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*Exxon Valdez* Oil Spill  
Restoration Project Final Report

Common Murre Population Monitoring at the Barren Islands, Alaska, 1999

Restoration Project 99144  
Final Report

This final report was submitted for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program to assess project progress. Peer review comments have been addressed in this version of the report.

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# Common Murre Population Monitoring at the Barren Islands, Alaska, 1999

## Restoration Project 99144 Final Report

**Study History:** *Exxon Valdez* Oil Spill Trustee Council-sponsored common murre damage assessment studies were initiated at the Barren Islands in 1989 as part of Department of Interior - Fish and Wildlife Service (DOI-FWS) Bird Study No. 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 murre). During the damage assessment work, three progress reports were written (Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992), and a final report of 1989-1991 results was completed in 1993 (see Nysewander *et al.* 1993, Effects of the *T/V Exxon Valdez* oil spill on murre: A perspective from observations at breeding colonies). In 1992, murre restoration monitoring work began at the Barren Islands as part of Restoration Project No. 11 (see Dragoo *et al.* 1995, Effects of the *T/V Exxon Valdez* oil spill on murre: A perspective from observations at breeding colonies four years after the spill), and two additional restoration monitoring projects were conducted there in 1993-1994 (Restoration Projects 93049 and 94039, respectively—see Roseneau *et al.* 1995, Common murre restoration monitoring in the Barren Islands, Alaska, 1993; and Roseneau *et al.* 1996a, Common murre restoration monitoring in the Barren Islands, Alaska, 1994). In 1996 and 1997, the Barren Islands murre colonies were censused again to reassess the recovery status of this injured species in the spill area (Projects 96144 and 97144; see Roseneau *et al.* 1997a, common murre population monitoring at the Barren Islands, Alaska, 1996; and Roseneau *et al.* 1998a, common murre population monitoring at the Barren Islands, Alaska, 1997, respectively). The study continued as Project 99144 in 1999 (see DOI-FWS FY 99 common murre population monitoring detailed project description).

**Abstract:** Murre were censused at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet Barren Islands colonies by the same methods used during the 1993-1994 and 1996-1997 restoration monitoring projects. Counts were pooled and averaged with estimates obtained during the 1989-1997 U.S. Fish and Wildlife Service, 1990-1992 University of Washington, and 1991 Dames & Moore postspill studies, and analyzed for trends. Positive trends were present at a small East Amatuli Island - Light Rock plot set and Light Rock, and a significant increase was also found at the Nord Island - Northwest Islet colony. The increasing strength of the East Amatuli Island - Light Rock trends coupled with the Nord Island - Northwest Islet increase indicated that murre populations were continuing to recover at these important northern Gulf of Alaska nesting locations.

**Key Words:** Barren Islands, common murre, East Amatuli Island, East Amatuli Light Rock, *Exxon Valdez*, Gulf of Alaska, Nord Island, oil spill, population monitoring, Prince William Sound, restoration monitoring, thick-billed murre, *Uria aalge*, *Uria lomvia*.

**Project Data:** The 1989-1999 Barren Islands census data have been compiled in Excel spread sheets and are available on Mac or PC disks, or in printed form upon request. These data can also be found in tables and appendices attached to the 1993-1999 annual and final reports.

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## **FYECUTIVE SUMMARY**

### **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. When winds and currents swept oil through the region during April-May 1989, many of these seabirds were killed: they comprised 74% of 30,000 bird carcasses recovered by 1 August. Based on this information and a computer modeling study, estimates of total bird mortality suggested that 74,000 to 315,000 murres died after contacting floating oil. Because mortality of murres appeared to be high, the U.S. Fish and Wildlife Service (FWS) conducted *Exxon Valdez* Oil Spill Trustee Council-sponsored murre damage assessment and restoration studies at the Barren Islands during 1989-1991 and 1992-1997, respectively. In 1999, the Barren Islands colonies were recensused. Evidence was found that murre populations were continuing to recover at the nesting colonies 10 years after the spill. Positive trends first discovered on a small East Amatuli Island - Light Rock plot set in 1994, and on the much larger Light Rock section of the nesting complex in 1997, strengthened when 1999 scores were included in the analyses. *Also*, a significant increase was found in the Nord Island - Northwest Islet whole-colony counts for the first time since postspill studies began.

### **Objectives**

The objective was to test the null hypothesis that murre populations have not increased at the Barren Islands colonies since 1989, the year of the spill.

### **Methods**

The East Amatuli Island - Light Rock and Nord Island - Northwest Islet murre colonies were censused completely, and counts were also made on sets of multicount plots. Plots were counted from boats by the same methods used during the 1993-1994 and 1996-1997 restoration studies (i.e., the counts were made by two observers using standard protocols that took into account daily and seasonal attendance patterns of adults). Results were pooled and averaged with corresponding information from 1989-1997 U.S. Fish and Wildlife Service (FWS), 1990-1992 University of Washington (UW), and 1991 Dames & Moore (D&M) postspill studies. Linear regressions were run to test for trends, and differences between counts and averages of previous postspill estimates were checked with one-sample *t*-tests. The 0.1 significance level was used to increase the power of the tests and reduce Type II error (the 0.9 confidence interval was adequate for our purposes).

### **Results**

East Amatuli Island - Light Rock: Positive trends were still present on East Amatuli Island - Light Rock multicount plots BMP 3-4 and Light Rock, and these trends were stronger than those found on these population monitoring plot sets in 1997.

Nord Island - Northwest Islet: A significant increase was found at the Nord Island - Northwest Islet colony, the first increase seen at this nesting complex since postspill studies began.. Also, the 1999 Nord Island - Northwest Islet multicount plot BMP 1-1 score was significantly higher than the average of all previous estimates on this population monitoring plot set.

### **Discussion**

Evidence was found that common murre populations were continuing to recover at the Barren Islands nesting colonies 10 years after the spill. Positive trends first discovered on East Amatuli Island - Light Rock multicount plots BMP 3-4 in 1994, and on the much larger Light Rock section

of the nesting complex in 1997, strengthened when 1999 scores were included in the analyses (see Tables 2 and 3, and Figs. 4b and 5b, respectively). **Also**, a significant increase was apparent in the Nord Island - Northwest Islet whole-colony counts for the first time since postspill studies began (Table 3, Fig. 7b). The strengthening trends at East Amatuli Island - Light Rock and the increase in numbers found at Nord Island - Northwest Islet were correlated with the presence of large numbers of nonbreeding birds that were probably 3-, 4-, 5-, and 6-year-old subadults from the strong 1993-1996 chick cohorts.

## **Conclusions**

The increasing strength of two positive trends at the Barren Islands East Amatuli Island - Light Rock colony and a significant increase in numbers at the nearby Nord Island - Northwest Islet nesting complex indicated that murre populations were continuing to recover at these important northern Gulf of Alaska breeding locations.

## **Recommendations**

1. Based on 1999 results, we recommend recensusing the Barren Islands East Amatuli - Light Rock and Nord Island - Northwest Islet common murre colonies in 2002. Given the amount of high quality baseline information that has accrued since 1993, counting these nesting complexes every third year should be sufficient to track changes in population numbers and monitor the recovery status of this injured species at these important northern Gulf of Alaska breeding locations.
2. In future years, we recommend using the following population monitoring plot sets to track changes in murre numbers at the Barren Islands nesting colonies: East Amatuli Island - Light Rock multicount plots BMP 1-8 and BMP 3-4, Light Rock plots BCP 47-64, and Nord Island - Northwest Islet plots BCP 1-28. If time allows, we also recommend counting East Amatuli Island plots BCP 1-46 once each field season (these counts combined with Light Rock data provide a whole East Amatuli Island - Light Rock colony count that helps assess population changes).



## 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 T/V *Exxon Valdez* oil spill (e.g., Sowls *et al.* 1978, Piatt *et al.* 1990, FWS 1994). When winds and currents swept oil through the region during April-May 1989, many of these seabirds were killed: they comprised 74% of 30,000 bird carcasses recovered by 1 August (see Piatt *et al.* 1990).<sup>1</sup> Based on this information and a computer modeling study, estimates of total bird mortality suggested that 74,000-315,000 murres died after contacting floating oil (see Piatt *et al.* 1990, ECI 1991).

Because the impact of the spill on common murres appeared to be severe, the U.S. Fish and Wildlife Service (FWS) made murre population counts at the Barren Islands during the 1989-1991 *Exxon Valdez* Oil Spill Trustee Council-sponsored damage assessment studies (e.g., Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993). FWS biologists also counted murres at these islands in 1992, as part of the first Trustee Council restoration project designed to assess the recovery status of this species in the spill area (see Dragoo *et al.* 1995).

Other research groups also made population counts at the Barren Islands murre colonies during the early 1990's. University of Washington (UW) investigators counted birds at East Amatuli Island - Light Rock in 1990-1992, during Exxon- and Minerals Management Service-funded studies (see Boersma *et al.* 1995), and Dames & Moore (D&M) biologists censused this nesting complex and the Nord Island - Northwest Islet colony in 1991 during an Exxon-supported project (see Erikson 1995).

In 1993-1994, we censused the East Amatuli Island - Light Rock and Nord Island - Northwest Islet murre colonies (Restoration Projects 93049 and 94039; see Roseneau *et al.* 1995 and 1996a, respectively). Trends were not apparent in the 1989-1993 FWS counts, or in the combined 1989-1994 FWS, UW, and D&M estimates from Nord Island - Northwest Islet and the larger sections of East Amatuli Island - Light Rock. However, increases were found on two small sets of East Amatuli Island - Light Rock plots counted in 1989-1994 and 1990-1994, respectively.

We also censused the Barren Islands murre colonies in 1996-1997 (Projects 96144 and 97144; see Roseneau *et al.* 1997a and 1998a). Although a positive trend was still present on one of the small East Amatuli Island - Light Rock plot sets in 1996, no convincing evidence was found that indicated population numbers had increased on the larger sections of the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies over the 7-year postspill interval. However, by 1997 the positive trend on the small East Amatuli Island - Light Rock plot set had strengthened, and a significant increase was also present on the Light Rock section of the colony. These trends and the fact that counts on six of the seven East Amatuli Island - Light Rock and Nord Island - Northwest Islet plot sets were significantly higher than the averages of previous postspill estimates suggested that murre populations were beginning to increase at the Barren Islands colonies (the high 1997 counts were associated with the presence of large numbers of nonbreeding birds at the colonies, almost certainly 3- and 4-year-old subadults belonging to the strong 1993-1994 chick cohorts — see Roseneau *et al.* 1995, 1996a, 1996b, 1997a, 1997b, 1998a, 1998b).

Murre population monitoring work was not conducted at the Barren Islands in 1995 or 1998. However, we counted birds on three sets of East Amatuli Island - Light Rock plots during our Alaska Predator Ecosystem Experiment (APEX) studies (Projects 951635 and 981635; see this study and Roseneau *et al.* 1996b, 1997a, 1999).

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<sup>1</sup> Seventy percent of the murre carcasses were common murres (Piatt *et al.* 1990; J.F. Piatt, pers. comm.).

In 1999, we censused the Barren Islands murre colonies again (this study, project 99144) and found that positive trends were still present at the small East Amatuli Island - Light Rock plot set and Light Rock. We also detected a significant increase in numbers at the Nord Island - Northwest Islet colony. The increasing strength of the East Amatuli Island - Light Rock trends coupled with the Nord Island - Northwest Islet increase indicated that murre populations were continuing to recover at these important northern Gulf of Alaska nesting locations.

## OBJECTIVES

The project was designed to test the null hypothesis that murre populations have not changed at the Barren Islands colonies since 1989, the year of the spill. The specific objective was to count murre colonies at the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies and compare the estimates with counts made during the 1989-1997 FWS, 1990-1992 UW, and 1991 D&M studies.

## METHODS

The Barren Islands are located at about 58° 55' N, 152° 10' W, between the Kodiak archipelago and the Kenai Peninsula (Fig. 1). The study area consisted of East Amatuli and Nord islands and two nearby islets, East Amatuli Light Rock (Light Rock) and Northwest Islet (Figs. 2 and 3). These sites, which comprise the East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies, contain all of the murre colonies currently breeding in the island group (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a).

We used the M/V *Surfbird*, a 21-m-long FWS research vessel, and the Amatuli Cove camp to support the population counts (Fig. 2). Two people were based on the boat during 14-29 July. The vessel-based census team was intermittently assisted by two APEX seabird studies investigators stationed at Amatuli Cove camp (Project 991635). The APEX team members also counted some of the East Amatuli Island - Light Rock monitoring plot sets both before and after the vessel-based crew visited the study area.

Population census data were collected and analyzed by the same methods used during the 1993-1994 and 1996-1997 restoration monitoring projects (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). To compare our counts with information from previous studies, we censused Light Rock, Nord Island, and Northwest Islet completely to obtain whole-colony estimates of birds on major subdivisions of the colonies (e.g., East Amatuli Island, Light Rock). We also counted smaller, previously established plot sets ("multicount plots"; see Roseneau *et al.* 1995, 1996a, 1997a, 1998a) several times to obtain data for statistical analyses of among-year differences and trends in population size. The multicount plot sets, which provide additional indices for detecting changes in numbers, contained about 10-15% of the murre colonies on the cliffs at each nesting complex.

At East Amatuli Island - Light Rock, we counted 19 population census plots (BCP 47-64) and eight multicount plots (BMP 1-8) set up in 1993 (Fig. 3a; also see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). The multicount set included two plots used during the 1989-1991 and 1992 FWS damage assessment and restoration projects (one at East Amatuli Island and one on Light Rock; see Nysewander *et al.* 1993, Dragoo *et al.* 1995). We also counted some plot subsections separately because they were equivalent to four plots used during the 1990-1992 University of Washington (UW) studies (the OSTR plots: Oval, Swatch, Triangle Rock S, and Triangle Rock NW; see Boersma *et al.* 1995). The multicount plots sampled both central and peripheral nesting areas in general proportion to the number of birds using these habitats (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). Plot boundaries were located using photographs in Alaska Maritime National Wildlife Refuge (AMNWR) files.

To census birds at Nord Island - Northwest Islet, we used 28 population census plots (BCP 1-28) and 11 multicount plots (BMP 1-11) set up during the 1993-1994 restoration studies (Fig. 2b; also see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). Twenty-six of these plots (BCP 1-10 and 12-27) were established during the 1989-1991 FWS damage assessment projects (e.g., Nysewander *et al.* 1993, Dragoo *et al.* 1995; population census plots BCP 1-10 and 24 were equivalent to multicount plots BMP 1-10 and 11, respectively—see Fig. 3b), and two (BCP 11 and 28) were set up in 1993 to cover areas containing small numbers of birds not reported earlier (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). AMNWR photographs were used to locate plot boundaries.

All population census team members had previous experience counting murres at the Barren Islands nesting colonies. Two people censused East Amatuli Island - Light Rock several times during 1990-1997, one of them counted Nord Island - Northwest Islet in 1996-1997, and the team leader censused both colonies on numerous occasions in 1993-1994 and 1996-1997.

Census team members counted plots from outboard-powered, 4.8-m-long, ridged-hulled inflatable boats and inflatable rafts with the aid of 7 x 42 binoculars and hand-held tally meters (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). Boats were tied to bull kelp (*Nereocystis spp.*) 30-90 m in front of the plots or were allowed to drift slowly past them at similar distances. Distances between birds and observers varied, depending on the height and configuration of the cliffs and other factors (e.g., presence of offshore rocks); however, these variables were kept as consistent as possible between counts, including those made during 1993-1997.

Counts were made during the part of the nesting season when attendance was most stable. The census period was defined as the interval between the peak of laying and first sea-going of chicks (e.g., Hatch and Hatch 1989; Byrd 1989; Roseneau *et al.* 1995, 1996a, 1997a, 1998a). 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 birds (e.g., Boersma *et al.* 1995; Dragoo *et al.*, unpubl. data). All counts were made during 1100-2000 hrs Alaska Daylight Time (ADT).

Plots were counted by two observers. During the counts, one person recorded the scores without revealing his or her own count to the other team member. The recorder compared the scores to see if they were within 15% of each other (i.e., within 7.5% of their average). If they were not and if time allowed, the plot was recounted until the scores fell within this range.

Birds were estimated by 10's; however, observers often counted the last group of individuals on a plot by 1's if the remaining birds consisted of less than 10 individuals (Roseneau *et al.* 1996a, 1997a, 1998a). The only exceptions were three small East Amatuli Island multicount plots that were always counted by 1's to match UW methods (see Boersma *et al.* 1995), and the top of Light Rock, where birds were sometimes estimated by 50's, because of high densities.

The East Amatuli Island section of the East Amatuli Island - Light Rock colony was not censused because of weather. However, we counted Light Rock five times, and censused multicount plots BMP 1-8 (see Fig. 2a) six times. We also counted the Nord Island - Northwest Islet colony and Nord Island - Northwest Islet multicount plots BMP 1-11 (see Fig. 2b) three times.

To analyze the data, we calculated one-day totals for Light Rock, East Amatuli Island - Light Rock multicount plots BMP 1-8 and 3-4, Nord Island - Northwest Islet, and Nord Island - Northwest Islet multicount plots BMP 1-11. We also calculated one-day totals for parts of multicount plots BMP 1, 5, and 8 at East Amatuli Island - Light Rock, because sections of these plots were equivalent to the UW OSTR plots. To obtain single values for the UW Light Rock, East Amatuli Island ("Mainland"), and East Amatuli Island - Light Rock ("E. Amatuli Island Total") counts reported by Boersma *et al.* (1995), we averaged numbers listed as ranges in Table 1 of their

publication.<sup>1</sup> Results were pooled with corresponding data from previous **FWS**, **UW**, and **D&M** postspill studies (i.e., Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993, Dragoo *et al.* 1995; Roseneau *et al.* 1995, 1996a, 1997a, 1998a; Boersma *et al.* 1995; Erikson 1995). **UW** and **D&M** estimates were treated as additional counts and averaged with **FWS** data (e.g., the respective 1992 **UW** and **FWS** Light Rock scores of 9,655 and 5,960 birds were averaged to obtain an estimate of 7,808 individuals for that year). Linear regressions were run to test for trends, and differences between counts and averages of previous postspill estimates were checked with one-sample t-tests. The 0.1 significance level was used to increase the power of the tests and reduce Type II error (the 0.9 confidence interval was adequate for our purposes).

## RESULTS

### East Amatuli Island - Light Rock

At East Amatuli Island - Light Rock, we censused Light Rock (Appendices 1-5), and the eight multicount plots set up at the colony in 1993 (Appendices 6-8). The multicount data also provided information on the small 1989-1992 **FWS** and 1990-1992 **UW** OSTR plot sets (see Dragoo *et al.* 1995 and Boersma *et al.* 1995, respectively).

Multicount plots BMP 1-8 will eventually become the primary set of plots for monitoring post-1992 trends at the East Amatuli Island - Light Rock colony. This plot set, counted three to eight times each year since it was established in 1993, contains more plots, birds, and nesting habitat than the other sets of multicount plots that have longer count histories (e.g., BMP 3-4, **UW** OSTR plots).

No trend was found on multicount plots BMP 1-8 when 1998-1999 data were pooled with previous scores (linear regression; see Table 1 and Fig. 4a). However, the increase first detected on the smaller BMP 3-4 plot set in 1994 was still present (linear regression,  $P < 0.01$ , see Table 2 and Fig. 4b; also see Roseneau *et al.* 1996a), and this positive trend strengthened when 1998-1999 counts were included in the analysis ( $r^2 = 0.78$ ,  $P < 0.01$  in 1999 *vs*  $r^2 = 0.73$ ,  $P < 0.01$  in 1997 and  $r^2 = 0.63$ ,  $P < 0.02$  in 1996; see Roseneau *et al.* 1997a, 1998a).

In contrast, the small **UW** OSTR plot set did not exhibit a trend when the 1998-1999 counts were pooled with 1990-1997 scores (linear regression; see Table 2 and Fig. 5a).

The increase first discovered at Light Rock in 1997 was still present (linear regression,  $P < 0.01$ ; see Table 3 and Fig. 5b), and this positive trend strengthened when 1999 data were included in the analysis ( $r^2 = 0.69$ ,  $P < 0.01$  in 1999 *vs*  $r^2 = 0.52$ ,  $P < 0.04$  in 1997; see Roseneau *et al.* 1998a).

A complete count of the entire East Amatuli Island - Light Rock colony was not obtained in 1999 (see Table 3 and Fig. 6). However, the 1999 score of 35,209 birds was significantly higher than the average of all previous estimates at this nesting complex (1991-1996 mean = 31,917 individuals; one-sample *t*-test,  $P < 0.01$ ).

### Nord Island - Northwest Islet

At Nord Island - Northwest Islet, we censused the entire colony (Appendices 9-11) and the 11 multicount plots that were set up in 1989 (Appendices 8 and 12). Although a significant increase

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<sup>1</sup> Numbers listed as ranges in Table 1 of Boersma *et al.* (1995) were the individual scores of **two** observers making the counts (A.B. Kettle, pers. comm.).

was not apparent in the multicount plot BMP 1-11 data, a positive trend was found in the whole colony counts over the 10-year postspill period (linear regression,  $P < 0.09$ ; see Table 1 and 3, and Figs. 7a and 7b, respectively). Also, the 1999 count of 4,091 birds on multicount plots BMP 1-11 was significantly higher than the average of all previous estimates on this plot set (1989-1997 means = 3,362; one-sample t-test,  $P < 0.02$ ).

## DISCUSSION

We found evidence that common murre populations were continuing to recover at the Barren Islands nesting colonies 10 years after the spill. Positive trends first discovered on East Amatuli Island - Light Rock multicount plots BMP 3-4 in 1994, and on the much larger Light Rock section of the nesting complex in 1997, strengthened when 1999 scores were included in the analyses (see Tables 2 and 3, and Figs. 4b and 5b, respectively). Also, a significant increase was apparent in the Nord Island - Northwest Islet whole-colony counts for the first time since postspill studies began (Table 3, Fig. 7b).

The strengthening trends at East Amatuli Island - Light Rock and the increase in numbers found at Nord Island - Northwest Islet were correlated with the presence of large numbers of nonbreeding birds that were probably 3-, 4-, 5-, and 6-year-old subadults from the strong 1993-1996 chick cohorts (productivity was about 0.50, 0.70, 0.70, and 0.70 fledglings per egg at East Amatuli Island - Light Rock in 1993, 1994, 1995, and 1996, respectively, and 0.70 and 0.70 fledglings per egg at Nord Island - Northwest Islet in 1993 and 1994, respectively; see Roseneau *et al.* 1995, 1996a, 1998a, 1998b). As in 1997, these nonbreeders were often seen roosting in groups of up to several hundred individuals in **areas** of the colonies where birds were either absent or found in only small numbers during the 1993-1996 breeding seasons. They were also observed rafting on the water in front of both colonies in aggregations ranging from a few hundred to a few thousand individuals (about 1,000-1,500 and 1,500-2,000 birds were loafing on the water near the southeast corner of Nord Island on 23 and 26 July, respectively).

## CONCLUSIONS

The increasing strength of two positive trends at the Barren Islands East Amatuli Island - Light Rock colony and a significant increase in numbers at the nearby Nord Island - Northwest Islet nesting complex indicated that murre populations were continuing to recover at these important northern Gulf of Alaska breeding locations.

## RECOMMENDATIONS

1. Based on 1999 results, we recommend recensusing the Barren Islands East Amatuli - Light Rock and Nord Island - Northwest Islet common murre colonies in 2002. Given the amount of high quality baseline information that has accrued since 1993, counting these nesting complexes every third year should be sufficient to track changes in population numbers and monitor the recovery status of this injured species at these important northern Gulf of Alaska breeding locations.
2. In future years, we recommend using the following population monitoring plot sets to track changes in murre numbers at the Barren Islands nesting colonies: East Amatuli Island - Light Rock multicount plots BMP 1-8 and BMP 3-4, Light Rock plots BCP 47-64, and Nord Island - Northwest Islet plots BCP 1-28. Also, if time allows, we recommend counting East Amatuli Island plots BCP 1-46 once each field season (these counts combined with Light Rock data

provide a whole East Amatuli Island - Light Rock colony count that helps assess population changes).

## ACKNOWLEDGMENTS

We would like to thank Margaret A. Blanding and Erica Sommer for helping to make the 1999 Barrens Islands murre population monitoring project a success. Their boating skills and willingness to spend long hours at sea counting plots made our job much easier. Our thanks also go to Philip Schempf and Captain Joe McClung, Raptor Management Office, Juneau. Phil arranged for our use of the *M/V Surfbird*, and Joe gave us constant, cheerful assistance, both in Homer and while sailing under his expert command. Joe's maritime expertise and willingness to help contributed significantly to the safety and success of the project. Trina Fellows and Kris Thorsrud, AMNWR headquarters, monitored our daily radio calls and were always prepared to help us with logistical needs. The study was funded by the *Exxon Valdez* Oil Spill Trustee Council, as part of their ongoing restoration monitoring effort; additional support was provided by AMNWR.

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Table 1. Average counts of murre on the primary East Amatuli Island - Light Rock and Nord Island - Northwest Islet multicount plots at the Barren Islands, Alaska during 1989-1999 (number of counts shown in parentheses).

Year	East Amatuli Island - Light Rock (EAILR)		Nord Island - Northwest Islet (NINI)	
	Multicount Plots BMP 1-8		Multicount Plots BMP 1-11	
	Numbers of Birds	CV(%) <sup>a</sup>	Numbers of Birds	CV(%)
1989 <sup>b</sup>	ND <sup>c</sup>		2,431 (2)	5.1
1990 <sup>b</sup>	ND		4,383 (3)	12.9
1991 <sup>b</sup>	ND		3,558 (2)	4.0
1992 <sup>d</sup>	ND		2,971 (5)	10.6
1993 <sup>e</sup>	5,807 (4)	6.9	4,003 (5)	12.9
1994 <sup>e</sup>	5,599 (8)	4.9	2,890 (5)	22.1
1995 <sup>e</sup>	5,225 (5)	11.2	ND	
1996 <sup>f</sup>	5,648 (7)	7.0	2,825 (6)	6.3
1997 <sup>e</sup>	7,139 (7)	11.1	3,835 (6)	8.8
1998 <sup>e</sup>	7,275 (3)	5.5	ND	
1999 <sup>k</sup>	6,245 (6)	3.9	4,091 (3)	3.5

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Regression Analysis: Count vs. Year (Significance Level = 0.1)

EAILR Multicount Plots BMP 1-8	NINI Multicount Plots BMP 1-11
No significant correlation (n = 7)	No significant correlation (n = 9)

<sup>a</sup> CV = coefficient of variation (standard deviation divided by the mean and multiplied by 100)

<sup>b</sup> Data are from Nysewander and Dipple (1990, 1991); Dipple and Nysewander (1992); and Nysewander *et al.* (1993). Counts on Nord Island - Northwest Islet plots BMP 1-11 were 2,519 and 2,343 (SD = 125) in 1989; 4,991, 3,869, and 4,288 (SD = 567) in 1990; and 3,659 and 3,457 (SD = 143) in 1991.

<sup>c</sup> ND = no data.

<sup>d</sup> Data are from Dragoo *et al.* (1995). Counts on Nord Island - Northwest Islet plots BMP 1-11 were 3,008, 2,637, 2,744, 3,449, and 3,016 (SD = 314) in 1992.

<sup>e</sup> Data are from Roseneau *et al.* (1995). Counts were 6,148, 5,835, 6,002, and 5,242 (SD = 398) on East Amatuli Island - Light Rock plots BMP 1-8, and 4,589, 4,513, 3,813, 3,479, and 3,623 (SD = 514) on Nord Island - Northwest Islet plots BMP 1-11 in 1993.

<sup>f</sup> Data are from Roseneau *et al.* (1996a). Counts were 5,423, 5,215, 5,530, 6,145, 5,635, 5,741, 5,674, and 5,430 (SD = 277) on East Amatuli Island - Light Rock plots BMP 1-8, and 1,970, 2,685, 3,031, 3,046, and 3,718 (SD = 636) on Nord Island - Northwest Islet plots BMP 1-11 in 1994.

**Table 1 (Continued)**

- <sup>g</sup> Data are from Roseneau *et al.* (1997a). Counts were 4,791, 5,074, 5,937, 4,597, and 5,727 (SD = 584) on East Amatuli Island - Light Rock plots BMP 1-8 in 1995.
- <sup>h</sup> Data are from Roseneau *et al.* (1997a). Counts were 6,148, 5,504, 5,527, 5,099, 5,419, 6,198, and 5,638 (SD = 396) on East Amatuli Island - Light Rock plots BMP 1-8, and 3,035, 2,367, 2,659, 2,656, 2,704, and 3,028 (SD = 178) on Nord Island - Northwest Islet plots BMP 1-11 in 1996.
- <sup>i</sup> Data are from Roseneau *et al.* (1998a). Counts were 6,427, 6,102, 7,851, 6,836, 7,835, 6,781, and 8,139 (SD = 795) on East Amatuli Island - Light Rock plots BMP 1-8, and 3,267, 3,662, 3,797, 4,072, 4,026, and 4,183 (SD = 357) on Nord Island - Northwest Islet plots BMP 1-11 in 1997.
- <sup>j</sup> Data are from D. G. Roseneau and A.B. Kettle, unpubl. data (see Appendix 6). Counts were 7,335, 7,643, and **6,846** (SD = **402**) on East Amatuli Island - Light Rock plots HMP 1-8 in 1998.
- <sup>k</sup> Data are from this study (see Appendices 7 and 12). Counts were 6,165, 5,968, 6,078, 6,586, 6,493, and 6,182 (SD = **242**) on East Amatuli Island - Light Rock plots BMP 1-8, and 4,128, 3,934, and 4,212 (SD = 143) on Nord Island - Northwest Islet plots BMP 1-11 in 1999.

**Table 2. Average counts of murre on East Amatuli Island - Light Rock multicount plots BMP 3-4 and the four UW OSTR plots at the Barren Islands, Alaska during 1989-1999 (number of counts shown in parentheses).**

Year	East Amatuli Island - Light Rock			
	FWS Multicount Plots BMP 3-4		UW OSTR Plots	
	Numbers of Birds	CV(%) <sup>a</sup>	Numbers of Birds	CV(%)
1989	852 (2) <sup>b</sup>	14.8	ND <sup>c</sup>	
1990	575 (2) <sup>b</sup>	32.8	648 (2-5) <sup>d</sup>	
1991	860 (2) <sup>b</sup>	27.2	811 (5-6) <sup>d</sup>	
1992	745 (5) <sup>e</sup>	32.6	818 (6-10) <sup>d</sup>	
1993 <sup>f</sup>	1,375 (8)	12.6	1,003 (5)	9.1
1994 <sup>g</sup>	1,246 (8)	8.1	866 (8)	5.4
1995 <sup>h</sup>	1,130 (5)	14.7	724 (5)	11.3
1996 <sup>i</sup>	1,392 (7)	7.8	785 (7)	8.2
1997 <sup>j</sup>	1,959 (7)	16.7	880 (7)	21.3
1998 <sup>k</sup>	1,974 (3)	5.9	834 (3)	3.4
1999 <sup>l</sup>	1,652 (6)	8.5	808 (6)	11.8

Regression Analysis: Count vs. Year (Significance Level = 0.1)

Multicount Plots BMP 3-4

UW OSTR Plots

$r^2 = 0.78, H_0: \text{Slope} = 0, P < 0.01$  (n = 11)

No significant correlation (n = 10)

<sup>a</sup> CV = coefficient of variation (standard deviation divided by the mean and multiplied by 100).

<sup>b</sup> Data are from Nysewander and Dipple (1990, 1991); Dipple and Nysewander (1992); and Nysewander *et al.* (1993). Counts on BMP 3-4 were 763 and 941 in 1989 (SD = 126); 708 and 441 in 1990 (SD = 189); and 1,025 and 694 (SD = 234) in 1991.

<sup>c</sup> ND = no data.

<sup>d</sup> Data are from Boersma *et al.* (1995). Only the averages of the counts were reported for 1990, 1991, and 1992. Numbers of counts were listed as ranges because they apparently varied among the four plots each year (e.g., in 1990, at least one plot was only counted two times and at least one was counted five times).

<sup>e</sup> Data are from Dragoo *et al.* (1995). Counts were 467, 948, 926, 893, and 493 (SD = 243) on BMP 3-4 in 1992.

<sup>f</sup> Data are from Roseneau *et al.* (1995). Counts were 1,580, 1,259, 1,540, 1,492, 1,505, 1,254, 1,263, and 1,110 (SD = 174) on BMP 3-4, and 1,091, 1,086, 1,022, 889, and 928 (SD = 92) on the OSTR plots in 1993.

Table 2 (Continued).

<sup>g</sup> Data are from Roseneau *etal.* (1996a). Counts were 1,110, 1,153, 1,270, 1,439, 1,258, 1,301, 1,188, and 1,245 (SD = 101) on BMP 3-4, and 871, 788, 850, 949, 842, 899, 873, and 855 (SD = 46) on the OSTR plots in 1994.

<sup>h</sup> Data are from Roseneau *et al.* (1997a). Counts were 1,040, 1,148, 1,323, 900, and 1,238 (SD = 166) on BMP 3-4 and 652, 697, 793, 652, and 828 (SD = 82) on the OSTR plots in 1995.

<sup>i</sup> Data are from Roseneau *etal.* (1997a). Counts were 1,443, 1,408, 1,421, 1,326, 1,240, 1,580, and 1,329 (SD = 108) on BMP 3-4, and 778, 709, 899, 823, 720, 788, and 775 (SD = 64) on the OSTR plots in 1996.

<sup>j</sup> Data are from Roseneau *et al.* (1998a). Counts were 1,683, 1,933, 2,295, 1,525, 2,085, 1,768, and 2,423 (SD = 328) on BMP 3-4, and 713, 567, 982, 955, 1,073, 823, 1,047 (SD = 187) on the OSTR plots in 1997.

<sup>k</sup> Data are from D. G. Roseneau and A. B. Kettle, unpubl. data. Counts were 2,000, 2,075, and 1,847 (SD = 116) on BMP 3-4 (*see* Appendix 8), and 847, 853, and 801 (SD = 28) on the OSTR plots in 1998.

<sup>l</sup> Data are from this study. Counts were 1,753, **1,554**, 1,603, 1,884, 1,619, and 1,501 (SD = 141) on BMP 3-4 (*see* Appendix 8), and 946, 735, 713, 894, 818, and 743 (SD = 95) on the OSTR plots in 1999.

**Table 3. Average counts of murres at the Barren Islands, Alaska East Amatuli Island - Light Rock and Nord Island - Northwest Islet colonies during 1989-1999 (number of counts shown in parentheses).**

Year	East Amatuli Island - Light Rock				Nord Island - Northwest Islet	
	East Amatuli Light Rock Number of Birds CV(%) <sup>a</sup>	East Amatuli Island Number of Birds CV(%)	Entire Colony Number of Birds CV(%)		Entire Colony Number of Birds CV(%)	
1989	6,912 (2) <sup>b</sup>	10.2	ND <sup>c</sup>		ND	11,838 (2) <sup>b</sup> 6.5
1990	5,865 (2) <sup>b</sup>	10.5	ND		ND	12,278 (2) <sup>b</sup> 6.5
1991	9,256 (1) <sup>d</sup>		26,501 (1) <sup>e</sup>		31,660 (4) <sup>f</sup> 17.9	14,419 (3) <sup>g</sup> 13.1
1992	7,808 (2) <sup>h</sup>	33.5	25,129 (1) <sup>i</sup>		34,784 (1) <sup>j</sup>	11,212 (1) <sup>k</sup>
1993 <sup>l</sup>	8,454 (4)	8.4	24,775 (2)	6.5	32,722 (2) 5.7	13,422 (4) 15.5
1994 <sup>m</sup>	7,750 (5)	7.5	25,054 (2)	3.2	32,871 (2) 0.7	11,797 (4) <b>11.0</b>
1996 <sup>n</sup>	8,620 (4)	13.0	19,722 (1)		27,550 (1)	11,688 (3) 5.3
1997 <sup>n</sup>	10,377 (5)	4.3	25,400 (1)		35,209 (1)	16,423 (5) 6.2
1999 <sup>p</sup>	11,115 (5)	9.7	ND		ND	16,633 (3) 4.2

Regression Analysis: Count vs. Year (Significance Level = 0.1)

East Amatuli Light Rock

$r^2 = 0.68$ ,  $H_0$ : Slope = 0,  $P < 0.01$  (n = 8)

Nord Island - Northwest Islet

$r^2 = 0.36$ ,  $H_0$ : Slope = 0,  $P < 0.09$  (n = 9)

East Amatuli Island - Light Rock

No significant correlation (n = 6)

<sup>a</sup> CV = coefficient of variation [standard deviation (SI) divided by the mean and multiplied by 100].

<sup>b</sup> Data are from Nysewander and Dipple (1990, 1991), Dipple and Nysewander (1992), and Nysewander *et al.* (1993). Counts at Light Rock were 7,410 and 6,413 in 1989 (SD = 705), and 5,430 and 6,300 in 1990 (SD = 615), and counts at Nord Island - Northwest Islet were 12,381 and 11,294 in 1989 (SD = 769), and 11,713 and 12,842 (SD = 798) in 1990.

<sup>c</sup> ND = no data.

<sup>d</sup> Data are from Boersma *et al.* (1995). The number listed here is the average of the two values (8,918 and 9,594; mean = 9,256) reported in Table 1 of their publication; in all cases, numbers that appear to be ranges in their table are the individual scores of two observers. The previously reported 1991 FWS count of 5,529 murres was not used, because it included 3,429 birds on the cliffs and 2,100 individuals on nearby waters (see Nysewander and Dipple 1991).

<sup>e</sup> Data are from Boersma *et al.* (1995). The number listed here is the average of the two values (25,468 and 27,534; mean = 26,501) reported in Table 1 of their publication.

**Table 3** (Continued).

- <sup>1</sup>Data are from Boersma *et al.* (1995; Table 1) and Erikson (1995; Table 2). The number listed here was derived by first averaging the two values (34,386 and 37,128; mean = 35,757) reported by Boersma *et al.* and then averaging this number with three counts made by Erikson (28,660, 25,213, and 37,010; mean of four counts = 31,660, SD = 5,656).
- <sup>2</sup>Data are from Dipple and Nyswander (1992), Nyswander *et al.* (1993), and Erikson (1995). The number listed here is the average of two counts reported by Dipple and Nyswander and Nyswander *et al.* (13,404 and 13,262) and the count made by Erikson (16,592; mean of three counts = 14,419, SD of three counts = 1,883).
- <sup>3</sup>Data are from Dragoo *et al.* (1995) and Boersma *et al.* (1995; Table 1). The number listed here was derived by averaging the two values (9,573 and 9,736; mean = 9,655) reported by Boersma *et al.* and then averaging this number with the count made by Dragoo *et al.* (5,960; mean of two counts = 7,808, SD = 2,613).
- <sup>4</sup>Data are from Boersma *et al.* (1995; Table 1). The number listed here is the average of the two values (24,814 and 25,444; mean = 25,129) reported in their publication.
- <sup>5</sup>Data are from Boersma *et al.* (1995; Table 1). The number listed here is the average of the two values (34,387 and 35,180; mean = 34,784) reported in their publication.
- <sup>6</sup>Data are from Dragoo *et al.* (1995).
- <sup>7</sup>Data are from Roseneau *et al.* (1995). Counts were 9,414, 8,134, 7,760, and 8,507 (SD = 709) at Light Rock; 23,632 and 25,917 (SD = 1,616) at East Amatuli Island; 31,392 and 34,051 (SD = 1,880) at East Amatuli Island - Light Rock; and 12,474, 16,484, 12,817, and 11,913 (SD = 2,075) at Nord Island - Northwest Islet in 1993.
- <sup>8</sup>Data are from Roseneau *et al.* (1996a). Counts were 6,749, 7,412, 8,450, 7,916, and 8,223 (SD = 682) at Light Rock; 25,615 and 24,492 (SD = 794) at East Amatuli Island 33,027 and 32,715 (SD = 221) at East Amatuli Island - Light Rock; and 11,071, 10,461, 12,296, and 13,361 (SD = 1,292) at Nord Island - Northwest Islet in 1994 (the average East Amatuli Island and East Amatuli Island - Light Rock counts of 25,195 and 33,011 listed in Table 1 of Roseneau *et al.* 1996a were incorrect; the corrected values of 24,054 and 32,871 are reported here).
- <sup>9</sup>Data are from Roseneau *et al.* (1997a). Counts were 7,828, 8,294, 10,273, and 8,133 (SD = 1,116) at Light Rock, and 12,392, 11,199, and 11,474 (SD = 625) at Nord Island - Northwest Islet in 1996.
- <sup>10</sup>Data are from Roseneau *et al.* (1998a). Counts were **10,511**, 9,809, 10,022, 10,757, and 10,787 (SD = 441) at Light Rock, and 15,137, 17,260, 15,506, 16,932, and 17,278 (SD = 1,023) at Nord Island - Northwest Islet in 1997.
- <sup>11</sup>Data are from this study (see Appendices 1-5 and 9-11). Counts were 9,956, 10,229, 12,454, 10,959, and 11,978 (SD = 1,083) at East Amatuli Island - Light Rock, and 16,951, 15,840, and 17,108 (SD = 691) at Nord Island - Northwest Islet in 1999.

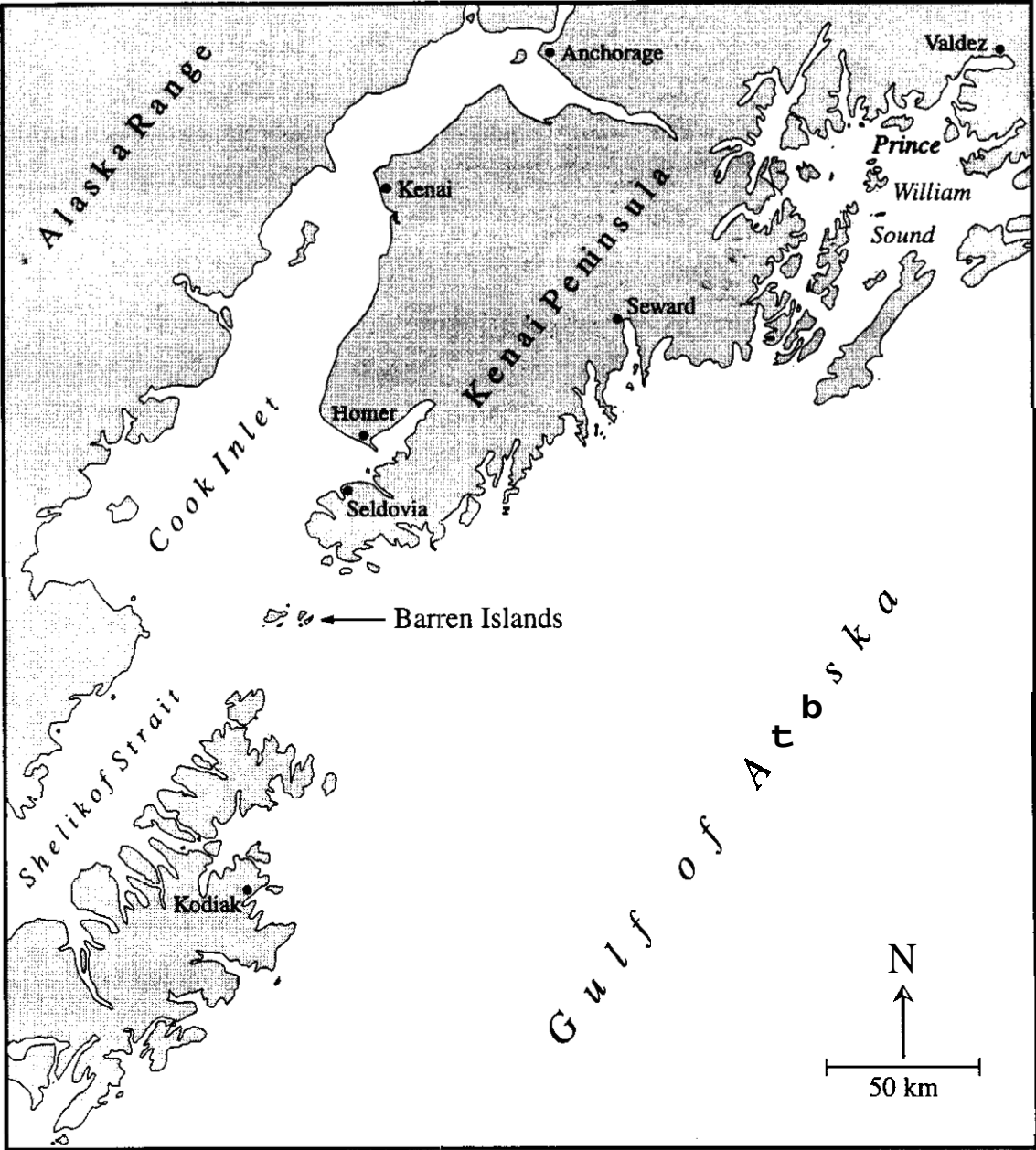


Figure 1. Location of the Barren Islands, Alaska.

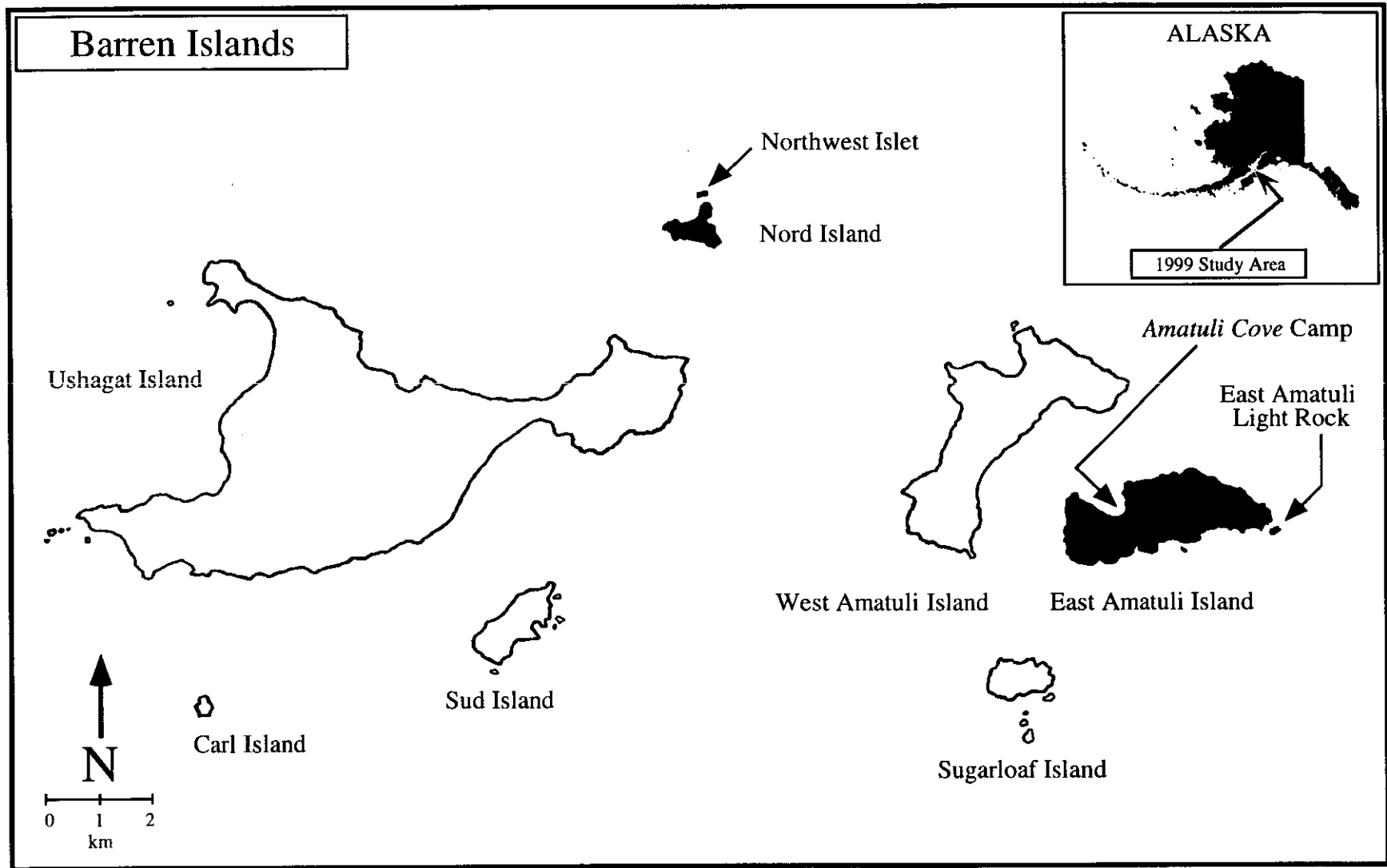


Figure 2. The East Amatuli Island - Light Rock and Nord Island - Northwest Islet study areas (shown in black), Barren Islands, Alaska (the study areas contain all of the known murre nesting habitat in the island group).



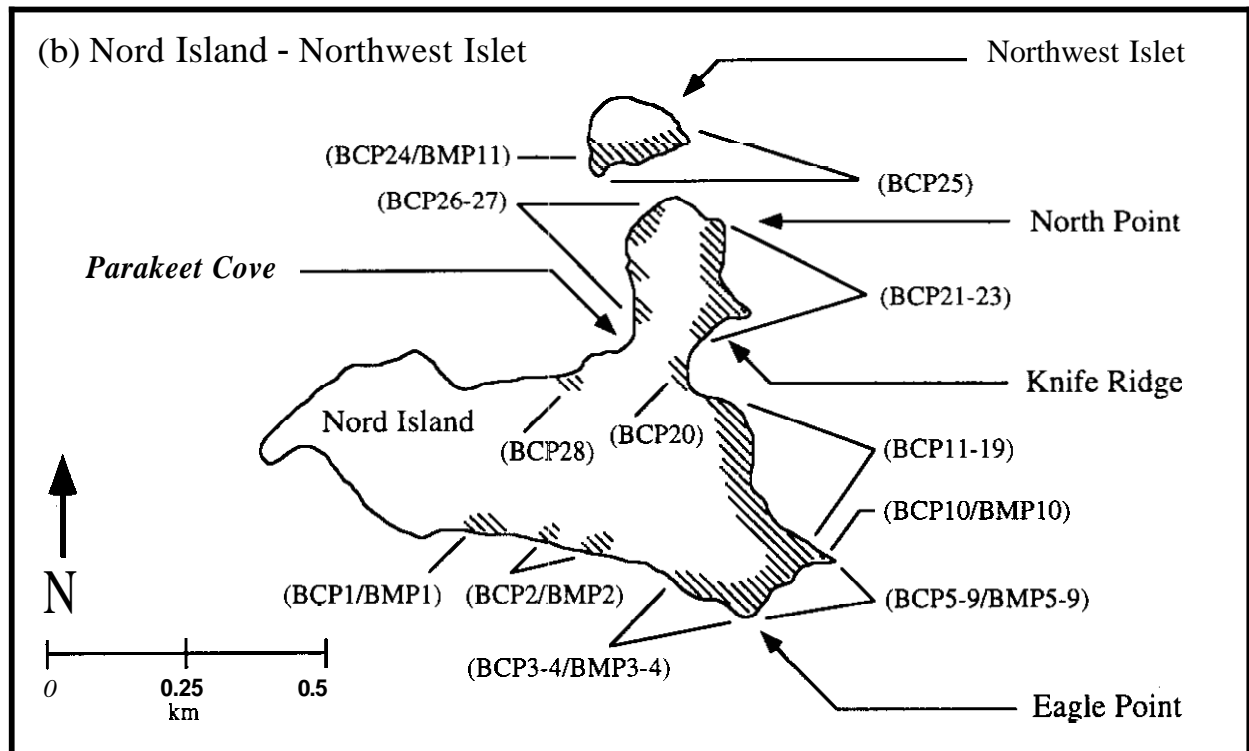
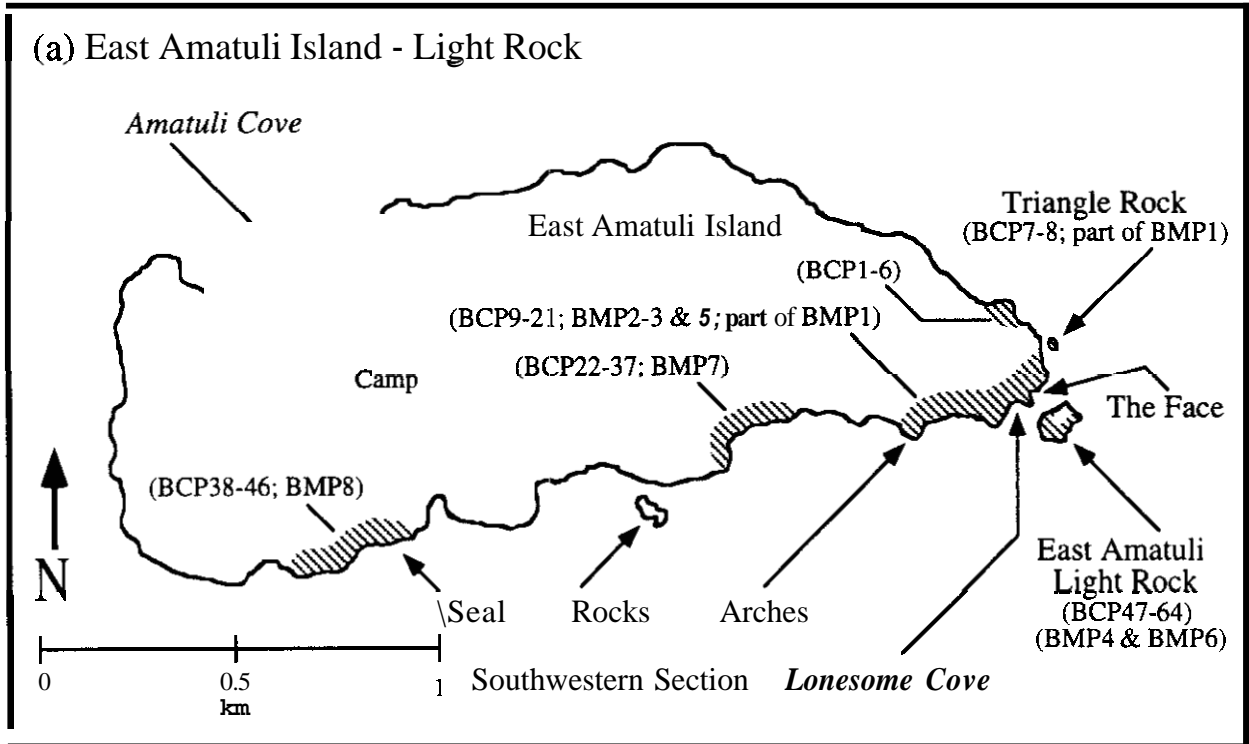


Figure 3. Murre nesting habitat (shaded areas), population census plots (BCP), and multicount plots (BMP) at the (a) East Amatuli Island - Light Rock and (b) Nord Island - Northwest Islet seabird colonies, Barren Islands, Alaska.

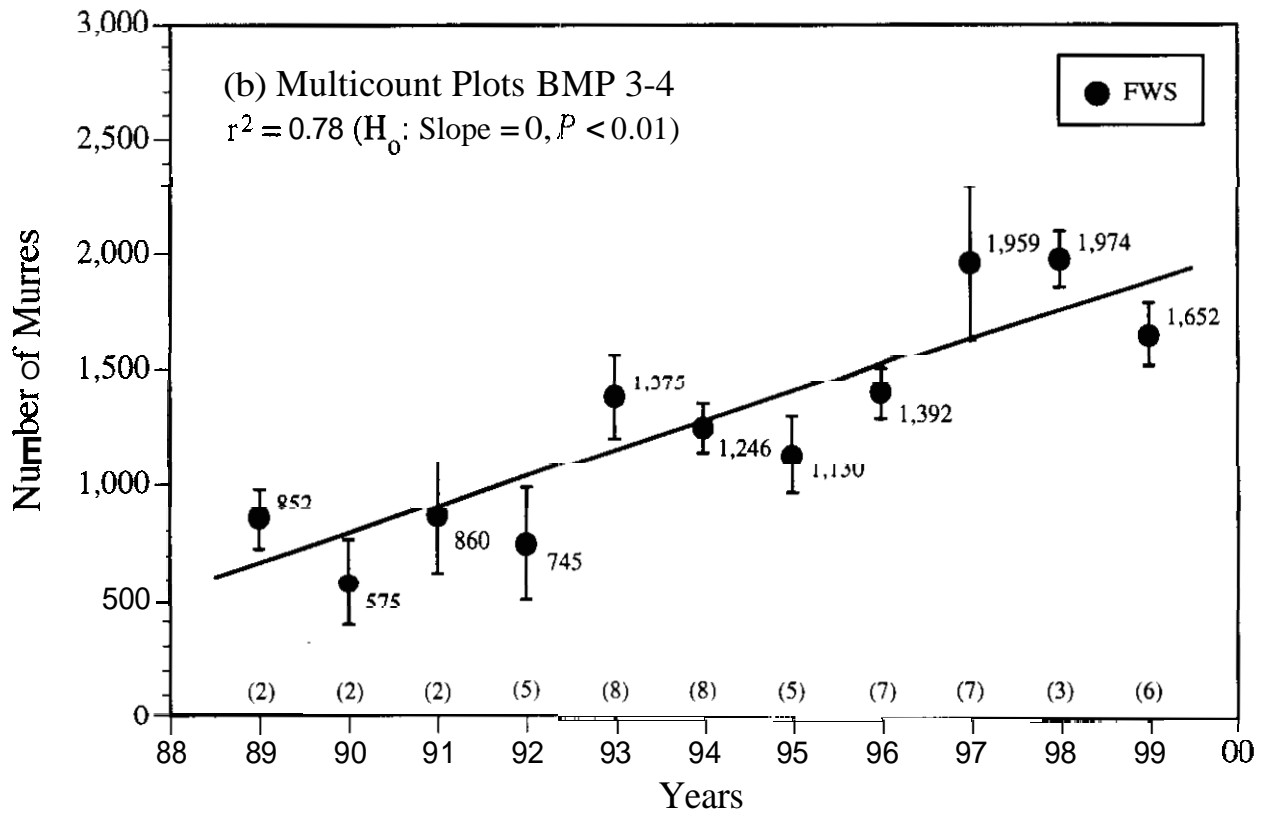
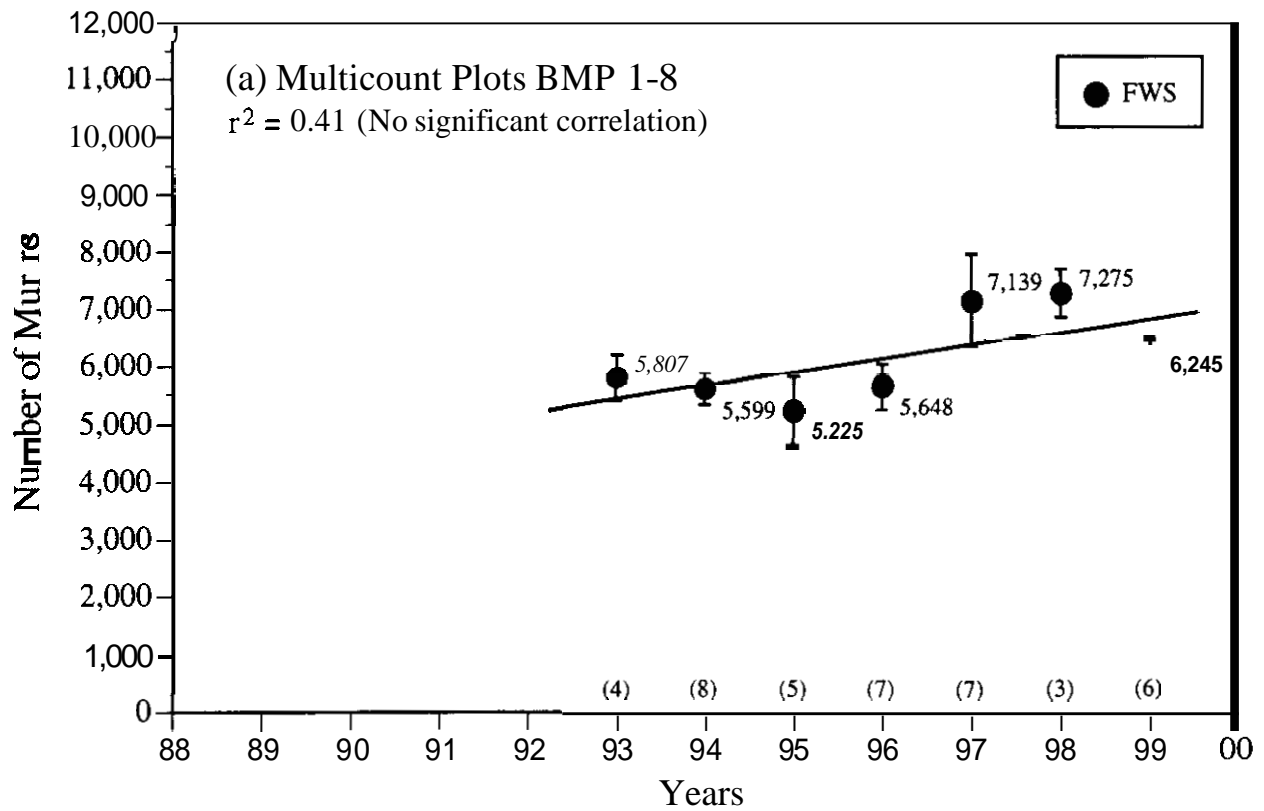


Figure 4. Average counts of murres on (a) East Amatuli Island - Light Rock multicount plots BMP 1-8 and (b) BMP 3-4, Barren Islands, Alaska 1989-1999. Counts were made by the U.S. Fish and Wildlife Service (FWS). Number of counts shown in parentheses; error bars = standard deviation.

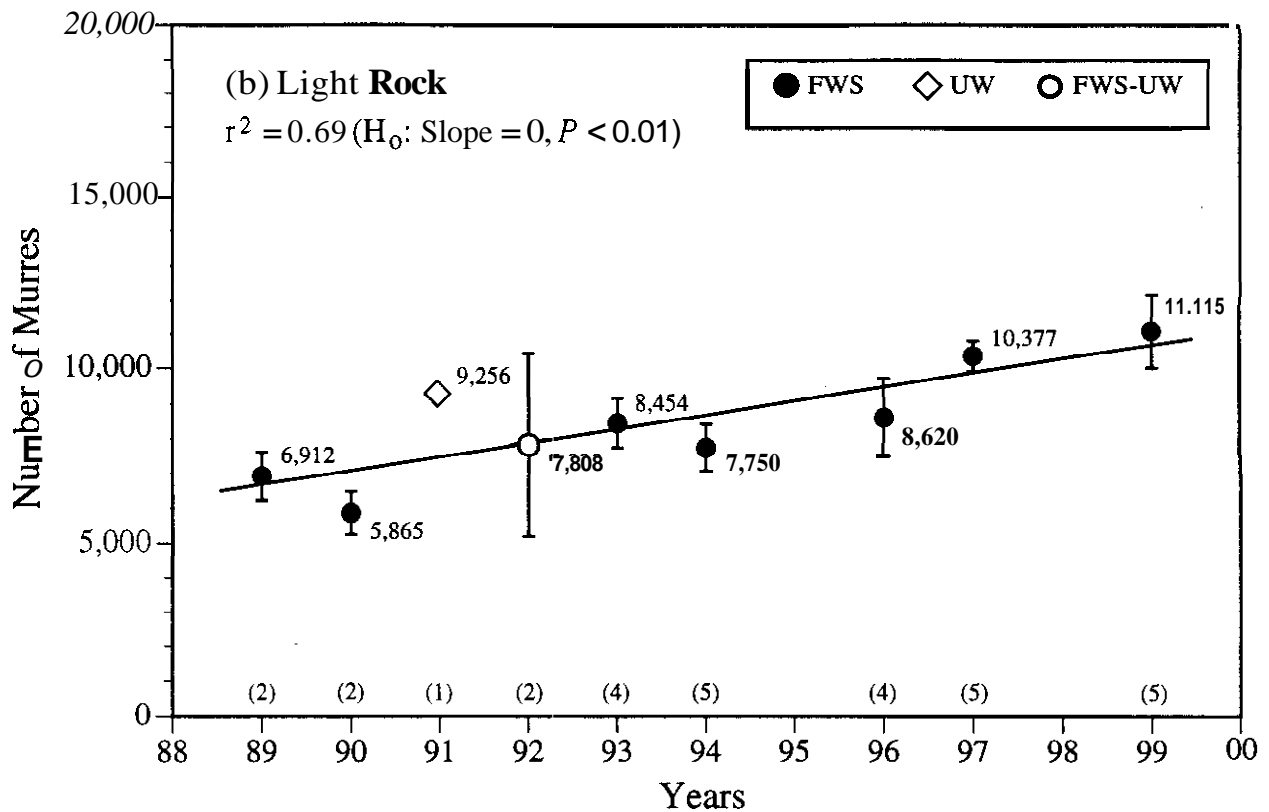
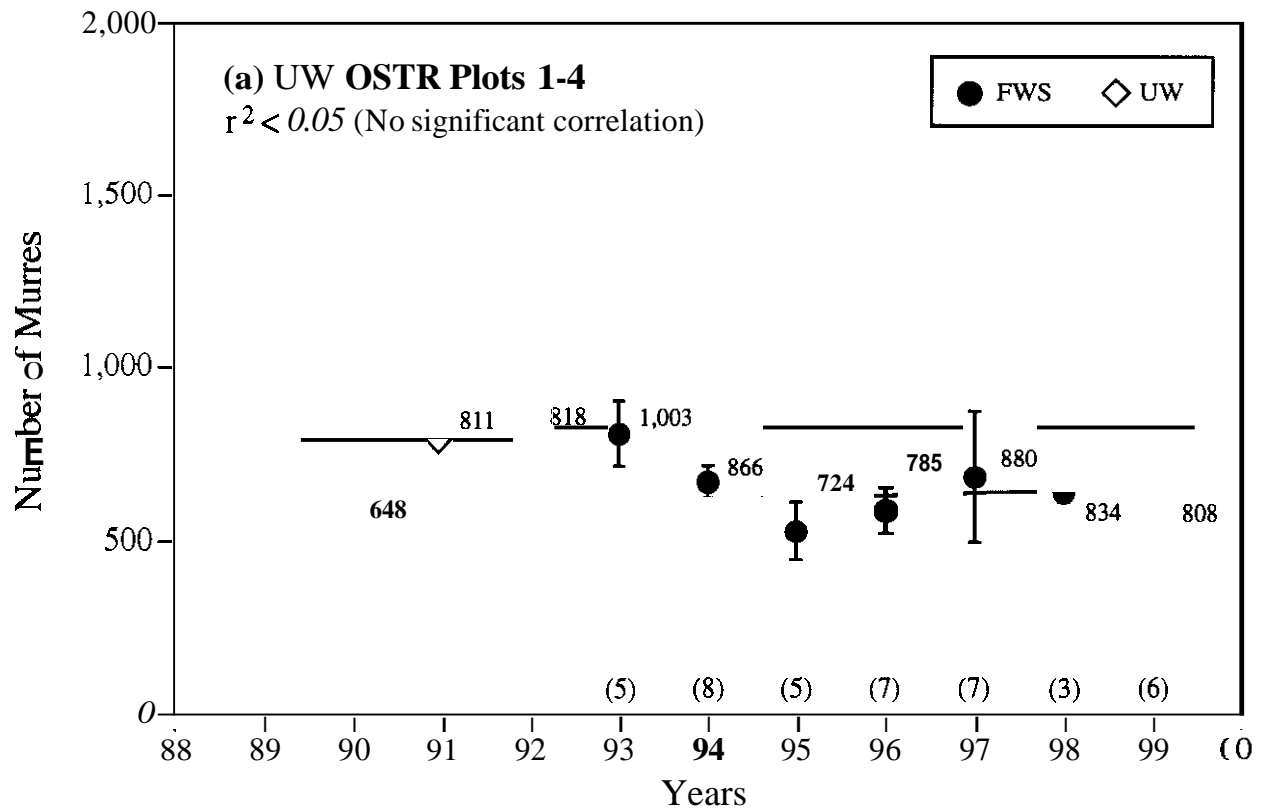


Figure 5. Average counts of murrens on (a) the University of Washington (UW) Oval, Swatch, Triangle Rock NW, and Triangle Rock S (OSTR) plots, and (b) Light Rock, Barren Islands, Alaska 1989-1999. Counts were made by UW (*see* Boersma *et al.* 1995) and the U.S. Fish and Wildlife Service (FWS). Number of counts shown in parentheses; error bars = standard deviation.

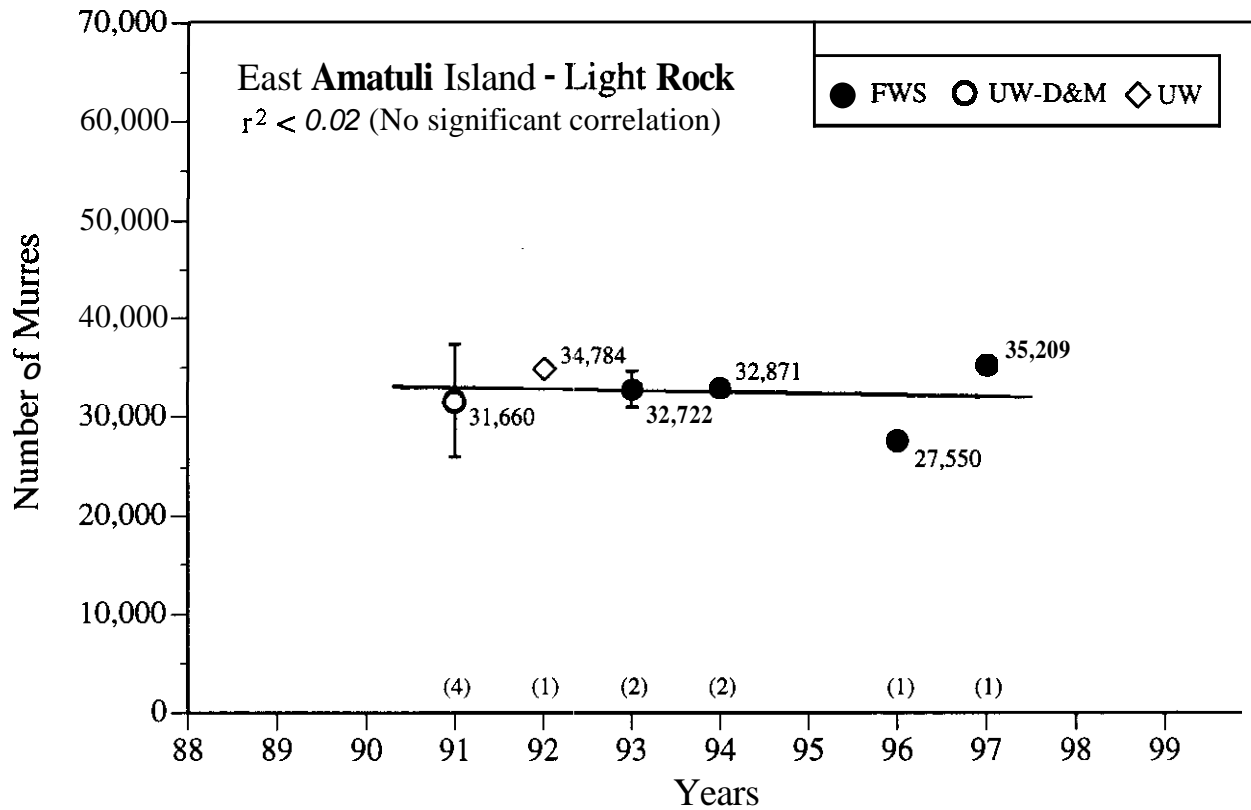


Figure 6. Average counts of murrens at East Amatuli Island - Light Rock, Barren Islands, Alaska 1991-1997 (no counts were obtained in 1989-1990 or 1998-1999). Counts were made by the University of Washington (UW; see Boersma *et al.* 1995), Dames & Moore (D&M; see Erikson 1995), and the U.S. Fish and Wildlife Service (FWS). Number of counts shown in parentheses; error bars = standard deviation.

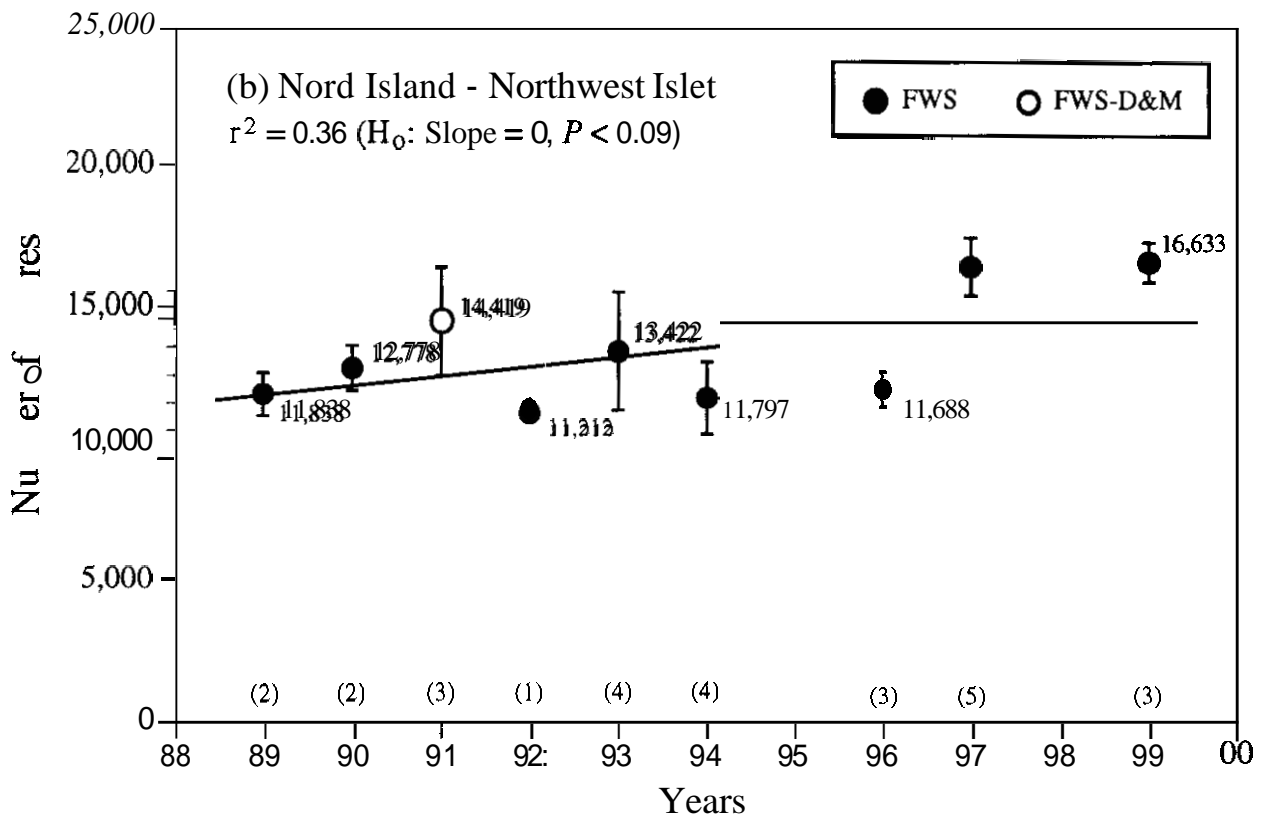
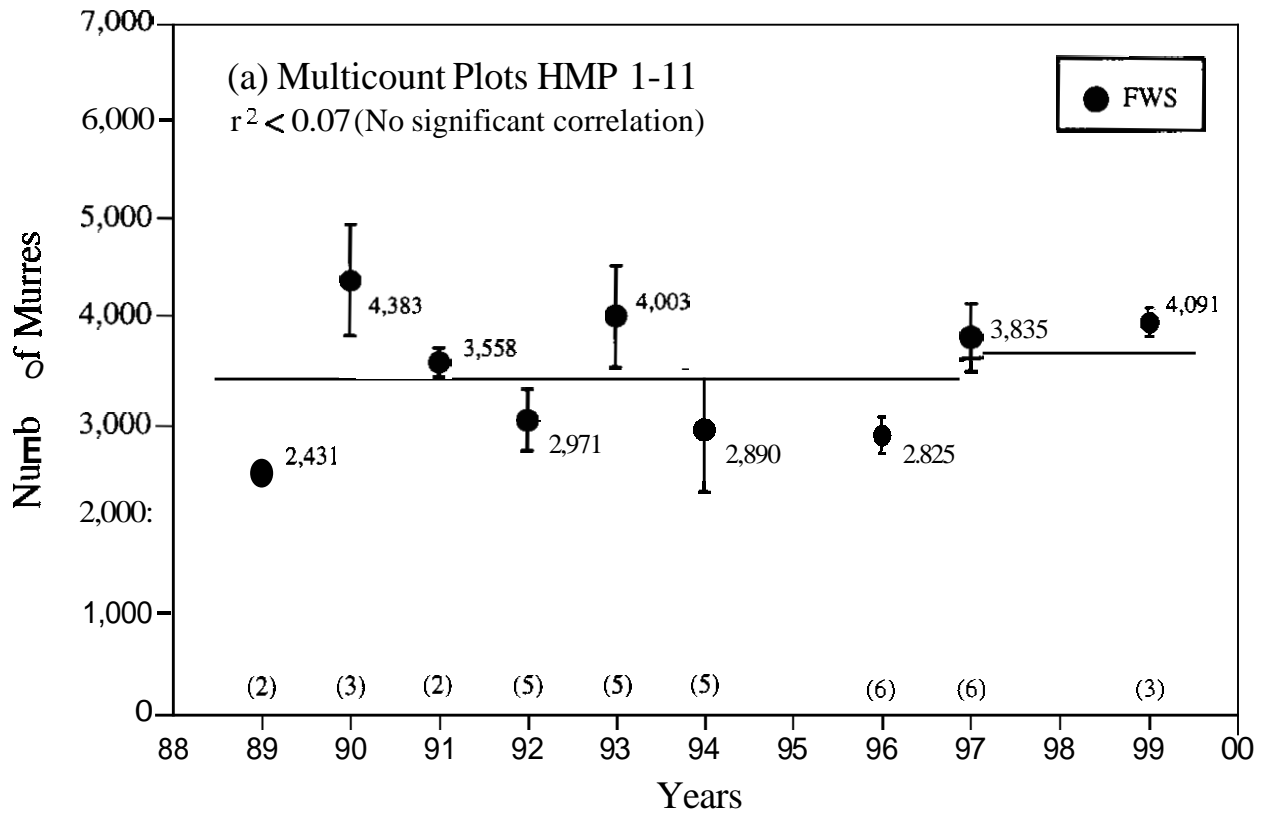


Figure 7. Average counts of murre on (a) Nord Island - Northwest Islet multicount plots BMP 1-11 and (b) Nord Island - Northwest Islet, Barren Islands, Alaska 1989-1999. Counts were made by the **U.S.** Fish and Wildlife Service (FWS) and Dames & Moore (D&M, see Erikson 1995). Number of counts shown in parentheses; error bars = standard deviation.

## Appendix 1. Counts of murres at East Amatuli Light Rock, 17 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

FWS Plot Number	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
		Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP47	1115	320			320	310			310	315
BCP48	1140	1,080	1180		1,130	1,160	1100		1,130	1,130
BCP49	1130	220	230	240	230	240	220		230	230
BCP50	1132	80	90	80	83	80	90		85	84
BCP51	1151	1,110	1160		1,135	1,180			1,180	1,158
BCP52	1215	460			460	440			440	450
BCP53	1200	460	470		465	490	530	480	500	483
BCP54	1207	1,100			1,100	1,100	1040		1,070	1,085
BCP55	1235	420			420	440			440	430
BCP56	1230	650	640		645	620	660		640	643
BCP57	[Included in BCP61]									
BCP58	1252	320	320		320	330			330	325
BCP59	1249	650	620		635	650			650	643
BCP60	1254	230	240		235	250			250	243
BCP61+57	1312	2,140	1,950	2080	2,057	1,860			1,860	1,959
BCP62	1351	260	270		265	250			250	258
BCP63	1303	160	160		160	170			170	165
BCP64	1334	360			360	350			350	355
TOTAL (Whole Rock)		10,020			10,020	9,920			9,885	9,956

## Appendix 2. Counts of murrelets at East Amatuli Light Rock, 19 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

FWS Plot Number	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
		Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP47	1330	290			290	300			300	295
BCP48	1358	1150			1,150	1180			1,180	1,165
BCP49	1353	220			220	230			230	225
BCP50	1347	90	80		85	80			80	83
BCP51	1404	1180			1,180	1,160			1,160	1,170
BCP52	1436	380			380	390			390	385
BCP53	1410	560			560	580	550		565	563
BCP54	1421	1,200			1,200	1,250			1,250	1,225
BCP55	1315	500	500		500	495			495	498
BCP56	1425	700	720		710	710			710	710
BCP57	[Included in BCP61]									
BCP58	1245	300			300	300			300	300
BCP59	1240	720			720	790			790	755
BCP60	1245	170	170	160	167	150	160		155	161
BCP61+57	1259	2,230	2,420	2380	2,343	2,190	2300	2160	2,217	2,280
BCP62	1439	80	90		85	85			85	85
BCP63	1317	115	120		118	123			123	121
BCP64	1342	210	220		215	200			200	208
TOTAL (Whole Rock)		10,095			10,223	10,213			10,230	10,229

### Appendix 3. Counts of murres at East Amatuli Light Rock, 20 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

FWS Plot Number	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
		Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP47	1815	330			330	305			305	318
BCP48	1805	1,500			1,500	1,540			1,540	1,520
BCP49	1800	260	260		260	270			270	265
BCP50	1755	90	80		85	75	80		78	82
BCP51	1824	1,380	1,400		1,390	1,430			1,430	1,410
BCP52	1900	510			510	520			520	515
BCP53	1838	580	580	590	583	620			620	602
BCP54	1850	1,400			1,400	1,270			1,270	1,335
BCP55	1905	680			680	670			670	675
BCP56	1856	1,000			1,000	990			990	995
BCP57	[Included in BCP61]									
BCP58	1912	380	410		395	390			390	393
BCP59	1920	910	930		920	910			910	915
BCP60	1915	255			255	260			260	258
BCP61+57	1936	2,610	2,500	2480	2,530	2,350	2,490		2,420	2,475
BCP62	1909	200	200		200	205			205	203
BCP63	1929	200	190		195	205			205	200
BCP64	1820	280	310		295	290			290	293
TOTAL (Whole Rock)		12,565			12,528	12,300			12,373	12,454



#### Appendix 4. Counts of murre at East Amatuli Light Rock, 22 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

FWS Plot Number	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
		Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP47	1747	210	210		210	210			210	210
BCP48	1756	1,080	1,030		1,055	970	1,020		995	1,025
BCP49	1738	220	220		220	230			230	225
BCP50	1741	80	90		85	75			75	80
BCP51	1817	1,340			1,340	1,300	1,390		1,345	1,343
BCP52	1845	500			500	500			500	500
BCP53	1805	560	560		560	490	510		500	530
BCP54	1831	1,200			1,200	1,280			1,280	1,240
BCP55	1736	590	580		585	610			610	598
BCP56	1841	880			880	840			840	860
BCP57	[Included in BCP61]									
BCP58	1655	320			320	330			330	325
BCP59	1658	680	740		710	700			700	705
BCP60	1701	290	290		290	260			260	275
BCP61+57	1723	2,570	2,380	2,420	2,457	2,340	2,340	2,380	2,353	2,405
BCP62	1705	230	240		235	240			240	238
BCP63	1711	150	150		150	150			150	150
BCP64	1749	250			250	250			250	250
TOTAL (Whole Rock)		11,150			11,047	10,775			10,868	10,959

## Appendix 5. Counts of murrelets at East Amatuli Light Rock, 28 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

FWS Plot Number	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
		Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP47	1819	320			320	310			310	315
BCP48	1831	1,290			1,290	1,350			1,350	1,320
BCP49	1835	250	240	250	247	260			260	254
BCP50	1834	60			60	60			60	60
BCP51	1838	1,300			1,300	1,420			1,420	1,360
BCP52	1901	520			520	550			550	535
BCP53	1842	640	650		645	640			640	643
BCP54	1852	1,200			1,200	1,260			1,260	1,230
BCP55	1800	780			780	740			740	760
BCP56	1904	670			670	700			700	685
BCP57	[Included in BCP61]									
BCP58	1740	400			400	370			370	385
BCP59	1743	750	760	710	740	700			700	720
BCP60	1756	250			250	250			250	250
BCP61+57	1805	2,670	2,600		2,635	2,660			2,660	2,648
BCP62	1757	320	320		320	300			300	310
BCP63	1802	180	190		185	190			190	188
BCP64	1819	320			320	310			310	315
TOTAL (Whole Rock)		11,920			11,882	12,070			12,070	11,978

## Appendix 6. Counts of murre on multicount plots at East Amatuli Island - Light Rock, 1998.

Note: Counts were made by 1's and 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate that the plots are census plots counted from boats, not land; BMP numbers indicate that the plots are also multicount plots that are counted from boats at least five separate times on different days to help track population trends; ABK = Arthur B. Kettle; SZ = Stephanie Zuniga.

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (SZ)					Observer 1 & 2
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average
BMP1	BCP7-9	29 Jul	1823	454				454	423				423	439
BMP2	BCP11-12	29 Jul	1814	920				920	940				940	930
BMP3	BCP18-19	29 Jul	1807	950				950	1,060				1,060	1,005
BMP4	Part of BCP47-49	29 Jul	1803	1,020				1,020	970				970	995
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			<i>3,344</i>				<i>3,344</i>	<i>3,393</i>				<i>3,393</i>	<i>3,369</i>
BMP5	Part of BCP20-21	29 Jul	1652	995				995	990				990	993
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			<i>4,339</i>				<i>4,339</i>	<i>4,383</i>				<i>4,383</i>	<i>4,362</i>
BMP6	BCP51	29 Jul	1748	1,170				1,170	1,260				1,260	1,215
BMP7*	BCP22	29 Jul	1740	1,082				1,082	1,082				1,082	1,082
BMP8	BCP38-42	29 Jul	1721	684				684	668				668	676
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			<i>6,105</i>				<i>6,105</i>	<i>6,133</i>				<i>6,133</i>	<i>6,120</i>
TOTAL	8 Plots: BMP1-8	29 Jul		7,275				7,275	7,393				7,393	7,335
BMP1	BCP7-9	31 Jul	1859	540				540	516				516	528
BMP2	BCP11-12	31 Jul	1850	770				770	740				740	755
BMP3	BCP18-19	31 Jul	1840	900				900	880				880	890
BMP4	Part of BCP47-49	31 Jul	1835	1,105				1,105	1,265				1,265	1,185
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			<i>3,315</i>				<i>3,315</i>	<i>3,401</i>				<i>3,401</i>	<i>3,358</i>
BMP5	Part of BCP20-21	31 Jul	1915	1,160				1,160	1,210				1,210	1,185
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			<i>4,475</i>				<i>4,475</i>	<i>4,611</i>				<i>4,611</i>	<i>4,543</i>
BMP6	BCP51	31 Jul	1816	1,150				1,150	1,190				1,190	1,170
BMP7	BCP22	31 Jul	1803	1,220				1,220	1,250				1,250	1,235

Appendix 2 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (SZ)					Observer 1 & 2 Average	
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average		
BMP8	BCP38-42	31 Jul	1733	684				684	706				706	695	
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			6,379				6,379	6,567				6,567	0	6,473
TOTAL	8 Plots: BMP1-8	31 Jul		7,529				7,529	7,757				7,757	7,643	
BMP1	BCP7-9	3 Aug	1553	522				522	539				539	531	
BMP2	BCP11-12	3 Aug	1546	705				705	730				730	718	
BMP3	BCP18-19	3 Aug	1538	875				875	960				960	918	
BMP4	Part of BCP47-49	3 Aug	1525	990				990	867				867	929	
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			3,092				3,092	3,096				3,096	0	3,096
BMP5	Part of BCP20-21	3 Aug	1611	890				890	900				900	895	
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			3,982				3,982	3,996				3,996	0	3,991
BMP6	BCP51	3 Aug	1516	1,050				1,050	1,120				1,120	1,085	
BMP7	BCP22	3 Aug	1507	1,005				1,005	1,030				1,030	1,018	
BMP8	BCP38-42	3 Aug	1440	774				774	730				730	752	
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			5,761				5,761	5,756				5,756	0	5,761
TOTAL	8 Plots: BMP1-8	3 Aug		6,811				6,811	6,876				6,876	6,846	
<i>Mean of 3 counts on 4 plots (BMP1-4)</i>									<i>Range = 3,096 - 3,369</i>		<i>SD = 155</i>		<i>3,274</i>		
<i>Mean of 3 counts on 5 plots (BMP1-5)</i>									<i>Range = 3,991 - 4,543</i>		<i>SD = 281</i>		<i>4,299</i>		
<i>Mean of 3 counts on 7 plots (BMP1-5 &amp; 7-8)</i>									<i>Range = 5761 - 6,473</i>		<i>SD = 356</i>		<i>6,118</i>		
MEAN OF 3 COUNTS ON 8 PLOTS (BMP1-8)									<i>Range = 6,846 - 7,643</i>		<i>SD = 402</i>		<i>7,275</i>		

\* This plot total is an estimate. It was derived by averaging the 31 July and 3 August counts of 1,235 and 1,018 birds (mean = 1,082 birds).

## Appendix 7. Counts of murres on multicount plots at East Amatuli Island - Light Rock, 1999.

Note: Counts were made by 1's and 10's from small boats; times are Alaska Daylight Time; FWS = U.S. Fish & Wildlife Service; BCP numbers indicate that the plots are census plots counted from boats, not land; BMP numbers indicate that the plots are also multicount plots that are counted from boats at least five separate times on different days to help track population trends; ABK = Arthur B. Kettle; MAB = Margaret A. Blanding; DGR = David G. Roseneau; ES = Erica Sommer.

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (ES)					Observer 1 & 2 Average
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP7-9	8 Jul	1847	600				600	594				594	597
BMP2	BCP11-12	8 Jul	1843	665				665	677				677	671
BMP3	BCP18-19	8 Jul	1812	815				815	804				804	810
BMP4	Part of BCP47-49	8 Jul	1807	975				975	910				910	943
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			3,055				3,055	2,985				2,985	3,020
BMP5	Part of BCP20-21	8 Jul	1824	920				920	809				809	865
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			3,975				3,975	3,794				3,794	3,885
BMP6	BCP51	8 Jul	1749	770				770	780				780	775
BMP7	BCP22	8 Jul	1740	830				830	730				730	780
BMP8	BCP38-42	8 Jul	1648	759				759	689				689	724
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			5,564				5,564	5,213				5,213	0
<b>TOTAL</b>	<b>8 Plots: BMP1-8</b>	<b>8 Jul</b>		<b>6,334</b>				<b>6,334</b>	<b>5,993</b>				<b>5,993</b>	<b>6,165</b>
BMP1	BCP7-9	17 Jul	1248	503				503	479				479	491
BMP2	BCP11-12	17 Jul	1211	619				619	598				598	609
BMP3	BCP18-19	17 Jul	1203	783				783	714				714	749
BMP4	Part of BCP47-49	17 Jul	1240	860				860	750				750	805
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			2,765				2,765	2,541				2,541	0
BMP5	Part of BCP20-21	17 Jul	1313	750				750	716				716	733
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			3,515				3,515	3,257				3,257	0

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR)					Observer 2 (MAB)					Observer 1 & 2 Average
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP6	BCP51	17 Jul	1151	1,110	1,160			1,135	1,180			1,180		1,158
				Observer 1 (ABK)					Observer 2 (ES)					
BMP7	BCP22	17 Jul	1151	740				740	818			818		779
BMP8	BCP38-42	17 Jul	1105	641				641	646			646		644
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			4,896				4,896	4,721			4,721	0	4,810
TOTAL	8 Plots: BMP1-8	17 Jul		6,006				6,031	5,901			5,901		5,968
BMP1	BCP7-9	19 Jul	1439	511				511	483			483		497
BMP2	BCP11-12	19 Jul	1423	690				690	652			652		671
BMP3	BCP18-19	19 Jul	1414	637				637	728			728		683
BMP4	Part of BCP47-49	19 Jul	1403	914				914	925			925		920
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			2,752				2,752	2,788			2,788	0	2,771
BMP5	Part of BCP20-21	19 Jul	1715	760				760	764			764		762
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			3,512				3,512	3,552			3,552	0	3,533
				Observer 1 (DGR)					Observer 2 (MAB)					
BMP6	BCP51	19 Jul	1404	1,180				1,180	1,160			1,160		1,170
				Observer 1 (ABK)					Observer 2 (ES)					
BMP7	BCP22	19 Jul	1352	815				815	802			802		809
BMP8	BCP38-42	19 Jul	1320	570				570	562			562		566
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			4,897				4,897	4,916			4,916	0	4,908
TOTAL	8 Plots: BMP1-8	19 Jul		6,077				6,077	6,076			6,076		6,078

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (ABK)					Observer 2 (ES)					Observer 1 & 2	
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	Average	
BMP1	BCP7-9	23 Jul	1904	683				683	653				653		668
BMP2	BCP11-12	23 Jul	1856	735				735	707				707		721
BMP3	BCP18-19	23 Jul	1849	1,010				1,010	933				933		972
BMP4	Part of BCP47-49	23 Jul	1843	970				970	853				853		912
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			3,398				3,398	3,146				3,146	0	3,273
BMP5	Part of BCP20-21	23 Jul	1927	845				845	867				867		856
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			4,243				4,243	4,013				4,013	0	4,129
BMP6	BCP51	23 Jul	1836	800				800	750				750		775
BMP7	BCP22	23 Jul	1827	945				945	829				829		887
BMP8	BCP38-42	23 Jul	1800	810				810	780				780		795
<i>Subtotal</i>	<i>7 Plots: BMP1-5 &amp; 7-8</i>			5,998				5,998	5,622				5,622	0	5,811
<b>TOTAL</b>	<b>8 Plots: BMP1-8</b>	<b>23 Jul</b>		<b>6,798</b>				<b>6,798</b>	<b>6,372</b>				<b>6,372</b>		<b>6,586</b>
BMP1	BCP7-9	7 Aug	1841	650				650	610				610		630
BMP2	BCP11-12	7 Aug	1834	642				642	673				673		658
BMP3	BCP18-19	7 Aug	1829	677				677	681				681		679
BMP4	Part of BCP47-49	7 Aug	~1845	986				986	894				894		940
<i>Subtotal</i>	<i>4 Plots: BMP1-4</i>			2,955				2,955	2,858				2,858	0	2,907
BMP5	Part of BCP20-21	7 Aug	1905	955				955	860				860		908
<i>Subtotal</i>	<i>5 Plots: BMP1-5</i>			3,910				3,910	3,718				3,718	0	3,815
BMP6	BCP51	7 Aug	1813	1,080				1,080	990				990		1,035
BMP7	BCP22	7 Aug	1800	1,055				1,055	946				946		1,001

Appendix 7 (Continued).

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR)					Observer 2 (MAB)					Observer 1 & 2 Average	
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average		
BMP8	BCP38-4Z	7 Aug	1731	642				642	641				641	642	
<i>Subtotal</i>	<i>7 Plots BMP1-5 &amp; 7-8</i>			5,607				5,607	5,305				5,305	0	5,458
<b>TOTAL</b>	<b>8 Plots: BMP1-8</b>	<b>7 Aug</b>		4,552				4,552	4,359				4,359	6,493	
BMP1	BCP7-9	10 Aug	1747	494				494	489				489	492	
BMP2	BCP11-12	10 Aug	1727	645				645	607				607	626	
BMP3	BCP18-19	10 Aug	1710	647				647	653				653	650	
BMP4	Part of BCP47-49	10 Aug	1705	850				850	852				852	851	
<i>Subtotal</i>	<i>4 Plots BMP1-4</i>			2,636				2,636	2,601				2,601	0	2,619
BMP5	Part of BCP20-21	10 Aug	1753	1,023				1,023	952				952	988	
<i>Subtotal</i>	<i>5 Plots BMP1-5</i>			3,659				3,659	3,553				3,553	0	3,607
BMP6	BCP51	10 Aug	1701	943				943	854				854	899	
BMP7	BCP22	10 Aug	1639	1,120				1,120	883				883	1,002	
BMP8	BCP38-42	10 Aug	1607	688				688	659				659	674	
<i>Subtotal</i>	<i>7 Plots BMP1-5 &amp; 7-8</i>			5,467				5,467	5,095				5,095	0	5,283
<b>TOTAL</b>	<b>8 Plots: BMP1-8</b>	<b>10 Aug</b>		6,410				6,410	5,949				5,949	6,182	
<i>Mean of 6 counts on 4 plots (BMP1-4)</i>									<i>Range = 2,619 - 3,273</i>		<i>SD = 247</i>		<i>2,874</i>		
<i>Mean of 6 counts on 5 plots (BMP1-5)</i>									<i>Range = 3,387 - 4,125</i>		<i>SD = 269</i>		<i>3,726</i>		
<i>Mean of 6 counts on 7 plots (BMP1-5 &amp; 7-8)</i>									<i>Range = 4,810 - 5,811</i>		<i>SD = 370</i>		<i>5,277</i>		
<b>MEAN OF 6 COUNTS ON 8 PLOTS (BMP1-8)</b>									<b>Range = 5,968 - 6,586</b>		<b>SD = 242</b>		<b>6,245</b>		



Appendix 8. Counts of murre on multicount plots at the Nord Island - Northwest Islet and East Amatuli Island Light Rock colonies, Barren Islands, Alaska, 1989-1999 (1989-1992 data are from Dragoo *et al.* 1995 and Nysewander 1993; 1993-1994 data are from Roseneau *et al.* 1995 and 1996a; 1995-1996 data are from Roseneau *et al.* 1997a; 1997 data are from Roseneau *et al.* 1998a; 1998 data are from D. G. Roseneau and A. B. Kettle, unpubl. data; and 1999 data are from this study).<sup>1</sup>

Nord Island - Northwest Islet													East Amatuli Island - Light Rock					
Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD) <sup>2</sup>	Date	BMP3	BMP4	Total	(SD)
<u>1989</u>													<u>1989</u>					
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)
<u>1990</u>													<u>1990</u>					
19 Jul	136	436	13	249	1,240	726	110	1,460	252	127	242	4,991		ND <sup>3</sup>	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)
<u>1991</u>													<u>1991</u>					
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)
<u>1992</u>													<u>1992</u>					
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	
18 Aug	85	169	10	178	682	380	114	523	301	168	134	2,744		10 Aug	388	538	926	
24 Aug	70	321	0	163	780	541	150	760	311	165	188	3,449		18 Aug	392	501	893	
26 Aug	42	151	7	113	730	488	101	855	251	142	136	3,016		26 Aug	199	294	493	
Mean	71	203	5	132	700	475	102	724	278	135	144	2,971	(314.2)	Mean	330	415	745	(243.2)

Nord Island - Northwest Islet													East Amatuli Island - Light Rock					
Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD)	Date	BMP3	BMP4	Total	(SD)
<u>1993</u>													<u>1993</u>					
19 Jul	90	210	10	140	1,130	960	120	1,360	240	120	209	4,589		22 Jul	813	767	1,580	
3 Aug	60	175	10	141	1,090	903	90	1,208	480	103	253	4,513		26 Jul	570	689	1,259	
4 Aug	55	153	9	85	1,100	585	95	965	415	143	208	3,813		31 Jul	815	725	1,540	
9 Aug	48	150	1	113	910	443	101	1,108	370	85	150	3,479		2 Aug	735	757	1,492	
17 Aug	123	254	0	115	710	530	140	1,000	380	136	235	3,623		11 Aug	733	772	1,505	
Mean	75	188	6	119	988	684	109	1,128	377	117	211	4,003	(514.4)	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)
<u>1994</u>													<u>1994</u>					
27 Jul	39	153	0	57	490	435	75	135	260	87	239	1,970		27 Jul	550	560	1,110	
28 Jul	54	111	9	50	513	513	120	579	418	96	222	2,685		28 Jul	588	565	1,153	
14 Aug	40	155	9	90	648	630	103	605	393	90	268	3,031		30 Jul	545	725	1,270	
15 Aug	69	205	11	105	685	565	138	568	405	102	193	3,046		31 Jul	584	855	1,439	
16 Aug	78	280	9	130	797	655	124	895	439	92	219	3,718		5 Aug	528	730	1,258	
Mean	56	181	8	86	627	560	112	556	383	93	228	2,890	(636.0)	6 Aug	546	755	1,301	
														14 Aug	548	640	1,188	
														15 Aug	495	750	1,245	
														Mean	548	698	1,246	(101.1)
<u>1995</u>													<u>1995</u>					
ND'	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		27 Jul	425	615	1,040	
Mean	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		31 Jul	508	640	1,148	
														6 Aug	533	790	1,323	
														8 Aug	375	525	900	
														21 Aug	480	758	1,238	
														Mean	464	666	1,130	(166.0)

Appendix 8 (Continued).

Nord Island - Northwest Islet													East Amatuli Island - Light Rock					
Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD)	Date	BMP3	BMP4	Total	(SD)
<u>1996</u>													<u>1996</u>					
22 Jul	88	252	5	64	603	548	94	735	305	105	236	3,035		19 Jul	618	825	1,443	
24 Jul	74	244	5	81	505	520	118	633	355	87	245	2,867		20 Jul	560	848	1,408	
25 Jul	64	233	10	89	463	533	112	568	293	93	201	2,659		21 Jul	578	843	1,421	
26 Jul	65	175	6	80	500	545	85	563	293	85	259	2,656		22 Jul	586	740	1,326	
27 Jul	73	291	5	87	448	465	93	264	693	85	200	2,704		12 Aug	480	760	1,240	
9 Aug	79	242	4	81	588	618	112	660	315	100	229	3,028		13 Aug	585	995	1,580	
Mean	74	240	6	80	518	538	102	571	376	93	228	2,825	(177.7)	14 Aug	464	865	1,329	
Mean														Mean	553	839	1,392	(108.4)
<u>1997</u>													<u>1997</u>					
28 Jul	68	110	6	99	745	600	140	640	365	115	379	3,267		6 Jul	818	865	1,683	
30 Jul	90	285	4	107	625	753	125	814	420	135	304	3,662		7 Jul	1,038	895	1,933	
1 Aug	86	210	3	93	780	698	115	1,020	358	103	331	3,797		15 Jul	1,010	1,285	2,295	
2 Aug	100	313	0	118	695	685	205	1,030	490	138	298	4,072		23 Jul	705	820	1,525	
3 Aug	115	348	3	123	790	725	176	842	425	170	309	4,026		25 Jul	1,065	1,020	2,085	
4 Aug	100	345	4	120	750	925	175	825	495	145	299	4,183		26 Jul	900	868	1,768	
Mean	93	269	3	110	731	731	156	862	426	134	320	3,835	(337.0)	27 Jul	1,235	1,188	2,423	
Mean														Mean	967	992	1,959	(328.1)
<u>1998</u>													<u>1998</u>					
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		29 Jul	1,005	995	2,000	
Mean	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		31 Jul	890	1,185	2,075	
														3 Aug	918	929	1,847	
														Mean	938	1036	1,974	(116.2)

Appendix 8 (Continued).

Nord Island - Northwest Islet													East Amatuli Island - Light Rock					
Date	BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8	BMP9	BMP10	BMP11	Total	(SD)	Date	BMP3	BMP4	Total	(SD)
1999													1999					
23 Jul	153	260	4	109	854	778	207	803	400	115	445	4,128		8 Jul	810	943	1,753	
26 Jul	125	280	5	153	655	843	228	845	400	100	300	3,934		17 Jul	749	805	1,554	
29 Jul	108	350	4	100	890	940	153	865	295	102	405	4,212		19 Jul	683	920	1,603	
Mean	129	297	4	121	800	854	196	838	365	106	383	4,091	(142.6)	23 Jul	972	912	1,884	
														7 Aug	679	940	1,619	
														10 Aug	650	851	1,501	
														Mean	757	895	1,652	(141.4)

<sup>1</sup> This table contains some values that are slightly different from previously published figures (e.g., Dragoo *et al.* 1995). These revisions 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 pre-1993 East Amatuli Island - Light Rock counts are also reported here. Nord Island - Northwest Islet plots BMP1-11 are equivalent to previously reported plots A1, A2, B, C, D, E, G, H1, H2, I, and NW Islet, respectively, and they are also equivalent to plots BCP1-10 and BCP24 (see Appendices 8-11). East Amatuli Island - Light Rock plots BMP3 and BMP4 are equivalent to the previously reported "Mainland" and "Lt. Rock" plots, respectively (see Dragoo *et al.* 1995). The 13 August 1989 total for Nord Island - Northwest Islet plot BMP10 is an estimated value (see Dragoo *et al.* 1995).

<sup>2</sup> SD = standard deviation.

<sup>3</sup> ND = no data.

Appendix 2. Counts of murrelets at Nord Islet and Northwest Islet, 23 July 1992.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP1	A1	1212	155	165		160	145		145	153	
BCP2	A2	1215	260			260	260		260	260	
BCP3	B	1225	4			4	4		4	4	
BCP4	C	1230	106	108		107	110		110	109	
BCP5	D	1243	852	862		857	850		850	854	
BCP6	E	1250	780	790		785	770		770	778	
BCP7	G	1255	210	220		215	205	190	198	207	
BCP8	H1	1300	790	820		805	780	820	800	803	
BCP9	H2	1317	410			410	390		390	400	
BCP10	I	1320	110	120		115	115		115	115	
BCP11	(None) <sup>1</sup>	1323	1			1	1		1	1	
BCP12	J	1324	1			1	1		1	1	
BCP13	P	1329	250	245		248	240		240	244	
BCP14	Q + R <sup>2</sup>	1339	1,910			1,910	1,810		1,810	1,860	
BCP15	S [also "S-1" or "R-S"] <sup>3</sup>	1354	550	570	540	553	530		530	542	
BCP16	W [also "S-2"] <sup>4</sup>	1400	324	334		329	340		340	326	
BCP17	T (right)	1413	350	340	340	343	340		340	342	
BCP18	T (left)	1409	460	480		470	470		470	470	
BCP19	U	1430		200		200	190		190	190	
BCP20	V ["V-1" + "V-X"] <sup>5</sup>	1433	100	100	100	100	✕		✕	✕	
BCP21	X	1440	3,200	3,500		3,350	3,460		3,460	3,405	
BCP22	Y	1521	1,380			1,380	1,420		1,420	1,400	
BCP23	Z	1530	1,100			1,100	1,110		1,110	1,105	
BCP24	NW Islet Plot	1733	470			470	420		420	445	
BCP25	Remainder NW Islet <sup>6</sup>	1724	1,732			1,732	1,821		1,821	1,777	
BCP26	("Smaller NW Islet") [Subislet-2] <sup>7</sup>	1541	518			518	536		536	527	
BCP27	Parakeet Cove	1614	510			510	520		520	515	

Appendix 9 (Continued).

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP28	(None) [West Parakeet] <sup>8</sup>	1622	18			18	18			18	18
TOTAL (Whole Island)			16,551			16,951	16,956			16,969	16,951

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

<sup>2</sup> 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.

<sup>3</sup> Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

<sup>4</sup> Plot W (BCP16) is equivalent to Plot "S-2".

<sup>5</sup> Plot V was counted as "V-1" (1433 hrs: DGR = 40, 40, and 40 birds, MAB = 40 birds) + "V-X" (1435 hrs: DGR = 60, 60, and 60 birds, MAB = 60 birds).

<sup>6</sup> 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 23 July 1999 counts were: (1550 hrs) DGR = 232 birds; MAB = 241 birds.

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

<sup>8</sup> Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted prior to 1993.

## Appendix 10. Counts of murres at Nord Island - Northwest Islet, 26 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP1	A1	1312	125	125		125	125		125	125	
BCP2	A2	1315	270	290		280	280	280	280	280	
BCP3	B	1321	5			5	5		5	5	
BCP4	C	1323	155	155	155	155	150		150	153	
BCP5	D	1337	650			650	660		660	655	
BCP6	E	1330	850	860		855	830		830	843	
BCP7	G	1345	230	240		235	220		220	228	
BCP8	H1	1354	850			850	840		840	845	
BCP9	H2	1548	400			400	400		400	400	
BCP10	I	1404	100			100	100		100	100	
BCP11	(None) <sup>1</sup>	1405	0			0	0		0	0	
BCP12	J	1406	0			0	0		0	0	
BCP13	P	1554	170			170	160		160	165	
BCP14	Q + R <sup>2</sup>	1610	1,580			1,580	1,550		1,550	1,565	
BCP15	S [also "S-1" or "R-S"] <sup>3</sup>	1605	570	580		575	570		570	573	
BCP16	W [also "S-2"] <sup>4</sup>	1620	241	251		246	241		241	244	
BCP17	T (right)	1629	450	450		450	460		460	455	
BCP18	T (left)	1634	480	490		485	470		470	478	
BCP19	U	1638	150			150	150		150	150	
BCP20	V ["V-1"+V-X"] <sup>5</sup>	1422	95			95	95		95	95	
BCP21	X	1425	2,700	2,600		2,650	2,670		2,670	2,660	
BCP22	Y	1458	1,250			1,250	1,230		1,230	1,240	
BCP23	Z	1507	1,140			1,140	1,090		1,090	1,115	
BCP24	NW Islet Plot	1700	300			300	300		300	300	
BCP25	Remainder NW Islet <sup>6</sup>	1520	2,096			2,096	2,102		2,102	2,099	
BCP26	("Smaller NW Islet") [Subislet-2] <sup>7</sup>	1515	523			523	469		469	496	
BCP27	Parakeet Cove	1705	550	550		550	560		560	555	

Appendix 10 (Continued).

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP28	(None) [West Parakeet] <sup>8</sup>	1712	16			16			16	16	
TOTAL (Whole Island)			15,946			15,931			15,743	15,840	

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

<sup>2</sup> 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.

<sup>3</sup> Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-S".

<sup>4</sup> Plot W (BCP16) is equivalent to Plot "S-2".

<sup>5</sup> Plot V was counted as "V-1" (1448 hrs: DGR = 35 birds, MAB = 35 birds) + "V-X" (1422 hrs: DGR = 60 birds, MAB = 60 birds).

<sup>6</sup> 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 26 July 1999 counts were: (1535 hrs) DGR = 186 birds; MAB = 172 birds.

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

<sup>8</sup> Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted prior to 1993.



## Appendix 11. Counts of murres at Nord Island - Northwest Islet, 29 July 1999.

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 census plots counted from boats, not land; DGR = David G. Roseneau and MAB = Margaret A. Blanding.

New FWS Plot Number	Previous FWS Plot Numbers & Names	Time	Observer 1 (DGR)				Observer 2 (MAB)				Observer 1 & 2 Average
			Count 1	Count 2	Count 3	Average	Count 1	Count 2	Count 3	Average	
BCP1	A1	1519	110	110		110	105		105	108	
BCP2	A2	1525	350			350	350		350	350	
BCP3	B	1527	4			4	4		4	4	
BCP4	C	1530	100			100	100		100	100	
BCP5	D	1540	870	910		890	890		890	890	
BCP6	E	1533	920			920	960		960	940	
BCP7	G	1551	150	160		155	150		150	153	
BCP8	H1	1600	850			850	880		880	865	
BCP9	H2	1554	300			300	290		290	295	
BCP10	I	1602	101			101	102		102	102	
BCP11	(None) <sup>1</sup>	1603	0			0	0		0	0	
BCP12	J	1604	0			0	0		0	0	
BCP13	P	1627	185			185	190		190	188	
BCP14	Q + R <sup>2</sup>	1634	1,950			1,950	1,970		1,970	1,960	
BCP15	S [also "S-1" or "R-S"] <sup>3</sup>	1638	620			620	570		570	595	
BCP16	W [also "S-2"] <sup>4</sup>	1701	279			279	289		289	284	
BCP17	T (right)	1705	280	280	280	280	290		290	285	
BCP18	T (left)	1707	480	460		470	480		480	475	
BCP19	U	1714	160	150		155	160		160	158	
BCP20	V ["V-1" + V-X"] <sup>5</sup>	1719	90			90	90		90	90	
BCP21	X	1739	3,100			3,100	3,370		3,370	3,235	
BCP22	Y	1612	1,380			1,380	1,270		1,270	1,325	
BCP23	Z	1748	1,160	1,200		1,180	1,140		1,140	1,160	
BCP24	NW Islet Plot	1430	400			400	410		410	405	
BCP25	Remainder NW Islet <sup>6</sup>	1436	1,915			1,915	1,811		1,811	1,863	
BCP26	("Smaller NW Islet") [Subislet-2] <sup>7</sup>	1440	715			715	690		690	703	
BCP27	Parakeet Cove	1503	550	550		550	560		560	555	

Appendix 11 (Continued).

BCP28	(None) [West Parakeet] <sup>8</sup>	1510	20	20	20	20	20
TOTAL (Whole Island)			17,039	17,069	17,141	17,141	17,108

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

<sup>2</sup> 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.

<sup>3</sup> Plot S (BCP15) is equivalent to Plot "S-1" and it is also equivalent to Plot "R-".

<sup>4</sup> Plot W (BCP16) is equivalent to Plot "S-2".

<sup>5</sup> Plot V was counted as "V-1" (1719 hrs: DGR = 30 birds, MAB = 30 birds) + "V-X" (1720 hrs: DGR = 60 birds, MAB = 60 birds).

<sup>6</sup> 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 29 July 1999 counts were: (1436 hrs) DGR = 225 birds; MAB = 211 birds.

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

<sup>8</sup> Consists of a small group of birds found on a high cliff west of Parakeet Cove that was apparently not counted prior to 1993.

## Appendix 12. Counts of murre on multicount plots at Nord Island - Northwest Islet, 1999.

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 that the plots are 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, MAB = Margaret A. Blanding.

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR)					Observer 2 (MAB)					Observer 1 & 2 Average
				Count 1	Count 2	Count 3	Count 4	Average	Count 1	Count 2	Count 3	Count 4	Average	
BMP1	BCP1 (A1)	23 Jul	1212	155	165			160	145			145	153	
BMP2	BCP2 (A2)	23 Jul	1215	260				260	260			260	260	
BMP3	BCP3 (B)	23 Jul	1225	4				4	4			4	4	
BMP4	BCP4 (C)	23 Jul	1230	106	108			107	110			110	109	
BMP5	BCP5 (D)	23 Jul	1243	852	862			857	850			850	854	
BMP6	BCP6 (E)	23 Jul	1250	780	790			785	770			770	778	
BMP7	BCP7 (G)	23 Jul	1255	210	220			215	205	190		198	207	
BMP8	BCP8 (H1)	23 Jul	1300	790	820			805	780	820		800	803	
BMP9	BCP9 (H2)	23 Jul	1317	410				410	390			390	400	
BMP10	BCP10 (I)	23 Jul	1320	110	120			115	115			115	115	
BMP11	BCP24 (NW Islet Plot)	23 Jul	1733	470				470	420			420	445	
<i>Subtotal</i>	<i>6 Plots: BMP1-4, BMP10, BMP11</i>			<i>1,105</i>				<i>1,116</i>	<i>1,054</i>			<i>1,054</i>	<i>1,086</i>	
<i>Subtotal</i>	<i>8 Plots: BMP1-6, BMP10, BMP11</i>			<i>2,737</i>				<i>2,758</i>	<i>2,674</i>			<i>2,674</i>	<i>2,718</i>	
<b>TOTAL</b>	<b>11 Plots: BMP1-11</b>			<b>4,147</b>				<b>4,188</b>	<b>4,049</b>			<b>4,062</b>	<b>4,128</b>	
BMP1	BCP1 (A1)	26 Jul	1312	125	125			125	125			125	125	
BMP2	BCP2 (A2)	26 Jul	1315	270	290			280	280			280	280	
BMP3	BCP3 (B)	26 Jul	1321	5				5	5			5	5	
BMP4	BCP4 (C)	26 Jul	1323	155	155	155		155	150			150	153	
BMP5	BCP5 (D)	26 Jul	1337	650				650	660			660	655	
BMP6	BCP6 (E)	26 Jul	1330	850	860			855	830			830	843	
BMP7	BCP7 (G)	26 Jul	1345	230	240			235	220			220	228	
BMP8	BCP8 (H1)	26 Jul	1354	850				850	840			840	845	
BMP9	BCP9 (H2)	26 Jul	1548	400				400	400			400	400	
BMP10	BCP10 (I)	26 Jul	1404	100				100	100			100	100	

Appendix 12 (Continued)

New FWS Multicount Plot Number	New FWS Boat Plot Number & Previous Plot Number/Name	Date	Time	Observer 1 (DGR)					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	
BMP11	BCP24 (NW Islet Plot)	26 Jul	1700	300				300					300		300
<i>Subtotal</i>	<i>6 Plots: BMP1-4, BMP10, BMP11</i>			955				965					960		963
<i>Subtotal</i>	<i>8 Plots: BMP1-6, BMP10, BMP11</i>			2,455				2,470					2,450		2,461
<b>TOTAL</b>	<b>11 Plots: BMP1-11</b>			3,935				3,955					3,910		3,934
BMP1	BCP1 (A1)	29 Jul	1519	110	110			110	105				105		108
BMP2	BCP2 (A2)	29 Jul	1525	350				350	350				350		350
BMP3	BCP3 (B)	29 Jul	1527	4				4	4				4		4
BMP4	BCP4 (C)	29 Jul	1530	100				100	100				100		100
BMP5	BCP5 (D)	29 Jul	1540	870	910			890	890				890		890
BMP6	BCP6 (E)	29 Jul	1533	920				920	960				960		940
BMP7	BCP7 (G)	29 Jul	1551	150	160			155	150				150		153
BMP8	BCP8 (H1)	29 Jul	1600	850				850	880				880		865
BMP9	BCP9 (H2)	29 Jul	1554	300				300	290				290		295
BMP10	BCP10 (I)	29 Jul	1602	101				101	102				102		102
BMP11	BCP24 (NW Islet Plot)	29 Jul	1430	400				400	410				410		405
<i>Subtotal</i>	<i>6 Plots: BMP1-4, BMP10, BMP11</i>			1,065				1,065	1,071				1,071		1,069
<i>Subtotal</i>	<i>8 Plots: BMP1-6, BMP10, BMP11</i>			2,855				2,875	2,921				2,921		2,899
<b>TOTAL</b>	<b>11 Plots: BMP1-11</b>			4,155				4,180	4,241				4,241		4,212
<i>Mean of 3 counts on 6 plots (BMP1-4, BMP10, AND BMP11)</i>									<i>Range = 963 - 1,086</i>		<i>SD = 67</i>		<i>1,039</i>		
<i>Mean of 3 counts on 8 plots (BMP1-6, BMP10, AND BMP11)</i>									<i>Range = 2,461 - 2,899</i>		<i>SD = 220</i>		<i>2,693</i>		
<b>MEAN OF 3 COUNTS ON 11 PLOTS (BMP1-11)</b>									<b>Range = 3,934 - 4,212</b>		<b>SD = 143</b>		<b>4,091</b>		