Exxon Valdez Oil Spill
Restoration Project Final Report

Common Murre Restoration Monitoring in the Barren Islands, Alaska, 1993

Restoration Project 93049
Final Report

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Study History: Murre studies sponsored by the *Exxon Valdez* Oil Spill Trustee Council were initiated in 1989 as Department of Interior - Fish and Wildlife Service (DOI-FWS) Bird Study Number 3 (Population Surveys of Seabird Nesting Colonies in Prince William Sound, the Outside Coast of the Kenai Peninsula, Barren Islands, and other nearby Colonies, with Emphasis on Changes in Numbers and Reproduction of Murres). During the course of this 3-year long damage assessment project, 3 progress reports were submitted to the Trustee Council (see Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992), and a final report was completed in 1993 (see Nysewander *et al.* 1993, Effects of the *T/V Exxon Valdez* Oil Spill on Murres: A Perspective from Observations at Breeding Colonies). Restoration monitoring work started in 1992, and Barren Islands murre studies were continued as part of Restoration Project Number 11 (see Dragoo *et al.* 1994, Effects of the *T/V Exxon Valdez* Oil Spill on Murres: A Perspective from Observations at Breeding Colonies Four Years After the Spill). This initial restoration monitoring effort became Restoration Project 93049 in 1993, a study that was implemented after approval of a detailed DOI-FWS study plan that emphasized collecting population numbers, nesting chronology, and productivity data at both Barren Islands colonies (see DOI-FWS Detailed Project Description, Monitoring Recovery of Common Murres in the Barren Islands).

Abstract: This report summarizes the results of the second year of common murre (*Uria aalge*) restoration monitoring work conducted in the northern Gulf of Alaska for the *Exxon Valdez* Oil Spill Trustee Council. Information on population numbers, nesting chronology, and productivity of murres were collected by U.S. Fish and Wildlife Service (FWS) biologists at the injured East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies in the Barren Islands during the 1993 breeding season. These data are presented and statistically compared with information reported in the 1989-1992 FWS murre damage assessment and restoration studies. Although murre productivity was high (average = 0.63 fledglings per egg) at the Barren Islands in 1993 compared to values reported from other Alaskan colonies, no trends were found in population numbers over the 5-year postspill interval.

Key Words: *Ammodytes hexapterus*, avian predation, bald eagle, Barren Islands, capelin, common murre, common raven, *Cyclorrhynchus psittacula*, East Amatuli Island, *Exxon Valdez*, *Falco peregrinus pealei*, forage fish, glaucous-winged gull, Gulf of Alaska, humpback whale, *Mallotus villosus*, *Megaptera novaeangliae*, monitoring, murre, nesting chronology, Nord Island, oil spill, population census, population counts, Prince William Sound, productivity, *Uria aalge*, *Uria lomvia*, reproduction, restoration, sand lance.

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EXECUTIVE SUMMARY

Introduction

The Barren Islands supported one of the largest breeding concentrations of common murres *(Uria aalge)* in the path of the *Exxon Valdez* oil spill. Many murres died during the event: 74% of 30,000 bird carcasses recovered by 1 August were murres , and some estimates of total bird mortality suggested that losses of these birds may have ranged from 74,000 to 314,000 individuals. Because murre mortality appeared to be high and large populations of these birds nested in the Barren Islands, the U.S. Fish and Wildlife Service (FWS) conducted *Exxon Valdez* Oil Spill Trustee Council-sponsored murre damage assessment and restoration studies there during 1989-1991 and 1992, respectively. In 1993, FWS biologists performed additional restoration monitoring work at the Barren Islands during 15 June - 9 September. Although common murre productivity was high at the colonies compared to values reported from other Alaskan nesting locations, no trends were found in population numbers over the 5-year postspill interval.

Objectives

The project objective was to collect population numbers, productivity, and nesting chronology data at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies and evaluate the recovery status of this injured species at these important northwestern Gulf of Alaska nesting locations 5 years after the spill.

Methods

Population Counts: Three different types of counts were made at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet murre colonies to compare data with information from previous FWS postspill studies and assess differences among years and trends in population numbers: censuses of entire colonies, including some major subsections of the nesting complexes (e.g., East Amatuli Island, Light Rock); counts on sets of multicount plots; and counts on productivity plots. The multicount and population census plot counts were made from boats using standard FWS methods and protocols that took into account daily and seasonal attendance patterns of adults. Productivity plots were also counted using standard procedures. Count results were compared with information from previous FWS postspill studies, whenever corresponding data were available. One-way analysis of variance (ANOVA) and Tukey HSD multiple pairwise comparison tests were used to check for differences among years. Trends in population numbers were checked with Kendall's Tau rank correlation tests.

Timing of Nesting Events: Median hatching dates were used to describe nesting chronology at both colonies. These dates were derived from productivity plot data by calculating midpoints between events and, if required, adding 32 days to laying dates. Plots were treated as sample units during all calculations. Productivity plot data were also used to calculate first and mean laying dates and mean hatching dates, and these data and incidental colony-wide observations of first laying dates were compared with FWS postspill information and data from other Gulf of Alaska colonies. The difference between study site median hatching dates was checked with a 2-tailed *t*-test.

Productivity: Productivity data were collected at regular intervals on 10 East Amatuli Island - Light Rock and 8 Nord Island study plots using standard FWS methods that included noting incubation and brooding postures of adults and calculating midpoints between events. Fledglings per egg laid was the measurement of productivity, and during calculations, plots were treated as sample units. Hatching success, fledging success, and numbers of chicks per adult were also calculated for comparison with information from the 1989-1992 FWS Barren Islands studies and other Alaskan colonies. Differences among years in periodic and 1-day chicks per adult numbers, the only information available from the previous FWS postspill investigations, were checked with Tukey HSD multiple pairwise comparison and ANOVA tests, and 2-tailed *t*-tests, respectively.

Avian Predators: Some information on avian predators was obtained at the Barren Islands murre colonies during population and productivity work. Incidental observations were recorded to provide general information on predation at both study sites.

Results

Population Counts: Several population count data sets were obtained at the East Amatuli Island - Light Rock colony; however, comparisons to previous FWS postspill information was limited to Light Rock and 2 historical multicount plots, because these were the only parts of the colony counted during the 1989-1992 FWS studies. Although the Light Rock estimate was significantly higher than the average 1990 count (Tukey HSD, $P = 0.017$), it did not differ from the 1989 score, and no trend was found over the 5-year postspill period. Counts on the 2 multicount plots were similar to the Light Rock results. The average 1993 score was significantly higher than all previous FWS estimates (Tukey HSD; $P = 0.034$, < 0.001, $= 0.037$, and < 0.001 for 1989, 1990, 1991, and 1992, respectively) and no trend was detected over the postspill interval.

The entire Nord Island - Northwest Islet colony and 11 historical multicount plots were also counted several times. The 1993 whole-colony estimate did not differ from the 1989-1991 FWS scores, and no trend was found over the 5-year postspill period. Although the 1993 and 1990 FWS multicount plot estimates were significantly higher than the average 1989 and 1992 FWS counts (Tukey HSD; $P = 0.006$ and 0.016, and 0.002 and 0.005, respectively), results were similar to the whole-colony analysis: no trend was present over the postspill interval.

Timing of Nesting Events: Incidental observations of first eggs at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies were 24 and 30 June, respectively. However, eggs were not laid on study plots at the nesting complexes until 9 and 12 July, respectively. Mean laying dates were 16 and 19 July, and median hatching dates were 16 and 19 August. The 3-day difference between hatching dates was significant [$t_{0.10(2)}$, $= 1.98$, $P = 0.065$].[1]

Productivity: Productivity was high at the East Amatuli Island - Light Rock and Nord Island study sites: 0.55 and 0.71 chicks fledged per egg laid on the study plots, respectively. The difference between colonies was significant (2-tailed *t*-test, $P = 0.043$). Most of this difference resulted from losses of chicks on 2 East Amatuli Island - Light Rock plots during a late season storm that had little impact on the remainder of the plots, including those at Nord Island.

Based on periodic-visit data, numbers of chicks per adult were the same at both study sites (0.35 chicks/adult). These values were not significantly different from the reported 1992 Nord Island periodic number (0.29 chicks/adult).

Avian Predators: Bald eagles *(Haliaeetus leucocephalus)*, peregrine falcons *(Falco peregrinus pealei)*, glaucous-winged gulls *(Larus glaucescens)*, and common ravens *(Corvus corax)* were present at the colonies. Eagles targeted adult murres (Nord Island), whereas gulls and ravens took eggs (both colonies), particularly when eagles flushed birds from nesting ledges (peregrine falcons rarely interacted directly with murres). Eggs laid early in the nesting season appeared to be more vulnerable to gulls and ravens than those laid after attendance stabilized. Some observations suggested that avian predation was higher at Nord Island - Northwest Islet than at East Amatuli

[1] Subscripts indicate the *t*-test was a 2-tailed test conducted at the 0.10 significance level.

Island - Light Rock. Eagles continued to flush murres from the Nord Island nesting cliffs well past the time these events stopped at East Amatuli Island - Light Rock (at least mid-August vs. 6 July), and gulls and ravens continued to take advantage of the incidents to search for unprotected eggs.

Discussion

Population Counts: Abilities to detect changes in population size increase with the number of counts, and the small number of counts made on the East Amatuli Island - Light Rock and Nord Island - Northwest Islet multicount plots during the 1989-1991 FWS studies (only 2-3 per year per colony) reduced the power of the tests to detect trends in population numbers at the colonies. However, because more than 1 count was made each year, and because count patterns were generally similar between data sets, the results of the trend analyses were probably correct, and it appears unlikely that total population sizes changed significantly over the 5-year postspill interval.

Timing of Nesting Events: Although the 3 day difference in median hatching dates between study sites was significant (2-tailed t-test, $P = 0.065$), it may not have been as significant as suggested by calculated dates, because less frequent visits to Nord Island reduced variability. Mean laying dates suggested that Barren Islands birds nested about 1.0-1.5 weeks ahead of the 1991-1992 breeding schedules. Incidental observations of first eggs were earlier than dates reported in the 1989-1991 FWS studies, and similar to those reported from these and several other northern Gulf of Alaska colonies during the mid- and late 1970's.

Productivity: Productivity values obtained at both study sites were high, compared to values reported from other Gulf of Alaska nesting colonies during the late 1970's - early 1980's and the late 1980's - early 1990's (e.g., Ugaiushak Island, Semidi Islands), and they were well within the ranges reported from other regions of Alaska during the mid-1970's - early 1990's (e.g., Pribilof Islands in the Bering Sea, Bluff in Norton Sound). Periodic chicks per adult values were within the range reported from the Semidi Islands in the late 1980's - early 1990's.

High murre productivity at the Barren Islands study sites indicated that prey availability was high during critical times of the breeding cycle. Numerous observations of birds returning to the nesting colonies throughout July and August with fish in their bills that were almost certainly either capelin *(Mallotus villosus)* or Pacific sand lance *(Ammodytes hexapterus)*; large, dense schools of small fish detected on vessel fish-finders; and the presence of large concentrations of feeding humpback whales *(Megaptera novaeangliae)* during late June - late August provided evidence that prey resources were abundant and available in the region throughout most of the nesting season.

Avian Predators: Harassment of murres by bald eagles during early July may have influenced the later stabilization of adult attendance and rapid initiation of egg-laying at Nord Island - Northwest Islet. The continuing presence of eagles at this colony after mid-July was probably related to the proximity of Ushagat Island, which supports several nesting pairs of these raptors.

Conclusions

1. Based on analyses of FWS count data, no trends in murre population numbers were detected over the 5-year interval following the spill (i.e., over the years 1989-1993).

2. Based on mean laying dates reported in the 1992 FWS study, murres apparently nested about 1.0-1.5 weeks earlier than in 1991-1992. First-egg dates were earlier than reported in the 1989-1992 FWS studies, and were about the same as those reported for these and several other northern Gulf of Alaska colonies in the mid- and late 1970's (e.g., Chisik, Ugaiushak, and Hinchinbrook islands).

3. Productivity (fledglings per egg laid) of murres was high at the Barren Islands colonies, compared to ranges reported from other Gulf of Alaska nesting locations in the late 1970's - early 1980's and late 1980's - early 1990's (e.g., Ugaiushak and Semidi islands). Chicks per adult values fell within normal ranges, based on information from other Alaskan colonies in the late 1980's - early 1990's (e.g., Semidi Islands, Agattu Island).

4. The high productivity of murres at the Barren Islands colonies was probably related to the availability and abundance of forage fish during critical parts of the nesting season (e.g., the chick-rearing period). Although forage fish were obviously available to deep-diving birds (e.g., common murres), they were apparently not available to surface-feeding species (e.g., black-legged kittiwakes, a species that experienced a near-complete breeding failure at the Barren Islands colonies in 1993).

5. Avian predation may occur more frequently over a longer period of time at the Nord Island - Northwest Islet murre colony, compared to the East Amatuli Island - Light Rock colony, because nearby Ushagat Island contains habitat that supports several nesting pairs of bald eagles that commute to Nord Island to prey on seabirds.

INTRODUCTION

The Barren Islands, in the northwestern Gulf of Alaska, supported one of the largest breeding concentrations of common murres *(Uria aalge)* in the path of the *Exxon Valdez* oil spill (e.g., Sowls *et al.* 1978, Piatt *et al.* 1990, FWS 1994).[1] These diving, fish-eating seabirds spend most of their lives at sea and are highly vulnerable to floating oil (e.g., Bourne 1968, Clark 1969, Vermeer and Vermeer 1975, Roseneau and Herter 1984). When winds and currents swept oil through the Gulf of Alaska in April and early May 1989 (Fig. 1), large numbers of murres were already beginning to aggregate in waters near the breeding colonies and many of them died because of the event (Piatt *et al.* 1990). Piatt *et al.* (1990) reported that 74% of the 30,000 bird carcasses recovered by 1 August were murres, and they estimated total direct mortality of all bird species at 100,000-300,000 individuals.[2] These figures suggest that 74,000-222,000 murres died during the spill. Later, a computer modeling study that relied on a review of recovered carcasses, a 72% murre component, and the experimental release of carcasses at sea calculated that 375,000-435,000 birds of all species were killed by the event (ECI 1991; the 375,000-435,000 figure was listed as the "best approximation"). This higher estimate of total avian mortality, combined with revised proportions of species in the salvaged carcass pool, suggested that 271,500-314,900 murres died after contacting the floating oil.

Because the impact of the oil spill on common murres appeared to be severe, and large populations of these birds nested at the Barren Islands colonies, the U.S. Fish and Wildlife Service (FWS) conducted *Exxon Valdez* Oil Spill Trustee Council-sponsored murre damage assessment studies there during 1989-1991 (e.g., Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993). FWS biologists also monitored populations and productivity of common murres in these islands in 1992, as part of the first Trustee Council restoration project designed to evaluate recovery of this injured species in the spill area (Dragoo *et al.* 1994).

In 1993, we conducted a more intensive restoration project to monitor common murre recovery in the Barren Islands. We compared our results with data from previous FWS postspill studies at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies. Although common murre productivity was high at both nesting locations compared to values reported from other Alaskan sites, no trends were found in population numbers over the 5-year postspill interval.

OBJECTIVES

Our objective was to monitor the recovery of common murres at the Barren Islands nesting colonies. The objective was met by collecting population and productivity data at both colonies, testing 1989-1993 FWS information for postspill trends, and comparing reproductive timing and

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[1] Prespill estimates of murres listed for the Barren Islands colonies in Sowls *et al.* (1978) and the FWS Alaska seabird colony catalog computer data base and colony status record archives are incorrect. Bailey (1975a) estimated 20,000 birds at Nord Island - Northwest Islet in 1975, not 30,000 birds, as erroneously reported in Bailey (1975b, 1976). Also, Bailey (1975a,b; 1976) estimated 61,400 murres at the East Amatuli Island - Light Rock colony in 1975, and Manuwal (1980) estimated 50,000 birds there in 1979, not 100,000 individuals, which was an error created when he listed the 50,000 bird estimate in a table reporting seabird pairs. During the late 1970's, the East Amatuli Island - Light Rock colony was estimated to contain about 15% thick-billed murres *(U. Lomvia)* and 85% common murres (see Manuwal 1980). In 1993, small numbers of thick-billed murres were found on the East Amatuli Island cliffs, but they were not observed nesting at Light Rock or Nord Island - Northwest Islet. In general, these observations suggest that the total Barren Islands population probably consists of more than 85% common murres.

[2] Seventy percent of the murre carcasses were common murres (Piatt *et al.* 1990; J.F. Piatt, pers. comm.).

success measurements with data from other studies to see if these variables were within the ranges reported from other Alaskan populations.

METHODS

The Barren Islands are located at about 58° 55' N, 152° 10' W between the Kodiak Archipelago and the Kenai Peninsula (Fig. 1). Our study sites consisted of East Amatuli and Nord islands and 2 closely associated islets, East Amatuli Light Rock (Light Rock) and Northwest Islet (Fig. 2). These 4 areas, which we have named the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies, contain all of the murre nesting habitat in the Barren Islands group.

At East Amatuli Island - Light Rock, most of the murre nesting habitat is concentrated between Arches and Triangle Rock on a series of high steep cliffs at the southeastern end of East Amatuli Island, and on the terraced sides and broad flat top of nearby Light Rock (Fig. 3a). Smaller numbers of murres nest on the south-facing cliffs near the island's western end, between Arches and Seal Rocks, and on the headlands just northwest of Triangle Rock.

Most of the murres at Nord Island - Northwest Islet nest on a series of high shear cliffs on the eastern side of Nord Island between Eagle and North points (Fig. 3b). Several smaller cliffs and rock outcrops on the southern and northwestern sides of the island, the southern and western flanks of adjacent Northwest Islet, and 2 nearby rocks provide the remainder of the murre nesting habitat at this colony.

We set up 2 camps in the Barren Islands to support the 1993 murre restoration monitoring study (Fig. 2). One, located at Amatuli Cove, served as base of operations for collecting population census and productivity data at East Amatuli Island - Light Rock. The other, situated on the north side of Ushagat Island, supported similar work at Nord Island - Northwest Islet. Teams of 2-3 people occupied the camps continuously during 15 June - 9 September, and 2 other project personnel visited the camps intermittently during 17 July - 20 August to help count population plots.

Field teams used 4.8 m-long, ridged-hulled, outboard-powered inflatable boats to census the colonies and commute to productivity study sites. Four-meter long, outboard-powered inflatable rafts were also used during the most labor intensive phases of the population work. Light helicopters and a 23-m long vessel were hired to supply the camps and transport personnel between Homer and the study area. The vessel also provided support for the population and productivity work at Nord Island when weather and tidal conditions prevented travel by small boat.

Population Counts

We made 3 types of counts at the Barren Islands murre colonies to obtain information for comparison with other postspill studies and improve chances of detecting among-years differences and trends in population size. The East Amatuli Island - Light Rock and Nord Island - Northwest Islet complexes were censused completely to obtain whole-colony estimates and estimates of birds in major subdivisions of the colonies (e.g., East Amatuli Island, Light Rock, Nord Island, Northwest Islet). More frequent counts were made on a series of multicount plots at both colonies to collect data for statistical analyses of among-year differences and trends in population size. These special sets of plots contained about 10-15% of the murres on the cliffs at the nesting complexes. We also counted about 500 birds on a series of productivity plots at both colonies every time we visited these special study sites. The productivity plot counts provided information on seasonal attendance patterns that helped define the boundaries of the census period, and they also supplied us with additional sets of data for population trend analyses.

To count murres at East Amatuli Island - Light Rock, we divided the colony into 64 population census plots (BCP1-64) and 8 multicount plots (BMP1-8; see Fig. 3a). These plots included University of Washington (UW) plots established during Exxon sponsored studies in 1990-1991 (P.D. Boersma, pers. comm. 1993), and the multicount plots used during the 1989-1992 FWS postspill studies (the "Mainland" plot on East Amatuli Island and the "Lt. Rock" plot on Light Rock; see Table A1 in Dragoo *et al.* 1994). When setting up the new plots, we combined several UW plots into larger units to make boundaries easier to find. Care was taken to ensure that the new plots still allowed comparisons of counts among years. The multicount plots were scattered throughout the colony to sample both central and peripheral areas in general proportion to the number of birds using these habitats. Initially, all previously established plots were located by using photographs in the Alaska Maritime National Wildlife Refuge (AMNWR) archives and maps and photographs on loan from UW staff. After 29 July, we used a new set of photographs taken for the AMNWR files to find the plot boundaries.

To census birds at Nord Island - Northwest Islet, we used 26 population census plots (BCP1-10 and 12-27) and 11 multicount plots (BMP1-11) established during previous FWS postspill studies to count birds and track population size (see Nysewander *et al.* 1993, Dragoo *et al.* 1994). We also set up 2 new census plots (BCP11 and 28) in areas that contained small numbers of murres not reported before (see Fig. 3b). Historical plots were located from photographs in AMNWR files. The new plots and several others established during the earlier FWS studies were photographed to update AMNWR records.

Five of the 6 people counting the East Amatuli Island - Light Rock and Nord Island - Northwest Islet population plots had previous experience censusing large murre colonies in Alaska. Also, 2 team members working at East Amatuli Island - Light Rock counted it in 1990-1992, and 1 person assigned to Nord Island - Northwest Islet helped census it in 1992.

The population census and multicount plots were counted from boats by teams of observers equipped with 7 x 42 binoculars and hand-held tally-meters. Distances between observers and birds varied, depending on the height and configuration of cliffs and other factors (e.g., presence of offshore rocks), but were kept as consistent as possible between all counts. In most cases, boats were either tied to bull kelp (*Nereocystis* spp.) growing 30-90 m in front of the plots or were allowed to drift slowly past them at similar distances. However, when strong tidal currents were present, observers took turns censusing birds and operating boats to maintain counting positions. On a few occasions when currents were running and time was short, 2 boat-based teams censused the same plots. In these instances, 1 person in each boat counted all of the plots, while the other crew members kept the vessels in position in front of the plots.

Productivity plot counts were made with the aid of binoculars and 15 x 60 power spotting scopes from land-based observations posts. Observers were assigned to specific plots at both study sites, and each person then counted his or her own plots at least once during every visit to them throughout the nesting season.

All counts of birds on the multicount and population census plots were made during the part of the breeding season when attendance was most stable. The census period was defined as the interval between the peak of egg-laying and the first sea-going of chicks (e.g., Hatch and Hatch 1989, Byrd 1989). Start and stop dates were initially based on our general observations of egg-laying at the closely monitored productivity plots. After attendance data from these frequently visited plots were analyzed, we used the results to refine the census interval. We also used this information to identify multicount and population census plot counts that were made before numbers of adults stabilized on the nesting cliffs. These counts were not included in the respective databases.

We used a combination of census guidelines, sun-time, and information on attendance patterns from previous Barren Islands studies to determine the best times of day for counting plots (e.g., Dragoo *et al.* 1994, unpubl. data). All counts were made during 1100-2000 hrs Alaska Daylight Time (ADT), with the exception of 8 Light Rock plots on 2 August.[1]

Population census and multicount plots were counted by 10's (i.e., birds were estimated in 10-bird groups; if bird densities varied markedly on different sections of a plot, observers refined their sight pictures by counting a few groups of 10 birds by 1's). The only exceptions were 3 East Amatuli Island multicount plots that were counted by 1's to match methods used during other studies. We also counted productivity plots by 1's, because the plots were small and this level of precision was needed to calculate comparative chicks per adult information.

In almost all cases, 2 people counted the same population census and multicount plots at the same time (only 1 observer counted the Nord Island - Northwest Islet colony on 19 July). During the counts, 1 person recorded both scores without revealing his or her own count to the other observer (if a third person was present, that person served as recorder). The recorders compared the plot scores as they were being made to see if they were within 15% of each other (i.e., within 7.5% of their average). If they were not, and time allowed, the plots were recounted until the scores fell within this range. Certain plots were difficult to count and the 15% accuracy level was waved to ensure censuses were completed in 1 day (e.g., some plots atop Light Rock, and some on the southeast corner of Nord Island).

The 15% level of accuracy was chosen for the multicount and population census plot counts instead of the more commonly used 10% level, because these plots were censused from boats, not stable observations posts on land, and because wind and sea conditions often limited acceptable counting conditions to 4-6 hours at the colonies (when tidal ranges were large, this interval was typical even on calm days). Using the 15% level reduced overall times needed to census plot sets and helped ensure that complete counts of entire colonies or large parts of colonies—e.g., Light Rock and the multicount plot sets—could be made in 1 day during the appropriate time (1100-2000 hrs).

We censused the East Amatuli Island - Light Rock colony twice, and counted Light Rock separately 2 additional times.[2] Multicount plots BMP1-8 were counted 4 times, and all of these plots, with the exception of BMP6, were counted on 1 additional date. Plots BMP3-4, the only multicount plots counted by FWS crews in previous years, were counted 8 times.

The Nord Island - Northwest Islet colony was censused 4 times, and multicount plots BMP1-11 were counted on 5 occasions. We also counted 6 of these plots on 1 additional date (BMP1-4 and 10-11).

To compare our population data with previous FWS postspill information, we calculated 1-day totals for Light Rock, East Amatuli Island - Light Rock multicount plots BMP3-4, Nord Island - Northwest Islet, and Nord Island - Northwest Islet multicount plots BMP1-11. We also calculated

[1] On 2 August, 8 of the Light Rock plots were counted during 1025-1100 hrs. We retained these scores because in 5 cases, 1 observer counted the plots 1 or more times after 1100 hrs, and in 3 cases when counts were made shortly before 1100 hrs, only 40 (6%) fewer birds were present on the plots, compared to counts made during late afternoon, 3 August.

[2] The East Amatuli Island - Light Rock count made on 31 July and 1 August was an exception to the 1-day census rule. The split count was retained in the database because counts of the whole colony are scarce.

the average number of adults counted on the East Amatuli Island - Light Rock and Nord Island productivity plots during the census period. These results were grouped with corresponding data from previous FWS postspill studies (e.g., Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993, Dragoo *et al.* 1994) and tested for differences and trends among years. We used Kendall's Tau rank correlation tests to check for trends, and 1-way analysis of variance (ANOVA) and Tukey HSD multiple pairwise comparison tests to detect differences among years at the 0.1 significance level (we selected the 0.1 significance level for all tests to increase their power and reduce Type II error; the 0.90 confidence interval was both adequate and acceptable for our purposes).[1]

Timing of Nesting Events

We used median hatching dates derived from the East Amatuli Island - Light Rock and Nord Island productivity plot data to describe nesting chronology. These dates were calculated for each plot in the respective data sets, and then the averages of these dates were used to measure timing of events at the study sites. The difference between study site hatching dates was checked with a 2-tailed *t*-test.

Because actual nesting events (e.g., laying and hatching of eggs, fledging of chicks) were not observed on the productivity plots, we defined the dates nest sites changed status (i.e., from an egg to a chick) as the midpoints between the closest pre- and post-event observation dates. Two methods were used to maintain precision during data analysis. Nest sites having data gaps of more than 7 days between pre- and post-event laying and hatching observation dates were excluded from the data sets. At sites where the range of possible laying dates was smaller than the range of possible hatching dates (i.e., the number of days between respective pre- and post-event observation dates), we calculated hatching dates by adding 32 days to laying dates (see Byrd 1986).[2]

Data on median hatching dates, the variable we considered to be the most appropriate for measuring timing of murre nesting events, were not collected during the 1989-1992 FWS Barrens Islands damage assessment and restoration projects. Therefore, we calculated first and mean laying dates and mean hatching dates from our productivity plot data, and also compiled incidental observations of first laying dates from other sections of the colonies for comparison with information from these and other studies (e.g., Manuwal 1978, 1980; Manuwal and Boersma 1978; Nysewander *et al.* 1993; Dragoo *et al.* 1994).

Productivity

We used fledglings per egg laid as our measure of productivity. We also calculated hatching success, fledging success, and numbers of chicks per adult for comparison with information from other studies.[3] All calculations treated plots as sample units.

The productivity data were collected on 10 East Amatuli Island - Light Rock and 8 Nord Island study plots (LPP1-10 and LPP1-8, respectively—see Figs. 3a and 3b). Teams of 2-3 people checked these plots with 7 x 42 binoculars and 15-60 power spotting scopes from land-based

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[1] Bonferroni multiple pairwise comparison tests were run in conjunction with the Tukey HSD tests (see Wilkinson *et al.* 1992, page 244). The Tukey test proved to be more sensitive in detecting differences among data sets.

[2] We checked incubation times at nest sites where data gaps were relatively small for both events by subtracting laying dates from hatching dates. These calculations suggested that 32 days was a reasonable estimate for incubation times of Barren Island birds.

[3] The terms "fledglings", "fledging", and "fledged", as used in this report, refer to sea-going chicks. Murre chicks actually jump from nesting ledges before they are fully capable of flight and fledge several weeks later at sea.

observation posts as often as possible, weather permitting. Viewing distances varied between 30-100 m, and observers were assigned specific plots for the duration of the field season. Nest sites, defined as sites with eggs, were mapped on 20 x 25 cm photographs or sketched by hand, and data were recorded in notebooks using previously established codes. Plot checks consisted of searching for eggs, chicks, and adults in incubation and brooding postures, and counting total numbers of adults. Observations began before eggs were laid and ended several days after chicks started going to sea at East Amatuli Island - Light Rock, and just as they were beginning to leave the nesting cliffs at Nord Island - Northwest Islet.

To support the productivity work, we set up temporary running-line mooring systems in Lonesome and Parakeet coves to anchor our boats during visits to the study plots (see Figs. 3a and 3b; landing areas consisted of large boulders and rock shelves, not beaches). We also installed several fixed climbing ropes and safety lines at the study sites to ensure safe, efficient access to the observation posts.

The East Amatuli Island - Light Rock study plots and 2 nearby observation posts were set up in late June. The observation posts were located about 50 m and 100 m above high tide line on a headland opposite Light Rock because these sites were accessible from Lonesome Cove, and because they provided unobstructed views of a variety of nesting habitats in the heavily-used central portion of the colony. After the observation posts were in place, we selected 9 plots of about 50 nest sites each in a 300-m wide section of the island that contained nesting ledges of differing sizes in protected and exposed areas 10-100 m above maximum sea level (plots LPP1-4 on cliffs surrounding Lonesome Cove and LPP5-9 on sections of a larger shear cliff we named "The Face", north of the cove; see Fig. 3a). We also set up 1 similar-size plot on the northwest side of Light Rock opposite the observation posts (LPP10). Two criteria were used to help select the plots: habitat types and visibility of nesting ledges (i.e., plots were selected in a manner that sampled as many different habitats as possible in areas where the nesting ledges could be seen from the observation posts).[1] Observers visited the observation posts 30 times and checked each plot for eggs and chicks 15 times during 4 July - 7 September.

At Nord Island, we used 6 study plots established during the 1989-1992 FWS postspill studies (LPP1-6; see Nysewander *et al.* 1993, Dragoo *et al.* 1994) and 2 plots that we set up in nearby nesting areas in late June (LPP7-8; these plots were added to increase sample size and coverage of nesting habitats). All of the plots were situated about 30-80 m above high tide line on the southeastern side of Knife Ridge (see Fig. 3b), and they contained about 20-100 nest sites each. Boundaries of historical plots were identified from color photographs in AMNWR files, and data were collected from the same observation post used in previous years. Study team members visited the observation post 23 times and checked each plot for eggs and chicks 9-12 times during 26 June - 7 September.

We used postures of incubating and brooding birds to supplement direct observations of presence or absence of eggs and chicks (e.g., Byrd 1989, Nysewander *et al.* 1993). Incubating birds sit forward with their backs humped, tails held down, and wings slightly lowered with uncrossed tips. Brooding individuals extend 1 wing and lower it to mantle (shelter) chicks after they are about 2-3 days old (Byrd 1989). Birds seen in incubation posture on 3 or more consecutive occasions were assumed to have eggs, and individuals observed wing-mantling once were assumed to be brooding chicks.

We also assumed that all chicks reaching an age of at least 15 days old before they disappeared from nest sites survived and went to sea (i.e. "fledged"; e.g., Hunt *et al.* 1981; Byrd 1986, 1989),

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[1] In most cases, truly random sampling designs cannot be used at large murre colonies because of physical limitations of finding areas where ledges can be seen from nearby vantage points.

unless we had specific information indicating that they died from natural causes (e.g., storms, avian predators, falling rocks). Chick ages were derived from hatching date calculations (see above) and direct observations of chicks. Nest sites without sufficient data to indicate whether "fledging" had occurred were excluded from the analyses.

The only productivity data available from the 1989-1992 FWS postspill studies (e.g., Nysewander *et al.* 1993, Dragoo *et al.* 1994) were chicks per adult measurements. In 1992, Nord Island study plots LPP1-6 were visited 7 times during 2 July - 25 August to collect this information, and boat-based counts of chicks and adults were also made at several visible nesting areas in multicount plots BMP1-11 on 11 September (Dragoo *et al.* 1994). To compare our data with the 1992 periodic-visit results, we divided the total number of chicks found on plots LPP1-8 by the average number of adults counted on them during the census period. We then used the reported 28 July mean laying date to help identify the day in our data set that was chronologically most similar to 11 September 1992 and then calculated the mean number of chicks per adult on plots LPP1-8 for that date (7 September) for comparison with the 1-day boat-based value.

We used the same procedure to compare our 1-day chicks per adult results with the Nord Island single-visit information collected at 11 plots on 11-12 September 1991 (Nysewander *et al.* 1993). Based on the reported mean laying date of 25 July (see Dragoo *et al.* 1994), we calculated the mean number of chicks per adult on plots LPP1-8 for the day in the nesting cycle when chick-ages were closest to ages on the 1991 observation date (again, 7 September).[1]

The 1992 and 1993 periodic-visit results were compared with a 2-tailed *t*-test. ANOVA and Tukey HSD multiple pairwise comparison tests were used to check the 1991-1993 1-day values for differences among years (again in each case, we used the 0.1 significance level to increase the power of the tests and reduce Type II error).

Avian Predators

During the population and productivity work, we observed several interactions between murres and avian predators at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies. We recorded these incidental observations to provide general information on predation at both study sites.

RESULTS

Population Counts

At the East Amatuli Island - Light Rock colony, we censused Light Rock (Appendices 1-4), East Amatuli Island (Appendices 5-6), and East Amatuli Island - Light Rock (Appendices 2 and 5, and 3 and 6), and counted the set of 8 multicount plots (Appendix 7). However, comparisons with previous FWS postspill data were limited to the counts of Light Rock and multicount plots BMP3-4 (see Appendix 8), because these were the only parts of the colony counted during the 1989-1992 FWS damage assessment and restoration studies (see Nysewander *et al.* 1993 and Dragoo *et al.* 1994).

Although our average 8,454 bird estimate at Light Rock was significantly higher than the reported 1990 FWS score of 5,865 individuals (Tukey HSD, $P = 0.017$), it did not differ from the

[1] We did not compare our data with the 1991 East Amatuli Island - Light Rock chicks per adult information, because East Amatuli and Nord values were nearly identical (0.13 vs. 0.12, see Nysewander *et al.* 1993) and data were not available from other years (i.e., n = 2).

1989 FWS estimate of 6,912 birds, and no trend in numbers was apparent over the 5-year postspill period (Table 1, Fig. 4a).[1] Count results on multicount plots BMP3-4 were similar: although our average score of 1,375 birds was significantly higher than all previous FWS estimates on these plots (Tukey HSD; $P = 0.034$, < 0.001, $= 0.037$, and < 0.001 for 1989, 1990, 1991, and 1992, respectively; 1989-1992 range = 575-860 individuals), no trend was detected over the postspill interval (Table 2, Fig. 5a).

Counts of adults at the East Amatuli Island - Light Rock productivity plots indicated that numbers varied the least between peak laying and first sea-going of chicks (Fig. 6; also see chronology results below). These data confirmed that counts kept for population analyses were made during the most stable part of the nesting season at this colony.

The results of our Nord Island - Northwest Islet censuses (Appendices 9-12) and multicount plot counts (Appendix 13) generally agreed with the East Amatuli Island - Light Rock results. Our average whole-colony estimate of 13,422 birds did not differ from the respective 1989-1991 FWS scores of 11,838, 12,277, and 13,333 individuals, and no trend in numbers was detected over the 5-year postspill period (Table 1, Fig. 4b).[2] Although our average BMP1-11 multicount plot estimate of 4,003 birds and the 1990 FWS score of 4,383 individuals were both significantly higher than the reported 1989 and 1992 FWS estimates of 2,431 and 2,971 birds (Tukey HSD; $P = 0.006$ and 0.016, and 0.002 and 0.005, respectively), results were similar to the whole-colony analysis: no trend was present over the postspill interval (Table 2, Fig. 5b).

Our Nord Island - Northwest Islet productivity plot counts confirmed that counts kept for population analyses were made during the part of the nesting season when numbers varied the least at the colony (Fig. 7). Average numbers of murres on the 5 productivity plots that could be compared over the 4-year 1990-1993 interval (LPP1-5) followed the same general pattern observed on multicount plots BMP1-11 (see Figs. 8 and 5b, respectively), and statistical results were similar (see Tables 3 and 2, respectively). The 1990 and 1993 counts were significantly higher than the 1992 FWS estimate (398 and 412 birds, respectively, vs. 264 individuals; Tukey HSD, $P < 0.001$ in both cases).[3] However, just as in the case of the multicount plot scores, no trend was found over the 5-year postspill period (Table 3).

As noted above, the Nord Island - Northwest Islet multicount and productivity plot count patterns were remarkably similar in 1990-1993 (see Figs. 5b and 8). However, similarities in patterns of counts were also evident between other sets of data. For example, counts on Light Rock and East Amatuli Island - Light Rock multicount plots BMP3-4 tracked each other during 1989-1993 (excluding 1991, see Figs. 4a and 5a), and patterns on all sets of plots were similar in 1991-1993 (see Figs 4a,b; 5a,b; and 8).

Timing of Nesting Events

At least 15,000 murres were rafted up on the waters in front of the East Amatuli Island - Light Rock colony when we first checked it on 19 June, and we saw even larger aggregations that were estimated to contain more than 30,000 birds in the same general area as late as 30 June. The rafts became noticeably smaller during 1-4 July, when birds began visiting nesting ledges for longer periods of time, and attendance on the cliffs remained relatively stable after 6 July (Table 4, Fig. 6). Although 1 freshly laid egg was discovered in a flat area on top of Light Rock on 24 June and 2 more were found in the same area on 4 July, laying did not begin on our productivity plots until 9 July. The first chick was observed on the study plots on 9 August, and numbers of adults

[1] The 1992 FWS count of 5,960 birds was not included in the Tukey HSD analysis because n = 1.

[2] The 1992 FWS count of 11,212 birds was not included in the Tukey HSD analysis because n = 1.

[3] The 1991 FWS count of 301 birds was not included in the Tukey HSD analysis because n = 1.

started to decline on the nesting ledges on about 2 September. Sea-going of chicks was well underway by the time we made our last observations on 7 September.

Large rafts containing at least 15,000 murres were also present near the Nord Island - Northwest Islet colony when we first visited it on 16 June. These birds began frequenting the nesting cliffs on about 4 July, and numbers stabilized on the productivity plots on 12 July (Table 4, Fig. 7). However, birds did not settle down on the nesting ledges in the southeastern sector of the colony until 14 July. We obtained the first evidence of egg-laying on 30 June, when we discovered the shell of a recently eaten egg on a rock in Parakeet Cove. Although we found the remains of 7 more eggs eaten by avian predators (probably gulls) at the same location during 4-6 July, laying did not start on the productivity plots until 12 July (Table 4). The first chick was observed on the study plots on 9 August, and numbers of adults started to decline on the nesting ledges on 2 September (Fig. 8), the same dates we observed these events at East Amatuli Island - Light Rock. Chicks were just beginning to go to sea when we visited the plots for the last time on 7 September.

Laying started at the East Amatuli Island - Light Rock study plots 3 days after attendance stabilized on the nesting ledges (Table 4, Fig. 6), and it took several days to gain momentum and build toward a peak. In contrast, at Nord Island where numbers stabilized 6 days later (Table 4, Fig. 8), birds began to lay eggs immediately after settling on the study plots, and many eggs were apparently laid on 1 day (12 July). Median hatching dates at the East Amatuli Island - Light Rock and Nord Island study sites were 16 and 19 August (range = 12-20 and 16-19 August), respectively (Table 4), and the 3-day difference between locations was significant [$t_{0.10(2)}$, = 1.98, P = 0.065].[1]

Productivity

Productivity (fledgling per egg laid) of common murres was lower on the East Amatuli Island - Light Rock study plots than on the Nord Island plots (0.55 fledglings/egg, range = 0.31-0.81 vs. 0.71 fledglings/egg, range = 0.51-0.89, respectively; see Table 5), and the difference between locations (0.16 fledglings/egg) was significant [$t_{0.10(2)}$, = 2.19, P = 0.043]. Although hatching success did not differ between study sites, fledging success was lower at East Amatuli Island - Light Rock than at Nord Island (0.79 vs. 0.93 fledglings per egg hatched, respectively; see Table 5), and this difference (0.14 fledglings/egg) also proved to be significant [$t_{0.10(2)}$, = 2.90, P = 0.011].

Based on our periodic-visit data, numbers of chicks per adult were the same at both study sites (0.35 chicks/adult; see Table 5). These values were not significantly different from the reported 1992 Nord Island periodic number (0.29 chicks/adult, SD = 0.11, n = 6; see Dragoo *et al.* 1994).

The 1-day chicks per adult number that we calculated from our Nord Island data (0.27 chicks/adult, SD = 0.15, n = 8) was similar to the reported 1992 FWS single-visit value (0.34 chicks/adult, SD = 0.09, n = 6; see Dragoo *et al.* 1994). However, our results and the 1992 Nord Island chicks per adult number were both significantly higher than the 1991 FWS 1-day value (0.12 chicks/adult, SD = 0.04, n = 6, see Nysewander *et al.* 1993; Tukey HSD, $P < 0.001$ and = 0.018, respectively). No difference was found between the single-visit numbers reported for East Amatuli Island - Light Rock and Nord Island - Northwest Islet in 1991 (0.13 chicks/adult, SD = 0.05, n = 4, and 0.12 chicks/adult, SD = 0.04, n = 4, respectively; see Nysewander *et al.* 1993).

We did not include the 1989-1990 FWS 1-day chicks per adult results (0.1 and 0.1 chicks/adult, respectively; see Nysewander *et al.* 1993, Dragoo *et al.* 1994) in our analyses,

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[1] Subscripts indicate the t-test was a 2-tailed test conducted at the 0.10 significance level.

because they were single numbers without any measure of variability. Also, because methods used to obtain these values were not described, we did not know if they were comparable to any of the 1991-1993 information (we suspect not—they appeared to be rough estimates based on incidental boat-based observations that birds were flighty and not laying eggs).

Avian Predators

Bald eagles *(Haliaeetus leucocephalus)* were present at both colonies when we first arrived in mid-June. These predatory birds often flushed many hundreds (occasionally thousands) of murres from the cliffs when they flew by nesting and roosting areas. Eagle-induced flushing events were not observed at East Amatuli Island - Light Rock after 6 July; however, they were common at Nord Island - Northwest Islet until 17 July, and some were seen in the BCP4-7 sector of that colony as late as 17 August. Although eagles were never observed preying on murres at East Amatuli Island - Light Rock, we watched them take adult birds at Nord Island on 3 separate occasions during 3-17 August. During these events, adult eagles swooped in, neatly hooked murres off ledges in exposed nesting areas on the southeast corner of the island (the BCP4-7 vicinity), and carried them back to Ushagat Island. We also observed adult eagles leave Ushagat Island and fly directly toward Nord Island on 2 separate occasions during 3-5 August.

We saw glaucous-winged gulls *(Larus glaucescens)* and common ravens *(Corvus corax)* take murre eggs on several occasions at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies, and these predation episodes were often associated with eagle-induced flushing events. When eagles flushed murres from nesting ledges, gulls and ravens arrived and quickly searched the areas for unprotected eggs and chicks. Although gulls and ravens were often observed near our productivity plots during the incubation and chick-rearing periods at both colonies, no eggs or chicks were lost to these avian predators at either study site.

At least 1-2 pairs of peregrine falcons *(Falco peregrinus pealei)* were also present at both colonies during the nesting season. However, peregrines did not appear to interact with murres on a regular basis, because they targeted other species. Kittiwakes reacted more strongly to these predators when they flew by than murres did, which was not surprising because peregrines often take kittiwakes as prey (D.G. Roseneau, unpubl. data). At Nord Island, where 1 pair of falcons nested successfully, the birds preyed primarily on adult parakeet auklets *(Cyclorrhynchus psittacula)*.

DISCUSSION

Population Counts

We did not find any evidence of trends in population numbers at the Barren Islands murre colonies over the 5-year period following the spill. Abilities to detect changes in population size increase with the number of counts (Gerrodette 1987, Byrd 1989, and Hatch and Hatch 1989; also see Wanless *et al.* 1982 and Harris *et al.* 1985), and the small number of counts made on the East Amatuli Island - Light Rock and Nord Island - Northwest Islet multicount plots during the 1989-1991 FWS postspill studies (only 2-3 per colony per year) reduced the power of the tests to detect trends at the colonies.

The similarities that we found between some of the whole-colony, subcolony, multicount plot, and productivity plot count patterns helped illustrate the value of counting birds on several different sets of plots at large murre colonies. Prior to checking the multicount and productivity plot count patterns, we were skeptical that the previously established Nord Island - Northwest Islet multicount plots could be used to monitor trends in numbers of murres nesting at the colony, because 10 of the 11 plots were located in an area of the island where harassment by bald eagles was relatively high, compared to other sections of the nesting complex, including the productivity plots (see below). Because the general count patterns were similar on both sets of plots, we have more confidence in the multicount plot data, and believe they may be adequate to monitor population trends at this colony in future years.

Timing of Nesting Events

The 3-day difference in median hatching dates indicated birds nested a few days later at Nord Island - Northwest Islet than at East Amatuli Island - Light Rock. Several observations, including differences in attendance stabilization dates (12 vs. 6 July), incidental observations of first eggs (30 vs. 24 June), and dates eggs were first seen on study plots (12 vs. 9 July), supported this conclusion (see Table 4). However, the chronological difference between the study sites may not have been as significant as suggested by the median hatching dates, because fewer observations were obtained on the Nord Island productivity plots (only 9-12 vs. 15 at East Amatuli Island). Because we used mid-points to determine event dates, the smaller number of observations on the Nord Island plots tended to decrease variability. As a result, hatching may have taken place over a few more days time at Nord Island than indicated by our calculated dates.

Bald eagles may have influenced the later stabilization in adult attendance and rapid initiation of egg-laying at Nord Island - Northwest Islet (12 July vs. 6 and 9 July at East Amatuli Island - Light Rock; see Table 4). Although eagle-induced flushing events stopped at East Amatuli Island - Light Rock on 6 July, they continued to be common at Nord Island - Northwest Islet until 17 July. Harassment by eagles after the first week in July may have caused Nord Island birds to spend less time roosting and prospecting for nest sites before most individuals were physiologically ready to lay eggs.

Median hatching dates varied by as much as 9 days on the East Amatuli Island - Light Rock productivity plots. The wide range in timing of nesting events that we found at this study site demonstrated the value of using plots as sample units rather than nest sites.

Three eggs were found on top of Light Rock 5-15 days before eggs were laid on our productivity plots. The presence of these eggs and our incidental observations of large numbers of murres settling on the islet's top during 1-4 July suggested that nesting occurred a few days earlier in this relatively large, broad flat area, compared to the smaller ledges and terraces typical of the East Amatuli Island cliff-faces. Earlier nesting on top of Light Rock was not surprising, because common murres tend to prefer wide ledges and broad open places that allow them to nest in close physical contact with one another (e.g., Tuck 1961, Birkhead 1977, Birkhead and Harris 1985, Harris and Birkhead 1985). The bare rock shelves and gently sloping benches on the islet's top provide this kind of high quality habitat that attracts large, tightly packed concentrations of nesting murres, and these dense groups often lay eggs over shorter periods of time on schedules that may not follow the schedules of birds breeding at lower densities in more widely dispersed ledge-nesting habitats (e.g., Birkhead 1980, 1985; Harris and Birkhead 1985).

The first egg was found at Light Rock 8 days before the date remains of several dozen broken eggs were found on top of the islet during the 1992 FWS study (2 July; see Table A7 in Dragoo *et al.* 1994). Both the Light Rock and Nord Island first-egg dates (24 and 30 June, respectively) were earlier than the first-laying dates reported for the Barren Islands colonies in the 1989-1991 FWS studies (<26 July, 17 July, and <10 July, respectively; see Nysewander *et al.* 1993 and Dragoo *et al.* 1994), and both fell within the range of first dates derived from the 1977-1979 Light Rock data (about 20-30 June; e.g., Manuwal 1980; also see Table A7 in Dragoo *et al.* 1994). Both dates were also similar to the 1977-1978 Hinchinbrook and Chisik island first-laying dates (Hinchinbrook = 21 and 29 June, respectively; Chisik = 29 June in 1978), and the Light Rock date closely matched the reported 1974 and 1977 Ugaiushak Island first-egg dates (25 and 24 June, respectively; see Table A7 in Dragoo *et al.* 1994).

Mean laying dates on the East Amatuli Island - Light Rock and Nord Island study plots (16 and 19 July, respectively; see Table 4) averaged about 8 and 11 days earlier than the respective 1991 and 1992 dates listed in the 1992 FWS report (25 and 28 July; see Table 6 in Dragoo *et al.* 1994). These data suggested that birds nested about 1.0-1.5 weeks ahead of the 1991-1992 breeding schedules.

Productivity

Productivity (fledglings per egg laid) of murres nesting on the East Amatuli Island - Light Rock and Nord Island - Northwest Islet study plots was high (0.55 and 0.71 fledglings/egg, respectively; mean = 0.63; see Table 5) compared to values reported from other Gulf of Alaska colonies (numbers varied from about 0.30 fledglings/egg at Ugaiushak Island in 1977 to 0.46-0.64 and 0.52-0.58 fledglings/egg at the Semidi Islands in 1979-1980 and 1989-1991, respectively—see Wehle 1978; Hatch and Hatch 1990; Dragoo *et al.* 1991a,b; Dragoo *et al.* 1994). Results from both study sites were well within the ranges measured at nesting colonies in other regions of Alaska during the mid-1970's - early 1990's (e.g., in the southeastern and northeastern Bering seas—0.30-0.76 fledglings/egg at the Pribilof Islands during 1976-1987, and 0.51-0.73 fledglings/egg at Bluff in 1987-1990; see Byrd 1989 and Murphy 1993, respectively).

Chicks per adult information provided additional evidence that chick production was within normal ranges at the Barren Islands colonies. Periodic data from both sets of study plots (0.35 chicks/adult, see Table 5) fell near the mid-point of the range recorded at the Semidi Islands in 1989-1991 (0.32-0.40; see Baggot *et al.* 1989 and Dragoo *et al.* 1991a,b), and both of these values and our 1-day Nord Island study site results (0.27 chicks/adult) were within the range of reported values from Agattu Island in the southern Bering Sea during the same 3-year interval (e.g., 0.21-0.48; see Williams and Byrd 1992).

Most of the difference in productivity between the study sites (0.16 fledglings/egg, see Table 5) was caused by losses of chicks on 2 exposed East Amatuli Island - Light Rock study plots (LPP3 and 6) during a late-August storm that had little impact on the remainder of the plots, including those at Nord Island. The Nord Island plots are more sheltered from the elements than the East Amatuli Island - Light Rock plots, because they are situated near the back of a relatively narrow cut in the cliffs, and their location also discourages visits by avian predators. As a result, the Nord Island information may have overestimated productivity and the difference between the colonies was probably smaller than indicated by the data collected on our study plots. Indeed, barring unusual events, we would expect to find relatively small differences in productivity between the Barren Islands colonies, because birds from both locations feed in the same general areas and are subjected to the same basic environmental conditions throughout the nesting cycle (e.g., weather at sea and at the nesting cliffs, water and air temperatures, currents and tides, broad-scale oceanographic events).

Variation in productivity among plots was high at the East Amatuli Island - Light Rock and Nord Island study sites (up to 0.50 and 0.38 fledglings per egg laid, respectively). In most cases, these differences probably reflected differences in types of nesting habitat sampled by the study plots (in 2 instances, differences were magnified by direct losses of chicks during a storm—see above).

High productivity at the study sites indicated that prey availability was high during critical periods of the breeding cycle. Although we did not collect quantitative information on murre diets or the prey base, we were able to obtain some evidence that forage fish were both available and abundant in waters surrounding the nesting colonies. During the late incubation and chick-rearing periods, many birds returning to the colonies were carrying fish, including bright silver-green fish that were almost certainly Pacific sand lance *(Ammodytes hexapterus)* or capelin *(Mallotus villosus)*. Murres with bright silvery fish in their bills were also seen at the study plots on a regular basis throughout August - early September (birds also returned to nesting ledges with other species of unidentified fish, including some that may have been small gadids). Also, in July and August, we observed large, dense schools of small fish on our contract vessel's fish-finder on trips around, through, and to and from the Barren Islands. Most of these schools were detected at depths of 50-200 m, and many of them appeared to be at least 100-200 m in circumference and 50 m or more thick. The total biomass of these unidentified fish was impressive, particularly in the waters around Nord and Ushagat islands, because we estimated that about 150-200 humpback whales *(Megaptera novaeangliae)* fed on these balls of fish throughout most of July and August (feeding whales were almost always present and diving into the masses of fish seen on the fish-finder, and numerous concentrations of 5-15 whales were seen in the same areas nearly every day until about 25 August; 100 individual whales were counted from Nord Island in one 10 minute period on 1 day in early August).

We also obtained some evidence that forage fish were not available to surface-feeding seabirds during the early part of the nesting season. Shortly after our arrival in the Barren Islands in mid-June, it became obvious that black-legged kittiwakes *(Rissa tridactyla)* were experiencing a near-complete breeding failure. Most kittiwakes stopped building nests before they were complete and only a few pairs laid eggs. By the end of the nesting season, we could only account for a few kittiwake fledglings at the colonies.

Avian Predators

Based on our general observations, avian predation appeared to be higher during the pre-laying and early egg-laying periods than during subsequent stages of the breeding cycle. Bald eagles targeted adult murres (Nord Island), and glaucous-winged gulls and common ravens took eggs (both colonies), particularly when passing eagles flushed adults from nesting ledges. Peregrine falcons, although present, appeared to have little impact on murres, because they were few in number and tended to take other species. Eggs laid early in the season when most murres were still intermittently visiting the nesting ledges appeared to be more vulnerable to passing gulls and ravens than those laid after attendance stabilized.

Some of our observations suggested that avian predation was higher at Nord Island - Northwest Islet than at East Amatuli Island - Light Rock. Eagles continued to flush murres from the Nord Island nesting cliffs well past the time these events stopped at East Amatuli Island - Light Rock, and gulls and ravens continued to take advantage of these incidents to search for unprotected eggs. The continued harassment of the Nord Island birds by eagles appeared to be directly related to the colony's proximity to Ushagat Island.

Ushagat, the largest island in the Barren Islands group, contains abundant ledge- and tree-nesting habitat capable of supporting several pairs of bald eagles. In 1993, pairs occupied at least 4 of 6 known territories in the northern and western sectors of the island, and we identified 10 different adults and 3-4 subadults on 1 day (3 August). Some of these eagles (primarily adults) commuted to Nord Island to take advantage of the concentrations of nesting seabirds, which provided them with a nearby summer-long source of potential prey. In contrast, fewer eagles were seen and no nesting pairs were found at East Amatuli Island, a much smaller nearly treeless environment that contains considerably less potential nesting habitat for eagles (only 2 ground-nesting records are available, 1 in 1965 and 1 in 1977; D.G. Roseneau and K.A. Sundberg, pers. obs., respectively). During late June - early July, when eagles appeared to be the most numerous at East Amatuli Island, our maximum count was only 5 birds on 1 day (2 adults and 3 subadults), and we only saw 8 different individuals over a 10-day period (3 adults and 5 subadults, 2 of which were only seen once).

CONCLUSIONS

1. Based on analyses of FWS count data, no trends in murre population numbers were detected over the 5-year interval following the spill (i.e., over the years 1989-1993).

2. Based on mean laying dates reported in the 1992 FWS study, murres apparently nested about 1.0-1.5 weeks earlier than in 1991-1992. First-egg dates were earlier than reported in the 1989-1992 FWS studies, and were about the same as those reported for these and several other northern Gulf of Alaska colonies in the mid- and late 1970's (e.g., Chisik, Ugaiushak, and Hinchinbrook islands).

3. Productivity (fledglings per egg laid) of murres was high at the Barren Islands colonies, compared to ranges reported from other Gulf of Alaska nesting locations in the late 1970's - early 1980's and late 1980's - early 1990's (e.g., Ugaiushak Island, Semidi Islands). Chicks per adult values fell within normal ranges, based on information from other Alaskan colonies in the late 1980's - early 1990's (e.g., Semidi Islands in the western Gulf of Alaska, Agattu Island in the southern Bering Sea).

4. The high productivity of murres at the Barren Islands colonies was probably related to the availability and abundance of forage fish during critical parts of the nesting season (e.g., the chick-rearing period). Although forage fish were obviously available to deep-diving birds (e.g., common murres), they were apparently not available to surface-feeding species (e.g., black-legged kittiwakes, a species that experienced a near-complete breeding failure at the Barren Islands colonies in 1993).

5. Avian predation may occur more frequently over a longer period of time at the Nord Island - Northwest Islet murre colony, compared to the East Amatuli Island - Light Rock complex, because nearby Ushagat Island contains habitat that supports several nesting pairs of bald eagles that commute to Nord Island to prey on seabirds.

RECOMMENDATIONS

1. Because of the low number of counts on the East Amatuli - Light Rock and Nord Island - Northwest Islet multicount plots during 1989-1991, and the fact that only 2 plots were used to sample the East Amatuli - Light Rock colony during 1989-1992, we recommend counting the expanded multicount sets again in 1994 to ensure that an adequate, statistically solid database is available before considering adoption of a longer interval between counts to monitor trends in population numbers (e.g., counts at 3-year intervals instead of annually).

2. Productivity was within normal ranges in 1992, based on FWS chicks per adult information, and it was also within normal limits in 1993, based on our fledglings per egg and chicks per adult data. We recommend monitoring this variable again in 1994 to see if it remains within normal bounds (5 consecutive years of productivity within normal ranges is the preferred restoration objective for this variable and 1994 monitoring work has potential to provide another year of data toward this goal).

3. We recommend beginning studies to explore relationships between murre productivity levels and abundance and availability of important forage fish species at the Barren Islands colonies (e.g., capelin, sand lance).

4. We recommend beginning studies to explore relationships between timing of murre nesting events and physical environmental parameters (e.g., water temperatures, a variable that can influence distribution and availability of forage fishes).

ACKNOWLEDGMENTS

We would like to thank Margaret A. Blanding, Joel A. Cooper, Michael B. Gratz, and Mary K. Jensen for helping us make the 1993 Barrens Islands murre restoration project a success. Joel and Michael manned our Ushagat Island field camp, and Margaret and Mary assisted us at East Amatuli Island. Their boating and climbing skills and constant dedication to work allowed us to safely collect information in spite of sometimes hostile weather and sea conditions. We would also like to acknowledge Lynn M. Denlinger for her valuable assistance during the population counts, and for organizing, entering, and checking many of the postspill data sets. Special thanks also go to Michael Yourkowski, John Rodgers, and Douglas Bowen of the M/V *Kittiwake II*, and Michael Parks and Lydia Rabottini of the M/V *Waters* for their assistance in helping mobilize and demobilize the field camps, and for their safe and timely support during the population counts and late-season productivity work. Don Fell, Howard Reed, and the other pilots of Maritime Helicopters also deserve special mention for providing safe, efficient transportation during the field season. Trina Fellows and Carol Hagglund, Alaska Maritime NWR, monitored our radio calls on a daily basis and cheerfully helped us with many logistical needs. Steve Klosiewski, Division of Migratory Bird Management, provided valuable comments on an earlier draft of the report.

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Table 1. Average FWS counts of murres at the Barren Islands, Alaska nesting colonies in 1989-1993 (numbers of counts are shown in parentheses).

	East Amatuli Island - Light Rock						Nord Island - Northwest Islet	
	East Amatuli Light Rock		East Amatuli Island		Entire Colony		Entire Colony	
Year	Number of Birds	CV(%)[a]	Number of Birds	CV(%)	Number of Birds	CV(%)	Number of Birds	CV(%)
1989[b]	6,912 (2)	10.2	ND[c]		ND		11,838 (2)	6.5
1990[b]	5,865 (2)	10.5	ND		ND		12,277 (2)	6.5
1991[b]	ND[d]		ND		ND		13,333 (2)	0.8
1992[e]	5,960 (1)		ND		ND		11,212 (1)	
1993[f]	8,454 (4)	8.4	24,775 (2)	6.5	32,721 (2)	5.7	13,422 (4)	15.5

Tukey HSD Multiple Comparisons Test (Significance Level = 0.1)[g]

East Amatuli Light Rock	Nord Island - Northwest Islet
1990 1989 1993	1989 1990 1991 1993

Kendall's Tau Rank Correlation: Count vs. Year (Significance Level = 0.1)

East Amatuli Light Rock	Nord Island - Northwest Islet
Tau = 0.33, n = 4	Tau = 0.40, n = 5

[a] CV = coefficient of variation (standard deviation divided by the mean times 100).

[b] Data are from Nysewander and Dipple (1990, 1991); Dipple and Nysewander (1992); and Nysewander *et al.* (1993). Counts on Light Rock were 7,410 and 6,413 in 1989; 5,430 and 6,300 in 1990 Nord Island - Northwest Islet counts were 12,381 and 11,294 in 1989; 11,713 and 12,842 in 1990; and 13,404 and 13,262 in 1991.

[c] ND = no data.

[d] The previously reported July 17, 1991 single Light Rock count of 5,529 murres is not shown here because in included 3,429 birds on the cliffs and 2,100 individuals on nearby waters (see Nysewander and Dippel 1991).

[e] Data are from Dragoo *et al.* (1994). Counts were 5,960 at Light Rock and 11,212 at Nord Island - Northwest Islet in 1992.

[f] Data are from this study. Counts were 9,414, 8,134, 7,761, and 8,507 at Light Rock and 12,474, 16,484, 12,817, and 11,913 at Nord Island - Northwest Islet in 1993 (see Apps. 1-6 and 9-12).

[g] The 1992 data were not included in the Tukey HSD analyses because only one count was made at each location (i.e., n = 1).

Table 2. Average counts of murres on multicount plots at the Barren Islands, Alaska nesting colonies in 1989-1993 (numbers of counts are shown in parentheses).

	East Amatuli Island - Light Rock Multicount Plots BMP3-4		Nord Island - Northwest Islet Multicount Plots BMP1-11	
Year	Numbers of Birds	CV(%)[a]	Numbers of Birds	CV(%)
1989[b]	852 (2)	14.8	2,431 (2)	5.1
1990[b]	575 (2)	32.8	4,383 (3)	12.9
1991[b]	860 (2)	27.2	3,558 (2)	4.0
1992[c]	745 (5)	32.6	2,971 (5)	10.6
1993[d]	1,375 (8)	12.6	4,003 (5)	12.9

Tukey HSD Multiple Comparisons Test (Significance Level = 0.1)

East Amatuli Island - Light Rock

1989 1990 1991 1992 1993

Nord Island - Northwest Islet

1989 1992 1991 1990 1993

Kendall's Tau Rank Correlation: Count vs. Year (Significance Level = 0.1)

East Amatuli Island - Light Rock

Tau = 0.40, n = 5

Nord Island - Northwest Islet

Tau = 0.20, n = 5

[a] CV = coefficient of variation (standard deviation divided by the mean times 100).

[b] Data are from Nysewander and Dipple (1990, 1991); Dipple and Nysewander (1992); and Nysewander *et al.* (1993). East Amatuli - Light Rock counts were 763 and 941 in 1989; 708 and 441 in 1990; and 1,025 and 694 in 1991. Nord Island - Northwest Islet counts were 2,519 and 2,343 in 1989; 4,991, 3,869, and 4,288 in 1990; and 3,659 and 3,457 in 1991.

[c] Data are from Dragoo *et al.* (1994). Counts were 467, 948, 926, 893, and 493 at East Amatuli - Light Rock, and 3,008, 2,637, 2,744, 3,449, and 3,016 at Nord Island - Northwest Islet in 1992.

[d] Data are from this study. Counts were 1,580, 1,259, 1,540, 1,492, 1,505, 1,254, 1,263, and 1,110 at East Amatuli Island - Light Rock, and 4,589, 4,513, 3,813, 3,479, and 3,623 at Nord Island - Northwest Islet in 1993 (see App. 8).

Table 3. Average FWS counts of murres on productivity plots at the Barren Islands, Alaska nesting colonies in 1989-1993 (numbers of counts are shown in parentheses).

	East Amatuli Island - Light Rock Productivity Plots LPP1-10		Nord Island Productivity Plots LPP1-5	
Year	Numbers of Birds	CV(%)[a]	Numbers of Birds	CV(%)
1990[b]			412 (2)	2.7
1991[b]			301 (1)	0
1992[b]			264 (4)	14.7
1993[c]	481 (7)	7.6	398 (10)	4.8

Tukey HSD Multiple Comparisons Test (Significance Level = 0.1)[d]

Nord Island

1990 1993 1992

Kendall's Tau Rank Correlation: Count vs. Year (Significance Level = 0.1)

Nord Island

Tau = 0.33, n = 4

[a] CV = coefficient of variation (standard deviation divided by the mean times 100).

b Data are from unpubl. FWS field notes. Counts at Nord Island were 420 and 404 in 1990; 301 in 1991; and 306, 264, 212, and 272 in 1992.

c Data are from this study.

d The 1991 data were not included in the Tukey HSD analysis because only one count was made that year (i.e., n = 1).

Table 4. Dates of 1993 Barren Islands, Alaska common murre nesting events calculated from productivity plot data.[1]

Nesting Event	Data Type used for Calculations	East Amatuli Island	(SD) [2]	Nord Island	(SD)
Birds settled on cliffs [3]	Rafting and cliff observations and productivity plot observations	6 Jul		12 Jul	
First egg laid	Incidental observations [4]	24 Jun		30 Jun	
First egg laid on productivity plots	Productivity plot observations	9 Jul		12 Jul	
Median laying date	Laying and hatching data	15 Jul	(3.0)	18 Jul	(0.0)
Mean laying date	Laying and hatching data	16 Jul	(2.5)	19 Jul	(1.4)
Median hatching date	Laying and hatching data	16 Aug	(3.2)	19 Aug	(0.9)
Mean hatching date	Laying and hatching data	17 Aug	(2.7)	20 Aug	(1.4)
Mean incubation period	Hatching minus laying ($n > 2$)	33 days	(3.9)	30 days	(2.0)

1 Plots are the sample units; $n = 10$ at East Amatuli Island (including 1 on East Amatuli Light Rock) and $n = 8$ at Nord Island (see Figs. 3a and 3b).
2 SD = standard deviation (in days).
3 Date numbers stabilized on cliffs (see Figs. 6 and 8); at Nord Island, birds did not settle down on some nesting ledges in the southeastern sector of the colony until 14 July.
4 Incidental observations = nonsystematic observations obtained in other sections of the respective colonies.

Table 5. Measurements of common murre productivity on study plots at the Barren Islands, Alaska nesting colonies in 1993.[a]

Location (Productivity Plots)	Number of Eggs Laid	Hatching Success [b]	(SD) [c]	Fledging Success [d]	(SD)	Productivity [e]	(SD)	Chicks per Adult [f]	(SD)
East Amatuli Island (LPP1-10) [g]	249 [h]	0.70	(0.16)	0.79	(0.11)	0.55	(0.17)	0.35	(0.11)
Nord Island (LPP1-8) [i]	191 [j]	0.80	(0.15)	0.93	(0.06)	0.71	(0.12)	0.35	(0.14)

[a] Productivity plots (LPP) are the sample units; n = 10 at East Amatuli Island (including 1 on East Amatuli Light Rock) and n = 8 at Nord Island (see Figs. 3a and 3b).
[b] Hatching success = number of chicks hatched per number of eggs laid.
[c] SD = standard deviation.
[d] Fledging success = number of chicks fledged per number of eggs hatched ("fledging" or "fledged", as used in this report, refers to sea-going of chicks—murre chicks jump from nesting ledges before they are fully feathered or capable of flight and fledge several weeks later at sea).
[e] Productivity = number of chicks fledged per eggs laid.
[f] A measurement calculated from periodic observations for comparison with data from previous years (e.g., Dragoo *et al.* 1994, Nysewander et al. 1993).
[g] LPP10 is located on the northwest side of East Amatuli Light Rock (see Fig. 3a).
[h] Fifty-six of these eggs were excluded from the productivity portion of the analysis (i.e., calculations were based on 193 eggs).
[i] LPP1-6 were established during previous FWS postspill studies (e.g., Dragoo *et al.* 1994, Nysewander *et al.* 1993).
[j] Thirty-nine of these eggs were excluded from the productivity portion of the analysis (i.e., calculations were based on 152 eggs).

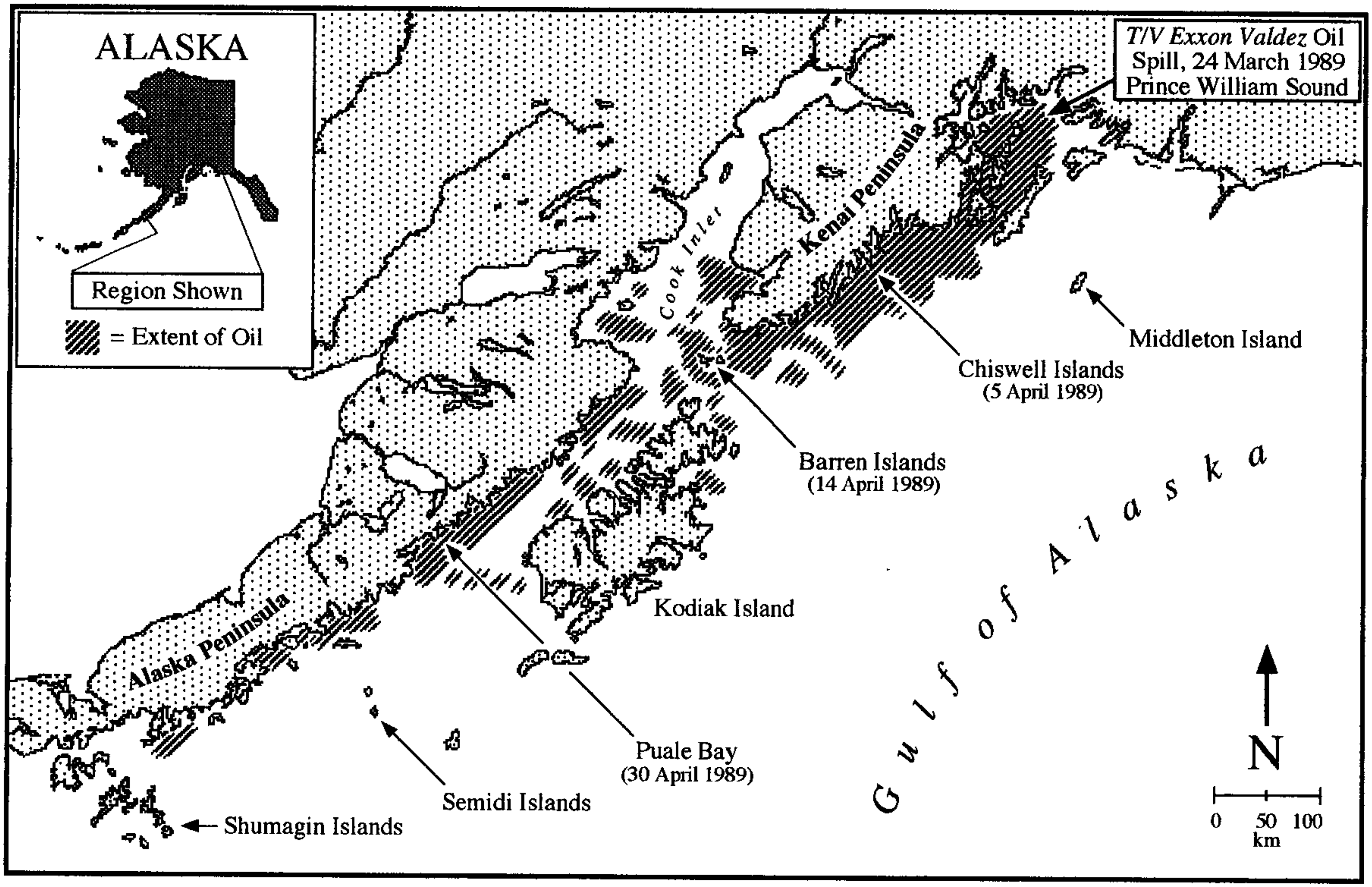


Figure 1. Distribution of oil from the *T/V Exxon Valdez* after it struck Bligh Reef in Prince William Sound on 24 March 1989. Dates in parentheses show when oil, driven by currents and wind, reached locations along the Gulf of Alaska coastline.

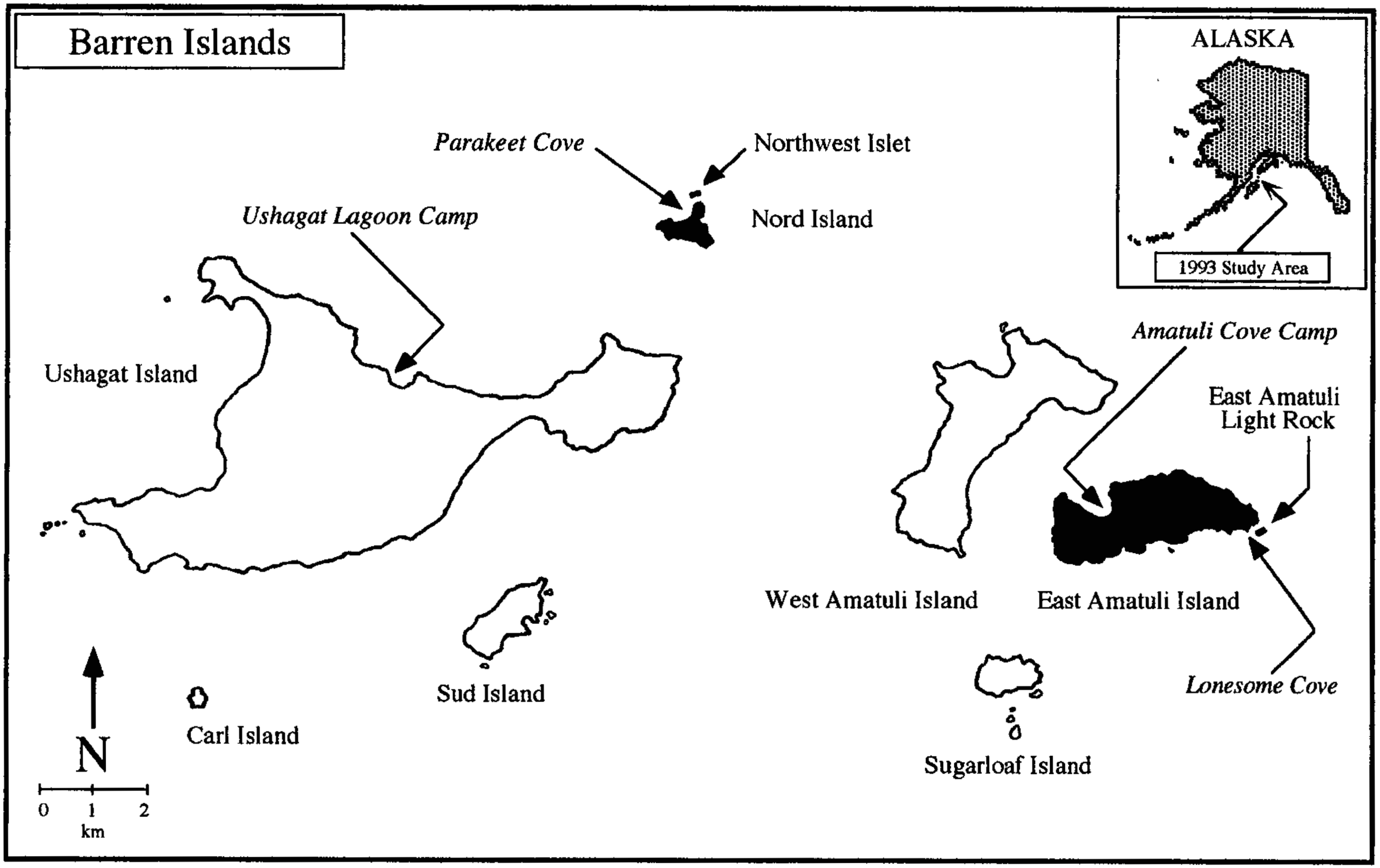
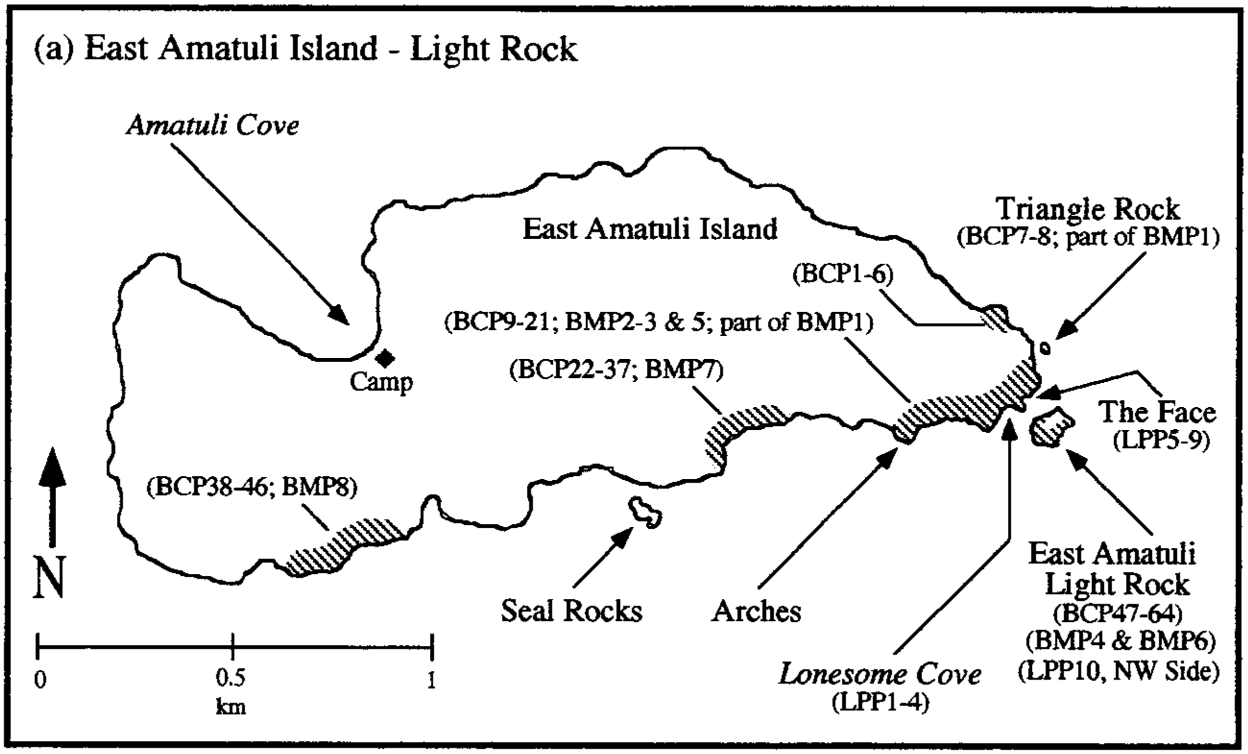


Figure 2. The East Amatuli Island - East Amatuli Light Rock and Nord Island - Northwest Islet study areas (in black) in the Barren Islands, Alaska (these locations contain all of the murre nesting habitat in the island group).



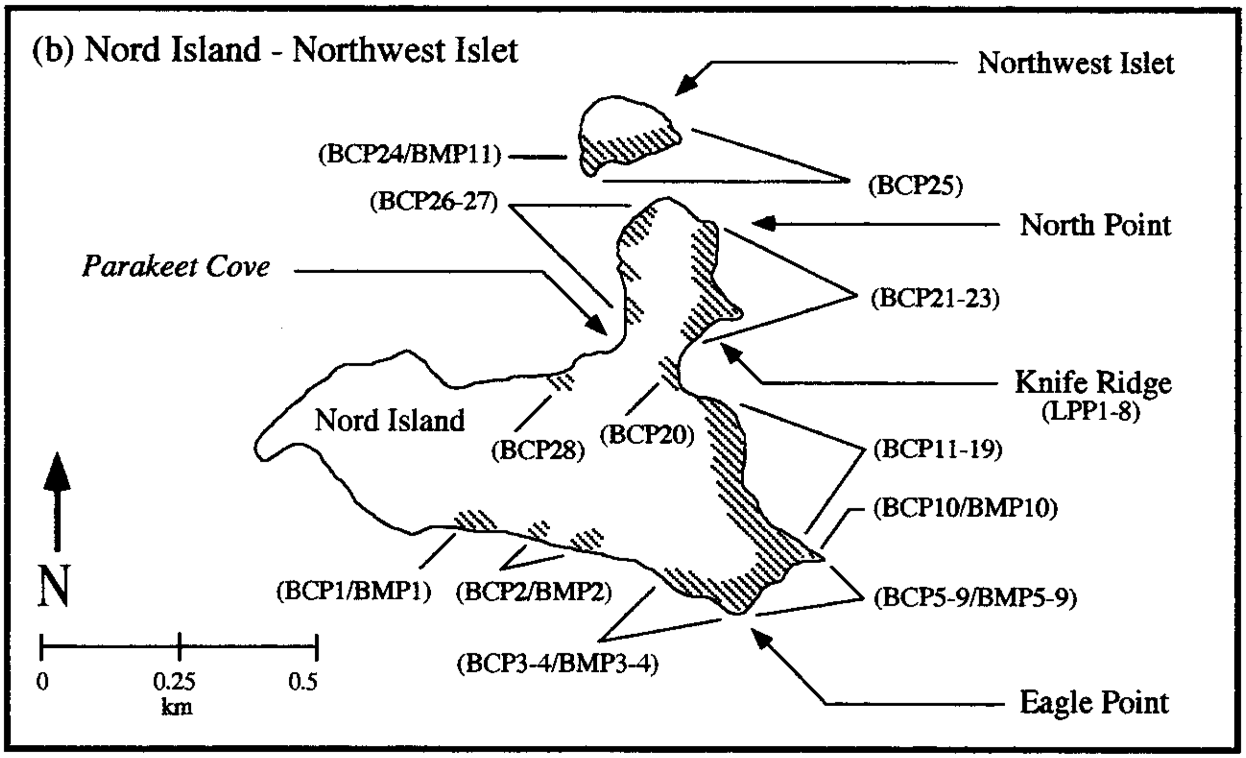


Figure 3. Murre nesting habitat (shaded areas), population census plots (BCP), multicount plots (BMP), and productivity plots (LPP) at the (a) East Amatuli Island - Light Rock and (b) Nord Island - Northwest Islet murre colonies, Barren Islands, Alaska.

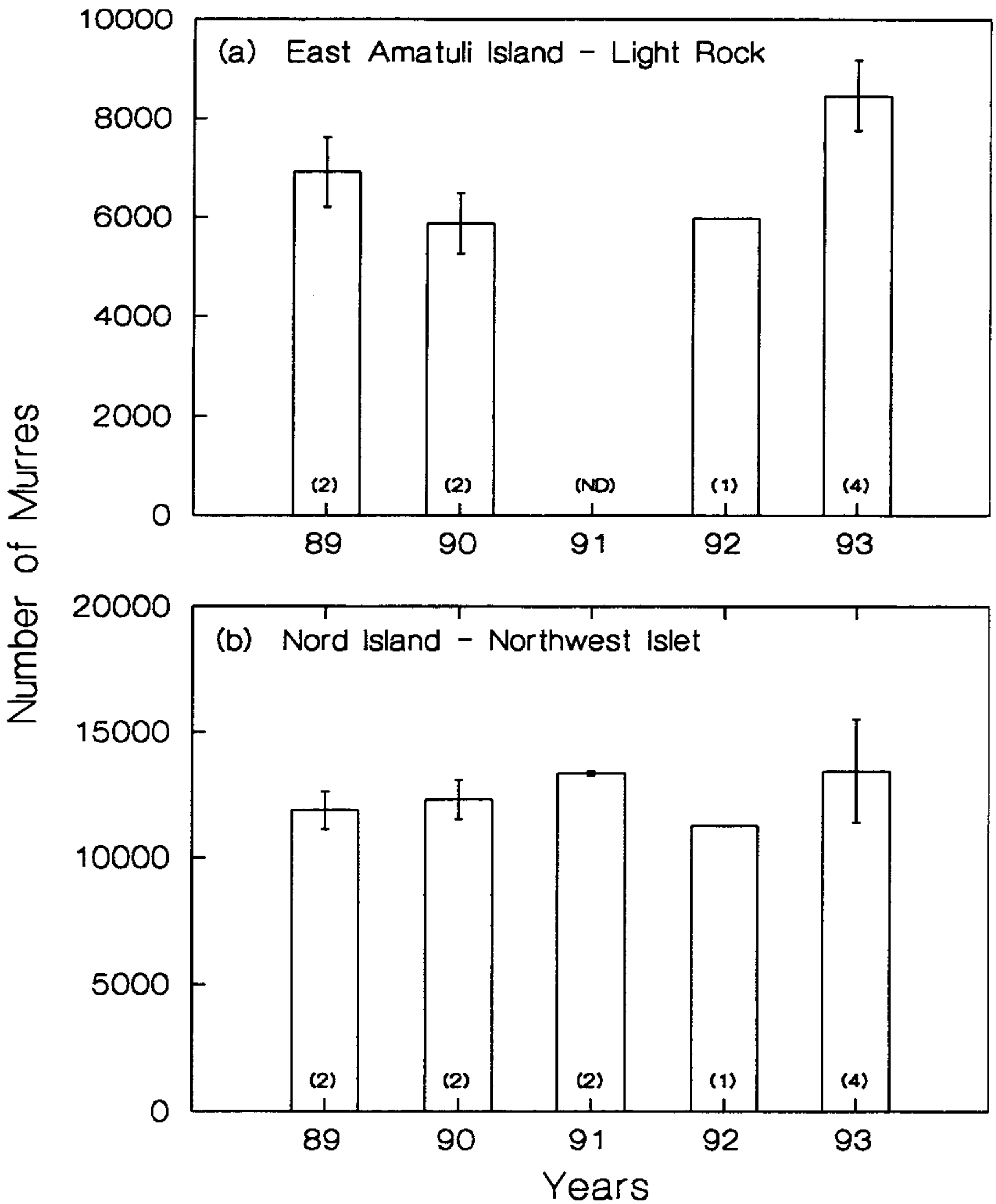


Figure 4. Average FWS counts of murres at (a) East Amatuli Light Rock and (b) Nord Island - Northwest Islet, Barren Islands, Alaska, 1989-1993 (see Nysewander *et al.* 1993, Dragoo *et al.* 1994). Data are from Table 1; numbers of counts are shown in parentheses; error bars = standard deviation; ND = no data. *Note: The previously reported 17 July 1991 single Light Rock count of 5,529 murres is not shown here because it included 3,429 birds on the cliffs and 2,100 individuals on nearby waters (see Nysewander and Dippel 1991).*

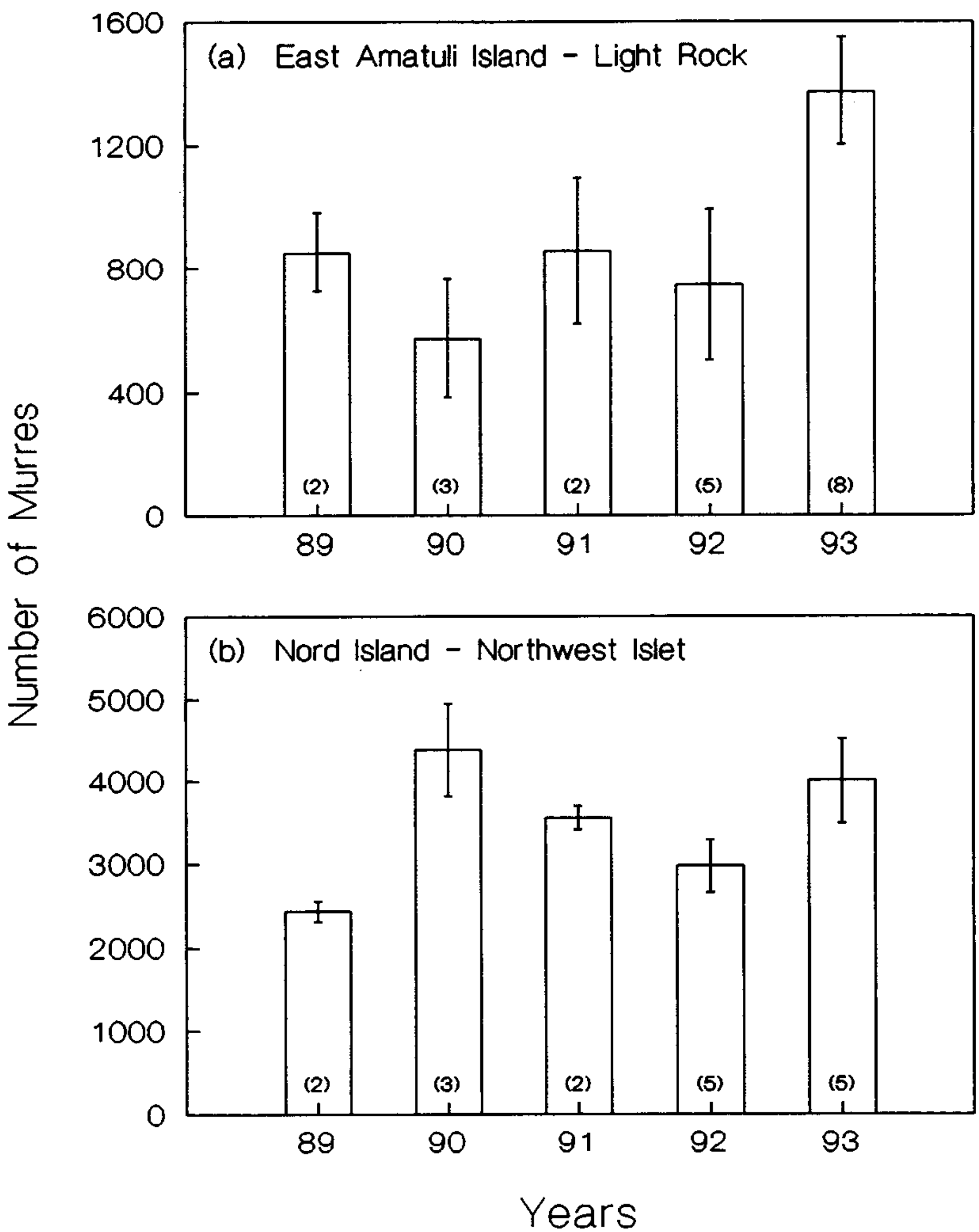


Figure 5. Average counts of murres on multicount plots (a) BMP3-4 at East Amatuli Island - Light Rock and (b) BMP1-11 at Nord Island - Northwest Islet, Barren Islands, Alaska, 1989-1993 (numbers of counts are shown in parentheses, error bars = standard deviation, data are from Table 2).

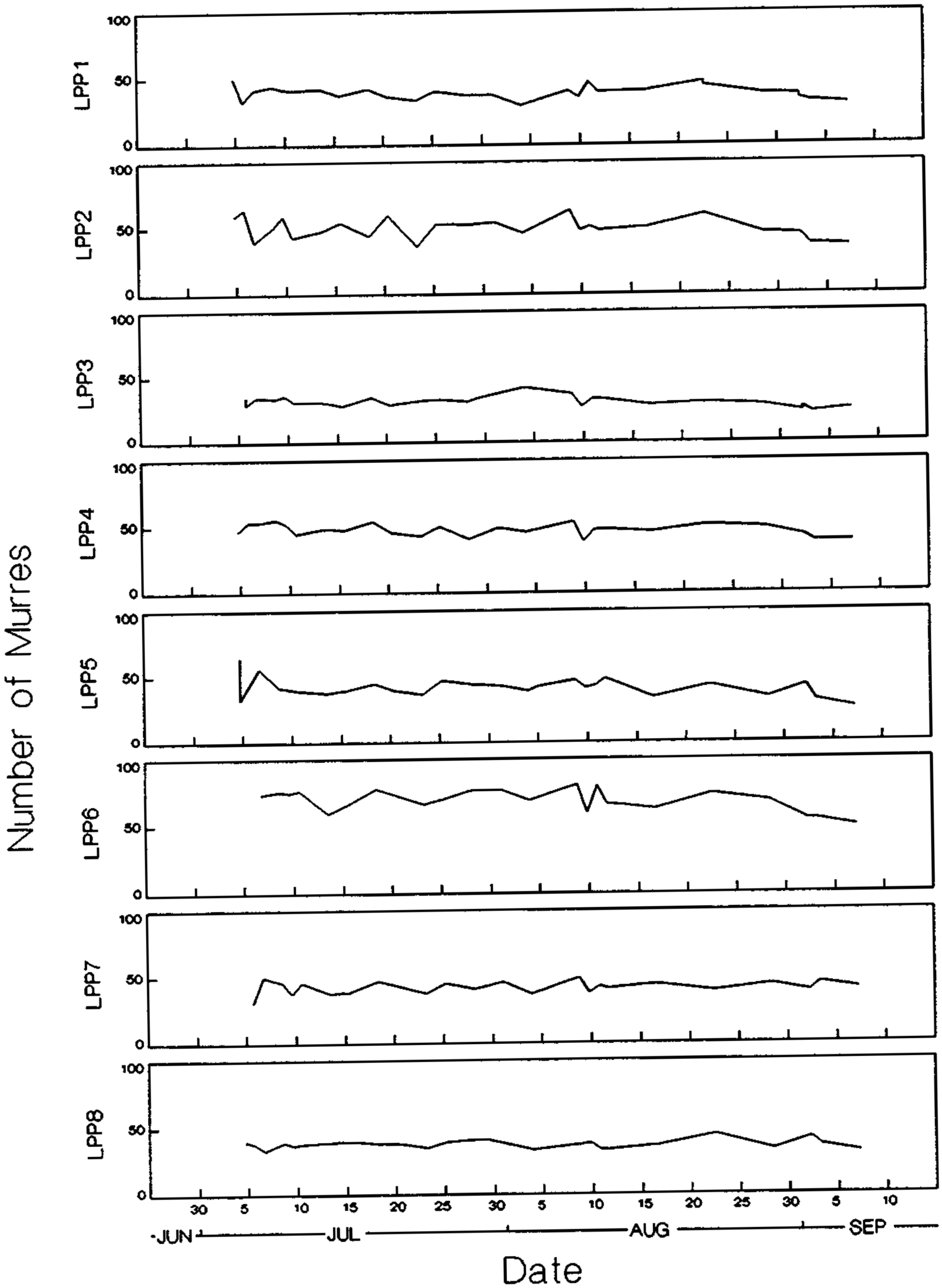


Figure 6. Counts of murres on productivity plots LPP1-10 at East Amatuli Island - Light Rock, Barren Islands, Alaska, 1993.

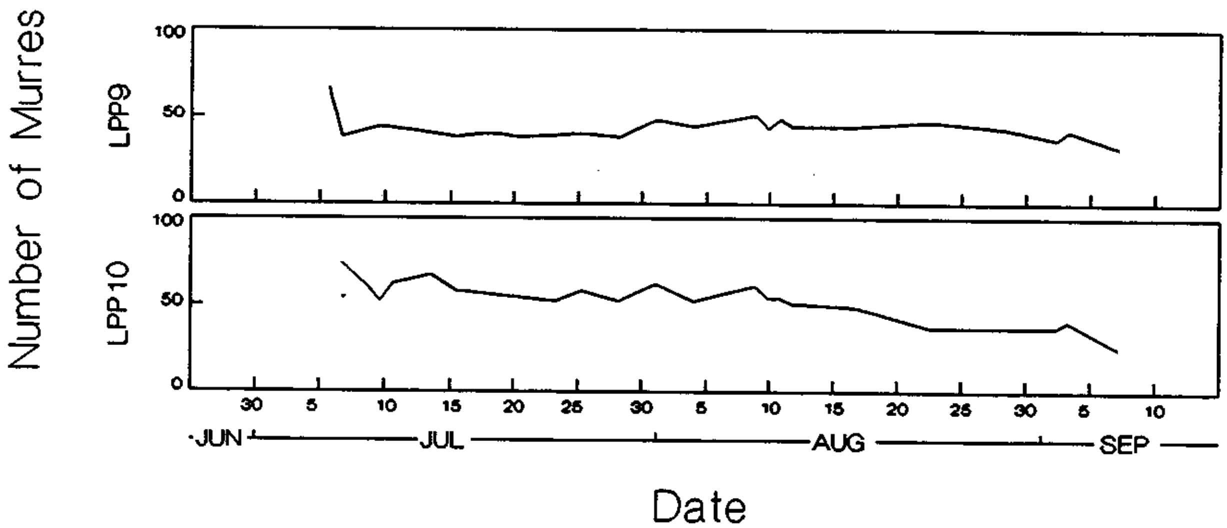


Figure 6 (Continued). Counts of murres on productivity plots LPP1-10 at East Amatuli Island - Light Rock, Barren Islands, Alaska, 1993.

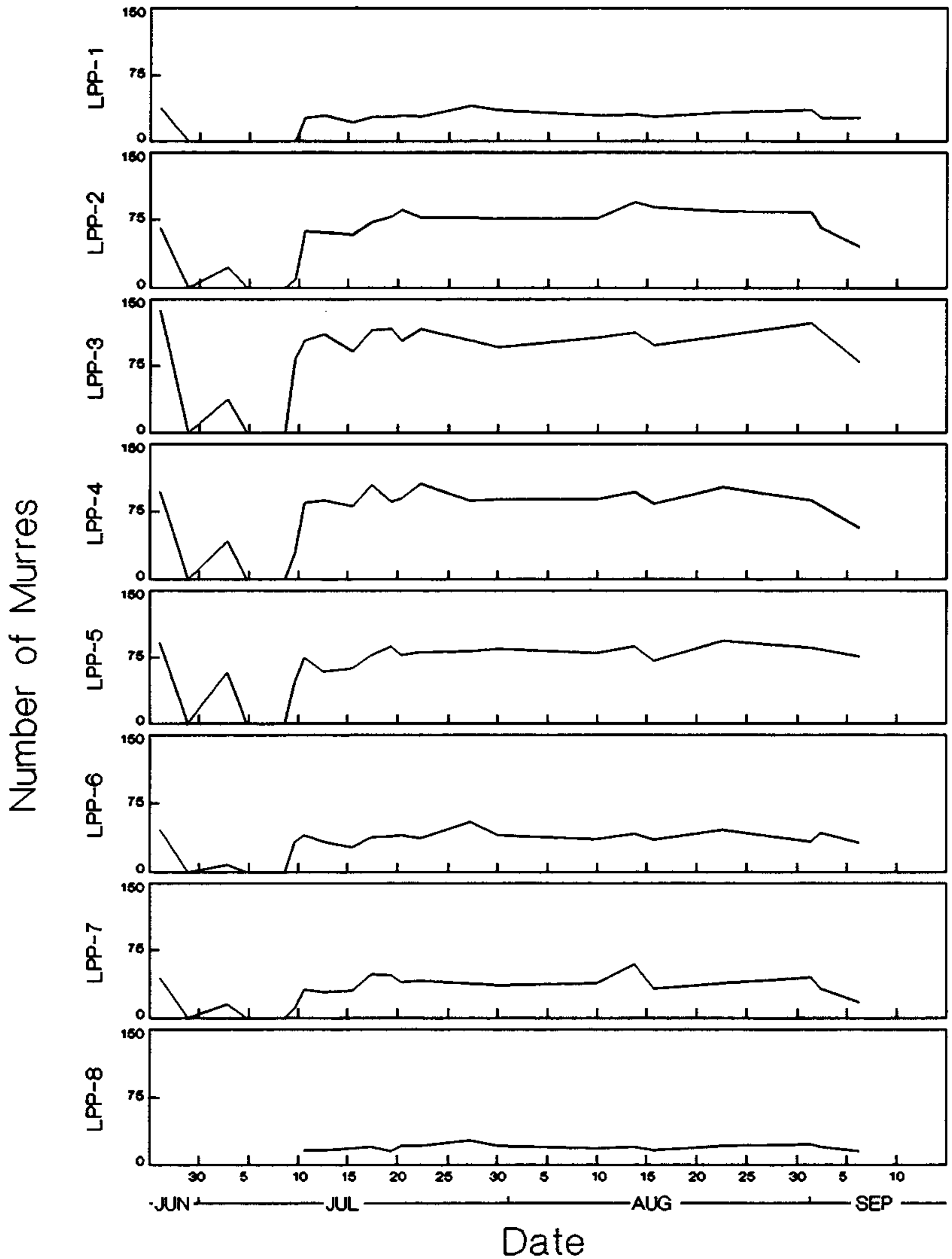


Figure 7. Counts of murres on productivity plots LPP1-8 at Nord Island, Barren Islands, Alaska, 1993.

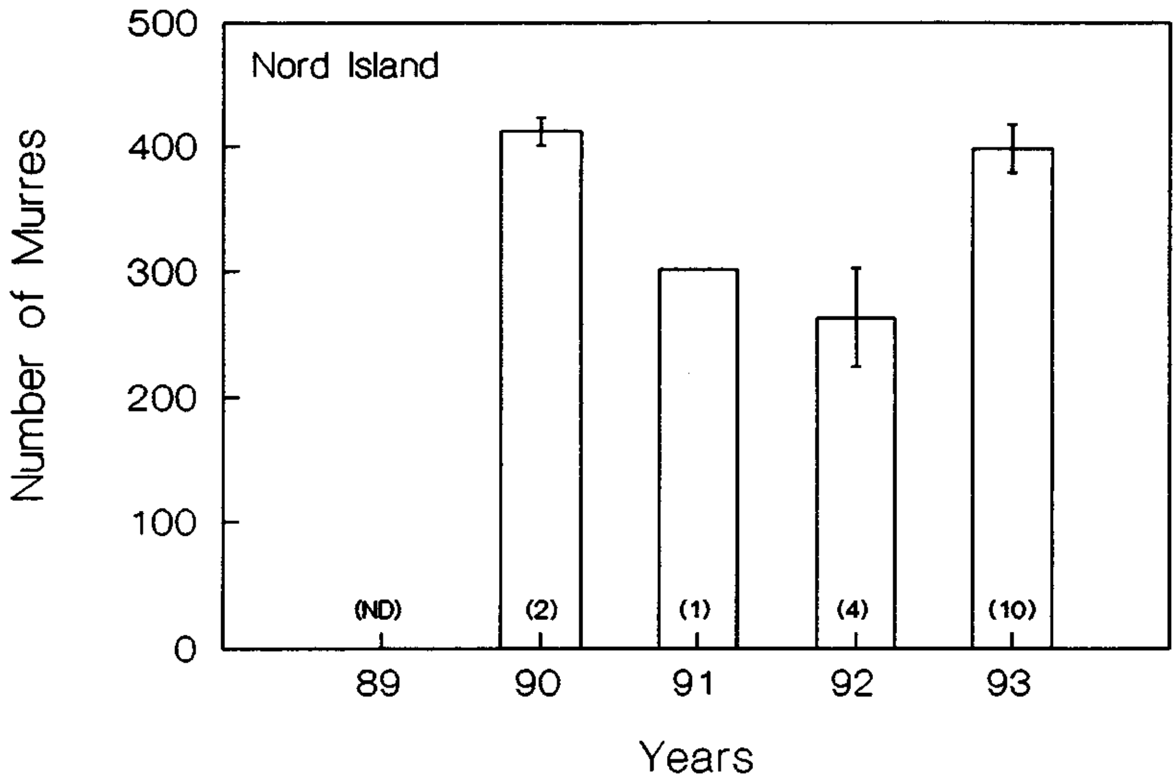


Figure 8. Average counts of murres on productivity plots LPP1-5 at Nord Island, Barren Islands, Alaska, 1989-1993 (numbers of counts are shown in parentheses, error bars = standard deviation, data are from Table 3).

Appendix 1. Counts of murres at East Amatuli Light Rock, 18 July 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau and LMD = Lynn M. Denlinger.

		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
Section[1]	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
1	1820	2,590	2,770		2,680	3,100			3,100	2,890
2	↓	80	70		75	100			100	88
3		1,840	1,840		1,840	1,790			1,790	1,815
4		1,960	1,840		1,900	1,700			1,700	1,800
5		350	370		360	330			330	345
6		380	420		400	400			400	400
7 (BCP55)		540	540		540	450			450	495
8	2000	1,590	1,596		1,593	1,570			1,570	1,582
TOTAL (Whole Rock)		9,330	9,446		9,388	9,440			9,440	9,414

[1]The census was made before photographs were obtained showing plot boundaries, so the observers arbitrarily divided the rock into temporary sections to make the count. After the photographs were in hand, it was apparent that Section 7 was equivalent to population census plot BCP55.

Appendix 2. Counts of murres at East Amatuli Light Rock, 1 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau and ABK = Arthur B. Kettle (observers made the counts from separate boats); times in parentheses (e.g., 1646) are estimated times; split times (e.g., 1325/1305) report Observer 1 and Observer 2 times, respectively, if they differed by more than 5 minutes.

		Observer 1 (DGR)				Observer 2 (ABK)				Observer 1 & 2
FWS Plot No.	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP47	1307/1258	160	150		155	155			155	155
BCP48-49	1300	1,335	1,265		1,300	1,020			1,020	1,160
BCP50	1304	60	60		60	65			65	63
BCP51	1325/(1305)	980	1,080		1,030	895			895	963
BCP52	1335/1330	480	500		490	440			440	465
BCP53	1320/(1315)	640			640	380			380	510
BCP54	1310/1325	940	1,010		975	840			840	908
BCP55	1333/1420	340			340	300			300	320
BCP56	1350/(1329)	720	810		765	400			400	583
BCP57	1350	130			130	130			130	130
BCP58	1422/1338	70	60		65	270			270	168
BCP59	1405/1345	520	510		515	505			505	510
BCP60	1420/1340	130	140		135	85			85	110
BCP61	1425/(1400)	1,090	1,180		1,135	2,480			2,480	1,808
BCP62	1423/1355	100	110		105	140			140	123
BCP63	1430/(1418)	110	120		115	65			65	90
BCP64	1251	70	75		73	70			70	71
TOTAL (Whole Rock)		7,875			8,028	8,240			8,240	8,134

Appendix 3. Counts of murres at East Amatuli Light Rock, 2 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population cenus plots counted from boats, not land; DGR = David G. Roseneau and ABK = Arthur B. Kettle (the observers made the counts from separate boats); times in parentheses (e.g., 1646) are estimated times; split times (e.g., 1325/1305) report Observer 1 and Observer 2 times, respectively, if they differed by more than 5 minutes.

		Observer 1 (DGR)					Observer 2 (ABK)					Observer 1 & 2
FWS Plot No.	Time	Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BCP47	1135/(1032)	170	170			170	180				180	175
BCP48	1130/1037	880	840			860	795				795	828
BCP49	1027/1042	150	140			145	165				165	155
BCP50	1025/1042	70	60			65	60				60	63
BCP51	1115	850	880			865	880	720	790	815	801	833
BCP52	1055/1144	330	360			345	370	380			375	360
BCP53	1040/1058	380	400			390	400				400	395
BCP54	1050/1134	870	850			860	930	960			945	903
BCP55	1145/1225	340	360			350	345				345	348
BCP56	1110/(1155)	490	520			505	420	430			425	465
BCP57	1208	130	130			130	130				130	130
BCP58	1225/1200	240	230			235	250	250			250	243
BCP59	1230/(1205)	500	530	470	480	495	320				320	408
BCP60	1245/1203	140	130			135	120				120	128
BCP61	1235/(1220)	1,700	1,650			1,675	2,440				2,440	2,058
BCP62	1242/(1222)	100	110	110	100	105	145				145	125
BCP63	1200/1242	100	90	100		97	65	65			65	81
BCP64	1205/1030	60	65			63	70				70	66
TOTAL (Whole Rock)		7,500	7,515			7,489	8,085				8,031	7,760

Appendix 4. Counts of murres at East Amatuli Light Rock, 3 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; ABK = Arthur B. Kettle and MAB = Margaret A. Blanding; times in parentheses (e.g., 1646) are estimated times.

		Observer 1 (ABK)					Observer 2 (MAB)					Observer 1 & 2
FWS Plot No.	Time	Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BCP47	(1630)	230				230	230				230	230
BCP48	1641	850	860			855	890				890	873
BCP49	(1646)	185	195			190	210				210	200
BCP50	(1647)	70	70			70	80				80	75
BCP51	(1700)	798	828	938	853	854	907	817	927		884	869
BCP52	1754	400	390	390		393	350	480	410		413	403
BCP53	1724	360	410			385	400	340			370	378
BCP54	1738	910				910	910				910	910
BCP55	1802	340	349			345	420	400			410	377
BCP56	1745	450	450			450	410	450			430	440
BCP57	(1818)	210				210	190				190	200
BCP58	1811	250				250	270				270	260
BCP59	1820	460				460	480				480	470
BCP60	(1814)	165				165	150				150	158
BCP61	1825	2,430				2,430	2,250				2,250	2,340
BCP62	1829	160				160	170				170	165
BCP63	1842	80				80	90				90	85
BCP64	1633	70				70	80				80	75
TOTAL (Whole Rock)		8,418				8,507	8,487				8,507	8,507

Appendix 5. Counts of murres at East Amatuli Island, 31 July 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger; ABK = Arthur B. Kettle; MAB = Margaret A. Blanding.

		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
FWS Plot No.	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP1	1937	65			65	75			75	70
BCP2	1937	35			35	45			45	40
BCP3	1933	150			150	130			130	140
BCP4	1933	60			60	50			50	55
BCP5	1930	110			110	110			110	110
BCP6	1928	110			110	120			120	115
BCP7	1925	130	130		130	130			130	130
BCP8	1720	360			360	330			330	345
BCP9	1715	380			380	350			350	365
BCP10	1710	130			130	120			120	125
BCP11	1835	290			290	280			280	285
BCP12	1830	400			400	400			400	400
BCP13	1840	1,030			1,030	980			980	1,005
BCP14	1825	990			990	860			860	925
BCP15	1815	475			475	455			455	465
BCP16	1855	2,260			2,260	2,380			2,380	2,320
BCP17	1800	2,620			2,620	2,470			2,470	2,545
BCP18	1740	620			620	670			670	645
BCP19	1740	160			160	180			180	170
BCP20	1640	3,720			3,720	3,800			3,800	3,760

Appendix 5 (Continued).

FWS Plot No.	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP21	1610	1,500			1,500	1,540			1,540	1,520
Subtotal (BCP1-BCP21)		*15,595*			*15,595*	*15,475*			*15,475*	*15,535*
		Observer 1 (ABK) Count 1	Count 2	Count 3	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Average	
BCP22	1958	750	770		760	760			760	760
BCP23	1953	1,240			1,240	1,480			1,480	1,360
BCP24	1938	690			690	990			990	840
BCP25	1922	890	790		840	760	850		805	823
BCP26	1916	150			150	135			135	143
BCP27	1910	43			43	40			40	42
BCP28	1902	440	430		435	440			440	438
BCP29	1849	250			250	300	250		275	263
BCP30	1827	610			610	590			590	600
BCP31	1827	690			690	650			650	670
BCP32	1801	190			190	220			220	205
BCP33	1750	690			690	730			730	710
BCP34	1730	240	250		245	270	265		268	256
BCP35	1725	500			500	480			480	490
BCP36	1721	80			80	100			100	90
BCP37	1720	230			230	260			260	245
BCP38	1705	116			116	111			111	114

Appendix 5 (Continued).

FWS Plot No.	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP39	1704	76			76	74	69		72	74
BCP40	1702	76	73		75	65	71		68	71
BCP41	1700	74	69	71	71	63	64		64	67
BCP42	1658	380			380	430			430	405
BCP43	1654	70			70	60			60	65
BCP44	1645	1,150			1,150	1,110			1,110	1,130
BCP45	1635	340			340	330	320		325	333
BCP46	1626	190	190		190	200	185		193	191
Subtotal (BCP22-BCP46)		*10,155*			*10,111*	*10,648*			*10,654*	*10,382*
TOTAL (Whole Island)		25,750			25,706	26,123			26,129	25,917

Appendix 6. Counts of murres at East Amatuli Island, 2 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger; ABK = Arthur B. Kettle; MAB = Margaret A. Blanding.

		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
FWS No.	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP1	1648	70			70	70			70	70
BCP2	1655	45			45	45			45	45
BCP3	1643	20			20	25			25	23
BCP4	1643	160			160	140			140	150
BCP5	1640	90			90	85			85	88
BCP6	1635	150			150	140			140	145
BCP7	1628	110			110	100			100	105
BCP8	1622	410			410	410			410	410
BCP9	1610	445			445	430			430	438
BCP10	1617	130			130	110			110	120
BCP11	1528	200	190		195	190	180		185	190
BCP12	1525	310	320		315	320			320	318
BCP13	1535	980	1,030		1,005	920	1,060		990	998
BCP14	1515	1,070			1,070	960			960	1,015
BCP15	1510	520			520	500			500	510
BCP16	1545	2,470			2,470	2,320			2,320	2,395
BCP17	1450	2,890			2,890	2,680			2,680	2,785
BCP18	1440	600			600	590			590	595
BCP19	1440	140			140	160			160	150
BCP20	1335	2,500			2,500	2,540			2,540	2,520

Appendix 6 (Continued).

FWS Plot No.	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP21	1310	1,120			1,120	1,070			1,070	1,095
Subtotal (BCP1-BCP21)		*14,430*			*14,455*	*13,805*			*13,870*	*14,163*
		Observer 1 (ABK) Count 1	Count 2	Count 3	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Average	
BCP22	1738	790	800		795	760			760	778
BCP23	1730	1340			1,340	1200			1,200	1,270
BCP24	1724	830			830	820			820	825
BCP25	1715	770	750		760	900	860		880	820
BCP26	1705	130			130	125			125	128
BCP27	1650	10			10	14			14	12
BCP28	1645	350	320		335	400	330		365	350
BCP29	1655	225			225	220			220	223
BCP30	1637	670			670	680			680	675
BCP31	1641	690	680		685	730			730	708
BCP32	1625	70			70	160			160	115
BCP33	1619	850			850	810			810	830
BCP34	1609	235			235	270			270	253
BCP35	1600	250			250	270	230		250	250
BCP36	1557	90	90		90	90			90	90
BCP37	1553	220	215		218	180	200		190	204
BCP38	1528	107	102		105	107	107		107	106

Appendix 6 (Continued).

FWS Plot No.	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP39	1524	73	66		70	64			64	67
BCP40	1522	62	62		62	55	54		55	58
BCP41	1520	60	60		60	43	53	57	51	56
BCP42	1515	390			390	380			380	385
BCP43	1513	75			75	60			60	68
BCP44	1510	1070	950		1,010	750	870		810	910
BCP45	1450	260	210		235	150	190	170	170	203
BCP46	1438	90			90	90			90	90
Subtotal (BCP22-BCP46)		*9,707*			*9,589*	*9,328*			*9,351*	*9,470*
TOTAL (Whole Island)		24,137			24,044	23,133			23,221	23,632

Appendix 7. Counts of murres on multicount plots at East Amatuli Island - Light Rock, 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate that the plots are population census plots counted from boats, not land; BMP numbers indicate that the plots are also mulitcount plots that are counted from boats at least five separate times on different days to help track population trends; DGR = David G. Roseneau; LMD = Lynn M. Denlinger; ABK = Arthur B. Kettle; MAB = Margaret A. Blanding; numbers ending other than 0 or 5 result from averaging several counts on some subsections of the plots; on 1 August, DGR replaced MAB as Observer 2 at plots BMP4 and BMP5; ND = no data.

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP1	BCP7-9	22 Jul	1825	1,031				1,031	1,064				1,064	1,048
BMP2	BCP11-12	22 Jul	1852	562				562	644				644	603
BMP3	BCP18-19	22 Jul	1917	745				745	880				880	813
BMP4	Part of BCP47-49	22 Jul	1912	740				740	793				793	767
Subtotal	*4 Plots: BMP1-4*			*3,078*				*3,078*	*3,381*				*3,381*	*3,230*
BMP5	Part of BCP20-21	22 Jul		ND				ND	ND				ND	ND
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	22 Jul		ND				ND	ND				ND	ND
BMP7	BCP22	22 Jul		ND				ND	ND				ND	ND
BMP8	BCP38-42	22 Jul		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP1	BCP7-9	23 Jul		ND				ND	ND				ND	ND
BMP2	BCP11-12	23 Jul		ND				ND	ND				ND	ND
BMP3	BCP18-19	23 Jul		ND				ND	ND				ND	ND
BMP4	Part of BCP47-49	23 Jul		ND				ND	ND				ND	ND
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	23 Jul	1316	853				853	850				850	852
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	23 Jul		ND				ND	ND				ND	ND
BMP7	BCP22	23 Jul	1240	615				615	745				745	680
BMP8	BCP38-42	23 Jul	1351	756				756	664				664	710
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
BMP1	BCP7-9	26 Jul	1314	803				803	759				759	781
BMP2	BCP11-12	26 Jul	1333	580				580	551				551	566
BMP3	BCP18-19	26 Jul	1405	562				562	578				578	570
BMP4	Part of BCP47-49	26 Jul	1431	692				692	685				685	689
(Subtotal)	*(4 Plots: BMP1-4)*			*2,637*				*2,637*	*2,573*				*2,573*	*2,605*

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP5	Part of BCP20-21	26 Jul	1610	895				895	888				888	892
(Subtotal)	*(5 Plots: BMP1-5)*			*3,532*				*3,532*	*3,461*				*3,461*	*3,497*
BMP6	BCP51	26 Jul		ND				ND	ND				ND	ND
BMP7	BCP22	26 Jul	1503	915				915	915				915	915
BMP8	BCP38-42	26 Jul	1530	634				634	622				622	628
Subtotal	*7 Plots: BMP1-5 & 7-8*			*5,081*				*5,081*	*4,998*				*4,998*	*5,040*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
BMP1	BCP7-9	30 Jul		ND				ND	ND				ND	ND
BMP2	BCP11-12	30 Jul		ND				ND	ND				ND	ND
BMP3	BCP18-19	30 Jul		ND				ND	ND				ND	ND
BMP4	Part of BCP47-49	30 Jul	1345	641				641	585				585	613
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	30 Jul		ND				ND	ND				ND	ND
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	30 Jul	1600	783				783	820				820	802
BMP7	BCP22	30 Jul		ND				ND	ND				ND	ND

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (MAB)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP8	BCP38-42	30 Jul	1700	718				718	744				744	731
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
				Observer 1 (DGR)					Observer 2 (LMD)					
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP7-9	31 Jul	1925	490				490	460				460	475
BMP2	BCP11-12	31 Jul	1830	690				690	680				680	685
BMP3	BCP18-19	31 Jul	1740	780				780	850				850	815
BMP4	Part of BCP47-49	31 Jul	1730	730				730	720				720	725
(Subtotal)	*(4 Plots: BMP1-4)*			*2,690*				*2,690*	*2,710*				*2,710*	*2,700*
BMP5	Part of BCP20-21	31 Jul	1700	950				950	920				920	935
(Subtotal)	*(5 Plots: BMP1-5)*			*3,640*				*3,640*	*3,630*				*3,630*	*3,635*
BMP6	BCP51	31 Jul	1745	1,030				1,030	1,000				1,000	1,015
BMP7	BCP22	31 Jul	1958	760				760	760				760	760

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP8	BCP38-42	31 Jul	1658	718				718	745				745	732
Subtotal	*7 Plots: BMP1-5 & 7-8*			*5,118*				*5,118*	*5,135*				*5,135*	*5,127*
TOTAL	8 Plots: BMP1-8			6,148				6,148	6,135				6,135	6,142
BMP1	BCP7-9	1 Aug		ND				ND	ND				ND	ND
BMP2	BCP11-12	1 Aug		ND				ND	ND				ND	ND
BMP3	BCP18-19	1 Aug		ND				ND	ND				ND	ND
BMP4	Part of BCP47-49	1 Aug	1258	780				780	740				740	760
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	1 Aug	1305	895				895	1,030				1,030	963
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	1 Aug		ND				ND	ND				ND	ND
BMP7	BCP22	1 Aug		ND				ND	ND				ND	ND
BMP8	BCP38-42	1 Aug		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP1	BCP7-9	2 Aug	1908	628				628	636				636	632
BMP2	BCP11-12	2 Aug	1900	585				585	570				570	578
BMP3	BCP18-19	2 Aug	1841	710				710	740				740	725
BMP4	Part of BCP47-49	2 Aug	1827	750				750	740				740	745
(Subtotal)	*(4 Plots: BMP1-4)*			*2,673*				*2,673*	*2,686*				*2,686*	*2,680*
BMP5	Part of BCP20-21	2 Aug	1845	800				800	880				880	840
(Subtotal)	*(5 Plots: BMP1-5)*			*3,473*				*3,473*	*3,566*				*3,566*	*3,520*
BMP6	BCP51	2 Aug	1813	880				880	850				850	865
BMP7	BCP22	2 Aug	1738	795				795	760				760	778
BMP8	BCP38-42	2 Aug	1520	687				687	657				657	672
Subtotal	*7 Plots: BMP1-5 & 7-8*			*4,955*				*4,955*	*4,983*				*4,983*	*4,969*
TOTAL	8 Plots: BMP1-8			5,835				5,835	5,833				5,833	5,834
				Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP7-9	2 Aug	1628	520				520	510				510	515
BMP2	BCP11-12	2 Aug	1525	510				510	505				505	508
BMP3	BCP18-19	2 Aug	1440	740				740	750				750	745

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (DGR)					Observer 2 (LMD)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP4	Part of BCP47-49	2 Aug	1820	785				785	750				750	768
(Subtotal)	*(4 Plots: BMP1-4)*			*2,555*				*2,555*	*2,515*				*2,515*	*2,535*
BMP5	Part of BCP20-21	2 Aug	1335	740				740	740				740	740
(Subtotal)	*(5 Plots: BMP1-5)*			*3,295*				*3,295*	*3,255*				*3,255*	*3,275*
BMP6	BCP51	2 Aug	1820	785				785	750				750	768
BMP7	BCP22	2 Aug		ND				ND	ND				ND	ND
BMP8	BCP38-42	2 Aug		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
				Observer 1 (ABK)					Observer 2 (MAB)					
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP7-9	3 Aug		ND				ND	ND				ND	ND
BMP2	BCP11-12	3 Aug		ND				ND	ND				ND	ND
BMP3	BCP18-19	3 Aug		ND				ND	ND				ND	ND
BMP4	Part of BCP47-49	3 Aug		ND				ND	ND				ND	ND
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	ABK	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP5	Part of BCP20-21	3 Aug		ND				ND	ND				ND	ND
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	3 Aug	1700	854				854	884				884	869
BMP7	BCP22	3 Aug		ND				ND	ND				ND	ND
BMP8	BCP38-42	3 Aug		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
BMP1	BCP7-9	11 Aug		ND				ND	ND				ND	ND
BMP2	BCP11-12	11 Aug	1956	524				524	550				550	537
BMP3	BCP18-19	11 Aug	1913	756				756	709				709	733
BMP4	Part of BCP47-49	11 Aug	1858	727				727	817				817	772
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	11 Aug	1818	918				918	927				927	923
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	11 Aug	1928	905				905	1,030				1,030	968

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	ABK	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP7	BCP22	11 Aug		ND				ND	ND				ND	ND
BMP8	BCP38-42	11 Aug		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
BMP1	BCP7-9	12 Aug	1535	831				831	864				864	848
BMP2	BCP11-12	12 Aug		ND				ND	ND				ND	ND
BMP3	BCP18-19	12 Aug		ND				ND	ND				ND	ND
BMP4	Part of BCP47-49	12 Aug		ND				ND	ND				ND	ND
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	12 Aug		ND				ND	ND				ND	ND
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	12 Aug		ND				ND	ND				ND	ND
BMP7	BCP22	12 Aug		ND				ND	ND				ND	ND
BMP8	BCP38-42	12 Aug	1058	607				607	596				596	602
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK) Count 1	Count 2	ABK	Count 4	Average	Observer 2 (MAB) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP1	BCP7-9	16 Aug		ND				ND	ND				ND	ND
BMP2	BCP11-12	16 Aug	2100	505				505	470				470	488
BMP3	BCP18-19	16 Aug	2025	608				608	580				580	594
BMP4	Part of BCP47-49	16 Aug	2020	670				670	650				650	660
Subtotal	*4 Plots: BMP1-4*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP5	Part of BCP20-21	16 Aug	2050	850				850	840				840	845
Subtotal	*5 Plots: BMP1-5*			*ND*				*ND*	*ND*				*ND*	*ND*
BMP6	BCP51	16 Aug	1950	820				820	817				817	819
BMP7	BCP22	16 Aug	1937	820				820	870				870	845
BMP8	BCP38-42	16 Aug		ND				ND	ND				ND	ND
Subtotal	*7 Plots: BMP1-5 & 7-8*			*ND*				*ND*	*ND*				*ND*	*ND*
TOTAL	8 Plots: BMP1-8			ND				ND	ND				ND	ND
BMP1	BCP7-9	17 Aug	1810	763				763	741				741	752
BMP2	BCP11-12	17 Aug	1745	564				564	551				551	558
BMP3	BCP18-19	17 Aug	1726	568				568	563				563	566
BMP4	Part of BCP47-49	17 Aug	1710	663				663	730				730	697
(Subtotal)	*(4 Plots: BMP1-4)*			*2,558*				*2,558*	*2,585*				*2,585*	*2,572*

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (MAB)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP5	Part of BCP20-21	17 Aug	1930	914				914	945				945	930
(Subtotal)	*(5 Plots: BMP1-5)*			*3,472*				*3,472*	*3,530*				*3,530*	*3,501*
BMP6	BCP51	17 Aug	1650	875				875	915				915	895
BMP7	BCP22	17 Aug	1634	833				833	790				790	812
BMP8	BCP38-42	17 Aug	1900	793				793	823				823	808
Subtotal	*7 Plots: BMP1-5 & 7-8*			*5,098*				*5,098*	*5,143*				*5,143*	*5,121*
TOTAL	8 Plots: BMP1-8			6,002				5,973	6,058				6,058	6,016
BMP1	BCP7-9	2 Sep	1910	583				583	515				515	549
BMP2	BCP11-12	2 Sep	1235	500				500	488				488	494
BMP3	BCP18-19	2 Sep	1838	490				490	510				510	500
BMP4	Part of BCP47-49	2 Sep	1848	580				580	640				640	610
(Subtotal)	*(4 Plots: BMP1-4)*			*2,153*				*2,153*	*2,153*				*2,153*	*2,153*
BMP5	Part of BCP20-21	2 Sep	1809	705				705	710				710	708
(Subtotal)	*(5 Plots: BMP1-5)*			*2,858*				*2,858*	*2,863*				*2,863*	*2,861*
BMP6	BCP51	2 Sep	1854	670				670	680				680	675
BMP7	BCP22	2 Sep	1931	920				920	1,060				1,060	990

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Former FWS Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (MAB)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP8	BCP38-42	2 Sep	1940	697				697	735				735	716
Subtotal	*7 Plots: BMP1-5 & 7-8*			*4,475*				*4,475*	*4,658*				*4,658*	*4,567*
TOTAL	8 Plots: BMP1-8			5,242				5,145	5,338				5,338	5,242
Mean of 6 count on 4 plots (BMP1-4)									*Range = 2,153 - 3,230*				*318*	*2,639*
Mean of 5 counts on 5 plots (BMP1-5)									*Range = 2,861 - 3,635*				*281*	*3,381*
Mean of 5 counts on 7 plots (BMP1-5 & 7-8)									*Range = 4,567 - 5,127*				*232*	*4,964*
MEAN OF 4 COUNTS ON 8 PLOTS (BMP1-8)									Range = 5,242 - 6,142				398	5,808

Appendix 8. Counts of murres on multicount plots at the Nord Island - Northwest Islet and East Amatuli Island - Light Rock colonies, Barren Islands, Alaska, 1989-1993 (1989-1992 data are from Dragoo *et al.* 1994 and Nysewander *et al.* 1993).[1]

Nord Island - Northwest Islet														East Amatuli Island - Light Rock				
Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD)[2]	Date	BMP3	BMP4	Total	(SD)
1989														1989				
27 Jul	154	127	7	139	460	531	74	274	375	159	219	2,519		27 Jul	339	424	763	
13 Aug	147	125	10	115	203	480	81	542	250	159	231	2,343		13 Aug	406	535	941	
Mean	151	126	9	127	332	506	78	408	313	159	225	2,431	(124.5)	Mean	373	480	852	(125.9)
1990														1990				
19 Jul	136	436	13	249	1,240	726	110	1,460	252	127	242	4,991		ND	ND	ND	ND	
14 Aug	134	310	13	231	875	468	155	898	380	144	261	3,869		15 Aug	292	416	708	
18 Aug	34	377	14	102	1,016	780	168	978	460	133	226	4,288		19 Aug	233	208	441	
Mean	101	374	13	194	1,044	658	144	1,112	364	135	243	4,383	(567.0)	Mean	263	312	575	(188.8)
1991														1991				
17 Aug	139	291	14	153	833	711	147	595	407	165	204	3,659		19 Aug	529	496	1,025	
22 Aug	140	220	12	126	830	514	103	825	358	129	200	3,457		1 Sep	375	319	694	
Mean	140	256	13	140	832	613	125	710	383	147	202	3,558	(142.8)	Mean	452	408	860	(234.1)
1992														1992				
6 & 9 Aug	95	181	9	143	688	473	71	873	285	84	106	3,008		7 Aug	232	235	467	
10 Aug	63	195	0	65	618	493	76	610	242	117	158	2,637		9 Aug	440	508	948	

Appendix 8 (Continued).

Nord Island - Northwest Islet

Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD)[2]
1992													
18 Aug	85	169	10	178	682	380	114	523	301	168	134	2,744	
24 Aug	70	321	0	163	780	541	150	760	311	165	188	3,449	
26 Aug	42	151	7	113	730	488	101	855	251	142	136	3,016	
Mean	71	203	5	132	700	475	102	724	278	135	144	2,971	(314.2)
1993													
19 Jul	90	210	10	140	1,130	960	120	1,360	240	120	209	4,589	
3 Aug	60	175	10	141	1,090	903	90	1,208	480	103	253	4,513	
4 Aug	55	153	9	85	1,100	585	95	965	415	143	208	3,813	
9 Aug	48	150	1	113	910	443	101	1,108	370	85	150	3,479	
17 Aug	123	254	0	115	710	530	140	1,000	380	136	235	3,623	
Mean	75	188	6	119	988	684	109	1,128	377	117	211	4,003	(514.4)

East Amatuli Island - Light Rock

Date	BMP3	BMP4	Total	(SD)
1992				
10 Aug	388	538	926	
18 Aug	392	501	893	
26 Aug	199	294	493	
Mean	330	415	745	(243.2)
1993				
22 Jul	813	767	1,580	
26 Jul	570	689	1,259	
31 Jul	815	725	1,540	
2 Aug	735	757	1,492	
11 Aug	733	772	1,505	
16 Aug	594	660	1,254	
17 Aug	566	697	1,263	
2 Sep	500	610	1,110	
Mean	666	710	1,375	(173.5)

[1] This table contains some values that are slightly different from previously published figures (e.g., Dragoo *et al.* 1994). These revisons were made after reviewing the 1989-1992 field notes. In 1989, count dates were 27 July and 13 August, not 26 July and 12 August. Also, mean plot values have been recalculated in several cases (e.g., Nord Island, 1990), and the number 318 reported for plot BMP4 at East Amatuli Light Rock on 1 September 1991 was changed to 319. Correct dates for East Amatuli Island and Light Rock counts are also reported here. Nord Island plots BMP1-11 are equivalent to previously reported plots A1, A2, B, C, D, E, G, H1, H2, I, and NW Islet, respectively. East Amatuli Island and Light Rock plots BMP3 and BMP4 are equivalent to the "Mainland" and "Lt. Rock" plots, respectively. The 13 August 1989 total for plot BMP10 is an estimated value (Dragoo *et al.* 1994).

[2] SD = standard deviation.

Appendix 9. Counts of murres at Nord Island - Northwest Islet, 19 July 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger; LMD made few counts because strong currents were present and one person had to operate the boat to keep it in position in front of the plots.

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP1	A1	1300	90			90					90
BCP2	A2	1305	210			210					210
BCP3	B	1313	10			10					10
BCP4	C	1315	140			140					140
BCP5	D	1330	1,130			1,130					1,130
BCP6	E	1323	960			960					960
BCP7	G	1320	120			120					120
BCP8	H1	1430	1,360			1,360					1,360
BCP9	H2	1340	240			240					240
BCP10	I	1445	120			120					120
BCP11	(None)[1]	1443	0			0					0
BCP12	J	1447	0			0					0
BCP13	P	1450	80			80					80
BCP14	Q + R[2]	1455	1,330			1,330					1,330
BCP15	S [also "S-1" or "R-S"][3]	1505	440			440					440
BCP16	W [also "S-2"][4]	1503	140			140					140
BCP17	T (right)	1510	250			250					250
BCP18	T (left)	1510	100			100					100
BCP19	U	1515	90			90					90
BCP20	V ["V-1"+"V-X"][5]	1520	160			160					160

Appendix 9 (Continued).

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP21	X	1525	1,750	1,750	1,810	1,770	1,700	1,800		1,750	1,760
BCP22	Y	1745	1,030			1,030					1,030
BCP23	Z	1755	1,060			1,060					1,060
BCP24	NW Islet Plot	1820	210	215		213	206			206	209
BCP25	Remainder NW Islet[6]	1810	1,150			1,150					1,150
BCP26	("Smaller NW Islet") [Subislet-2][7]	1824	200			200	210			210	205
BCP27	Parakeet Cove	1830	70			70	70			70	70
BCP28	(None) [West Parakeet][8]	1835	20			20	20			20	20
TOTAL (Whole Island)			12,460			12,483					12,474

[1] Consists of the area between BCP10 and BCP12 that was apparently not counted in previous years (i.e., 1989-1992).

[2] Plots Q and R were combined to form BCP14 because of a boundary problem that occurred during the 19 July and 3 August 1993 counts.

[3] Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

[4] Plot W (BCP16) is equivalent to Plot "S-2".

[5] Plot V was counted as "V-1" (1520 hrs: DGR = 10 birds) + "V-X" (1522 hrs: DGR = 150 birds).

[6] Includes a small islet immediately adjacent to Northwest Islet that was counted as part of "Remainder NW Islet" in 1992. In 1993, this small islet was designated "Subislet-1" and the 19 July 1993 count was: (1822 hrs) DGR = 75 birds; LMD = 75 birds.

[7] Consists of a small islet immediately adjacent to Nord Island that was designated "Smaller NW Islet" in 1992 and redesignated "Subislet-2" in 1993.

[8] Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted in previous years.

Appendix 10. Counts of murres at Nord Island - Northwest Islet, 3 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger.

New FWS	Previous FWS		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
Plot Number	Plot Numbers & Names	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP1	A1	1405	60	60		60	60			60	60
BCP2	A2	1415	180			180	170			170	175
BCP3	B	1425	10			10	10			10	10
BCP4	C	1440	135	140		138	145			145	141
BCP5	D	1505	1,110	1,150		1,130	1,050			1,050	1,090
BCP6	E	1455	905			905	900			900	903
BCP7	G	1450	90			90	90			90	90
BCP8	H1	1535	1,260	1,170		1,215	1,200			1,200	1,208
BCP9	H2	1545	500	470		485	480	470		475	480
BCP10	I	1600	110	100		105	95	105		100	103
BCP11	(None)[1]	1610	7			7	7			7	7
BCP12	J	1625	35			35	37			37	36
BCP13	P	1635	330	340		335	350	340		345	340
BCP14	Q + R[2]	1645	2,047			2,047	2,000			2,000	2,024
BCP15	S [also "S-1" or "R-S"][3]	1725	430			430	420			420	425
BCP16	W [also "S-2"][4]	1735	240	230		235	230			230	233
BCP17	T (right)	1750	300	300		300	310	320		315	308
BCP18	T (left)	1800	420	410		415	410			410	413
BCP19	U	1830	140	145		143	140	140		140	141
BCP20	V ["V-1"+V-X"][5]	1810	90	90		90	95			95	93
BCP21	X	1815	3,180	3,000		3,090	3,300	3,300		3,300	3,195

Appendix 10 (Continued).

New FWS	Previous FWS		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
Plot Number	Plot Numbers & Names	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP22	Y	1845	1,250	1,350		1,300	1,430	1,380		1,405	1,353
BCP23	Z	1910	1,330	1,390		1,360	1,350	1,270		1,310	1,335
BCP24	NW Islet Plot	1925	250	240	260	250	255			255	253
BCP25	Remainder NW Islet[6]	1935	1,220	1,180		1,200	1,150	1,280		1,215	1,208
BCP26	("Smaller NW Islet") [Subislet-2][7]	1930	510	490		500	500	520		510	505
BCP27	Parakeet Cove	1941	370	350		360	340			340	350
BCP28	(None) [West Parakeet][8]	1950	10			10	10			10	10
TOTAL (Whole Island)			16,519			16,424	16,534			16,544	16,484

[1] Consists of the area between BCP10 and BCP12 that was apparently not counted in previous years (i.e., 1989-1992).

[2] Plots Q and R were combined to form BCP14 because of a boundary problem that occurred during the 19 July and 3 August 1993 counts.

[3] Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

[4] Plot W (BCP16) is equivalent to Plot "S-2".

[5] Plot V was counted as "V-1" (1810 hrs: DGR = 50 birds; LMD = 55 birds) + "V-X" (1835 hrs: DGR = 40 birds; LMD = 40 birds).

[6] Includes a small islet immediately adjacent to Northwest Islet that was counted as part of "Remainder NW Islet" in 1992. In 1993, this small islet was designated "Subislet-1" and the 3 August 1993 counts were: (1935 hrs) DGR = 100 birds, 100 birds; LMD = 100 birds, 100 birds.

[7] Consists of a small islet immediately adjacent to Nord Island that was designated "Smaller NW Islet" in 1992 and redesignated "Subislet-2" in 1993.

[8] Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted in previous years.

Appendix 11. Counts of murres at Nord Island - Northwest Islet, 4 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger.

New FWS	Previous FWS		Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2
Plot Number	Plot Numbers & Names	Time	Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	Average
BCP1	A1	1740	60			60	50			50	55
BCP2	A2	1730	150	140		145	160	160		160	153
BCP3	B	1728	9			9	9			9	9
BCP4	C	1726	80			80	90			90	85
BCP5	D	1700	1,200			1,200	1,000			1,000	1,100
BCP6	E	1715	570			570	600			600	585
BCP7	G	1727	90			90	100			100	95
BCP8	H1	1645	1,010			1,010	920			920	965
BCP9	H2	1640	400			400	430			430	415
BCP10	I	1620	140	150	150	147	140			140	143
BCP11	(None)[1]	1748	12			12	11			11	12
BCP12	J	1747	40			40	45			45	43
BCP13	P	1750	350	360		355	330			330	343
BCP14	Q + R[2]	1500	1,910			1,910	1,830			1,830	1,870
BCP15	S [also "S-1" or "R-S"][3]	1550	460			460	440			440	450
BCP16	W [also "S-2"][4]	1610	150			150	170			170	160
BCP17	T (right)	1435	300	290		295	290	300		295	295
BCP18	T (left)	1320	330			330	334			334	332
BCP19	U	1428	100			100	100			100	100
BCP20	V ["V-1"+"V-X"][5]	1407	70			70	70			70	70
BCP21	X[6]	1345	2,320			2,320	2,070			2,070	2,195

Appendix 11 (Continued).

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP22	Y	1755	860			860	800			800	830
BCP23	Z	1805	1,000	1,010	1,100	1,037	970			970	1,003
BCP24	NW Islet Plot	1830	200			200	215			215	208
BCP25	Remainder NW Islet[7]	1835	890			890	840			840	865
BCP26	("Smaller NW Islet") [Subislet-2][8]	1820	205			205	200			200	203
BCP27	Parakeet Cove	1840	220			220	220			220	220
BCP28	(None) [West Parakeet][9]	1900	15			15	15			15	15
TOTAL (Whole Island)			13,141			13,179	12,449			12,454	12,817

[1] Consists of the area between BCP10 and BCP12 that was apparently not counted in previous years (i.e., 1989-1992).

[2] Plots Q and R were combined to form BCP14 because of a boundary problem that occurred during the 19 July and 3 August 1993 counts. Separate counts of these plots on 4 August were: Plot Q (1500 hrs: DGR = 420 birds; LMD = 430 birds); Plot R (1530 hrs: DGR = 1,490 birds; LMD = 1,400 birds).

[3] Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

[4] Plot W (BCP16) is equivalent to Plot "S-2".

[5] Plot V was counted as "V-1" (1407 hrs: DGR = 40 birds; LMD = 40 birds) + "V-X" (1425 hrs: DGR = 30 birds; LMD = 30 birds).

[6] LMD did not count Plot X; the count of 2,070 birds was made by M.B. Gratz.

[7] Includes a small islet immediately adjacent to Northwest Islet that was counted as part of "Remainder NW Islet" in 1992. In 1993, this small islet was designated "Subislet-1" and the 4 August 1993 counts were: (1830 hrs) DGR = 80 birds; LMD = 70 birds.

[8] Consists of a small islet immediately adjacent to Nord Island that was designated "Smaller NW Islet" in 1992 and redesignated "Subislet-2" in 1993.

[9] Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted in previous years.

Appendix 12. Counts of murres at Nord Island - Northwest Islet, 17 August 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; DGR = David G. Roseneau; LMD = Lynn M. Denlinger.

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (LMD)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP1	A1	1450	130	120		125	115	125		120	123
BCP2	A2	1500	250	270		260	240	255		248	254
BCP3	B	1510	0			0	0			0	0
BCP4	C	1510	110			110	120			120	115
BCP5	D	1530	710	750		730	700	680		690	710
BCP6	E	1545	510	520		515	550	540		545	530
BCP7	G	1520	150			150	130			130	140
BCP8	H1	1205	1,040			1,040	960			960	1,000
BCP9	H2	1156	390			390	370			370	380
BCP10	I	1150	130	135		133	140			140	136
BCP11	(None)[1]	1235	7			7	8			8	8
BCP12	J	1237	40			40	40			40	40
BCP13	P	1240	215	200		208	200	210		205	206
BCP14	Q + R[2]	1320	1,400			1,400	1,360			1,360	1,380
BCP15	S [also "S-1" or "R-S"][3]	1250	440	470		455	480	460		470	463
BCP16	W [also "S-2"][4]	1330	200	210		205	210	195		203	204
BCP17	T (right)	1440	320			320	340			340	330
BCP18	T (left)	1335	250	260		255	240	250		245	250
BCP19	U	1432	120	125		123	115	110		113	118
BCP20	V ["V-1"+"V-X"][5]	1434	55			55	55			55	55
BCP21	X	1350	1,890			1,890	1,840			1,840	1,865

Appendix 12 (Continued).

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Average	Observer 1 & 2 Average
BCP22	Y	1555	870			870	920			920	895
BCP23	Z	1605	890	950		920	920	960		940	930
BCP24	NW Islet Plot	1125	240			240	230			230	235
BCP25	Remainder NW Islet[6]	1620	980			980	935			935	958
BCP26	("Smaller NW Islet") [Subislet-2][7]	1630	330			330	300			300	315
BCP27	Parakeet Cove	1640	270			270	250			250	260
BCP28	(None) [West Parakeet][8]	1650	15			15	15			15	15
TOTAL (Whole Island)			11,952			12,035	11,783			11,791	11,913

[1] Consists of the area between BCP10 and BCP12 that was apparently not counted in previous years (i.e., 1989-1992).

[2] Plots Q and R were combined to form BCP14 because of a boundary problem that occurred during the 19 July and 3 August 1993 counts. Separate counts of these plots on August 17 were: Plot Q (1320 hrs: DGR = 230 birds; LMD = 210 birds); Plot R (1300 hrs: DGR = 1,170 birds; LMD = 1,150 birds).

[3] Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

[4] Plot W (BCP16) is equivalent to Plot "S-2".

[5] Plot V was counted as "V-1" (1434 hrs: DGR = 25 birds; LMD = 20 birds) + "V-X" (1340 hrs: DGR = 30 birds; LMD = 35 birds).

[6] Includes a small islet immediately adjacent to Northwest Islet that was counted as part of "Remainder NW Islet" in 1992. In 1993, this small islet was designated "Subislet-1" and the 17 August 1993 counts were: (1135 hrs) DGR = 70 birds; LMD = 70 birds.

[7] Consists of a small islet immediately adjacent to Nord Island that was designated "Smaller NW Islet" in 1992 and redesignated "Subislet-2" in 1993.

[8] Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted in previous years.

Appendix 13. Counts of murres on multicount plots at Nord Island - Northwest Islet, 1993.

Note: All counts were made by 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish and Wildlife Service; BCP numbers indicate the plots are population census plots counted from boats, not land; BMP numbers indicate the plots are also multicount plots that are counted from boats at least 5 separate times on different days to help track population trends; DGR = David G. Roseneau; LMD = Lynn M. Denlinger; JAC = Joel A. Cooper; MBG = Michael B. Gratz; only one observer made the July 19 count because strong currents were present and one person had to operate the boat to keep it in position in front of the plots; ND = no data.

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR)					Observer 2 (LMD)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP1	BCP1 (A1)	19 Jul	1300	90				90						90
BMP2	BCP2 (A2)	19 Jul	1305	210				210						210
BMP3	BCP3 (B)	19 Jul	1313	10				10						10
BMP4	BCP4 (C)	19 Jul	1315	140				140						140
BMP5	BCP5 (D)	19 Jul	1330	1,130				1,130						1,130
BMP6	BCP6 (E)	19 Jul	1323	960				960						960
BMP7	BCP7 (G)	19 Jul	1320	120				120						120
BMP8	BCP8 (H1)	19 Jul	1430	1,360				1,360						1,360
BMP9	BCP9 (H2)	19 Jul	1340	240				240						240
BMP10	BCP10 (I)	19 Jul	1445	120				120						120
BMP11	BCP11 (NW Islet Plot)	19 Jul	1820	210	215			213	206				206	209
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*780*				*783*						*779*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*2,870*				*2,873*						*2,869*
TOTAL	11 Plots: BMP1-11			4,590				4,593						4,589

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP1	BCP1 (A1)	3 Aug	1405	60	60			60	60				60	60
BMP2	BCP2 (A2)	3 Aug	1415	180				180	170				170	175
BMP3	BCP3 (B)	3 Aug	1425	10				10	10				10	10
BMP4	BCP4 (C)	3 Aug	1440	135	140			138	145				145	141
BMP5	BCP5 (D)	3 Aug	1505	1,110	1,150			1,130	1,050				1,050	1,090
BMP6	BCP6 (E)	3 Aug	1455	905				905	900				900	903
BMP7	BCP7 (G)	3 Aug	1450	90				90	90				90	90
BMP8	BCP8 (H1)	3 Aug	1535	1,260	1,170			1,215	1,200				1,200	1,208
BMP9	BCP9 (H2)	3 Aug	1545	500	470			485	480	470			475	480
BMP10	BCP10 (I)	3 Aug	1600	110	100			105	95	105			100	103
BMP11	BCP11 (NW Islet Plot)	3 Aug	1925	250	240	260		250	255				255	253
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*745*				*743*	*735*				*740*	*741*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*2,760*				*2,778*	*2,685*				*2,690*	*2,734*
TOTAL	11 Plots: BMP1-11			4,610				4,568	4,455				4,455	4,513

				Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	4 Aug	1740	60				60	50				50	55
BMP2	BCP2 (A2)	4 Aug	1730	150	140			145	160	160			160	153

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP3	BCP3 (B)	4 Aug	1728	9				9	9				9	9
BMP4	BCP4 (C)	4 Aug	1726	80				80	90				90	85
BMP5	BCP5 (D)	4 Aug	1700	1,200				1,200	1,000				1,000	1,100
BMP6	BCP6 (E)	4 Aug	1715	570				570	600				600	585
BMP7	BCP7 (G)	4 Aug	1727	90				90	100				100	95
BMP8	BCP8 (H1)	4 Aug	1645	1,010				1,010	920				920	965
BMP9	BCP9 (H2)	4 Aug	1640	400				400	430				430	415
BMP10	BCP10 (I)	4 Aug	1620	140	150	150		147	140				140	143
BMP11	BCP11 (NW Islet Plot)	4 Aug	1830	200				200	215				215	208
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*639*				*641*	*664*				*664*	*652*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*2,409*				*2,411*	*2,264*				*2,264*	*2,337*
TOTAL	11 Plots: BMP1-11			3,909				3,911	3,714				3,714	3,813
				Observer 1 (JAC) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MBG) Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	9 Aug	1248	45				45	50				50	48
BMP2	BCP2 (A2)	9 Aug	1257	160				160	140				140	150
BMP3	BCP3 (B)	9 Aug	1306	1				1	1				1	1
BMP4	BCP4 (C)	9 Aug	1312	95	90	110		100	120	130	125		125	113

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (JAC)					Observer 2 (MBG)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP5	BCP5 (D)	9 Aug	1635	920				920	900				900	910
BMP6	BCP6 (E)	9 Aug	1331	460	520	384	430	455	405	435	452		431	443
BMP7	BCP7 (G)	9 Aug	1403	95	100			98	115	95			105	101
BMP8	BCP8 (H1)	9 Aug	1543	1,060	1,250	1,110		1,140	940	1,045	1,240		1,075	1,108
BMP9	BCP9 (H2)	9 Aug	1530	360				360	380				380	370
BMP10	BCP10 (I)	9 Aug	1525	85				85	85				85	85
BMP11	BCP11 (NW Islet Plot)	9 Aug	1651	135	160			148	155	150			153	150
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*521*				*539*	*551*				*554*	*546*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*1,901*				*1,913*	*1,856*				*1,884*	*1,899*
TOTAL	11 Plots: BMP1-11			3,416				3,511	3,291				3,444	3,479
				Observer 1 (JAC)					Observer 2 (MBG)					
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	16 Aug	1833	105	130			118	120	120			120	119
BMP2	BCP2 (A2)	16 Aug	1846	215				215	230				230	223
BMP3	BCP3 (B)	16 Aug	1855	5				5	5				5	5
BMP4	BCP4 (C)	16 Aug	1859	110				110	105				105	108
BMP5	BCP5 (D)	16 Aug	1928	ND				ND	735				735	735
BMP6	BCP6 (E)	16 Aug	1903	790	690			740	665	690			678	709

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (JAC) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MBG) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP7	BCP7 (G)	16 Aug	2055	90				90	95				95	93
BMP8	BCP8 (H1)	16 Aug		ND				ND	ND				ND	ND
BMP9	BCP9 (H2)	16 Aug	2017	440	410			425	390	405			398	411
BMP10	BCP10 (I)	16 Aug	2013	95				95	100				100	98
BMP11	BCP11 (NW Islet Plot)	16 Aug	1942	190	190	189		190	185	196	180		187	188
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*720*				*732*	*745*				*747*	*740*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*ND*				*ND*	*2,145*				*2,160*	*2,183*
TOTAL	11 Plots: BMP1-11			ND				ND	ND				ND	ND
				Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	17 Aug	1450	130	120			125	115	125			120	123
BMP2	BCP2 (A2)	17 Aug	1500	250	270			260	240	255			248	254
BMP3	BCP3 (B)	17 Aug	1510	0				0	0				0	0
BMP4	BCP4 (C)	17 Aug	1510	110				110	120				120	115
BMP5	BCP5 (D)	17 Aug	1530	710	750			730	700	680			690	710
BMP6	BCP6 (E)	17 Aug	1545	510	520			515	550	540			545	530
BMP7	BCP7 (G)	17 Aug	1520	150				150	130				130	140
BMP8	BCP8 (H1)	17 Aug	1205	1,040				1,040	960				960	1,000

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (LMD) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP9	BCP9 (H2)	17 Aug	1156	390				390	370				370	380
BMP10	BCP10 (I)	17 Aug	1150	130	135			133	140				140	136
BMP11	BCP11 (NW Islet Plot)	17 Aug	1125	240				240	230				230	235
Subtotal	*6 Plots: BMP1-4, BMP10, BMP11*			*860*				*868*	*845*				*858*	*863*
Subtotal	*8 Plots: BMP1-6, BMP10, BMP11*			*2,080*				*2,113*	*2,095*				*2,093*	*2,103*
TOTAL	11 Plots: BMP1-11			3,660				3,693	3,555				3,553	3,623

				Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MBG) Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	1 Sep	1839	100	90			95	85	100			93	94
BMP2	BCP2 (A2)	1 Sep	1831	170	180			175	170				170	173
BMP3	BCP3 (B)	1 Sep	1830	0				0	0				0	0
BMP4	BCP4 (C)	1 Sep	1823	30	35			33	35				35	34
BMP5	BCP5 (D)	1 Sep	1812	750				750	785				785	768
BMP6	BCP6 (E)	1 Sep	1826	560				560	600				600	580
BMP7	BCP7 (G)	1 Sep		ND				ND	ND				ND	ND
BMP8	BCP8 (H1)	1 Sep		ND				ND	ND				ND	ND
BMP9	BCP9 (H2)	1 Sep		ND				ND	ND				ND	ND
BMP10	BCP10 (I)	1 Sep	1802	110				110	110				110	110

Appendix 13 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR) Count 1	Count 2	Count 3	Count 4	Average	Observer 2 (MBG) Count 1	Count 2	Count 3	Count 4	Average	Observer 1 & 2 Average
BMP11	BCP11 (NW Islet Plot)	1 Sep	1737	235	250			243	265	250			258	250
Subtotal	*6 Plots: BMP1-4 and 10-11*			*645*				*655*	*665*				*665*	*660*
Subtotal	*8 Plots: BMP1-6 and10-11*			*1,955*				*1,965*	*2,050*				*2,050*	*2,008*
TOTAL	11 Plots: BMP1-11			ND				ND	ND				ND	ND

Mean of 7 counts on 6 plots (BMP1-4, BMP10, AND BMP11) — *Range = 546 - 863* — *SD = 102* — *712*

Mean of 7 counts on 8 plots (BMP1-6, BMP10, AND BMP11) — *Range = 1,899 - 2,869* — *SD = 368* — *2,305*

MEAN OF 5 COUNTS ON 11 PLOTS (BMP1-11) — Range = 3,479 - 4,589 — SD = 515 — 4,003