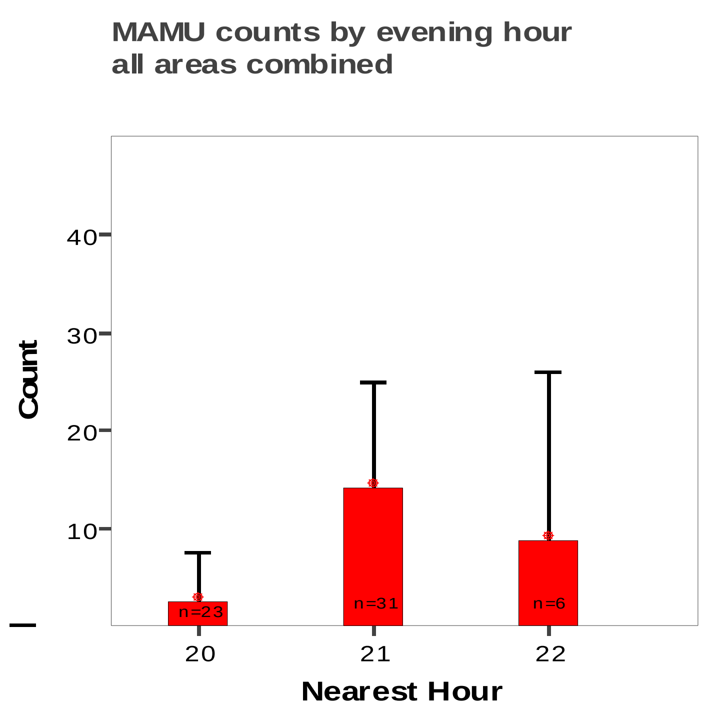

Figure 7. Number of Marbled Murrelets Counted per survey, between May 28 and July 30, 2007 (9-day intervals).

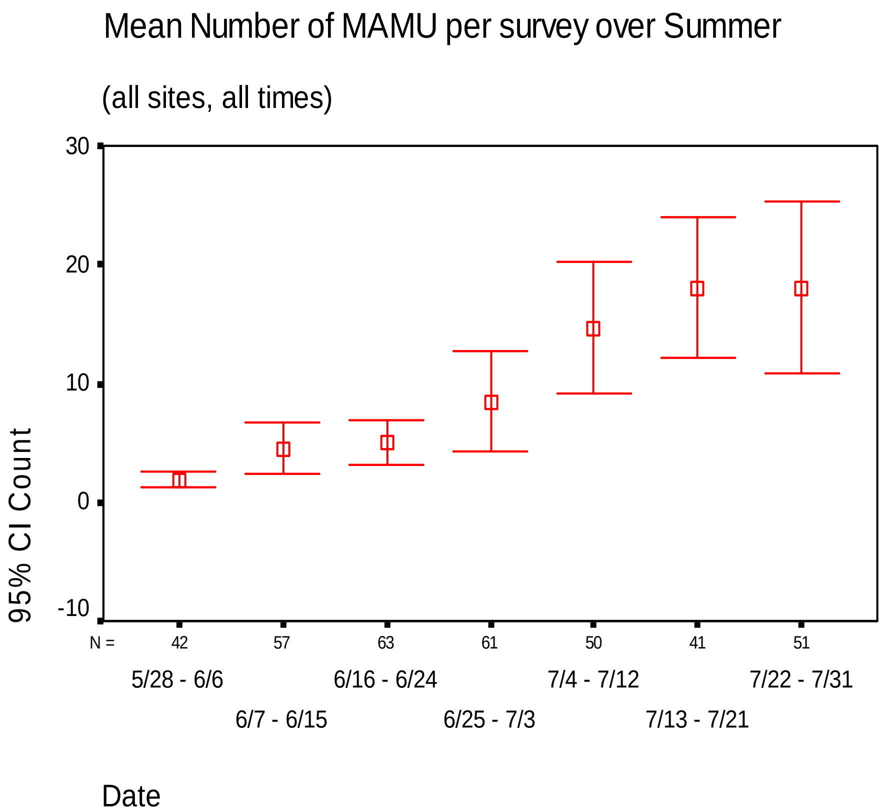

Figure 8. Number of Marbled Murrelets Counted per survey, between May 28 and July 30, 2007 (9-day intervals) at each study site

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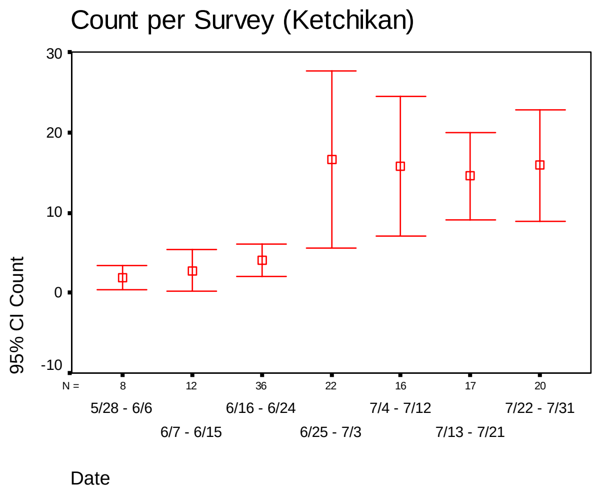
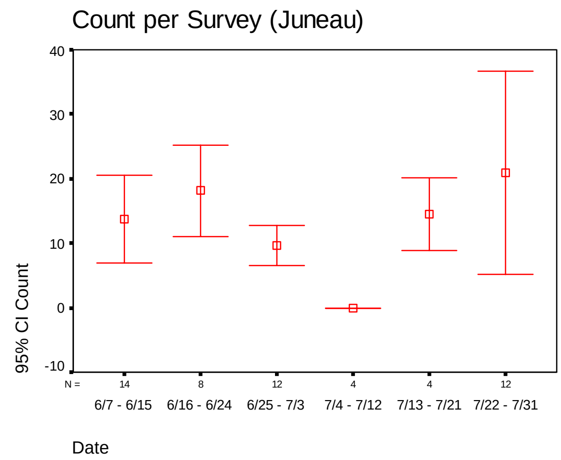
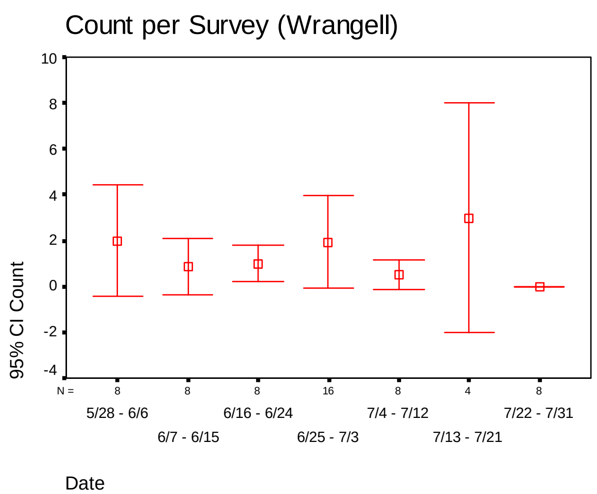
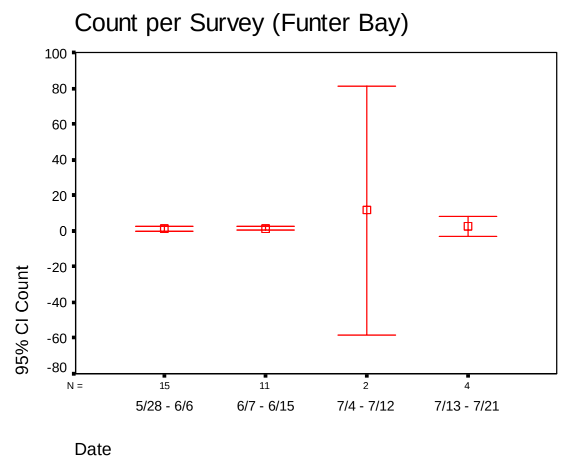








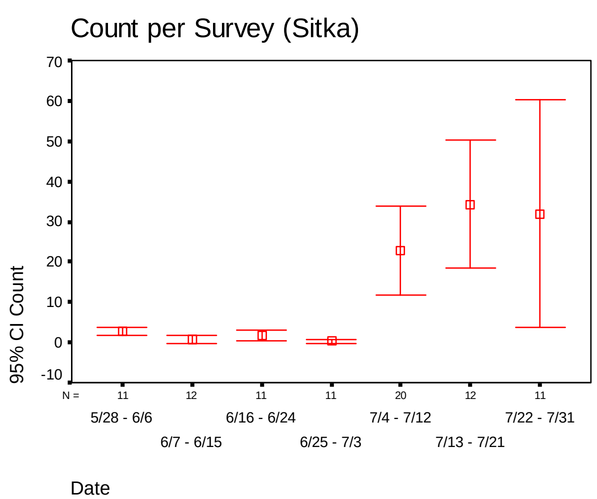
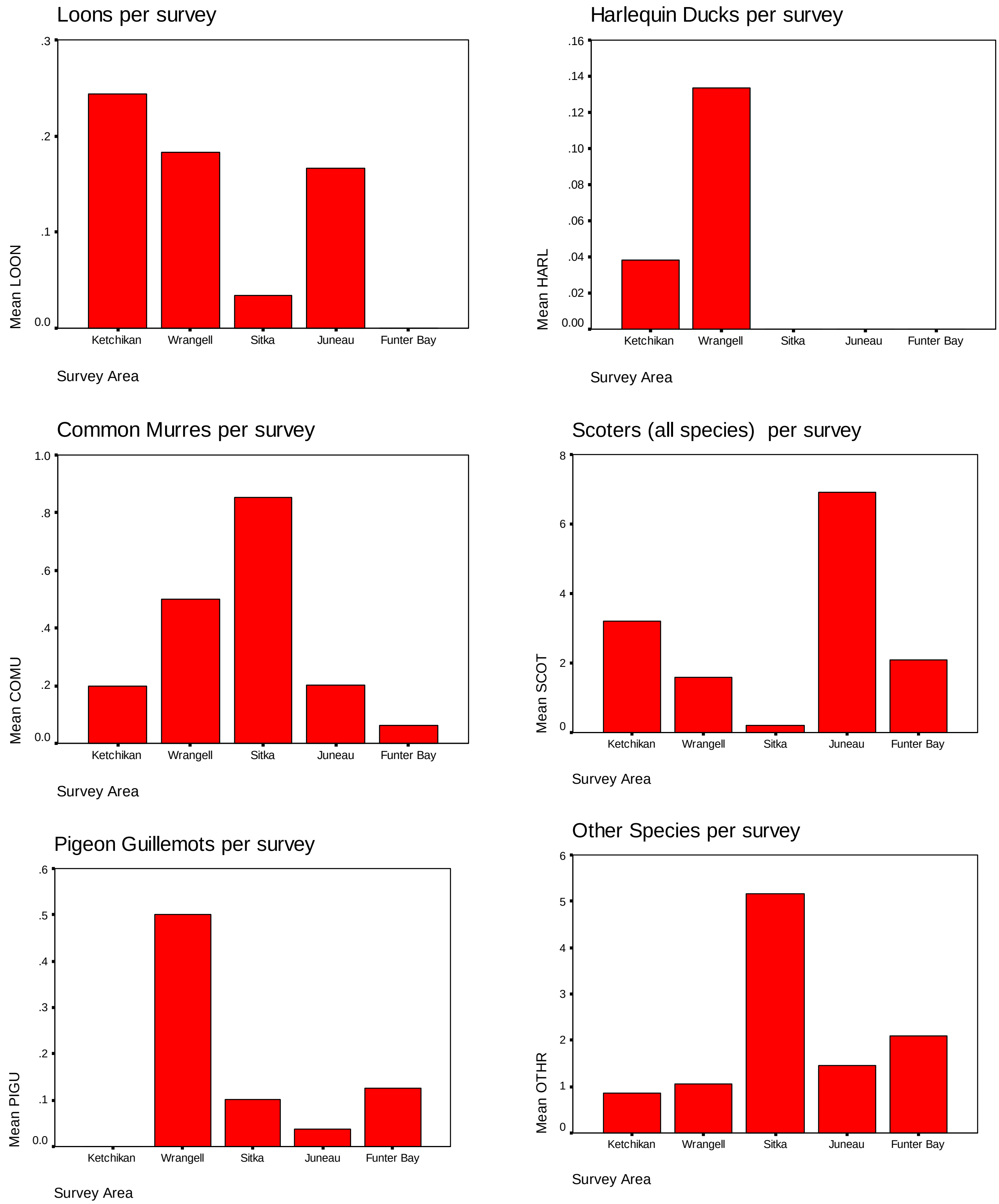


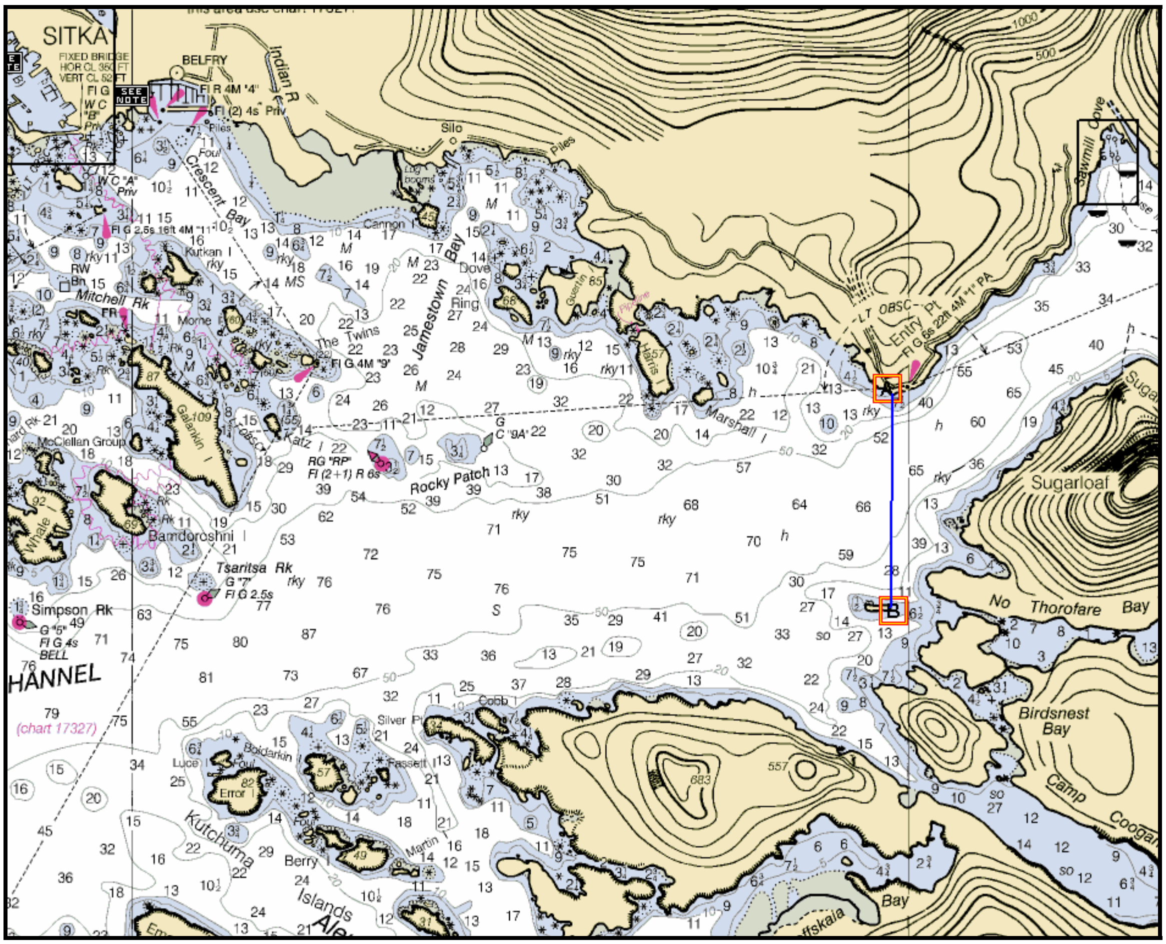
Figure 9.Numbers of other species counted per survey, by community



Appendix A

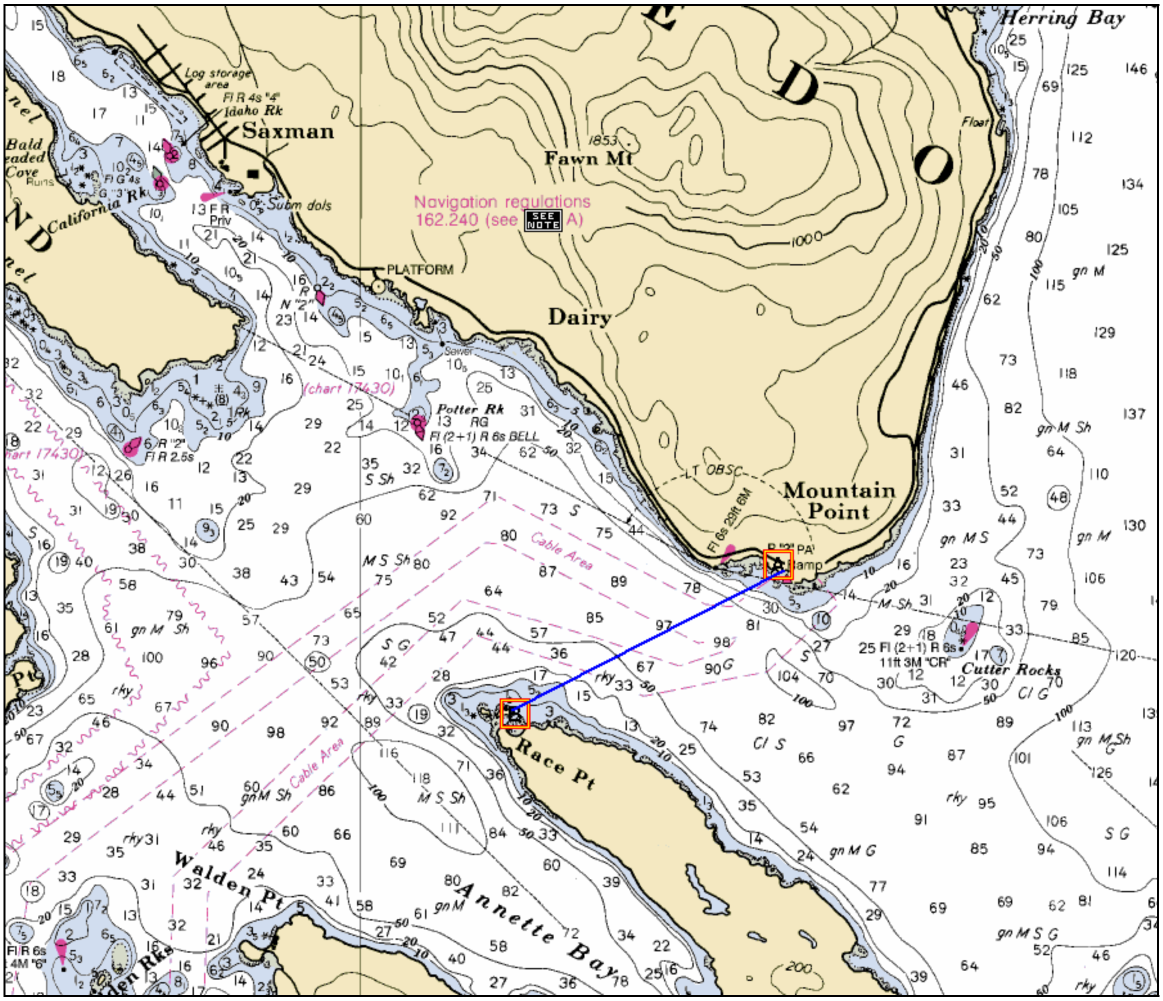
<u>Sitka -- Entrance Point</u>

Point A (scope)	57° 01.934’ N	135° 15.146’ W
Point B (terminus)	57° 01.217’ N	135° 15.153’ W
Distance 1.39 km		



Ketchikan – Mountain Point

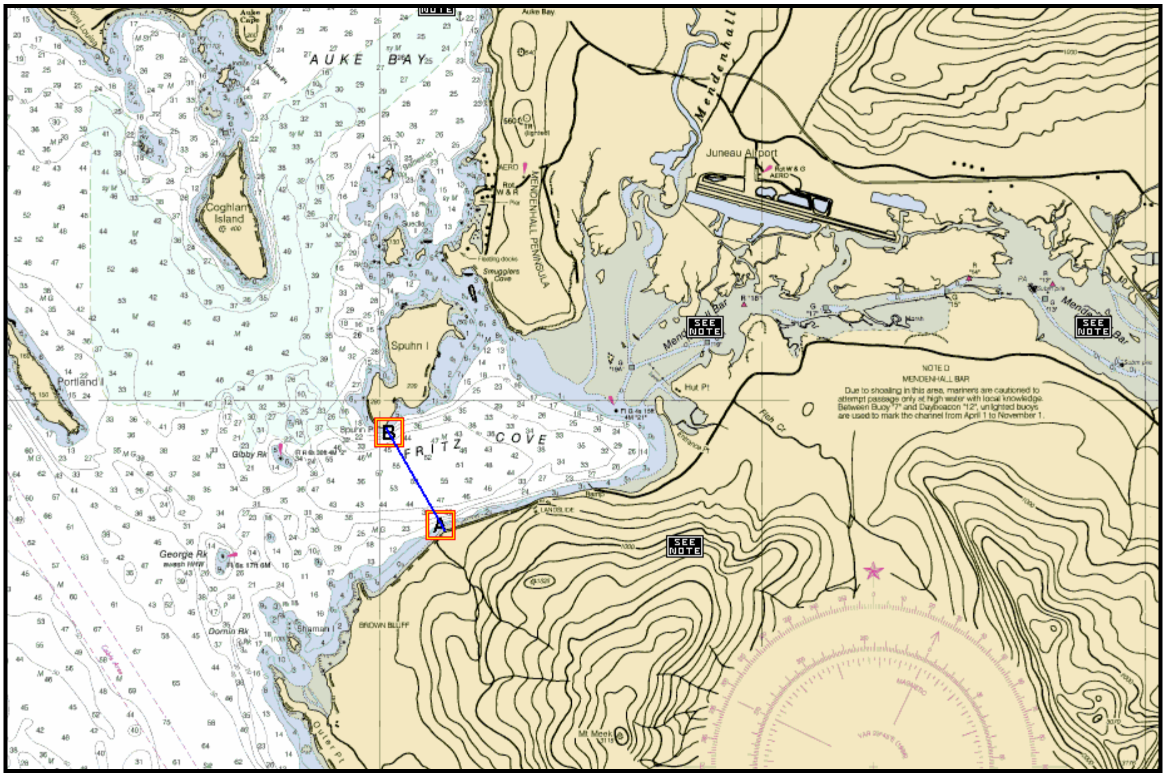
Point A (Scope) 55° 17.614' N 131° 32.510' W
Point B (Terminus) 55° 17.144' N 131° 34.113' W
Distance 1.90 km



<u>Juneau – North Douglas</u>

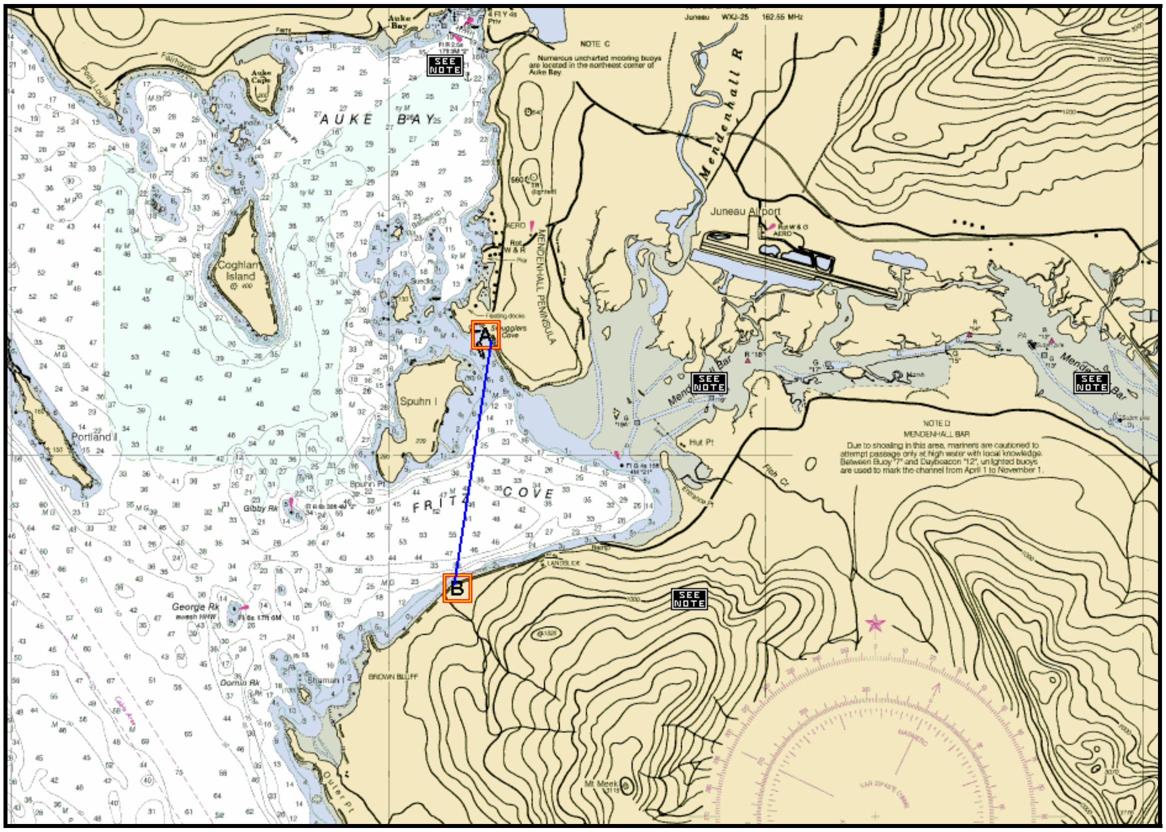
Point A (scope)	58° 19.105' N	134° 39.143' W
Point B (target)	58° 19.811' N	134° 39.920' W

Distance 1.51 km



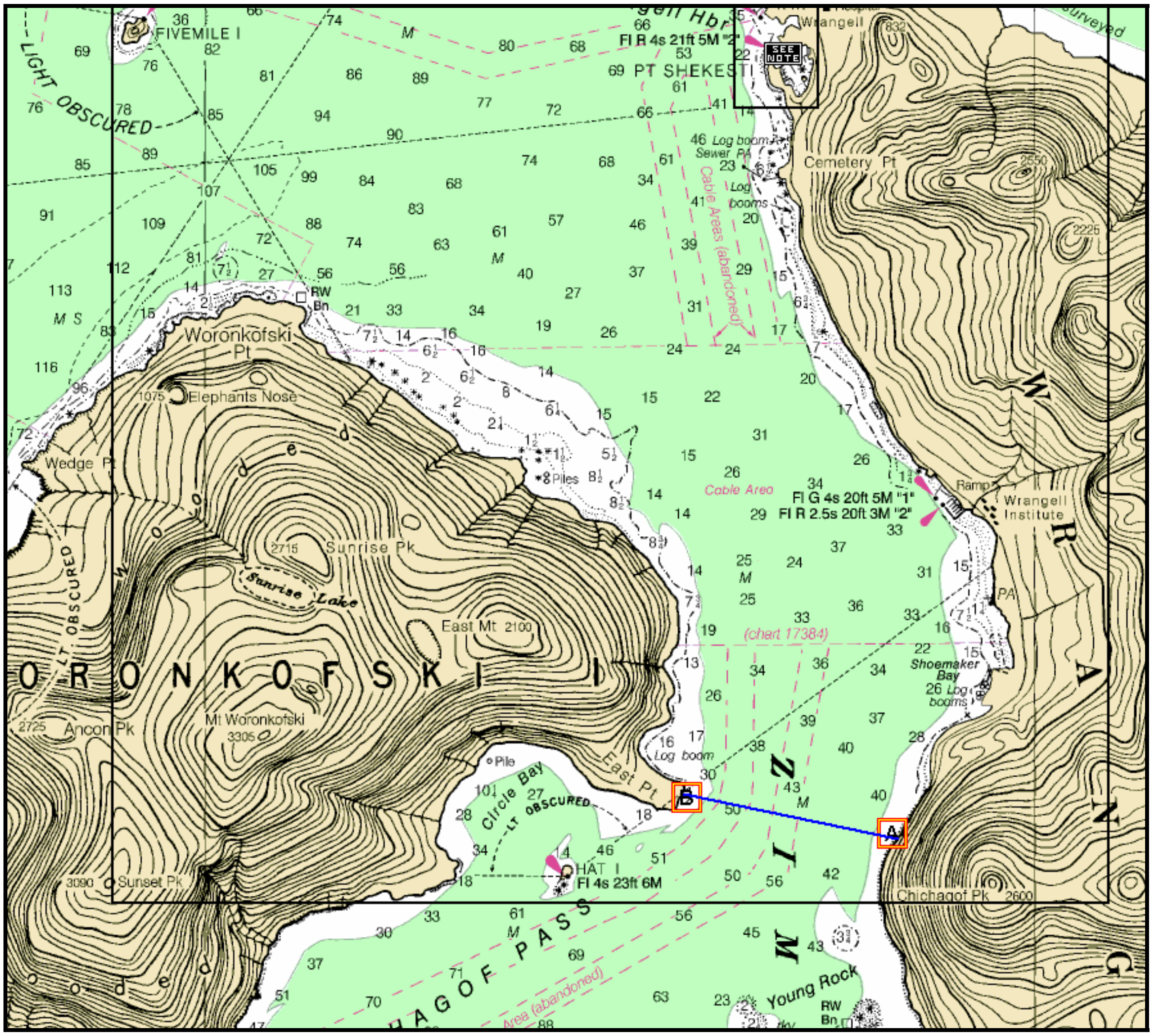
Juneau – Smugglers Cove

Point A (scope) 58 20.805’ N 134 38.635’ W
Point B (target) 58 19.101’ N 134 39.134’ W
Distance 3.19 km



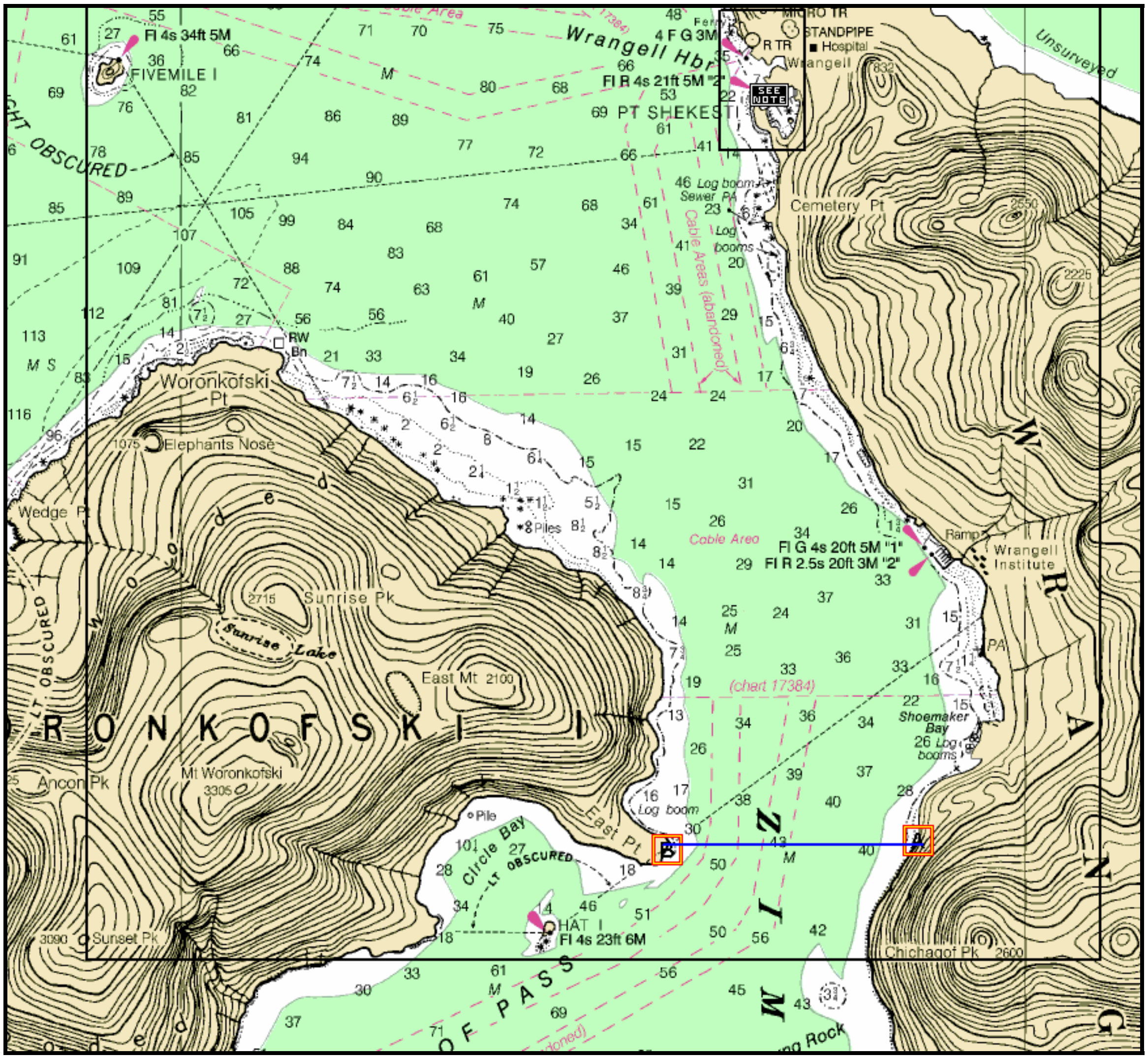
Wrangell – East Point

Point A (scope) 56° 22.765’ N 132° 21.646’ W
Point B (target) 56° 23.065’ N 132° 24.232’ W
Length – 2.71 km



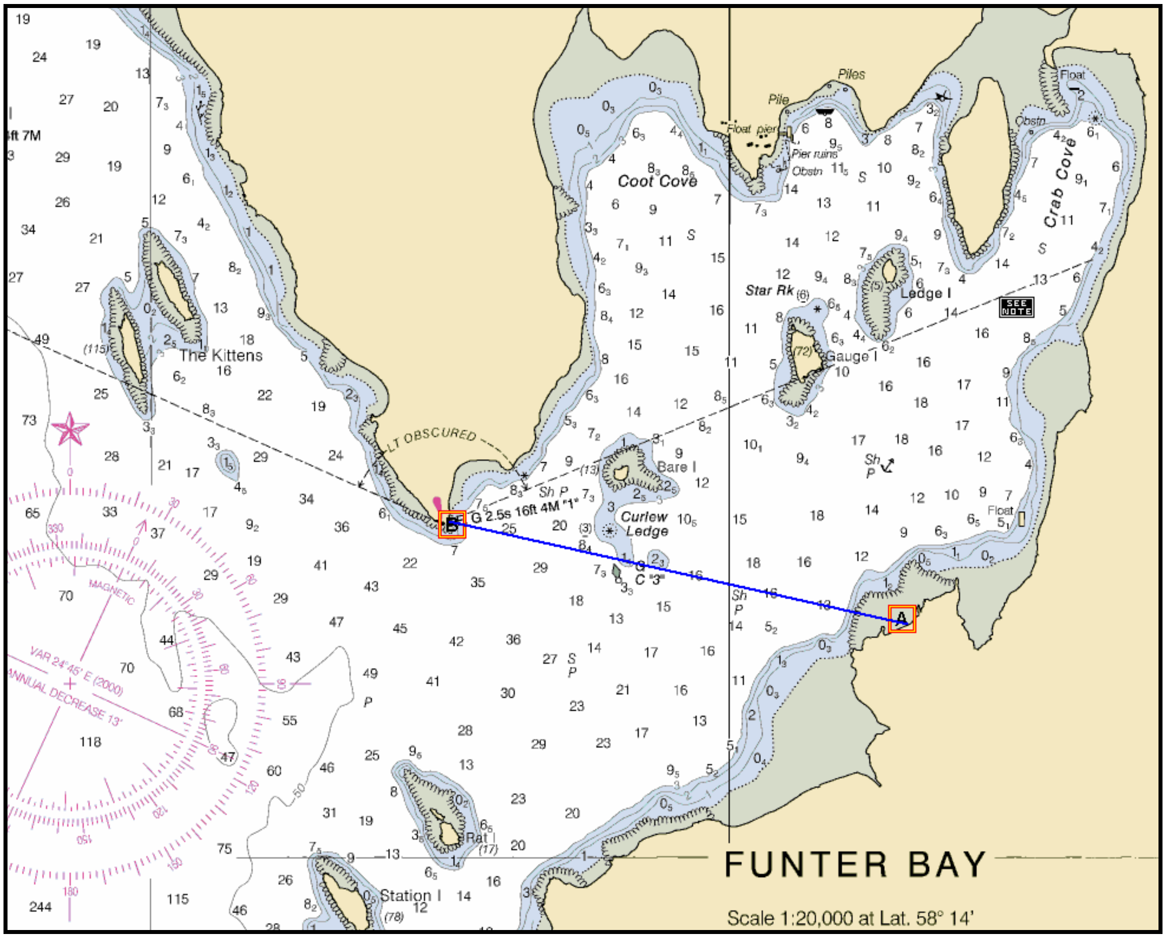
Wrangell – 7.5 Mile Zimovia Highway

Point A (scope)	56° 23.107' N	132° 21.203' W
Point B (target)	56° 23.065' N	132° 24.232' W
Length 3.16 km



Funter Bay – Clear Point

Point A (scope) 58° 14.424’ N 134° 53.382’ W
Point B (target) 58° 14.611’ N 134° 54.968’ W
Length 1.58 km



Appendix B

Counts of other species recorded during Flyway Surveys

Survey Area		LOON	COMU	PIGU	HARL	SCOT	OTHR	UNID
Ketchikan	Mean	.24	.20	.00	.04	3.21	.86	.71
	N	131	131	131	131	131	131	131
	Maximum	7	6	0	4	40	32	18
	Std. Error of Mean	.080	.070	.000	.031	.593	.281	.219
Wrangell	Mean	.18	.50	.50	.13	1.60	1.07	3.55
	N	60	60	60	60	60	60	60
	Maximum	3	16	4	6	38	39	75
	Std. Error of Mean	.077	.315	.131	.105	.707	.660	1.671
Sitka	Mean	.03	.85	.10	.00	.19	5.16	2.08
	N	88	88	88	88	88	88	88
	Maximum	2	9	2	0	7	119	40
	Std. Error of Mean	.025	.190	.043	.000	.099	1.741	.891
Juneau	Mean	.17	.20	.04	.00	6.91	1.46	.52
	N	54	54	54	54	54	54	54
	Maximum	4	7	2	0	43	18	8
	Std. Error of Mean	.091	.148	.037	.000	1.164	.584	.204
Funter Bay	Mean	.00	.06	.13	.00	2.09	2.09	1.03
	N	32	32	32	32	32	32	32
	Maximum	0	1	1	0	24	10	18
	Std. Error of Mean	.000	.043	.059	.000	.801	.524	.583
Total	Mean	.15	.39	.12	.04	2.67	2.13	1.51
	N	365	365	365	365	365	365	365
	Maximum	7	16	4	6	43	119	75
	Std. Error of Mean	.035	.078	.027	.021	.324	.463	.365

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: T-3 **Segment Number:** 1

Project Number: 10.11

Project Title: Murrelet Watch – A Citizen-based Monitoring Program in SE Alaska

Project Duration: January 1, 2007 – June 30, 2009

Report Period: 1 January 2009 – 30 June 2009

Report Due Date: September 30, 2009

Partner: Alaska Department of Fish and Game

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The marbled murrelet (*Brachyramphus marmoratus*) is currently listed as a threatened species in California, Oregon, Washington, and British Columbia. An estimated 687,061 (±201,162) *Brachyramphus* murrelets reside in SE Alaska in the summer (Agler et al. 1998), making it the geographic and demographic epicenter of the bird's range. The only published marbled murrelet dataset from SE Alaska that spans > 3 years is from Glacier Bay National Park where, between 1991 and 1999/2000, marbled murrelets declined by 75% – a rate of decline of 17.5% per year ($P < 0.05$) (Piatt and Kuletz 2005). We do not know if the broader population in Southeast Alaska has followed this Glacier Bay trend.

The high cost of large scale, randomized at-sea surveys makes it unlikely such surveys will be conducted on a routine basis in SE Alaska. If marbled murrelets are going to be monitored with any statistical power, trend data will need to be collected consistently over decades-long time periods. This requirement may be met by a local community-based approach, where citizen-volunteers are trained to collect survey data in a systematic way, from the same location, year after year. To that end, we propose using flyway counts (birds in flight over water), and audio-visual detection counts (birds in flight over land) as indices of Marble Murrelet abundance.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

The marbled murrelet is one of 13 sea bird species featured in Alaska's Comprehensive Wildlife Conservation Strategy (CWCS) (CWCS Appendix 4, page 180). It was selected because it is a species designated at risk, its population may be declining in the state, and it is sensitive to environmental disturbance. The CWCS conservation objective for marbled murrelets is to restore populations to their historical abundance, estimated to be 750,000 birds. One important action identified by the CWCS to achieve that objective is to determine abundance and monitor trends in the Alaska population in key locations including Southeast Alaska (CWCS Appendix 4, pages 213-215).

Alaska has primarily used fixed-width strip transects for vessel-based surveys. This is partially due to historical precedence. It is also partially due to the fact that in Alaska, large-scale surveys often census all bird species encountered, as well as marine mammals. When populations are dense, as they sometimes are in Alaska, there is insufficient time to collect necessary distance measures (K. Kuletz, personal communication). Hamer (1997) found that multi-species surveys lead to a negative bias for Marbled Murrelets and other small birds.

Audio-visual detection surveys are a common monitoring method for murrelets in the Pacific Northwest, and standardized survey protocols are in place (Pacific Seabird Group recommendations). While it is not difficult to detect Marbled Murrelets by this method, the surveys are typically conducted just before dawn (e.g., 2:30 AM on June 21), which may dampen volunteer enthusiasm somewhat. The second survey method, flyway counts, consist of 10-20 minute counts of marbled murrelets in flight over water (Kirchhoff, in prep). The counts, made with a spotting scope, are conducted during daylight hours, ideally between 5 and 10 AM. Flyway counts are most effective when terrain funnels large numbers of birds through waterways that are less than 3 km across. For waterways > 3 km, an unknown proportion of birds flying in the distant band likely go undetected. As with radar surveys, flyway surveys provide an index of abundance (not a population estimate). Depending on how stable and uniform these surveys are over time (within day and within season), they can be a useful tool for monitoring population trends in Marbled Murrelets.

In Southeast Alaska, we know from radio-tagged birds that Marbled Murrelets can make long flights 1 or more times per day between nesting and foraging sites (x = 78 km, + 27 km) (Whitworth et al. 2000). Other observers in Southeast Alaska, conducting visual counts from stationary points in the post-dawn hours, have detected hundreds to > 1,000 murrelets per hour flying to and from foraging and nesting areas (Van Vliet 1993, McAllister, unpublished data). Such mass movements along predictable flyways provide an ideal opportunity for population monitoring.

The surveys in this study were conducted by volunteers under the supervision of ADF&G staff. Some survey sites were accessed from community road systems, with volunteers conducting the surveys before or after work. In other cases, the surveys were conducted at remote sites, where volunteers established a field camp. At these latter sites, surveys were conducted throughout the day. The purpose of this study is to (1) identify patterns of flyways activity in time and space, across a number of survey locations in Southeast Alaska (2) determine within- and between-day variability in flyway counts at these locations, (3) identify optimal times and locations for conducting these surveys, (4) model the statistical power of different surveys to detect Marbled Murrelet population trends over a ten-year time frame, and (5) make recommendations for citizen-based monitoring in the future.

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Monitor long-term trends in Marbled Murrelet populations in Southeast Alaska, while building awareness and support for the conservation of nongame wildlife in the region.

A citizen-based program for monitoring population trends of Marbled-Murrelets (*Brachyramphus marmoratus*) using land-based flyway surveys was initiated during summer, 2007. Volunteers in 5 communities completed 365 surveys, from 7 locations, over 52 individual survey days during the summer. Surveys were conducted mostly in the mornings, before 0900 hours. The average number of Marbled Murrelets counted per 15 minute survey was 9.7. Counts were higher in July than in June, and higher in early morning versus late morning and afternoon. Counts were significantly higher in the Juneau, Sitka and Ketchikan areas compared to the Funter Bay and Wrangell areas. To reduce noise in the data, we selected a subset of data for the trend analysis. We included surveys conducted between 0530 and 0830 hours during the month of July only. The coefficient of variation (CV) for this subset was 24% lower (CV = 1.3) than the CV for the entire data set. From these data we modeled the power to detect changes in the Marbled Murrelet population over time. The power was relatively low. Assuming 5 survey sites, 21 surveys per year per site, similar CV's to those measured in 2007, and a 10 year monitoring effort, we were 71% likely to detect a 5% per annum decline in the population.

A total of 32 volunteers participated in flyway surveys during July 2008. Surveys were conducted from seven sites in Juneau, Petersburg, Sitka and Ketchikan, and from 2 remote field camp sites in eastern Icy Strait. Per the recommendations made in the 2007 report, flyway surveys during 2008 were conducted during shorter time intervals (7-17 July for community based surveys, and 20-27 for remote surveys). Volunteers completed 288 community-based flyway surveys from 7 locations in Southeast Alaska, and 347 flyway surveys from 2 field camps located in Icy Strait. To minimize unwanted variance in these data, analyses were restricted to surveys with visibility rated good to excellent.

The field-camp-based surveys in Icy Strait were conducted on the hour and half hour throughout the day. The waters of western Icy Strait, from Point Adolphus to Lemesurier Island, are an important foraging area for Marbled Murrelets, drawing many birds from long distances. Consistent with expectations, times of peak activity occurred in the early AM and late PM hours. We documented thousands of murrelets per hour flying westward in the early morning, and returning eastward in the late evening. Community-based surveys were conducted only during the peak morning and evening time periods. They showed relatively low counts compared to the Icy Strait sites, with peak activity measured in the tens to hundreds of birds per hour, depending on the site. The highest counts were from the Sitka and Ketchikan sites, and the lowest counts were recorded on the Petersburg sites. We modeled the power of these various surveys to detect different-sized changes in the murrelet population over time. The community-based surveys were highly variable, and as a consequence, had limited ability to detect even dramatic population changes. In contrast, the Icy Strait sites had relatively low coefficients of variation (< 0.30), and high statistical power.

IV. MANAGEMENT IMPLICATIONS

The relatively low and variable counts associated with the community based surveys translate into low power to detect population trends. Even with a sustained (10-year) annual monitoring program, the power to detect a 10% per annum decline is less than 20% (one-tailed t-test, P=0.10). In contrast, the peak morning and evening counts at 2 sites in Icy Strait had many birds, low variability, and acceptably high power to detect long-term trends (e.g., 98% power to detect a 4% per annum decline). While monitoring could be justified in Icy Strait using flyway counts, the method produces much lower, and more variable counts elsewhere in Southeast Alaska. For that reason, we do not recommend continuing citizen-science monitoring for Marbled Murrelets using land-based flyway counts in Southeast Alaska.

V. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY (January 1, 2009 – June 30, 2009)

There was no activity during the last segment period.

VI. PUBLICATIONS

None.

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
State Wildlife Grant

Grant Number: **T-3** **Segment Number: 1**

Project Number: **11.11**

Project Title: Population and habitat assessments for species of greatest conservation need in Southeast Alaska

Project Duration: January 1, 2007 – June 30, 2009

Report Period: 1 January 2007 – 31 December 2007

Report Due Date: March 30, 2008

Partner: Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Identify and evaluate various survey and monitoring strategies for selected species in Southeast Alaska and establish protocols.

JOB/ACTIVITY 1A: Review current scientific literature; consult with species experts, species working groups, and other partners; define specific survey and monitoring protocols.

JOB/ACTIVITY B: Design survey and monitoring techniques that provide both accuracy and precision for assessing population status and trends of various vertebrate species in Southeast Alaska.

JOB/ACTIVITY C: As needed, design and implement research to determine most accurate, defensible and cost-effective survey and monitoring techniques.

OBJECTIVE 2: Conduct survey and/or monitoring of selected species in Southeast Alaska to determine population status, abundance, and distribution of the species.

JOB/ACTIVITY A: Recruit, hire, and train a field crew as necessary to carry out fieldwork. Purchase equipment and arrange charters as necessary to support the fieldwork.

JOB/ACTIVITY B: Conduct surveys using identified techniques. Water-borne, aerial, and ground-based approaches may be employed, depending upon taxa studied. Amphibian work generally will follow USGS-ARMI (Amphibian Research and Monitoring Initiative) protocols when possible unless modified based on information from active Partner Project: T-1-6-18, Amphibian Monitoring in Southeast Alaska, Dr. Sanjay Pyare. Standard visual surveys, calling surveys, and pitfall trapping also may be utilized. Techniques for birds could include standard North American Breeding Bird Survey roadside counts, Alaska Landbird Monitoring System protocols, line transect surveys, point counts, calling surveys, and specialized techniques as needed to produce accurate and credible information on abundance and distribution. Mammal survey techniques include a variety of visual, aural, and sign (track, scat, hair) surveys with more specialized techniques as needed.

JOB/ACTIVITY 2C: Conduct genetic analysis where deemed appropriate to determine genetic relatedness and distinctiveness of island endemic species.

OBJECTIVE 3: Identify habitat types and needs associated with the selected species and identify existing or potential problems, needs, or concerns regarding habitats.

JOB/ACTIVITY 3A: Based on results of surveys, identify habitats that are important for population maintenance, especially for those species with indicated declines either on a national level or within the state. Participate in on-going project to identify important nesting and foraging habitats of Kittlitz's murrelets in Icy Bay by capturing on the water and fixing radio transmitters to approximately 30 Kittlitz's murrelets in May and June.

JOB/ACTIVITY 3B: Where practical, provide land managers with recommendations on habitat maintenance, especially if those habitats are negatively impacted through anthropogenic causes.

OBJECTIVE 4: Examine population dynamics and identify factors limiting population growth or reproductive success, such as predators, habitat loss or degradation, and contaminants.

JOB/ACTIVITY 4A: Where possible, gather supplemental ecological data to accompany population parameters on Southeast Alaskan vertebrates. These data may include life history and other demographic information, predation risks and factors, and habitat preference or avoidance parameters.

OBJECTIVE 5: Analyze, disseminate and share information and data with partners, cooperators, the scientific community, and the general public.

JOB/ACTIVITY 5A: Analyze data**,** prepare reports, maps, and associated publications and presentations.

JOB/ACTIVITY 5B: Attend conferences and workshops and/or write articles to present findings.

OBJECTIVE 6: Develop and implement a regional CWCS step-down strategy.

JOB/ACTIVITY 6A: Identify implementation partners.

JOB/ACTIVITY 6B: Identify implementation projects and activities.

JOB/ACTIVITY 6C: Implement projects and activities as part of objectives 1 – 5, or under a separate implementation grant.

Summary of Accomplishments

OBJECTIVE 1:

JOB/ACTIVITY 1A: Review current scientific literature; consult with species experts, species working groups, and other partners; define specific survey and monitoring protocols.

No Progress

JOB/ACTIVITY 1B: Design survey and monitoring techniques that provide both accuracy and precision for assessing population status and trends of various vertebrate species in Southeast Alaska.

No Progress

JOB/ACTIVITY 1C: As needed, design and implement research to determine most accurate, defensible and cost-effective survey and monitoring techniques.

No Progress

OBJECTIVE 2:

JOB/ACTIVITY A: Recruit, hire, and train a field crew as necessary to carry out fieldwork. Purchase equipment and arrange charters as necessary to support the fieldwork.

No progress

JOB/ACTIVITY B: Conduct surveys using identified techniques. Water-borne, aerial, and ground-based approaches may be employed, depending upon taxa studied. Amphibian work generally will follow USGS-ARMI (Amphibian Research and Monitoring Initiative) protocols when possible unless modified based on information from active Partner Project: T-1-6-18, Amphibian Monitoring in Southeast Alaska, Dr. Sanjay Pyare. Standard visual surveys, calling surveys, and pitfall trapping also may be utilized. Techniques for birds could include standard North American Breeding Bird Survey roadside counts, Alaska Landbird Monitoring System protocols, line transect surveys, point counts, calling surveys, and specialized techniques as needed to produce accurate and credible information on abundance and distribution. Mammal survey techniques include a variety of visual, aural, and sign (track, scat, hair) surveys with more specialized techniques as needed.

No Progress

JOB/ACTIVITY 2C: Conduct genetic analysis where deemed appropriate to determine genetic relatedness and distinctiveness of island endemic species.

No Progress

OBJECTIVE 3:

JOB/ACTIVITY 3A: Based on results of surveys, identify habitats that are important for population maintenance, especially for those species with indicated declines either on a national level or within the state. Participate in on-going project to identify important nesting and foraging habitats of Kittlitz’s murrelets in Icy Bay by capturing on the water and fixing radio transmitters to approximately 30 Kittlitz’s murrelets in May and June.

During 15 – 23 May 2007, we captured and attached radio-transmitters to 30 Kittlitz’s murrelets in Icy Bay. On 23 May, we surveyed Icy Bay for raptor nests (bald eagle and peregrine falcon) from a fixed-wing aircraft. This survey was to check old (known) bald eagle nests and find new eagle and falcon nests. We documented 4 active bald eagle nests and 1 active peregrine falcon eyrie. Subsequent to our activity in the field on this project, radio-marked birds led to the discovery of four active nests, of which 2 were visited on the ground and 1 was monitored from egg hatch to chick fledgling with a video camera.

JOB/ACTIVITY 3B: Where practical, provide land managers with recommendations on habitat maintenance, especially if those habitats are negatively impacted through anthropogenic causes.

No Progress

OBJECTIVE 4:

JOB/ACTIVITY 4A: Where possible, gather supplemental ecological data to accompany population parameters on Southeast Alaskan vertebrates. These data may include life history and other demographic information, predation risks and factors, and habitat preference or avoidance parameters.

No progress

OBJECTIVE 5:

JOB/ACTIVITY 5A: Analyze data**,** prepare reports, maps, and associated publications and presentations.

No Progress

JOB/ACTIVITY 5B: Attend conferences and workshops and/or write articles to present findings.

No Progress

OBJECTIVE 6:

JOB/ACTIVITY 6A: Identify implementation partners.

No progress

JOB/ACTIVITY 6B: Identify implementation projects and activities.

No progress

JOB/ACTIVITY 6C: Implement projects and activities as part of objectives 1 – 5, or under a separate implementation grant.

No Progress

Significant Deviations: none.

Additional Information: none.

Prepared By: Matthew Kirchhoff, Nongame Biologist, Region 1

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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Alaska Department of Fish and Game
State Wildlife Grant

GRANT NUMBER: T-3 **SEGMENT NUMBER:** 1

PROJECT NUMBER: 11.11

PROJECT TITLE: Population and habitat assessments for species of greatest conservation need in Southeast Alaska

PROJECT DURATION: January 1, 2007 – June 30, 2009

REPORT PERIOD: 1 January 2008 – 31 December 2008

REPORT DUE DATE: March 30, 2009

PARTNER: Alaska Department of Fish and Game

Project Objectives

OBJECTIVE 1: Identify and evaluate various survey and monitoring strategies for selected species in Southeast Alaska and establish protocols.

JOB/ACTIVITY 1A: Review current scientific literature; consult with species experts, species working groups, and other partners; define specific survey and monitoring protocols.

JOB/ACTIVITY 1B: Design survey and monitoring techniques that provide both accuracy and precision for assessing population status and trends of various vertebrate species in Southeast Alaska.

JOB/ACTIVITY 1C: As needed, design and implement research to determine most accurate, defensible and cost-effective survey and monitoring techniques.

OBJECTIVE 2: Conduct survey and/or monitoring of selected species in Southeast Alaska to determine population status, abundance, and distribution of the species.

JOB/ACTIVITY 2A: Recruit, hire, and train a field crew as necessary to carry out fieldwork. Purchase equipment and arrange charters as necessary to support the fieldwork.

JOB/ACTIVITY 2B: Conduct surveys using identified techniques. Water-borne, aerial, and ground-based approaches may be employed, depending upon taxa studied. Amphibian work generally will follow USGS-ARMI (Amphibian Research and Monitoring Initiative) protocols when possible unless modified based on information from active Partner Project: T-1-6-18, Amphibian Monitoring in Southeast Alaska, Dr. Sanjay Pyare. Standard visual surveys, calling surveys, and pitfall trapping also may be utilized. Techniques for birds could include standard North American Breeding Bird Survey roadside counts, Alaska Landbird Monitoring System protocols, line transect surveys, point counts, calling surveys, and specialized techniques as needed to produce accurate and credible information on abundance and distribution. Mammal survey techniques include a variety of visual, aural, and sign (track, scat, hair) surveys with more specialized techniques as needed.

JOB/ACTIVITY 2C: Conduct genetic analysis where deemed appropriate to determine genetic relatedness and distinctiveness of island endemic species.

OBJECTIVE 3: Identify habitat types and needs associated with the selected species and identify existing or potential problems, needs, or concerns regarding habitats.

JOB/ACTIVITY 3A: Based on results of surveys, identify habitats that are important for population maintenance, especially for those species with indicated declines either on a national level or within the state. Participate in on-going project to identify important nesting and foraging habitats of Kittlitz's murrelets in Icy Bay by capturing on the water and fixing radio transmitters to approximately 30 Kittlitz's murrelets in May and June.

JOB/ACTIVITY 3B: Where practical, provide land managers with recommendations on habitat maintenance, especially if those habitats are negatively impacted through anthropogenic causes.

OBJECTIVE 4: Examine population dynamics and identify factors limiting population growth or reproductive success, such as predators, habitat loss or degradation, and contaminants.

JOB/ACTIVITY 4A: Where possible, gather supplemental ecological data to accompany population parameters on Southeast Alaskan vertebrates. These data may include life history and other demographic information, predation risks and factors, and habitat preference or avoidance parameters.

OBJECTIVE 5: Analyze, disseminate and share information and data with partners, cooperators, the scientific community, and the general public.

JOB/ACTIVITY 5A: Analyze data**,** prepare reports, maps, and associated publications and presentations.

JOB/ACTIVITY 5B: Attend conferences and workshops and/or write articles to present findings.

OBJECTIVE 6: Develop and implement a regional CWCS step-down strategy.

JOB/ACTIVITY 6A: Identify implementation partners.

JOB/ACTIVITY 6B: Identify implementation projects and activities.

JOB/ACTIVITY 6C: Implement projects and activities as part of objectives 1 – 5, or under a separate implementation grant.

Summary of Accomplishments

OBJECTIVE 1:

JOB/ACTIVITY 1A: Review current scientific literature; consult with species experts, species working groups, and other partners; define specific survey and monitoring protocols.

No Progress

JOB/ACTIVITY 1B: Design survey and monitoring techniques that provide both accuracy and precision for assessing population status and trends of various vertebrate species in Southeast Alaska.

No Progress

JOB/ACTIVITY 1C: As needed, design and implement research to determine most accurate, defensible and cost-effective survey and monitoring techniques.

No Progress

OBJECTIVE 2:

JOB/ACTIVITY 2A: Recruit, hire, and train a field crew as necessary to carry out fieldwork. Purchase equipment and arrange charters as necessary to support the fieldwork.

No progress

JOB/ACTIVITY 2B: Conduct surveys using identified techniques. Water-borne, aerial, and ground-based approaches may be employed, depending upon taxa studied. Amphibian work generally will follow USGS-ARMI (Amphibian Research and Monitoring Initiative) protocols when possible unless modified based on information from active Partner Project: T-1-6-18, Amphibian Monitoring in Southeast Alaska, Dr. Sanjay Pyare. Standard visual surveys, calling surveys, and pitfall trapping also may be utilized. Techniques for birds could include standard North American Breeding Bird Survey roadside counts, Alaska Landbird Monitoring System protocols, line transect surveys, point counts, calling surveys, and specialized techniques as needed to produce accurate and credible information on abundance and distribution. Mammal survey techniques include a variety of visual, aural, and sign (track, scat, hair) surveys with more specialized techniques as needed.

No Progress

JOB/ACTIVITY 2C: Conduct genetic analysis where deemed appropriate to determine genetic relatedness and distinctiveness of island endemic species.

No Progress

OBJECTIVE 3:

JOB/ACTIVITY 3A: Based on results of surveys, identify habitats that are important for population maintenance, especially for those species with indicated declines either on a national level or within the state. Participate in on-going project to identify important nesting and foraging habitats of Kittlitz's murrelets in Icy Bay by capturing on the water and fixing radio transmitters to approximately 30 Kittlitz's murrelets in May and June.

During 5 – 24 May 2008, we captured 35 Kittlitz's murrelets and attached radio-transmitters to 27 of them in Icy Bay; additional captures took place after I left resulting in 40 birds captured with 32 radio-marked. Subsequent to our activity in the field on this project, radio-marked birds led to the discovery of 1 presumed-active nest, which could not be visited on the ground because of steep terrain. However, 1 nest was found while travelling to a 2007 nesting area and monitored with a video camera until the chick fledged.

JOB/ACTIVITY 3B: Where practical, provide land managers with recommendations on habitat maintenance, especially if those habitats are negatively impacted through anthropogenic causes.

No Progress

OBJECTIVE 4:

JOB/ACTIVITY 4A: Where possible, gather supplemental ecological data to accompany population parameters on Southeast Alaskan vertebrates. These data may include life history and other demographic information, predation risks and factors, and habitat preference or avoidance parameters.

No progress

OBJECTIVE 5:

JOB/ACTIVITY 5A: Analyze data**,** prepare reports, maps, and associated publications and presentations.

No Progress

JOB/ACTIVITY 5B: Attend conferences and workshops and/or write articles to present findings.

No Progress

OBJECTIVE 6:

JOB/ACTIVITY 6A: Identify implementation partners.

No progress

JOB/ACTIVITY 6B: Identify implementation projects and activities.

No progress

JOB/ACTIVITY 6C: Implement projects and activities as part of objectives 1 – 5, or under a separate implementation grant.

No Progress

Significant Deviations: none.

Additional Information: none.

Prepared By: Karen Blejwas, Nongame Biologist, Region 1

ALASKA DEPARTMENT OF FISH AND GAME
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Alaska Department of Fish and Game
State Wildlife Grant

GRANT AND SEGMENT NO. **T-8-1**

PROJECT NO. **1.0**

PROJECT TITLE: Marbled Murrelet Habitat Use and Activity Patterns at Port Snettisham, Alaska

PARTNER: Oregon State University

PRINCIPAL INVESTIGATOR: S. Kim Nelson

PROJECT DURATION: 8 May 2008 – 30 June 2010

REPORT PERIOD: 8 May 2008 – 7 May 2009

Project Objectives:

OBJECTIVE 1: Identify nesting habitat and locate nests.

OBJECTIVE 2: Monitor nesting activity, and assess the relationship between nesting habitat and nesting success.

OBJECTIVE 3: Determine daily flight and foraging patterns of birds.

OBJECTIVE 4: Identify preferred foraging habitat during incubation, chick-rearing, and post-fledging periods.

OBJECTIVE 5: Determine post-breeding dispersal movements.

Summary of Accomplishments:

We captured and radio-marked 40 murrelets in mid-May 2008. We tracked radio-marked birds using aerial and boat surveys, and six fixed data logger stations located within PS from mid-May through the end of July.

JOB/ACTIVITY 1: Identify nesting habitat and locate nests.

A total of 16 active inland nest sites were located via aerial telemetry, including one second nest attempt. Eight of the nests were located in trees and 8 on cliffs. Five tree nesting areas were accessed on foot; all cliff nest sites were inaccessible. Nests in 2008 were located closer to water than in 2007 where half of the nests were located more than 15 km inland. Detailed analyses of nesting habitat are in progress.

JOB/ACTIVITY 2: Monitor nesting activity, and assess the relationship between nesting habitat and nesting success.

Telemetry detections indicated only 2 nests successfully hatched with only one possible fledging. There was no difference between nest location (cliff or tree) and nest success. We are uncertain as to why most of the nests were unsuccessful, however heavy rains in

May and June created turbid waters in Snettisham and nesting birds were flying farther to forage than in previous years.

JOB/ACTIVITY 3: Determine daily flight and foraging patterns of birds.

The combination of boat surveys and data logger stations allowed us to determine daily and seasonal activity patterns of murrelets foraging inside PS. As in previous years, the mouth of PS had significantly higher nighttime detection totals than daytime detection totals, demonstrating that many murrelets exit interior PS during the late evening hours where they congregate at the mouth of PS. Murrelets returned to interior PS early in the morning hours and many were found foraging and loafing near the juncture of the Whiting and Speel arms of PS. However, other than the Whiting River data logger no differences were found in the numbers of murrelets present during the day compared to night.

One possible explanation for this nocturnal redistribution is that murrelets move to take advantage of alternate or better feeding opportunities at night. However, results from this study suggest that murrelets are not redistributing themselves in response to changes in fish prey abundance at night. Fish prey were more abundant at the inner transect compared to the outer transect during both night and day periods. If murrelets were foraging on fish prey at night, they would be expected to remain in the inner region. A second possible explanation for the shift in distribution is predator avoidance. Moving to the mouth of Port Snettisham may provide murrelets with open water where they can rest while avoiding nocturnal predators.

JOB/ACTIVITY 4: Identify preferred foraging habitat during incubation, chick-rearing, and post-fledging periods.

Preferred foraging habitat changed throughout the season perhaps in response to changes in water turbidity and prey availability. During incubation and early chick-rearing, nesting birds stayed close to nesting sites as they had in 2007. However, when significant rains fell in June, birds moved to locations in Tracy/Endicott Arms where water was less affected by runoff. Post-breeders and failed breeders left the area entirely, foraging in Icy Strait, Glacier Bay and unknown locations (see below).

JOB/ACTIVITY 5: Determine post-breeding dispersal movements.

Post-breeding dispersal dates in 2008 were similar to 2007; however some birds left PS earlier and spent more time in nearby Stephen’s Passage and the Tracy/Endicott Arm system than in previous years. As of 31 July and 12 August, only 9 and 6 birds, respectively, remained in PS and nearby areas. We were able to relocate two dispersed individuals, one near Point Adolphus in Icy Strait and one in lower Glacier Bay. Flights south to Kuiu Island and Frederick Sound produced no birds.

Significant Deviations: None to report.

Additional Information:

Reports:

Nelson, S.K., S.H. Newman, B.A. Barbaree, D.L. Whitworth, and H.R. Carter. 2009. Marbled Murrelet (*Brachyramphus marmoratus*) Breeding Ecology, Terrestrial Habitat Use, and Activity Patterns in Port Snettisham, Southeast Alaska, 2005-2007. Unpublished report prepared for the Alaska Department of Fish and Game by Wildlife Trust, New York, NY.

Newman, S. H., V.M. Padula, S.K. Nelson, and T.B. Haynes. 2008. Health Assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska. Unpublished report prepared for the Alaska Department of Fish and Game by Wildlife Trust, New York, NY. 41pp.

Publications in Review:

Padula, V.M., S.H. Newman, S.K. Nelson, T.B. Haynes, and C. Cray. In review. Health assessment of Marbled Murrelets in Port Snettisham, Southeast Alaska. Journal of Wildlife Diseases.

Haynes, T.B., S.K. Nelson, F. Poulsen, and V.M. Padula. In review. At-sea habitat use and patterns in spatial distribution of Marbled Murrelets in Port Snettisham, Southeast Alaska. Marine Ornithology.

Haynes, T.B. and S.K. Nelson. In review. Diel shifts in Marbled Murrelet distribution at-sea in Port Snettisham, Southeast Alaska.

Presentations:

Newman, S.H., S.K. Nelson, D.L. Whitworth, H.R. Carter, and M. Kirchhoff. Marbled Murrelet activity patterns and health at Port Snettisham, Alaska. Poster, 2006 Pacific Seabird Group Annual Meeting.

Nelson, S.K., S.H. Newman, D.L. Whitworth, H.R. Carter, and M. Kirchhoff. Marbled Murrelet activity patterns and health at Port Snettisham, Alaska. Poster, 2006 North American Ornithological Conference.

Nelson, S.K., S.H. Newman, B.A. Barbaree, D.L. Whitworth, and H.R. Carter. Nesting habitat, activity patterns, and distribution of Marbled Murrelets at Port Snettisham, Southeast Alaska. Paper, 2008 Pacific Seabird Group Annual Meeting and 2008 Oregon Chapter of the Wildlife Society Annual Meeting.

Haynes, T.B., S.K. Nelson, F. Poulsen, and V.M. Padula. At-sea habitat use and patterns in spatial distribution of Marbled Murrelets in Port Snettisham, Southeast Alaska. Poster, 2009 Pacific Seabird Group Annual Meeting.