

Triangle Island Seabird Research and Monitoring Station 2000



Triangle Island Seabird Research and Monitoring Station 2000

Seventh Annual Report to BC Ministry of Environment Lands Parks

Ecological Reserve Permit Number ST9910186

to

Environment Canada / Canadian Wildlife Service
(EC/CWS)

@

Pacific Wildlife Research Centre

Prepared by: J.L. Ryder, C. Gjerdrum, S. Wardrop, and D.F. Bertram, January 2001

Dates of Research Activities: April 16 - August 22, 2000

TABLE OF CONTENTS

ACKNOWLEDGMENTS	3
SUMMARY	4
WILDLIFE ECOLOGY CHAIR MANDATE AND MISSION STATEMENT.....	4
BACKGROUND AND RATIONALE	5
MEETING OUR ECOLOGICAL RESERVE PERMIT REQUIREMENTS	6
FIRST AID TRAINING	9
RESEARCH ACCOMPLISHMENTS.....	9
MANUSCRIPTS AND PAPERS FROM 2000.....	11
OTHER REFERENCES	13

Research Director: Dr. Douglas F. Bertram

Field Team leader: John L. Ryder and Krista D. Amey

Field team: Alison Agness*, Krista Amey, Jean-Francois Aublet*, Doug Bertram, Lori Barjaktarovic, Sean Boyd•, Mark Drever, Carina Gjerdrum, April Hedd, Andrew Lang*, Andrea Lonon, Jean-Francois Savard, Sharilynn Wardrop, Gregor Yanega

* = volunteer

• = at-sea surveys for telemetry project

Lab Support: Connie Smith, Barbara Sherman

Acknowledgments

We thank the Canadian Coast Guard and specifically the officers and crew of the Sir Wilfred Laurier who provided critical logistic support. We would also like to thank the officers and crew of the Canadian Coast Guard helicopter fleet for transporting gear and personnel to/from Triangle Island. Financial support was provided through core funding received from the Centre for Wildlife Ecology at SFU, by NSERC grants to Dr. Fred Cooke and Dr. Tony Williams, by a Nestucca oil spill research grant to Dr. Doug Bertram and Gary Kaiser, by a Climate change Action Fund (CCAF) research grant to Dr. Doug Bertram, and by an Important Bird Areas Community Action Fund (IBACAF) grant from the Canadian Nature Federation. Gary Kaiser provided invaluable technical support. Sean Boyd conducted the aerial surveys and provided technical support on telemetry techniques. Steve Shisko provided GIS mapping support. We would also like to thank our hard working field crew, whose tireless efforts in 2000 made the Triangle Island research project a huge success. Of special note, we would like to specifically acknowledge the excellent first aid administered by our field crew (Sharilynn Wardrop in particular) when Alison Agness fractured her right radius while night banding on August 15th, 2000.

Summary

In 2000 the CWS/NSERC Wildlife Ecology Research Group at Simon Fraser University continued their long term seabird research and monitoring activities on the Anne Vallée Ecological Reserve on Triangle Island, BC, under permit (#ST9910186) from the British Columbia Ministry of Environment Lands and Parks (BCMELP). In compliance with our permit this document provides the BCMELP with information to gauge the impact of our research activities on the Ecological Reserve. To this end, sequential photographs of the key research areas and trails are provided. Research activities were confined to Calamity Cove, Puffin Rock, South Bay and West Bay. We continued our banding program at Calamity Cove, South Bay and West Bay to study the demographics of Cassin's Auklets (858 captures) and Rhinoceros Auklets (347 captures). Chick growth, productivity, diet and provisioning were studied at South Bay, West Bay and Puffin Rock on five species: Cassin's Auklets, Rhinoceros Auklets, Tufted Puffins, Common Murres and Pelagic Cormorants. The second year of a foraging ecology study of Cassin's Auklets was continued in West Bay. A feasibility study to test the effects of radio-marking on Rhinoceros Auklets was completed in South Bay. Records of visitors to the island and marine mammal sightings are reported. Papers published or in press for 2000/01 are also included.

Wildlife Ecology Chair Mandate and Mission Statement

The mandate of the chair is to foster high quality graduate level research in the field of wildlife ecology, with specialization in behavioural, population and physiological ecology. The central concept is to provide an interface between the mission-oriented research and management policies of the Canadian Wildlife Service and the more curiosity-driven research of the university community. By encouraging this interface, the government agencies gain access to a broader base of scientific information for government policy and decision making, and university researchers benefit from a broader practical application for the more theoretical ideas that their disciplines generate. The seabird program seeks to foster research within this theme by concentrating on significant seabird populations of the following species: Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin and Common Murre.

In conjunction with the CWS mandate for preservation of migratory bird species the Chair has identified four requirements for conservation at the population level.

- 1) identifying population trends (with emphasis on those species which are suspected to be in serious decline)
- 2) understanding the demographic reasons for declines
- 3) understanding the environmental reasons for declines
- 4) taking action

Background and Rationale

Triangle Island is the largest seabird colony in British Columbia with over a million breeding seabirds (Rodway 1991). This includes the world's largest population of Cassin's Auklet, and significant populations of Rhinoceros Auklet, Tufted Puffin, Common Murre, Pigeon Guillemot, Leach's Storm Petrel, Glaucous-Winged gull, Pelagic Cormorant and Black Oystercatcher. In the 1950s, the British Columbia Provincial Museum visited Triangle Island to document the flora and fauna (Carl et al. 1951). During the 1970s, Kees Vermeer of the Canadian Wildlife Service (CWS) conducted pioneering studies of Triangle Island seabirds (eg, Vermeer 1979) and CWS studies continued throughout the 1980s (eg, Bertram and Kaiser 1993, Rodway et al. 1990). In 1994, the newly formed Wildlife Ecology Chair at Simon Fraser University (SFU) in conjunction with CWS chose Triangle Island as the logical site for a long term seabird research and monitoring station for British Columbia. In 1997, Scott Island Provincial Park was successfully nominated by the CWS as an Important Bird Area (IBA), and a conservation plan for the Scott Islands IBA was prepared in 1999 for the Canadian Nature Federation (Drever 1999). This area has also recently been identified as an ideal pilot region for a National Marine Wildlife Area which permits establishment of a Marine protected area (MPA) for wildlife conservation, research and education. The CWS and partners plan to declare a pilot MPA for the area by 2002 (Michael Dunn, CWS, pers. comm.). This year marked the seventh consecutive year that the research and monitoring activities on Triangle Island have been coordinated and implemented under the auspices of the Centre for Wildlife Ecology at SFU (recently renamed and formerly known as the Wildlife Ecology Research Chair).

The Centre for Wildlife Ecology integrates demographic, physiological, and behavioural studies to understand how seabird populations function. The main study species were Cassin's Auklet (CAAU), Rhinoceros Auklet (RHAU), Tufted Puffin (TUPU), Common Murre (COMU), and to a lesser extent the Pelagic Cormorant (PECO).

The specific objectives for 2000 were to: 1) continue work on marked populations of CAAU and RHAU for long term demographic studies and to measure the mass, condition, and breeding status of the individuals captured for comparison with the results from future years; 2) to measure productivity (hatching and fledging success) and chick growth of CAAU, RHAU and TUPU; 3) to quantify the food habits of CAAU, RHAU and TUPU; 4) to observationally quantify the breeding chronology, provisioning effort and breeding performance of COMU, TUPU and PECO; 5) to monitor the nocturnal activity patterns of adult CAAU through the application of high-frequency surveillance radar; 6) to correlate chick growth rates with observed provisioning rates and diet information for TUPU through graduate student research (C. Gjerdrum, 2nd year of study); 8) to further examine the foraging ecology of CAAU through application of radio-telemetry to evaluate the utility of proposed MPA boundaries, and to examine the extent of spatial overlap of birds at-sea with preferred prey distribution; and 9) to assess the feasibility of radio-marking Rhinoceros Auklets (a species of considerable interest to researchers in B.C. and Washington) for foraging ecology studies.

Meeting our Ecological Reserve Permit Requirements

In 1999, our permit ownership was transferred from SFU to CWS. In compliance with our permit (#ST9910186) this document provides the BCMELP with information to gauge the impact of our research activities on the Anne Valleé Ecological Reserve (established in the 1970s), which as of May 2000 includes Puffin Rock and the island foreshore out to 1 Km (Ian McLellan, BCMELP, pers. comm.). Our research activities are designed to have minimal impact on the flora and fauna. We have designated trails which are constantly maintained. In fragile regions of nesting habitat where burrows are abundant, we mark areas where the ground is firm and do not leave those paths. To gauge our impact on the island (Figure 1) we provide photographs of the key research areas. Table 1 identifies the location on the colony, the activities carried out at each site and references corresponding to photographs (Appendix 1). Table 2 provides the approximate area of each plot where burrows were monitored in 2000.

When we first arrived at the colony there were some signs of continued erosion of the slopes near the high tide mark, but very little compared to 1998/99. The trail leading to the cabin was still intact following repairs to the beach front in 1998, and our banding shelter in South Bay was found intact for the first time in three years. One of the posts used for holding our pheasant net in place at the South Bay banding site had come out of the ground again, and additional erosion had occurred at the base of the slope (where it meets the high tide mark) over the winter. Our radar monitoring site in West Bay was intact and unaltered (see Appendix 1; photos). In 2000, we continued seasonal monitoring of the nightly activity patterns of CAAU by installing a radar platform and power generator in the upper intertidal area of West Bay in the same location as 1998/99. This project originally began as a pilot project in 1996, and proved to be successful in surveying adult CAAU commuting from the burrows to the ocean (Bertram et al. 1999).

At the West Bay CAAU study site at plot C (see Figure 1) no additional ladders were installed in 2000. The existing ladders weathered the winter very well and only minor maintenance (i.e. new wire) was required. The wooden blockade that was erected in 1998 in the upper section of the impacted zone (to prevent further top-down erosion) held for a second year and additional vegetation sprouted behind and in front of the barrier. Visible signs of continued growth and expansion of vegetation within the impacted talus slope (particularly salmonberry) were evidenced in 2000. Burrows above the impacted area that were initially abandoned in 1998 were not used in 2000 to further facilitate this re-growth. The erosion prevention measures first implemented in 1998 have resulted in rapid plant recolonization across the impacted area, halting and reversing the spread of erosion to this point. We will carefully monitor the area for continued signs of improvement but do not feel that additional hands-on measures to prevent erosion are necessary at this time.

The trail on the north and south side of Khyber pass in West Bay was in very good condition when we arrived in April. The wooden barriers installed from 1997-1999 to prevent the trail from sloughing off (particularly in the middle section) held through the winter. The trail required minor maintenance during the course of the field season (i.e. new gravel and

additions to the wooden barriers). On the north side of the trail we also noted the re-growth of vegetation along the trail edge where the wooden barriers were present. This growth shored up the trail in several sections that were prone to sloughing off.

The trail to Puffin Rock required considerable upgrading and stair replacement in the upper 2/3 of the trail to prevent the continued erosion of the thin and fragile surface soil overlying the base rock. The installation of large driftwood/spare lumber stairs was largely unsuccessful in 1999, and contributed to additional slope erosion and destabilization in some areas. Luckily, there was no additional erosion apparent when Puffin Rock was first visited on May 5th and the stair rebuilding process began on May 15th, 2000. Ian McLellan and Rik Simmons provided 40 2x8x21" rough cedar boards to be used as stairs, and the existing stairs were systematically removed and replaced with cedar cut into 2x4' sections. Re-bar anchors were driven into the soil to hold the cedar boards in place, and these anchors were far less damaging to the surface soil layer than ones used previously, and kept the boards firmly in place. Finding ground to provide a firm hold for the re-bar proved to be quite challenging in some middle sections of the trail, and the trail was re-routed around two small but heavily impacted sections (each approximately 4' in length) barren of soil. For safety reasons, each piece of re-bar was marked with fluorescent flagging tape. Stair building and replacement was confined to the upper 2/3 of the trail, but additional stairs (to be provided by BC Parks) will be added where appropriate in 2001 (as discussed on Dec 13th, 2001 CWS/BC Parks meeting at PWRC). The bottom 1/3 of the trail is an area with tallus slope and loose rock, and it has clearly been impacted from our activities as well. Stairs will also be installed on this section of the trail where appropriate. We expect that the human impacts to the trail will be reduced substantially during the upcoming field season (approximately 1/2 as many trips in the season). The daily visits to Puffin Rock by M.Sc. graduate student Carina Gjerdrum to study Tufted Puffins concluded in 2000.

Safety concerns relating to working within the study plots on Puffin Rock were addressed in 2000 (see Puffin Rock safety plan draft, Appendix 5). The site has very steep topography and is covered by a thin layer of soil, and it can be a dangerous area to work in. Concerns raised by BC Parks and ourselves regarding the safety aspects of working at the Tufted Puffin plots resulted in the installation of a series of re-bar anchors with a safety line strung between them above our long-term study plot at the southeast corner of Puffin Rock (see Appendix 5 map). Tubular webbing was used to attach the safety line to the re-bar. All researchers were required to wear safety harnesses, and be roped into the safety lines using carabiners when accessing this plot. Safety helmets were also mandatory. Carina Gjerdrum successfully used these anchors and safety line system in 1999 to access her experimental study plots on the west side of Puffin Rock, following consultation with a technical climbing expert. We also found that the system worked very well, was easy to use/install and provided the necessary degree of protection should an accidental fall occur. We will continue to use the safety line system in 2001 and beyond.

In April of 2000, one additional Type II aluminum ladder was installed in South Bay at the top of the existing chain to the RHAU study plot (see Appendix 1, reference photo # 53). Ladders were previously installed at this site in 1998/99 (see 1998/99 reports to BC Parks) and this addition was added to compliment the existing links. Similar to West Bay, the ladder installations from the previous seasons weathered the winter very well and little maintenance was required to ensure they were safe for 2000. We also noted that the ladders

stabilized the slopes (similar to 1999) as there were no signs of continued talus erosion. Vegetative re-growth continued along the trails that were damaged in (and prior to) 1997. In order to fully access the upper portion of the study plot, an additional 2-3 ladders will need to be installed at the top of the chain over the next two seasons.

The South Bay food sampling location (behind the cabin) for RHAU was a site of concern when Rik Simmons visited the island on June 18th. The trail to the plot is very steep and traverses a small trough with fragile ground that can be easily eroded. Within a season the area is visited on nine occasions, separated by 10d intervals, to collect food samples beginning on June 15th. Two to three people use the trail during these visits, and safety helmet use is mandatory. Although use of the trail is infrequent, the potential for serious impacts due to erosion is high, particularly if the trough is widened through use and/or water runoff. The use of stairs in some “bench” sections of the trail as well as the use of an access rope was discussed as possible mitigative measures at the CWS/BC Parks meeting at PWRC on Dec. 13th, 2000. A more formal safety plan similar to the one for Puffin Rock (Appendix 5) is currently being prepared.

The cabin weathered the winter well again and required little maintenance in 2000. A few rotten steps were replaced, the roof was re-caulked to prevent rain from leaking into the cabin and new weather-stripping was added to the base of the door. The west trail leading to the cabin required some minor trail maintenance to replace rotten boards in the middle section, and new wooden blocks were installed (see Appendix 1, reference photo # 76). The BC Parks approved tent pad was renovated and expanded to accommodate a new 8x10' polyvinyl weatherport with an aluminum frame bolted to the platform (see Appendix 1). The tent was erected on May 28th and proved to be very durable, water-proof and mouse-proof to the end of the season. One complaint, though, was that it was very noisy in high winds when the cover was blown against the frame. The path leading from the cabin to the tent pad was shored up with driftwood logs to prevent erosion at the edge of the midden site.

Two study plots that were used in 1999 for Louise Blight's graduate research project were abandoned in 2000 (see 1999 report to BC Parks). Both were located in South Bay and were used for RHAU experiments; one area was located behind the cabin to the west and the other area was above the banding shelter in the southeast corner (plot S.E. at the NET). A lower section of plot S.E. was used again for monitoring RHAU chick growth later in the season, and five RHAU burrows in this plot were used to attach radio-transmitters to adults as well. The CAAU telemetry study plot at the north end of West Bay (first visited in 1999) was used again for deploying transmitters at the burrow locations. This plot was visited on five occasions from May 23rd to June 19th. We also assembled a data collection computer in 2000 (DCC II) for remote monitoring of radio-marked CAAU on the point of land jutting out from the north end of West Bay (see Figure 1). We made seven visits to this site to download data that had been collected during the summer (May 24, May 29, June 3, June 5, June 19, June 27, and July 7) and the unit was dismantled on July 7th. Locations of all the study plots and banding sites are provided in Figure 1. The total area of the plots monitored in 2000 was reduced to 4704 m², a decrease of 410 m² from the total area of 5114 m² used in 1999 (see Table 2). This decrease was due to the abandonment of the South Bay RHAU plots used for Louise Blight's M.Sc. research.

In addition to conducting research on the internationally known Triangle Island our presence and vigilance can help to protect the Ecological Reserve. There were two major

incidents that were observed in the summer of 2000 that BC Parks were alerted to. The first incident occurred on June 1st when a Vancouver Island helicopter flight was made to Triangle Island by a film crew. The crew hovered near the island for 30-45 minutes filming in various locations in South and West Bay, and caused noticeable disturbance to Common Murres and Peregrine Falcons at Puffin Rock. The second incident occurred on July 23rd when a blue-hulled boat (ID #21437) was witnessed firing shots from a small caliber rifle towards sealions in Northeast Bay.

BC Parks approved visits to Triangle Island included: 1) A helicopter chartered by Don Doyle of BCMELP censused the island's PEFA eyeries on June 16th, 2000, and, 2) Alaska Department of Fish and Game vessels (2) circumnavigated the island looking for marked sealions on July 3rd, 2000. A complete list of visitors to the island is recorded (Appendix 2). The number of vessels visiting the island was down substantially in 2000 compared to 1999, and only two confirmed landings by fishermen were made (from the same vessel). On both occasions the same person visited the research station and intertidal area. A list of unusual marine mammal observations is also included (Appendix 3). Marine mammal sightings increased substantially in 2000 compared to 1999, particularly for humpback whales.

It should also be noted that our departure from Triangle Island on August 22nd did not proceed as scheduled, and we did not receive Coast Guard ship support to remove our gear. We did receive helicopter support (Bell 212) to remove the crew and a portion of our gear (generators, motors, electronics, etc.) but the majority of our equipment remained at the research station for the winter.

First Aid Training

Crew safety is always our top priority at Triangle Island, and in 2000 we required that at least three people (at any given time) had taken the following first aid courses: a) Occupational First Aid Level I, b) Transportation Endorsement, and c) Standard Wilderness First Aid. The first two courses are necessary to meet our WCB requirements in the field, and we have insisted that at least two crew members present in the field had taken these courses in the past. Wilderness First Aid was a very practical addition to our safety requirements in 2000, and although it is not WCB certified proved to be the most useful first aid course in the field from our standpoint. On August 14th, one of our volunteers, Alison Agness, slipped and hyperextended her right hand while night banding in South Bay. Her wrist swelled immediately, and it was later revealed that she had fractured her radius (hairline fracture). Sharilynn Wardrop was present on site, had taken the required first aid courses, and did an expert job of splinting/icing the injury (as noted by hospital staff later). Alison was flown off the island on August 15th for further treatment. This incident reinforced the need to provide our field crew with wilderness first aid training, in addition to the mandatory first aid courses.

Research Accomplishments

The seventh year of our long term demographic study on CAAU and RHAU was successfully completed. In total, we banded 530 and recaptured 327 CAAU (total captured = 858) at West Bay, Calamity Cove and South Bay (Figure 2). In South Bay and Calamity

Cove, 208 RHAU were banded and 139 recaptured (total captured = 347, Figure 3). Chick growth, diet and productivity studies were also successfully conducted and these data are currently being entered and analyzed. Our radar project on CAAU nocturnal activity patterns was successful and over 552 hours of video footage was obtained over the 3 month observation period.

The second year of our radio-telemetry project to quantify the offshore foraging ranges of breeding CAAU was again successful. A total of 37 adults were radio-marked in late May/June, and flights were conducted at-sea by Sean Boyd of CWS on May 31-June 1st and June 15-16th, 2000. We found that CAAU were concentrated 30-60 km southwest of the colony (Ryder et al. 2001) well off the shelf-break in the same general area as 1999 (Boyd et al. 2000). A total of 32 radio-marked adults (91% of those with transmitters) were detected on at least one occasion during aerial at-sea surveys (Ryder et al. 2001). These results supported our findings from 1999, and there was extensive foraging area overlap (approximately 50%) in the core areas used from 1999-2000 (see Appendix 4). The project has continued to generate great interest within CWS and among other government and non-government organizations interested in the Scott Island's MPA.

Productivity of the four main seabird species studied in 2000 was excellent for the second year in a row. It was a great breeding year for Cassin's Auklets, Rhinoceros Auklets, Tufted Puffins, Common Murres and Pelagic Cormorants. Breeding success of burrow nesting CAAU was 75.3% (percentage of eggs laid that fledged chicks), while breeding success for burrow nesting RHAU was 58.0% and 77.4% for TUPU, respectively. Growth rates of chicks were as high or higher than values reported from the 1970s-90s and were similar to 1999 (Vermeer 1979, Vermeer 1987, Bertram et al. 1991, Bertram et al. 2001). Data for cliff nesting COMU have not been fully analyzed but breeding success was similar to 1999. A late summer storm wiped out several of the cliff nesting PECO nests, but breeding success was good in 2000 for those that remained. Several PECO nests still had chicks present when the crew departed the colony in August. Additional reproductive data and banding statistics are presented in Table 3. Moira Lemon is currently writing up the results of the permanent monitoring plot surveys from Triangle Island with an expected completion date of March 31st, 2001.

Louise Blight, a graduate student under the supervision of Dr. Tony Williams and Dr. Doug Bertram at Simon Fraser University, successfully defended her M.Sc. thesis in July, 2000. The title of her thesis was "Egg neglect and it's implications for egg predation in the Rhinoceros Auklet" (Blight, 2000). Louise studied the effects of rodent predation on Rhinoceros auklet eggs in relation to egg neglect in 1998, and investigated age-related responses of RHAU embryos to neglect in 1999. Based on her work from 1998, Louise published a paper in the journal *Condor* on the effects of rodent predation on Rhinoceros Auklet eggs (Blight et al. 1999). Louise is working on another manuscript titled "Results of an egg chilling experiment to test the cost of egg neglect in Rhinoceros Auklets" with Dr. Tony Williams of SFU.

Carina Gjerdrum, a graduate student under the supervision of Dr. Doug Bertram at Simon Fraser University completed her field studies on TUPU in 2000. Carina's study focused on correlations between chick growth rates with observed provisioning rates and diet information for TUPU. Carina had originally planned on studying TUPU parental abandonment decisions and their effects on nestling performance, but the excellent breeding

seasons of 1999-2000 resulted in little parental abandonment of chicks. She is in the process of writing up her M.Sc. thesis and expects to defend in 2001.

Several papers from past and present research projects conducted on Triangle Island were published in major scientific journals in 2000. Yolanda E. Morbey and Ronald C. Ydenberg published a paper in *Auk* on “The seasonal decline in nestling growth: support for the parental-quality hypothesis in Cassin’s Auklets” (Morbey and Ydenberg, 2000). This is the fourth paper that Yolanda has published following her work on CAAU at Triangle Island in 1994. Mark C. Drever, Louise K. Blight, Keith A. Hobson, and Douglas F. Bertram published a paper in the *Canadian Journal of Zoology* on “Predation on seabird eggs by Keen’s mice (*Peromyscus keeni*): using stable isotopes to decipher the diet of a terrestrial omnivore on a remote offshore island” (Drever et al. 2000). W. Sean Boyd, John L. Ryder, Steven G. Shisko, and Douglas F. Bertram published a technical report on the “At-sea foraging distributions of radio-marked Cassin’s Auklets breeding at Triangle Island, B.C.” (Boyd et al. 2000). Copies of papers published in 2000/2001 are included in Appendix 6.

Other papers from research conducted at Triangle Island are in preparation or have been submitted to major scientific journals. Douglas F. Bertram, David L. Mackas, and Stewart M. McKinnell submitted a paper to *Progress in Oceanography* (currently in press) titled “The Seasonal Cycle Revisited: Interannual Variation and Ecosystem Consequences”. Brett A. Vanderkist, Tony D. Williams, Lynn L. Loughheed, Douglas F. Bertram, and John L. Ryder submitted a paper titled “Indirect, physiological, assessment of reproductive state and breeding chronology in free-living birds: an example in the Marbled murrelet (*Brachyramphus marmoratus*)” to *Functional Ecology* in 1999, and it is currently in press. April Hedd, John L. Ryder, Laura L. Cowen, and Douglas F. Bertram submitted a paper to *Marine Ecology Progress Series* on “Inter-annual variation in the diet, provisioning and growth of cassin’s auklet at Triangle Island, British Columbia: Responses to variation in ocean climate?” Douglas F. Bertram, Anne Harfenist, Gail Davoren, Todd Golumbia, and J. Brown are currently working on a paper titled “Consistent patterns of interyear variation in Rhinoceros Auklet nestling development and diet across oceanographic domains”, which will be submitted in 2001. Colleen C. St. Clair, Randy C. St. Clair, and Tony D. Williams submitted a paper on the “Effects of kleptoparasitism by Glaucous-winged gulls on Tufted puffins” to *Auk* in 1999, and it is still in review in 2001. This paper was based on the TUPU research project undertaken by Colleen and Randy at Triangle Island from 1995-96. John L. Ryder, W. Sean Boyd, Steven G. Shisko, and Douglas F. Bertram currently have a technical report in review on the “At-sea foraging distributions of radio-marked Cassin’s Auklets breeding at Triangle Island, B.C., 2000”, expected to be published in 2001.

There were no requests from the media for information or updates on our research activities at Triangle Island in 2000. We now have a website available that highlights our research activities at Triangle Island, although it has not been widely publicized yet. The website address is: www.sfu.ca/biology/wildberg/bertram/triangle. Further information and a detailed daily log of the crews activities is archived at CWS in Doug Bertram’s office.

Manuscripts and papers from 2000

Bertram, D.F., D.L. Mackas, and S.M. McKinnell. 2001. The seasonal cycle revisited: interannual variation and ecosystem consequences. *Progress in Oceanography*. *In press*.

Bertram, D.F., A. Harfenist, G. Davoren, T. Golumbia, and J. Brown. Consistent patterns of interyear and intercolony variation in Rhinoceros Auklet nestling development and diet across oceanographic domains. *In prep.*

Blight, L. K. 2000. Egg neglect and its implications for egg predation in the Rhinoceros Auklet. M.Sc. Thesis, Simon Fraser University, Burnaby, B.C., Canada.

Blight, L.K., and T.D. Williams. 2001. Results of an egg chilling experiment to test the cost of egg neglect in Rhinoceros Auklets. *In prep.*

Boyd, W.S., J.L. Ryder, S.G. Shisko, and D.F. Bertram. 2000. At-sea foraging distributions of radio-marked Cassin's Auklets at Triangle Island, B.C. Technical Report Series No. 353. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Drever, M.C., L.K. Blight, K.A. Hobson, and D.F. Bertram. 2000. Predation on seabird eggs by Keen's Mice (*Peromyscus keeni*): using stable isotopes to decipher the diet of a terrestrial omnivore on a remote offshore island. *Can. J. Zool.* 78(11): 2010-2018.

Hedd, A., J.L. Ryder, L.L. Cowen, and D.F. Bertram. 2001. Inter-annual variation in the diet, provisioning and growth of Cassin's auklet at Triangle Island, British Columbia: Responses to variation in ocean climate?. *Marine Ecology Progress Series. Submitted December 2000.*

Morbey, Y.E., and R.C. Ydenberg. 2000. Seasonal decline in nestling growth: support for the parental-quality hypothesis in Cassin's Auklets. *Auk* 117(4): 1065-1068.

Ryder, J.L., W.S. Boyd, S.G. Shisko, and D.F. Bertram. 2001. At-sea foraging distributions of radio-marked Cassin's Auklets at Triangle Island, B.C., 2000. Technical Report Series No. XXX. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia. *In review.*

St. Clair, C.C., R.C. St. Clair and T.D. Williams. 2001. Effects of kleptoparasitism by Glaucous-winged gulls on Tufted Puffins. *Auk. In review.*

Vanderkist, B.A., T.D. Williams, L.L. Loughheed, D.F. Bertram, and J.L. Ryder. 2001. Indirect, physiological, assessment of reproductive state and breeding chronology in free-living birds: an example in the Marbled murrelet (*Brachyramphus marmoratus*). *Functional Ecology. In press.*

Other references

- Bertram, D.F., G.W. Kaiser, and R.C. Ydenberg. 1991. Patterns in the provisioning and growth of nestling Rhinoceros Auklets. *Auk* 108: 842-852.
- Bertram, D.F., and G.W. Kaiser. 1993. Rhinoceros Auklet (*Cerorhinca monocerata*) diet may gauge Pacific Sandlance (*Ammodytes hexapterus*) recruitment. *Can. J. Fish. Aquat. Sci.* 50: 1908-1915.
- Bertram, D.F., L.L. Cowen, and A.E. Burger. 1999. Use of radar for monitoring colonial burrow-nesting seabirds. *Journal of Field Ornithology* 70(2): 145-157.
- Bertram, D.F., D.L. Mackas, and S.M. McKinnell. 2001. The seasonal cycle revisited: interannual variation and ecosystem consequences. *Progress in Oceanography*. *In press*.
- Blight, L.K., J.L. Ryder and D.F. Bertram. 1999. Predation on Rhinoceros auklet eggs by a native population of *peromyscus*. *Condor* 101: 871-876.
- Carl, G.C., C.J. Guiguet and G.A. Hardy. 1951. Biology of the Scott Island Group, British Columbia. *B.C. Prov. Mus. Rep.* 10:21-63.
- Drever, M. 1999. Conservation plan for the Scott Islands Important Bird Area. Unpublished report to Canadian Nature Federation. 57 p.
- Rodway, M.S., M.J.F. Lemon, and K.R. Summers. 1990. British Columbia Seabird colony inventory: Report #4-Scott Islands. Census results from 1982 to 1989 with reference to the Nestucca oil spill. Technical Report Series No. 86. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.
- Rodway, M.S. 1991. Status and conservation of breeding seabirds in British Columbia. ICBP Technical Publication No. 11:42-102.
- Vermeer, K. 1979. Nesting requirement, food and breeding distribution of Rhinoceros Auklet, *Cerorhinca monocerata*, and Tufted Puffins, *Lunda cirrhata*. *Ardea* 67:101-110.
- Vermeer, K. and L. Cullen. 1979. Growth of Rhinoceros Auklets and Tufted Puffins, Triangle Island, British Columbia. *Ardea* 67: 22-27.
- Vermeer, K. 1987. Growth and nestling periods of Cassin's Auklets: Adaptations of planktivorous Auklets to breeding at northern latitudes. *Can. Tech. Report of Hydrography and Ocean Sciences* No. 93. 26 p.

Figure Captions

Figure 1. Triangle Island reference locations

Figure 2. Cumulative captures (a) total captures by date (b) captures and recaptures by date at West Bay (c) and Calamity Cove (d) for CAAU.

Figure 3. Cumulative captures (a) captures and recaptures by date at Calamity Cove and South Bay (b) for RHAU.

Figure 1. Triangle Island reference locations 2000

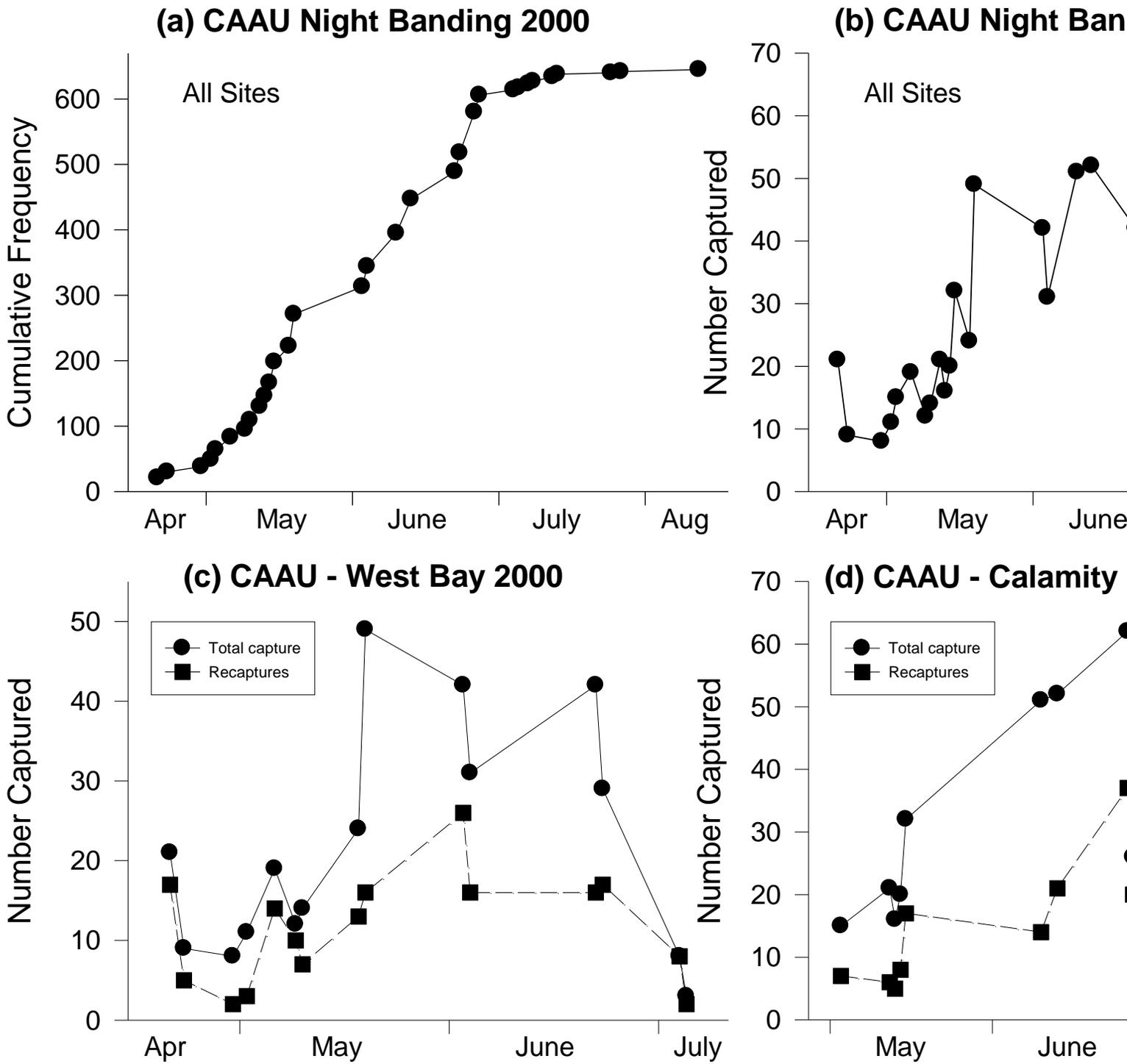


Figure 2. CAAU capture statistics 2000

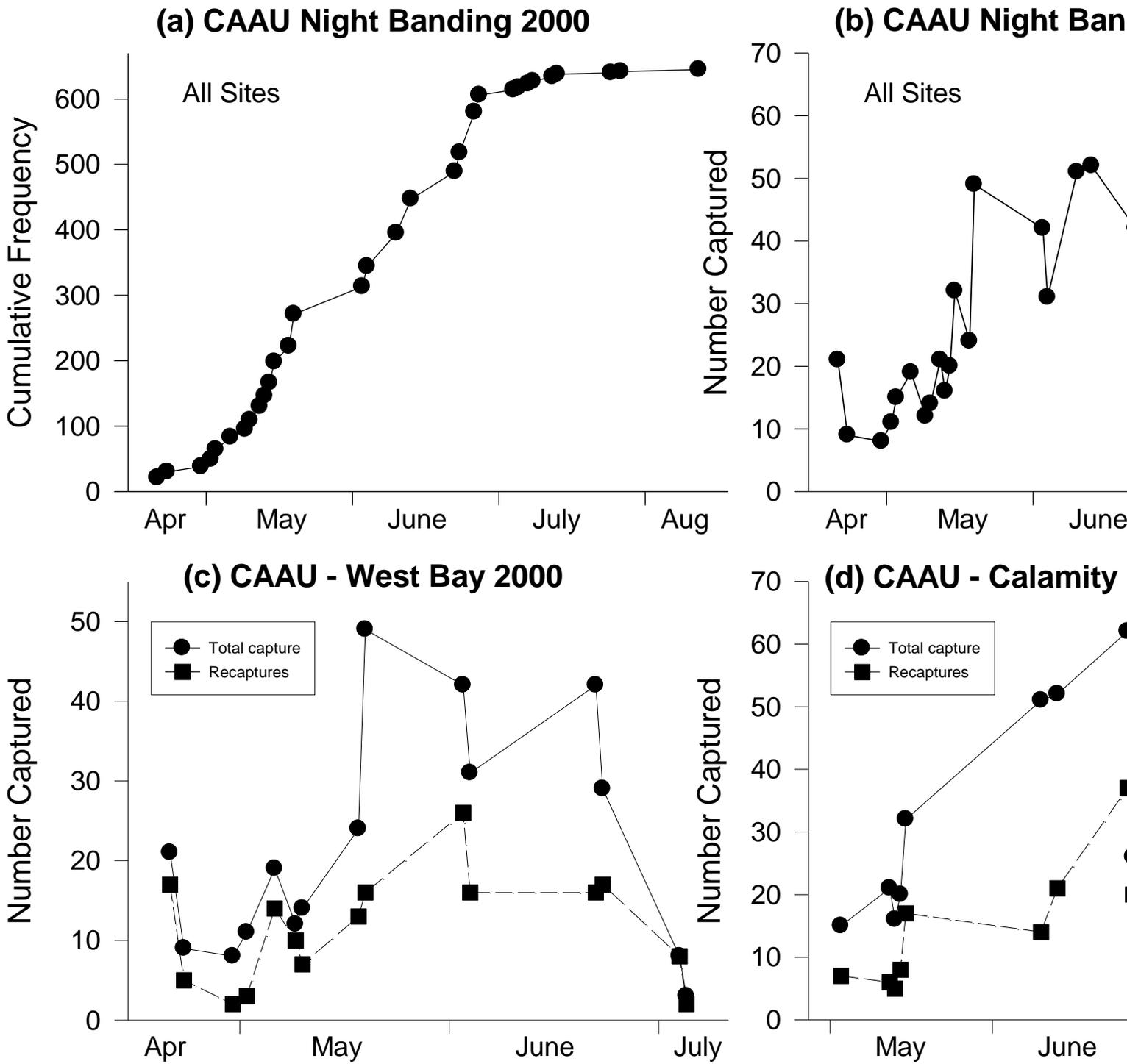


Figure 3. RHAU capture statistics 2000

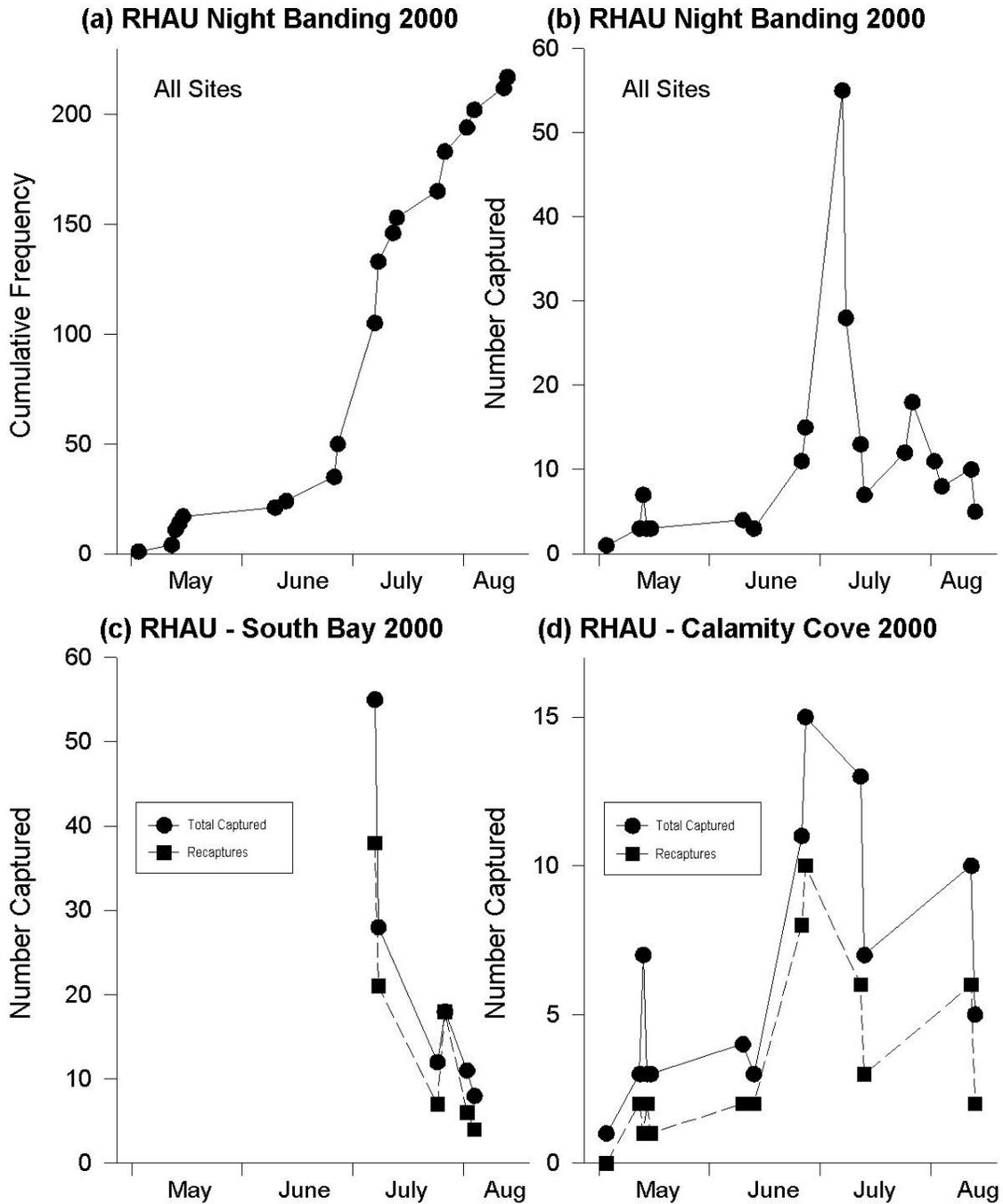


Table 1. Locations of research activity, man made structures and references to photographs in Appendix 1.

<u>Location</u>	<u>Site #</u>	<u>Activities</u>	<u>Man Made Structures</u>	<u>Photos*</u>
West Bay	I	Plot C trail ladders	Ladders anchored with rebar	1-8
		CAAU chick growth & productivity	trails to plots, plots, food sampling site	1-14
		CAAU banding	Banding shelter, permanent net supports, trail to shelter	15-20
		Radar surveillance site for CAAU	Radar platform, radar wave barrier, fuel cache (intertidal zone)	21-23
Khyber Pass	II	Travel between S and W Bay	Ropes on each side	24-27
Puffin Rock	III	Access trails and COMU/TUPU blind	Observation blind, trail ropes, trail to P. Rock	28-37
Calamity Cove	IV	CAAU/RHAU banding	Banding site, permanent net supports, trail to banding site	38-42
South Bay	V	CAAU/RHAU banding	Net supports, temporary banding shelter (intertidal zone)	43-46
		RHAU chick growth & productivity Plot Slide impacted trail	trails to plots, study plots main trail to access plots, ladders anchored with rebar	47-56, 49-54
	VII	Base Camp	Cabin and surrounding area Tent site Water tank Trails east of cabin Trails west of cabin Biffy Shed helicopter pad	61-74 61-62, 74 65-68 59-60 71-72, 75-78 69-70 57-58

* Original photos are archived at CWS in Doug Bertram's office.

Table 2. Approximate area of the plots used for burrow monitoring in 2000.

<u>Plot</u>	<u>Location</u>	<u>Species</u>	<u>Area</u>	<u>Total area</u>	<u>Use¹</u>
Net	South Bay	RHAU	10 x 10 metres	100 m ²	MO
Net	South Bay	RHAU	10 x 15 metres	150 m ²	MO
TELEMETRY	South Bay	RHAU	5 x 5 metres	25 m ²	STP
Slide	South Bay	RHAU	45 x 15 metres	675 m ²	MO
Cabin	South Bay	RHAU	22 x 15 metres	330 m ²	MO
Food sampling	Puffin Rock	TUPU	10 x 5 metres	100 m ²	GR/MO
Experimental	Puffin Rock	TUPU	20 x 10 metres	200 m ²	GR
Control	Puffin Rock	TUPU	50 x 20 metres	1000 m ²	GR
S. Saddle	Puffin Rock	TUPU	25 x 15 metres	375 m ²	MO
B	West Bay	CAAU	10 x 30 metres	300 m ²	MO
C	West Bay	CAAU	17 x 9 metres	153 m ²	MO
D	West Bay	CAAU	32 x 14 metres	448 m ²	MO
E	West Bay	CAAU	11 x 12 metres	132 m ²	MO
F	West Bay	CAAU	16 x 11 metres	176 m ²	MO
TELEMETRY	West Bay	CAAU	18 x 30 metres	540 m ²	STP
TOTALS:					
SOUTH BAY				1280 m ²	
WEST BAY				1749 m ²	
PUFFIN ROCK				1675 m ²	
TOTAL AREA				4704 m²	

¹ GR = graduate research (temporary for directed study); MO = monitoring by SFU/CWS (long term);
STP = short term project of SFU/CWS (temporary)

Table 3. Additional reproductive and banding statistics for 2000

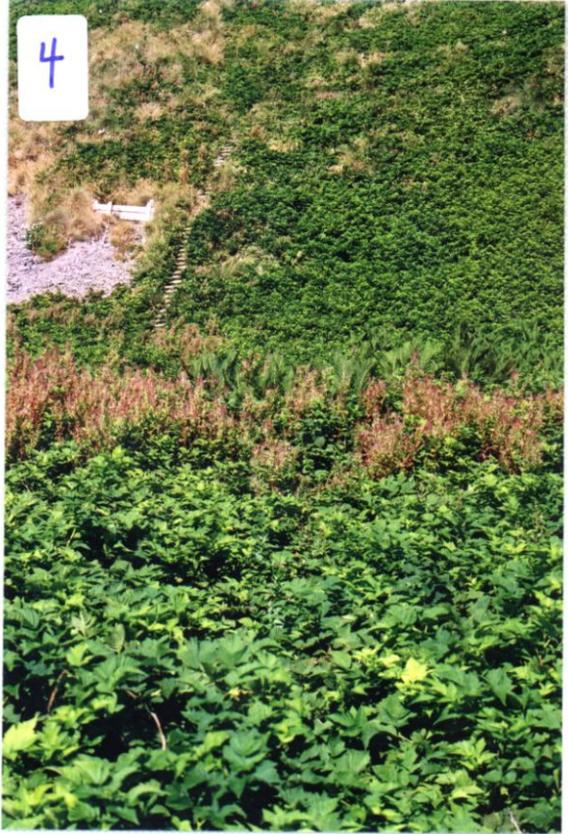
Reproductive Statistics												
	First	Burrow	First	Mean	First	Mean	Hatching	First	Mean	Fledging	Fledging	Breeding
Species	Seen	Usage	Egg	Laying	Hatch	Hatch	Success	Fledging	Fledging	Success	Wt. (Avg)	Success
Cassin's Auklet	16-Apr-00	51.3%*	18-Apr-00*	23-Apr-00*	25-Apr-00	15-May-00	81.0%	24-May-00	25-Jun-00	93.0%	166 (SD 13)	75.3%
Rhinoceros Auklet	16-Apr-00	41.2%	26-Apr-00*	5-May-00*	04-Jun-00	13-Jun-00	61.0%	26-Jul-00	05-Aug-00	95.0%	311 (SD 42)	58.0%
Tufted Puffin	16-Apr-00	78.6%*	N/A	N/A	19-Jun-00	28-Jun-00	80.0%	03-Aug-00	10-Aug-00	96.7%**	520 (SD 47)***	77.4%
Common Murre	04-May-00		01-Jun-00		01-Jul-00	11-Jul-00		26-Jul-00	30-Jul-00			
Pigeon Guillemot	04-May-00				30-Jun-00							
Glaucous-winged Gull	16-Apr-00		06-Jun-00	06-Jun-00	28-Jun-00							
Pelagic Cormorant	04-May-00		01-Jun-00	03-Jun-00	29-Jun-00	04-Jul-00		08-Aug-00				
Black Oystercatcher	16-Apr-00		01-Jun-00	03-Jun-00	24-Jun-00							
Banding Statistics												
	Total	Newly				Total	W/I Year	Prev. Yr.	Foreign	Banding		
Species	Captures	Banded	Adults	Fledgers	Chicks	Recaps	Recaps	Recaps	Recaps	Sessions		
Cassin's Auklet	858	530	364	3	163	327	138	189	0	15 WB		
Rhinoceros Auklet	347	208	81	3	124	139	27	112	0	13 CC		
Tufted Puffin	156	149	0	0	149	0	0	0	0	6 SB		
Chronology and Season Statistics												
Crew Arrival	16-Apr-00											
Crew Departure	22-Aug-00											
1st Night Banding	20-Apr-00											
# of BAEA Nests	5											
# of PEFA Nests	3											
* estimates likely BIASED as monitoring did not begin pre-laying												
** n=10 chicks still present in burrows on 18 Aug / conservative estimate												
*** only includes fledged chicks prior to the last visit on 18 Aug (i.e. 10 chicks still present in the burrows)												

Appendix 1: Photographs of Areas of Activity on Triangle in 2000

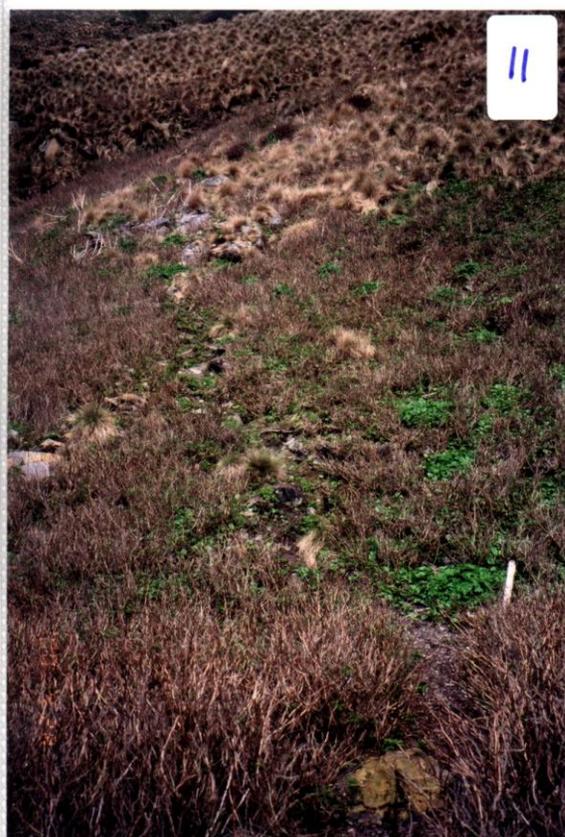
Photograph #	Site	Description	Photo date
1	West Bay	north trail to plot C with ladder erected	April 28
2	West Bay	north trail to plot C with ladder erected	August
3	West Bay	south trail to plot C with ladders erected	April 28
4	West Bay	south trail to plot C with ladders erected	August
5	West Bay	south ladders w/ erosion barrier plot C	April 28
6	West Bay	south ladders w/ erosion barrier plot C	August
7	West Bay	view of plot C impacted area w/ ladders	April 28
8	West Bay	view of plot C impacted area w/ ladders	August
9	West Bay	base of trail to plot B	April 28
10	West Bay	base of trail to plot B	August
11	West Bay	trail leading to plot B	April 28
12	West Bay	trail leading to plot B	August
13	West Bay	CAAU food sampling site at plot B	April 28
14	West Bay	CAAU food sampling site at plot B	August
15	West Bay	trail to banding shelter	April 28
16	West Bay	trail to banding shelter	August
17	West Bay	West bay banding shelter	April 28
18	West Bay	West bay banding shelter	August
19	West Bay	CAAU capture net	April 28
20	West Bay	CAAU capture net	August
21	West Bay	radar surveillance site	April 28
22	West Bay	radar surveillance site	August
23	West Bay	radar tent platform	August
24	Khyber Pass	north end of trail	April 28
25	Khyber Pass	north end of trail	August
26	Khyber Pass	south end of trail	April 28
27	Khyber Pass	south end of trail	August
28	Puffin Rock	base of trail leading to Puffin Rock	April 28
29	Puffin Rock	base of trail leading to Puffin Rock	August
30	Puffin Rock	trail leading to S. Saddle plot	April 28
31	Puffin Rock	trail leading to S. Saddle plot	August
32	Puffin Rock	trail on N. side of Saddle	April 28
33	Puffin Rock	trail on N. side of Saddle	August
34	Puffin Rock	trail leading to COMU/TUPU blind	April 28
35	Puffin Rock	trail leading to COMU/TUPU blind	August
36	Puffin Rock	COMU/TUPU blind rebuilt in 1999	April 28
37	Puffin Rock	trail leading to Puffin Rock (middle)	August
38	Calamity Cove	banding shelter	April 28
39	Calamity Cove	banding shelter	August
40	Calamity Cove	trail to capture net	April 28
41	Calamity Cove	trail to capture net	August
42	Calamity Cove	CAAU/RHAU capture net	August
43	South Bay	CAAU/RHAU capture net (west to east)	April 28
44	South Bay	CAAU/RHAU capture net (west to east)	August
45	South Bay	CAAU/RHAU capture net (east to west)	April 28

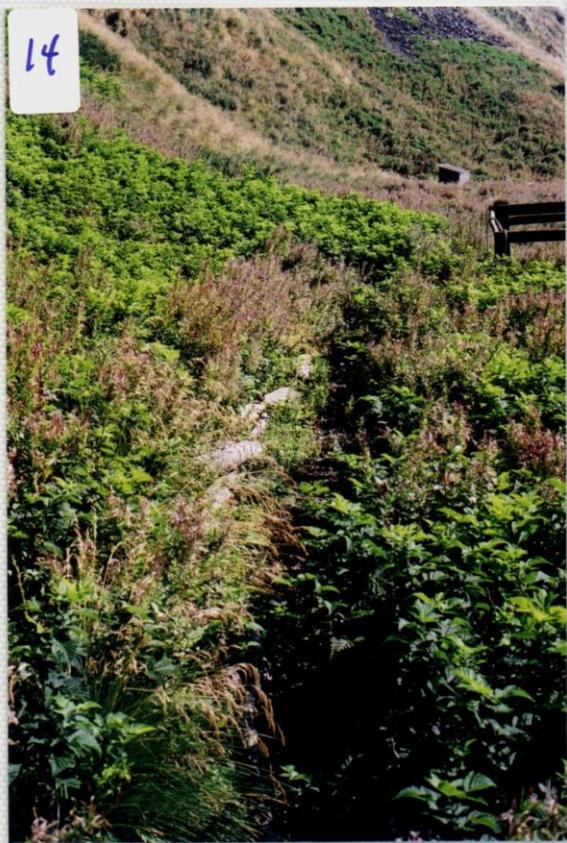
Appendix 1: Photographs of Areas of Activity on Triangle in 2000 continued...

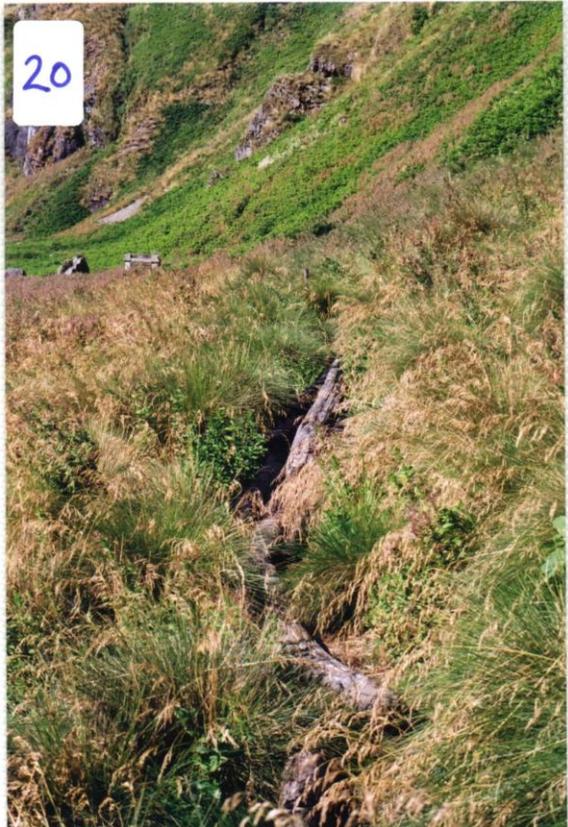
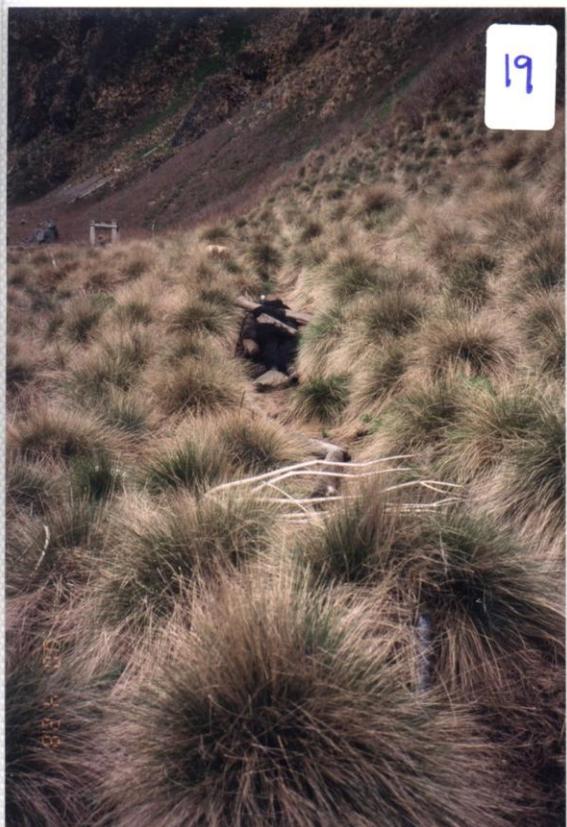
46	South Bay	CAAU/RHAU capture net (east to west)	August
47	South Bay	base of trail to Net plot	April 28
48	South Bay	base of trail to Net plot	August
49	South Bay	base of trail to Slide plot	April 28
50	South Bay	base of trail to Slide plot	August
51	South Bay	ladders erected to access Slide plot	April 28
52	South Bay	ladders erected to access Slide plot	August
53	South Bay	new ladder added to Slide plot (top)	April 28
54	South Bay	ladders erected to access slide plot (mid)	August
55	South Bay	trail to plot behind cabin (abandoned)	April 28
56	South Bay	trail to plot behind cabin (abandoned)	August
57	South Bay	helicopter pad	April 28
58	South Bay	helicopter pad	August
59	South Bay	trail east of cabin	April 28
60	South Bay	trail east of cabin	August
61	South Bay	tent pad site adjacent to cabin	April 28
62	South Bay	tent pad site refitted for new weatherport	August
63	South Bay	front of cabin	April 28
64	South Bay	front of cabin	August
65	South Bay	propane storage area (E. side of cabin)	April 28
66	South Bay	propane storage area (E. side of cabin)	August
67	South Bay	rear storage area behind cabin	April 28
68	South Bay	rear storage area behind cabin	August
69	South Bay	outhouse site	April 28
70	South Bay	outhouse site	August
71	South Bay	west boardwalk leading to cabin	April 28
72	South Bay	west boardwalk leading to cabin	August
73	South Bay	trail from cabin to weatherport (W. side)	August
74	South Bay	trail from cabin to weatherport (E. side)	August
75	South Bay	west trail leading to cabin (W. view)	April 28
76	South Bay	west trail leading to cabin (E. view)	August
77	South Bay	west trail leading to cabin (1998 repair)	April 28
78	South Bay	west trail leading to cabin (1998 repair)	August



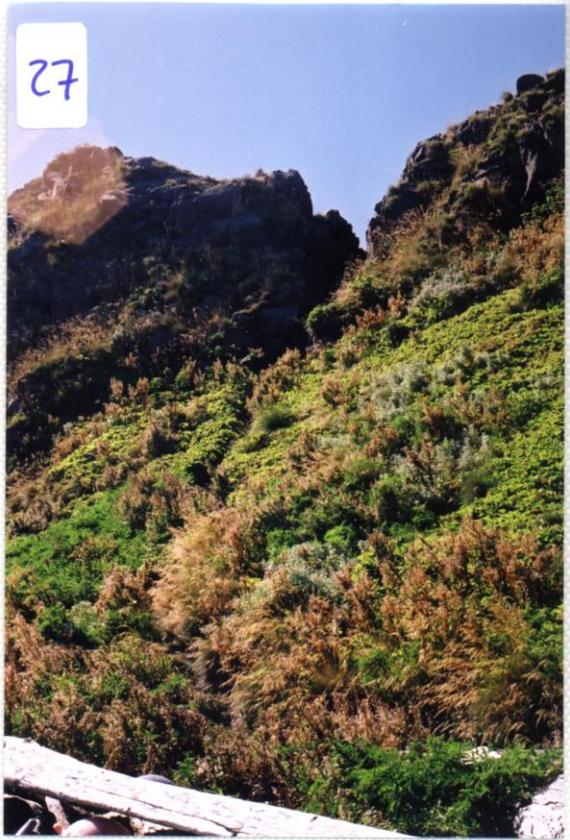
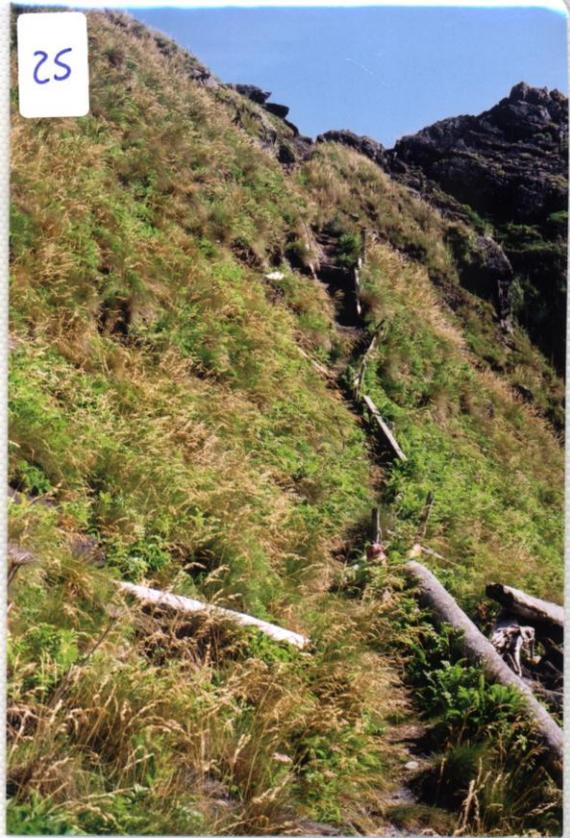




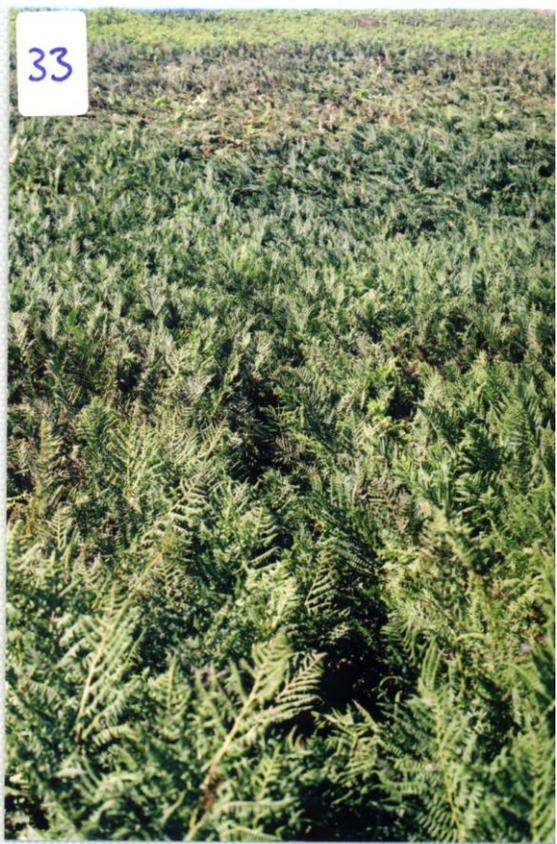






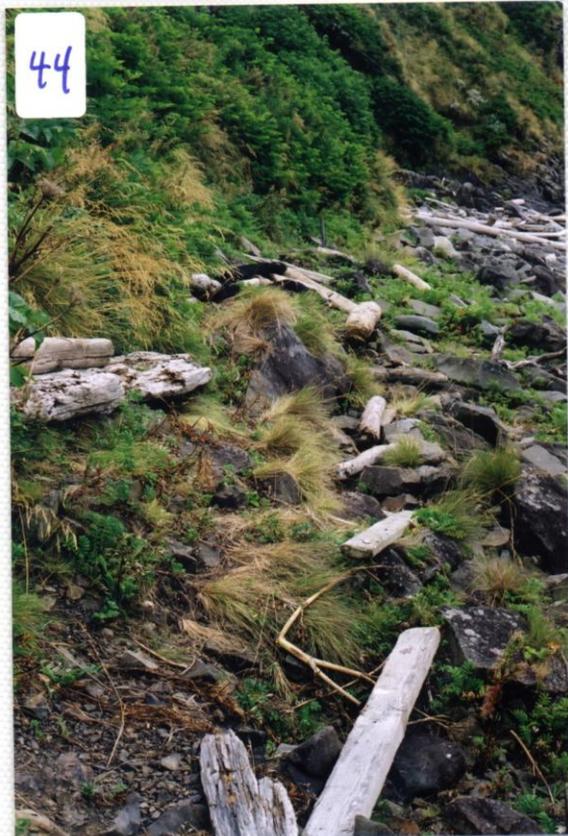


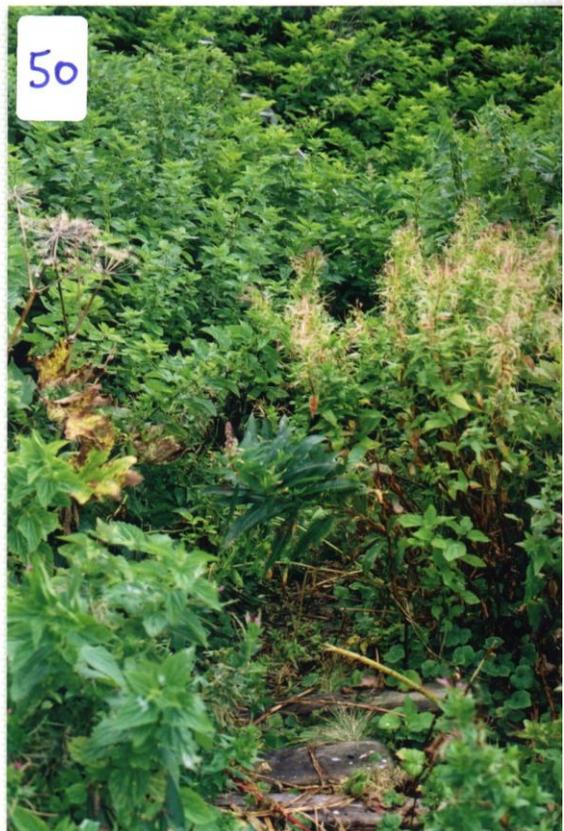
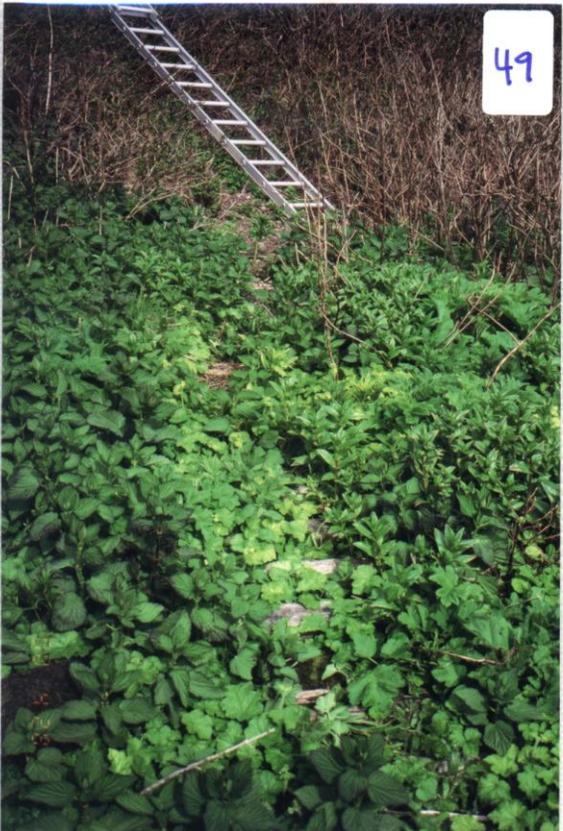


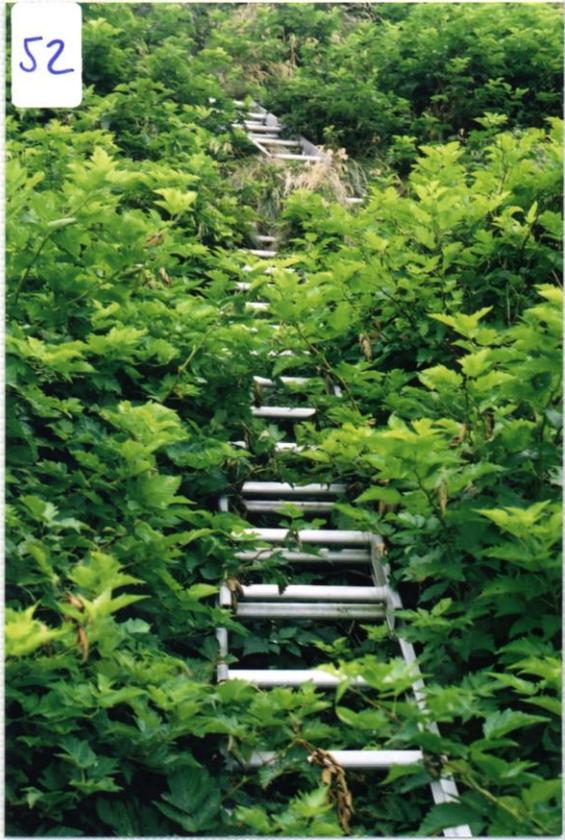




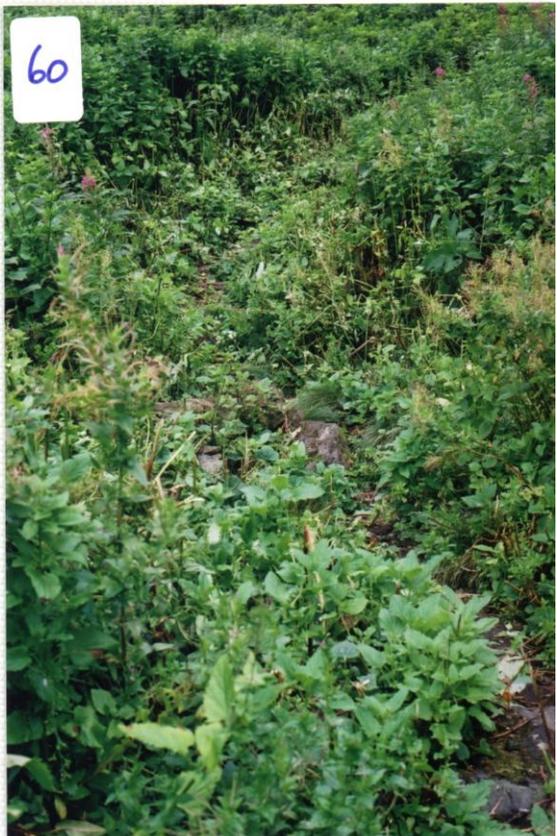


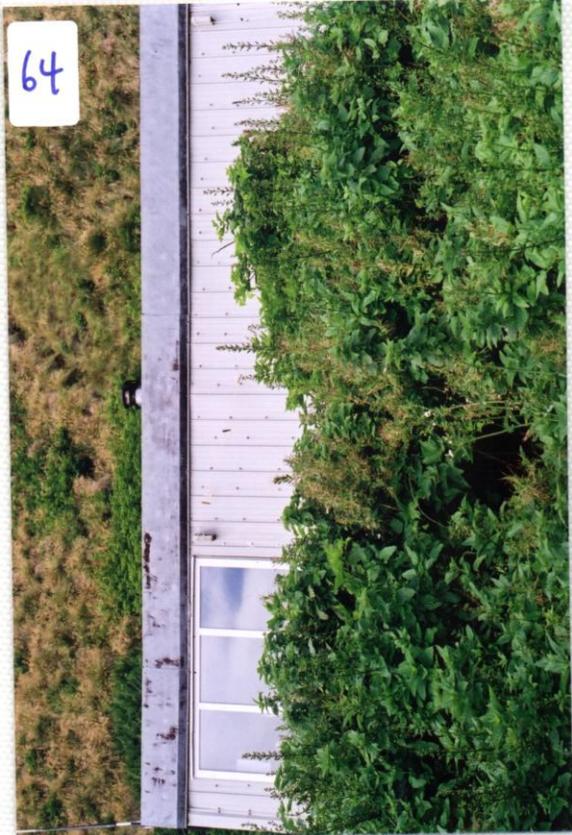




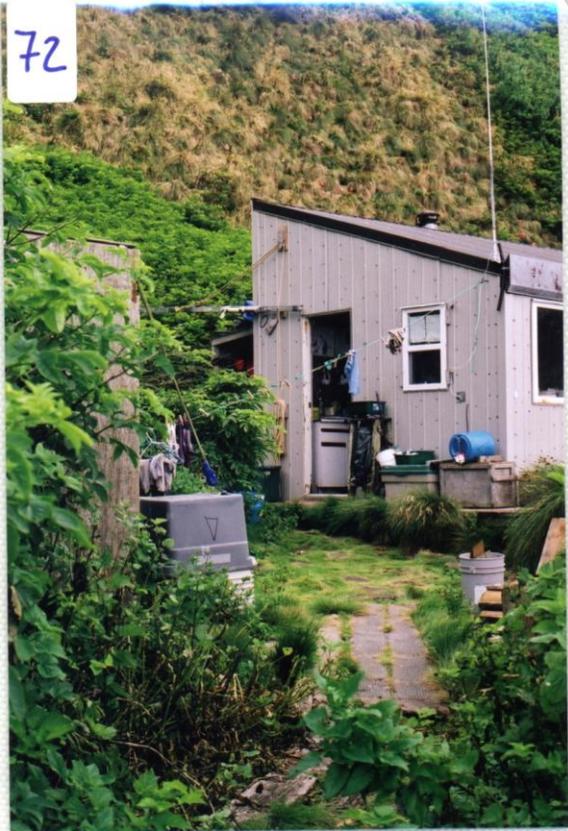


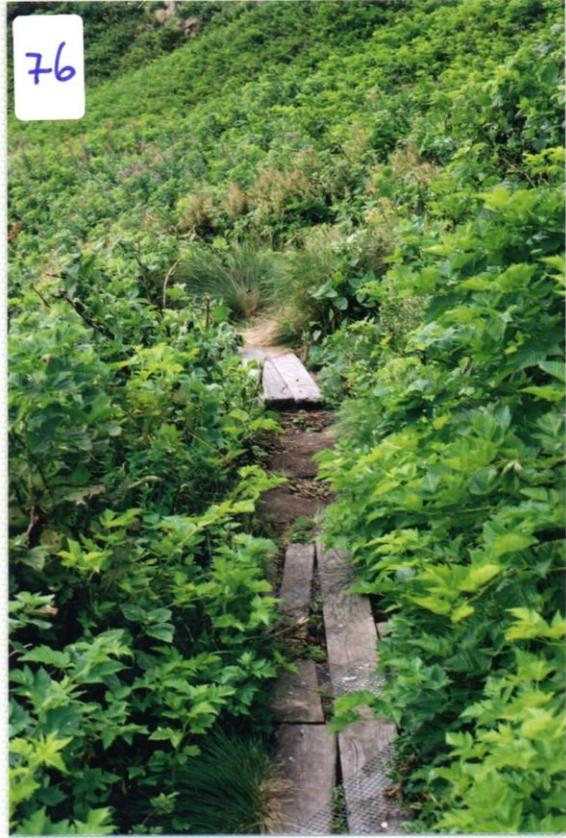












Appendix 2: Visitors to Triangle Island in 2000

Date:	Vessel name:	ID#:	Type²:	Anchored (Y/N):	Comments:
7 May, 2000	Sleepwalker	22678	F	Y	
10 May, 2000	Argyle No. 1	23279	F	Y	
13-14 May, 2000	Velma C.	21569	F	Y	
23 May, 2000	Ocean Zephyr	30552	F	N	Towing rusty boat by S. Bay West to East
23 May, 2000	?	125912	F	N	Rusty boat being towed
28 May, 2000	Sable Mist	30926	F	Y	
6 June, 2000	?	23561	F	N	Passed S. Bay
10 June, 2000	Argyle No. 1	23279	F	N	Passed S. Bay
21 June, 2000	Sable Mist	30926	F	Y	Came to shore to visit research station
23 June, 2000	Ste-Bo-J	25137	F	Y	
27-28 June, 2000	Ocean Sunrise	??514	F	Y	
28 June, 2000	Sable Mist	30926	F	Y	Came to shore to pick up floats
3 July, 2000	(2) AK Dept.of Fish and Game vessels		O	N	Surveyed for marked sealions at Triangle
7 July, 2000	Kiley Rand	27897	F	N	
13 July, 2000	Night Flight	25204	F	Y	
14-17 July, 2000	Emerald Pass	24806	F	Y	anchored all 4 dates
16-17 July, 2000	Night Flight	25204	F	Y	anchored both dates
21-22 July, 2000	?	21437	F	Y	anchored both dates
22 July, 2000	Emerald Pass	24806	F	Y	
23 July, 2000	?	21437	F	N	vessel appeared to be firing shots from small caliber rifle toward sealions, NE Bay
31 July-4 Aug, 2000	Emerald Pass	24806	F	Y	anchored all 5 dates
5 Aug, 2000	Emerald Pass	24806	F	Y	
13 Aug, 2000	Prancer	23992	F	Y	
13 Aug, 2000	Bold Performance	20702	F	Y	arrived @ 2130 with lights on and anchored

² TR=transport vessel, T=trawler, SB=sailboat, F=fishing vessel, O=other

Appendix 3: Major Marine Mammal Sightings in 2000

Date:	Species:	Number:	Location/comments:
8 May, 2000	Killer whale	5-7	Inside S. Bay
9 May, 2000	Sea otter (adult)	1	S. Bay
23 May, 2000	Humpback whale	1	Inside S. Bay / feeding @ 2200
31 May, 2000	Humpback whale	3	Inside S. Bay / 2 adults and a calf seen at 1055
1 June, 2000	Humpback whale	> 50	West of W. Bay / blowspouts seen all afternoon out to horizon
3 June, 2000	Humpback whale	2	Off Puffin Rock / 1 adult and a calf seen @ 1500
8 June, 2000	Minke whale	1	S. Bay / seen @ 1830
8 June, 2000	Pacific white-sided dolphin	7-10	S. Bay / seen @ 1900
8 June, 2000	Blue whale	≈ 4	> 15 miles south of S. Bay
10 June, 2000	Humpback whale	> 20	Outside of S. Bay
16 June, 2000	Humpback whale	2	S. Bay
16 June, 2000	Harbour porpoise	≈ 5	S. Bay
11 July, 2000	Humpback whale	≈ 15	> 10 miles south of S. Bay / seen all evening
29 July, 2000	Stellar sealion w/ "ringed neck"	1	Calamity Cove / scarred from monofilament line
1 Aug, 2000	Humpback whale	1	Below and west of Puffin Rock

Appendix 4. CAAU home ranges of radio-marked adults (1999-2000)

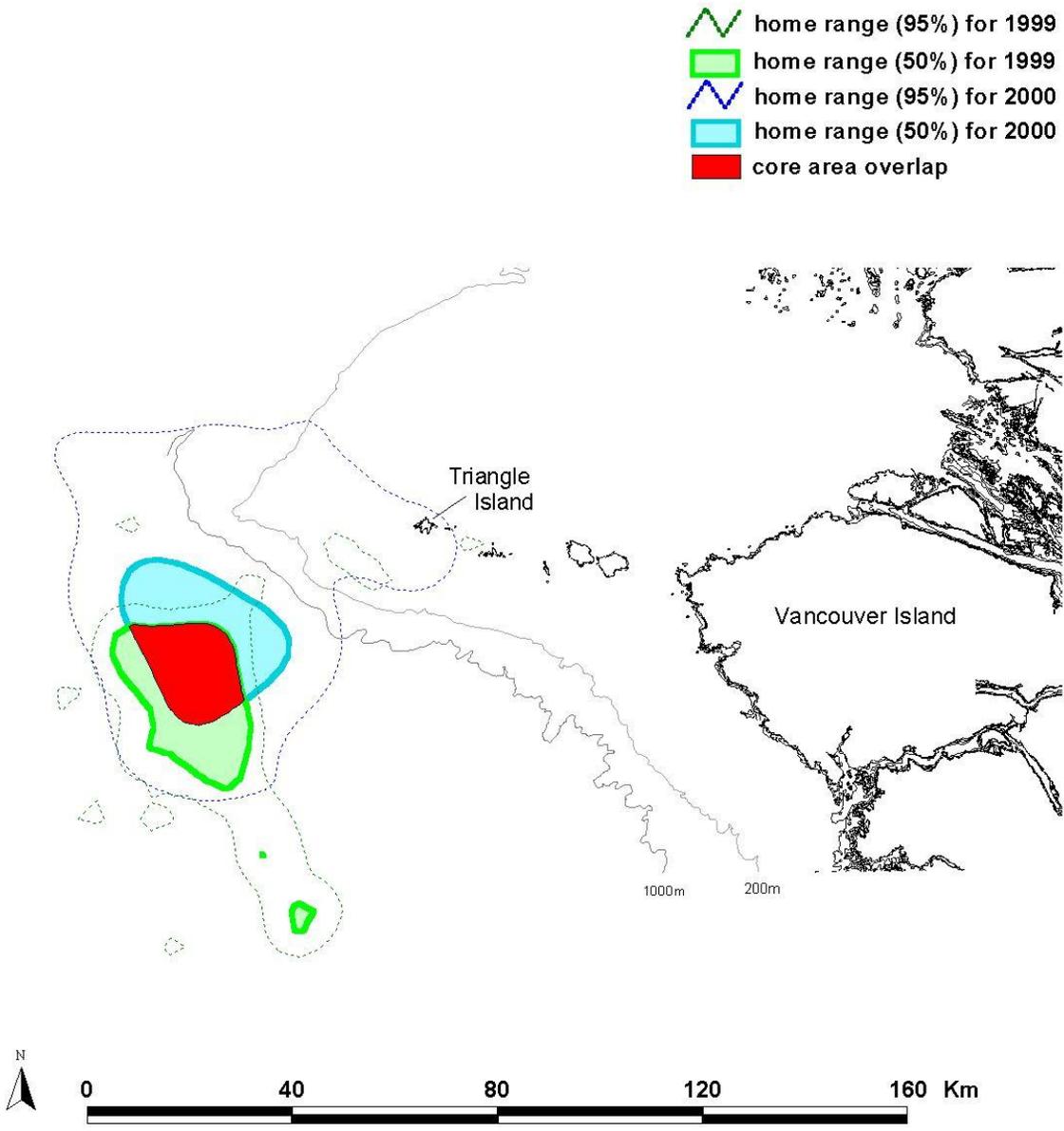


Fig. 2. Home ranges estimated for birds detected on 10 and 23 June, 1999 (green areas) and for birds detected on 1 and 15 June, 2000 (blue areas). Core areas are shaded and the overlap is indicated in red.

Appendix 5. Safety protocol for working on Puffin Rock

Safety Protocol for Puffin Rock **DRAFT 1**– Carina Gjerdrum, Sharilynn Wardrop

Description

Puffin Rock is a steeply sloped islet, rising to a height of approximately 100m, and is joined to the western point of the mainland of Triangle island. The most abundant plant species include salmonberry (*Rubus spectabilis*) and tufted hairgrass (*Deschampsia caespitosa*). Puffin Rock supports the densest breeding colony of Tufted Puffins on the island, estimated at about 25 000 pairs. They nest mainly around the perimeter of the islet and down the steepest slopes, above cliff edges, in burrows beneath the tufted hairgrass. An estimated 8000 Common Murres breed on the southeastern cliffs of Puffin Rock and on the rock off its west side. Several dozen Glaucous-winged gulls breed in open cup nests on the top of Puffin Rock, their main breeding area. One to two hundred Pelagic Cormorants nest along the Rock's cliffs on the western side. The nests of Cassin's Auklets can be found interspersed among the puffin burrows and across the saddle of the islet. Fork-tailed and Leach's Storm-Petrels can be heard calling from the southern end of Puffin Rock at night.

Walking

When walking to Puffin Rock, sturdy waterproof footwear is essential, as the rocks that join Puffin Rock to the main island are often inundated with tidal waters, making the walk quite slippery. During the highest flood tides it can be difficult or impossible to reach Puffin Rock. Pay attention to tide levels to avoid getting trapped by a very high tide when returning to the cabin. Safety helmets are recommended when crossing the intertidal region from the main island to Puffin Rock, and they **MUST** be worn while ascending Puffin Rock. The trail that leads up Puffin Rock (N. east side of Puffin Rock, see map) is clear of vegetation throughout the season and is clearly visible. There are also steps inserted at critical areas along the trail using re-bar anchors to ensure hiker safety and prevent erosion. These steps must be inspected on a monthly basis during the summer and be replaced if they are dislodged or cracked. The trail is steep and extreme care must be taken when using it. A nylon rope follows the trail to the top and is anchored into the rock in several places using pitons and tubular webbing. The rope is not meant to carry one's full weight but is instead an aide for support and balance during the climb. The rope, piton anchors and tubular webbing must be inspected at yearly intervals to ensure that they are not worn or damaged, and must be replaced if this has occurred.

The terrain at the top is flat and there is a trail that leads through the salmonberry to the observation blind located at the southern end of Puffin Rock. The trail is an easy one to walk and is located far from any cliff edges. Trails have also been cut through the salmonberry to the 2 main study plots on Puffin Rock (a and c on the map). Walking off the designated trails is not permitted.

On the slopes

A safety line was anchored into the soil above 2 TUPU study sites in 1999 (see map, lines a and b) and above the monitoring plot in 2000 (see map, line c). The safety line is a static climbing rope, attached with nylon, tubular webbing and carabiners, to several 4-foot long steel re-bar anchors. Anyone working on the slopes **MUST** wear a climbing harness with a 25m-long dynamic climbing rope clipped to the safety line between 2 of the anchors, with a locking carabiner. There must be at least 2 re-bar anchors on either side of the point where the climbing rope is attached to the safety line. At the beginning of the season the outermost re-bar anchors should be flagged with a different colour fluorescent flagging tape than the inner anchors. Therefore, when locking the climbing rope to the safety line, the researcher need only ensure that the anchors on either side have the same colour flagging tape. Due to the difficult terrain, the safety line could not be constructed to sustain a person's entire weight for extended periods of time. The safety line/anchors will, however, prevent someone from falling before they reach the cliff edge. The safety line does not permit the researcher to go into areas not already approved for study by BC Parks and on no occasion may the researcher be on the study slopes without being locked into the safety line. When checking burrows on Puffin Rock, at least two researchers must be present and safety helmets must be worn. At the end of the season the safety rope, tubular webbing and carabiners used to attach the rope to the anchors must be removed and stored for the winter. Re-bar anchors may be left in place, but they must be inspected at the start of each season to ensure they haven't rusted out and are still anchored properly. Replace re-bar anchors where necessary.

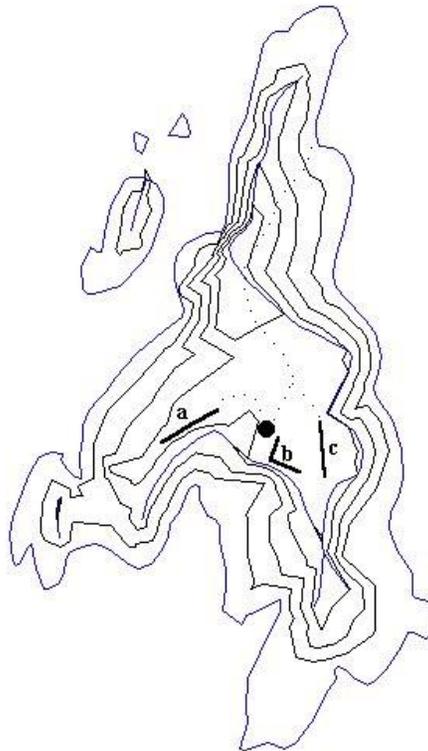
Blind Work

In situations where work on Puffin Rock is restricted to the blind only, it is possible for one person to ascend alone. In these circumstances, the researcher must take a fully charged hand-held radio with them, which someone will monitor from the cabin on an agreed upon working frequency. When ascending Puffin Rock alone, the researcher must alert the contact at the cabin when they begin to ascend the Puffin Rock trail and then confirm that they are safe on arrival at the top. Likewise, when descending from Puffin Rock, it is imperative to check in both at the start of the trail and again on arrival at the bottom. It is never acceptable to venture out onto the slopes unaccompanied. Note that sedentary work in the blind can be extremely cold, even on sunny days, so it is necessary to bring extra warm clothes or a very close friend when working in the blind.

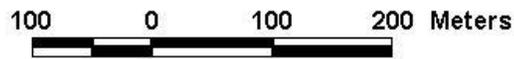
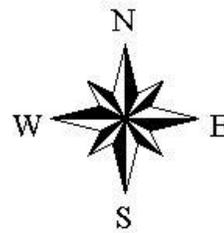
Maintenance

It is crucial that the trail up to Puffin Rock is maintained on a regular basis. The steep nature of the trail lends itself to risk of erosion, which can expose slippery rock faces. In addition, it is critical to minimize researcher impact on the slope and avoid erosion of the trail. Therefore, steps will be added and replaced where needed using 2"x 24" slabs of cedar wood anchored with 4 foot re-bar stakes. The re-bar will be flagged with fluorescent flagging tape to ensure that it is visible when climbing the trail, and to prevent injury.

Puffin Rock Safety Lines Triangle Island



- Blind
- Safety Line
- Path



Appendix 6. Copies of Triangle Island research papers published/in press
2000-

2001



Sea Foraging Distributions of Radio-Marked Cassin's Auklet Breeding at Triangle Island B.C.



redation on seabird eggs by Keen's mice.pdf



"The seasonal cycle
revisited- interannual



Seasonal Decline in Nestling Growth.cd