U.S. Fish & Wildlife Service

Seabird Population and Productivity Monitoring at Cape Peirce and Cape Newenham, Alaska 1990-2017

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Togiak National Wildlife Refuge
January 2018

Citation:

Hilwig, K. 2018. Seabird Population and Productivity Monitoring at Cape Peirce and Cape Newenham, Alaska, 1990-2017. U.S. Fish and Wildlife Service. Togiak National Wildlife Refuge. Dillingham, Alaska, Jan. 2018.

Keywords:

Alaska, Bering Sea, black-legged kittiwake, *Rissa tridactyla*, Cape Peirce, Cape Newenham, common murre, *Uria aalge*, pelagic cormorant, *Phalacrocorax pelagicus*, population, productivity, nesting success, seabird monitoring.

This annual progress report is a continuation of reports prepared since 1991 by multiple authors. Much of the current report uses the thoughts and words from previous authors, and should not be considered the sole work of the current author.

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Seabird Population and Productivity Monitoring at Cape Peirce and Cape Newenham, Alaska 1990-2017

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ABSTRACT

The abundance and reproductive success of black-legged kittiwakes, common murres, and pelagic cormorants was monitored annually at Cape Peirce from 1990-2014 and 2016-2017. Cape Newenham was monitored intermittently from 1990-2009. At Cape Peirce, an average of 1,104 kittiwakes (range = 238-1,606), 2,764 murres (range = 83-3962), and 93 cormorants (range = 24-123) were recorded during this period on the core plots of the colony. In 2017, an average of 238 kittiwakes, 92 murres, and 24 cormorants were counted on the core plots, which is the second lowest number of murres and the lowest number of kittiwakes and cormorants counted during the monitoring period. The overall productivity (nests with fledged chicks/total number of nests) of kittiwakes, murres, and cormorants at Cape Peirce averaged 20.2%, 34.6%, and 45.0% respectively. In 2017, productivity of kittiwakes, murres, and cormorants was 0%. Eighteen murre and 89 kittiwake eggs were observed, but subsequently failed. Cormorant chicks were observed in five nests but disappeared during the observation period. Twenty-seven years of seabird monitoring at Cape Peirce has revealed high variation in nesting adult counts and reproductive success. At Cape Newenham from 1991-2009, an average of 2,132 kittiwakes were counted annually (range = 1,676-2,424), while murres averaged 5,815 (range = 4,964-6,790), and cormorant numbers averaged 15 birds (range = 5-30).

INTRODUCTION

Eleven seabird species are known to nest in the Cape Peirce and Cape Newenham region. Of these, the black-legged kittiwake (*Rissa tridactyla*), common murre (*Uria aalge*), and pelagic cormorant (*Phalacrocorax pelagicus*) were selected for long-term monitoring, since they occupy different ecological niches, which when combined, act as a useful broad-based indicator for monitoring environmental change (Meehan et al. 1998).

Study plots were established at Cape Peirce in 1984 and at Cape Newenham in 1991. In subsequent years, new plots were added, while others were dropped or re-labeled using different numbering schemes. The most recent numbering system was established in 1990 (MacDonald and Carle 2006), and the protocol currently in use was developed by Mendenhall (1993). Since this time, the primary objectives of this study have remained the same: 1) to monitor population trends of black-legged kittiwakes, common murres, and pelagic cormorants and 2) to monitor changes in the productivity of black-legged kittiwakes, common murres, and pelagic cormorants over time. The goal of this report is to summarize the population counts and productivity data that have been collected since 1990.

STUDY AREA

Cape Peirce (N58° 33.22', W161° 46.03') and Cape Newenham (N58° 37.25', W162° 04.42') are located in Togiak National Wildlife Refuge, along the Bering Sea coast, between Kuskokwim Bay and Bristol

Bay. This remote area of rocky cliffs and rugged coves supports over a half million ledge-nesting seabirds (North Pacific Seabird Colony Register 2013), which makes it one of the largest aggregations of seabirds that nest on the Alaska mainland. Study plots at Cape Peirce were established along the sea cliffs, which extend south from the mouth of Nanvak Bay, while the plots at Cape Newenham were established along the south-facing cliffs of the Cape Newenham peninsula (Fig. 1). This region is primarily utilized by black-legged kittiwakes and common murres, which, respectively, account for approximately 20% and 60% of the seabirds that nest in the area (North Pacific Seabird Colony Register 2013). Other species which are known to nest in the area include the pelagic cormorant, red-faced cormorant (*Phalacrocorax urile*), double-crested cormorant (*Phalacrocorax auritus*), pigeon guillemot (*Cepphus columba*), glaucous-winged gull (*Larnus glaucescens*), mew gull (*Larnus canus*), parakeet auklet (*Aethia psittacula*), tufted puffin (*Fratercula cirrhata*), and horned puffin (*Fratercula corniculata*).

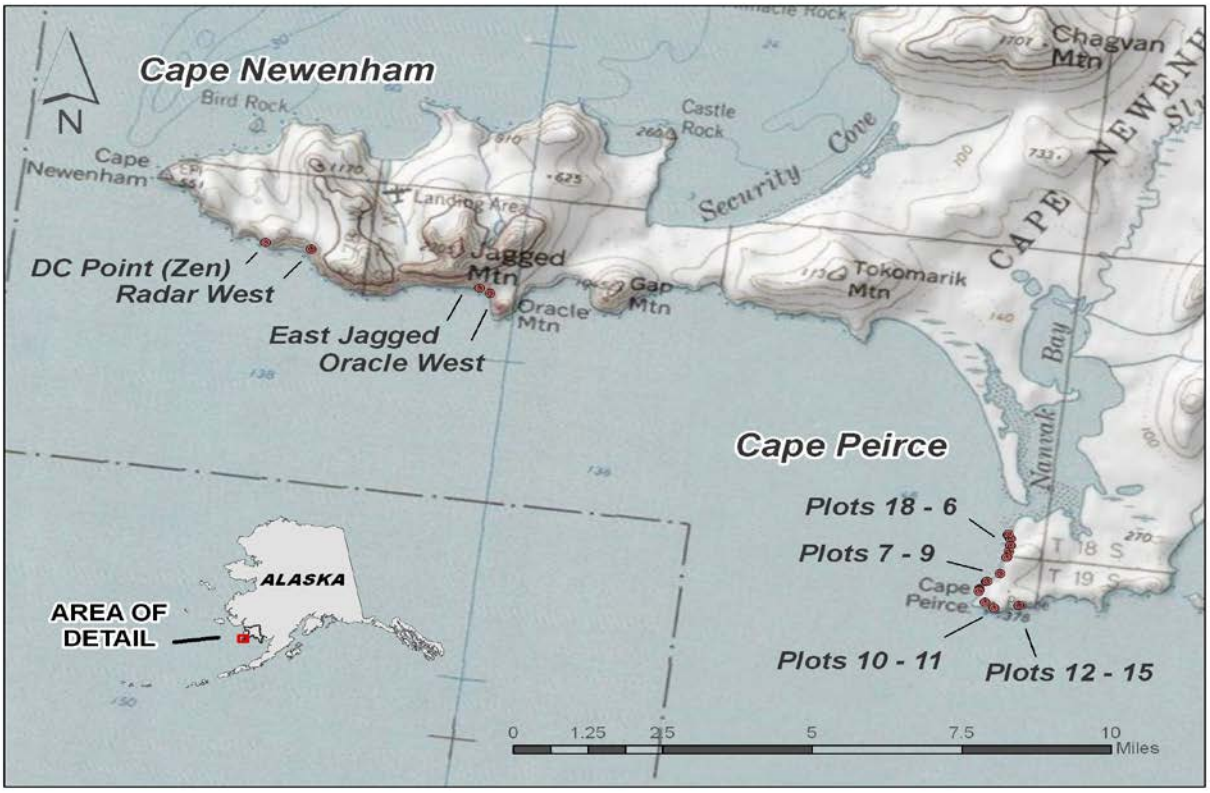

Figure 1. Location of the Cape Peirce and Cape Newenham seabird monitoring sites on Togiak National Wildlife Refuge, Alaska.

METHODS

POPULATION COUNTS

General methods for monitoring seabird populations are described in Mendenhall (1993). Populations at Cape Peirce and Cape Newenham were assessed via a series of sample plots that were established within each colony. Each plot represented a section of a cliff face that was visible from land-based observation points. A total of 38 plots were established at Cape Peirce and 16 were established at Cape Newenham. Each plot was surveyed from a pre-established observation point, which was marked with a standard surveyor's stake. Photographs were taken plot delineations to ensure they remained consistent from year to year. A summary of all observation points, including GPS locations, are contained in Appendix B.

Five to 12 replicate counts were completed annually at Cape Peirce (no counts were performed in 2015), while replicate counts were completed at Cape Newenham in 1991, 1992, and 2009. All counts were performed from 0830 - 1800 hours during the mid-incubation to early chick-rearing period, when adult attendance on the cliffs was least variable. All plots were usually counted in a single day.

During each replicate count, the number of adult kittiwakes, murres, and cormorants, as well as kittiwake and cormorant nests, were recorded for each plot. Active kittiwake and cormorant nests were defined as physical structures to which vegetation had been recently added. Nesting murres were defined as those observed in incubation or brooding postures. The number of birds and nests in each plot were counted two or more times, until the results from two consecutive counts were within 5%. The results from these two counts were then averaged and the mean was recorded. One replicate was considered the sum total from all the plots combined. Annual population indices were calculated from the average of five or more replicates in a given year. If fewer than five replicates were performed in a year, then data from that year were excluded. Changes in the population counts of kittiwakes, murres, and cormorants were evaluated over the time span of the data sets available.

PRODUCTIVITY

Seabird productivity was monitored following the methods described by Mendenhall (1993). Productivity monitoring was completed using the same plots as population monitoring. The intensity of monitoring changed over time. From 1990-2008, productivity was monitored intensively from May through September. A minimum of 25 nests per species were selected in each plot. If fewer than 25 nests were present in a plot, then all the nests were monitored. When time allowed, >25 nests per species were selected, with priority given to those plots that contained the largest number of nests. Productivity monitoring was performed less intensively starting in 2008. During this time, 25-plus nests per species were selected in each plot starting in mid-June and the status of the nests was checked every 2-3 days through approximately mid-July. Follow-up surveys (revisits) were completed in early-August, just prior to fledging, to determine the fate of each nest. Productivity values presented after 2007 represent the maximum annual productivity potential because of the two-visit sampling protocol. This is due to the assumption that a chick observed during the first visit had fledged if during the second visit no chick was observed and the known fledging date for that chick had been surpassed. This may bias productivity values presented after 2007 slightly higher because chick fledging was assumed to have occurred between visits rather than potential mortality events being directly observed. Productivity was not monitored in 2015. In 2016 and 2017, productivity plots were not revisited due to complete nesting failure. Productivity

data from Cape Newenham were compiled from reports by Haggblom (1992), Haggblom (1994), Haggblom and Moran (1994), and Haggblom (1997).

The following reproductive parameters were calculated by plot for kittiwakes and cormorants, and then averaged across the colony:

$$\text{Laying success} = \frac{(\text{nest sites w/ eggs})}{(\text{total nest starts})}, \qquad \text{Clutch size} = \frac{(\text{total eggs})}{(\text{nest sites w/ eggs})},$$

$$\text{Nesting success} = \frac{(\text{nest sites w/ chicks})}{(\text{nest sites w/ eggs})}, \qquad \text{Hatching success} = \frac{(\text{total chicks})}{(\text{total eggs})},$$

$$\text{Chick success} = \frac{(\text{total chicks fledged})}{(\text{total chicks})}, \qquad \text{Egg success} = \frac{(\text{total chicks fledged})}{(\text{total eggs})},$$

$$\text{Fledging success} = \frac{(\text{nests w/ fledged chicks})}{(\text{nest sites w/ chicks})}, \qquad \text{Reproductive success} = \frac{(\text{nests w/ fledged chicks})}{(\text{nest sites w/ eggs})},$$

$$\text{Fledglings / nest starts} = \frac{(\text{total chicks fledged})}{(\text{total nest starts})}, \qquad \text{Overall productivity} = \frac{(\text{nests w/ fledged chicks})}{(\text{total nest starts})}.$$

To assess the relative importance of egg loss, chick loss, and laying failure in limiting the annual productivity of kittiwakes and murres, the following parameters were also calculated:

$$\text{Egg loss} = \frac{(\text{nest sites w/ eggs - nest sites w/ chicks})}{(\text{total nest starts})},$$

$$\text{Chick loss} = \frac{(\text{nest sites w/ chicks - nest sites w/ fledged chicks})}{(\text{total nest starts})},$$

$$\text{Laying failure} = \frac{(\text{total nest starts - nest sites w/ eggs})}{(\text{total nest starts})}.$$

Incubation and brooding postures of murres were used to determine the presence of eggs and chicks (Williams and Byrd 1992). Because murre incubation posture was difficult to interpret, a breeding bird was not assumed to have an egg until it displayed incubation posture for at least one hour on three consecutive visits. Since brooding posture is more distinctive than incubation posture, a single nest check with an adult displaying brooding posture is considered sufficient to determine the presence of a murre chick. Three reproductive parameters were calculated for murres: hatching success (% of eggs laid that hatched), fledging success (% of nests with hatched chicks that fledged), and reproductive success (% active nests that fledged chicks). The following reproductive parameters were calculated annually by plot and then averaged across the colony:

$$\text{Hatching success} = \frac{(\text{nest sites w/ a chick})}{(\text{nest sites w/ an egg})}, \qquad \text{Fledging success} = \frac{(\text{nests w/ a fledged chick})}{(\text{nest sites w/ a chick})},$$

$$\text{Reproductive success} = \frac{(\text{nests w/ a fledged chick})}{(\text{nest sites w/ an egg})}.$$

Finally, the proportion of active murre nests that ended in egg loss, chick loss, or loss due to some unknown cause were calculated as follows:

$$\text{Egg loss} = \frac{(\text{nest sites w/ an egg - nest sites w/ a chick})}{(\text{nest sites w/ an egg})},$$

$$\text{Chick loss} = \frac{(\text{nest sites w/ a chick - nest sites w/ a fledged chick})}{(\text{nest sites w/ an egg})},$$

$$\text{Unknown loss} = 1 - \left(\frac{\text{nest sites w/ a fledged chick}}{\text{nest sites w/ an egg}} \right).$$

Annual egg laying, chick hatching, and chick fledging dates were calculated as the midpoint between when the event was first observed and the previous nest check. If an even number of days had passed between nest checks, the closest even Julian date was used. If actual hatching and fledging events were observed, the date of the observation was used. Using methods described by Hunt et al. (1981), black-legged kittiwakes were assumed to have a 26-day incubation period, with chicks fledging after 36 days. Pelagic cormorants were assumed to have an incubation period of 30 days, with chicks fledging at 48 days. Common murres were assumed to have a 32-day incubation period and the chicks were considered to have fledged if they were at least 15 days old (Byrd 1989). Mean laying, hatching and fledging dates presented for 1995-1997 were compiled from Haggblom 1996a, 1996b, and 1997. First laying date during this period was calculated using observed first hatching and subtracting the incubation period for each species listed above.

RESULTS AND DISCUSSION

POPULATION COUNTS

Black-legged Kittiwakes

Cape Peirce: Black-legged kittiwake adults were counted annually on 38 plots within the Cape Peirce colony from 1990-2008. Beginning in 2009, counts were only conducted on the core plots, which excluded plots 12-15 (Fig. 2). Plots were not counted in 2015. In 2017, the mean kittiwake count (238 ± 163 SD (standard deviation)) on the core plots was the lowest number observed during monitoring. The second lowest count was in 2006 (423 ± 120 SD) and the third lowest was in 2016 (546 ±347 SD). The long-term average kittiwake count from 1990-2017 on the core plots was 1,104 birds with a range of 238-

1,906 birds. The count data is summarized in Appendix A (Table 1), while Table 4 in the appendix summarizes the mean number of birds recorded by plot location.

Cape Newenham: Black-legged kittiwakes were counted on 16 plots at Cape Newenham in 1991, 1992, 1993, and 2009 (Fig. 3). The mean number of kittiwakes that were counted annually during this period averaged 2,132 birds (range = 1,676-2,424; Table 7, Appendix A).

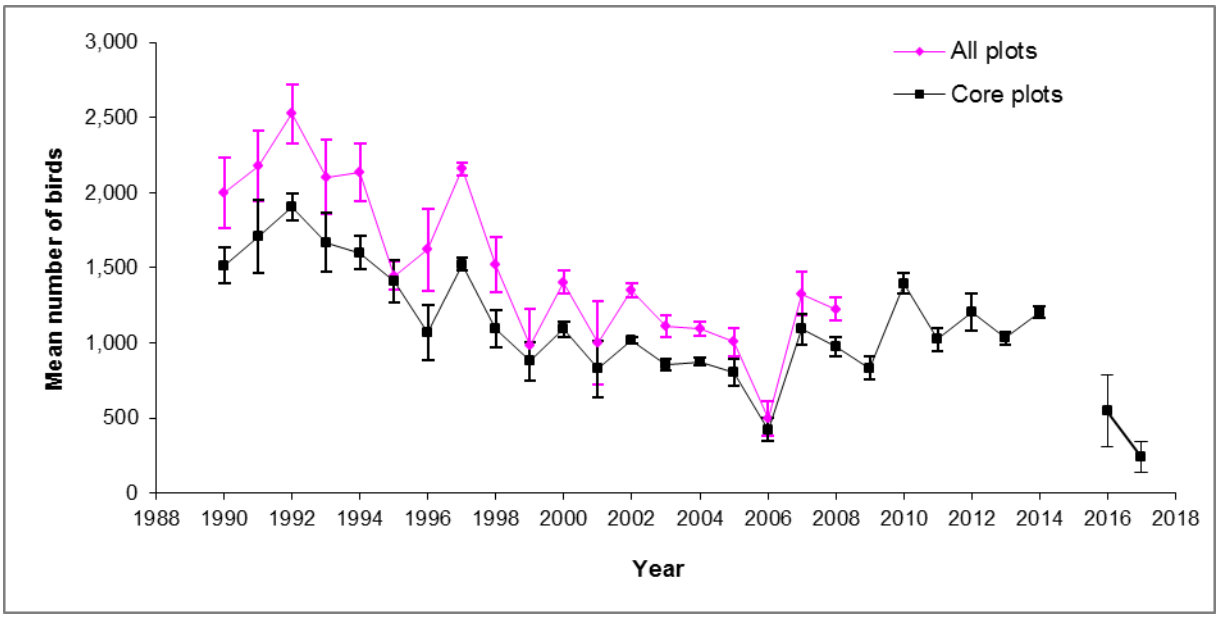

Figure 2. Mean number of black-legged kittiwakes counted on all plots, and a subset of core plots (excluding plots 12-15), at Cape Peirce, Alaska, 1990-2017. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

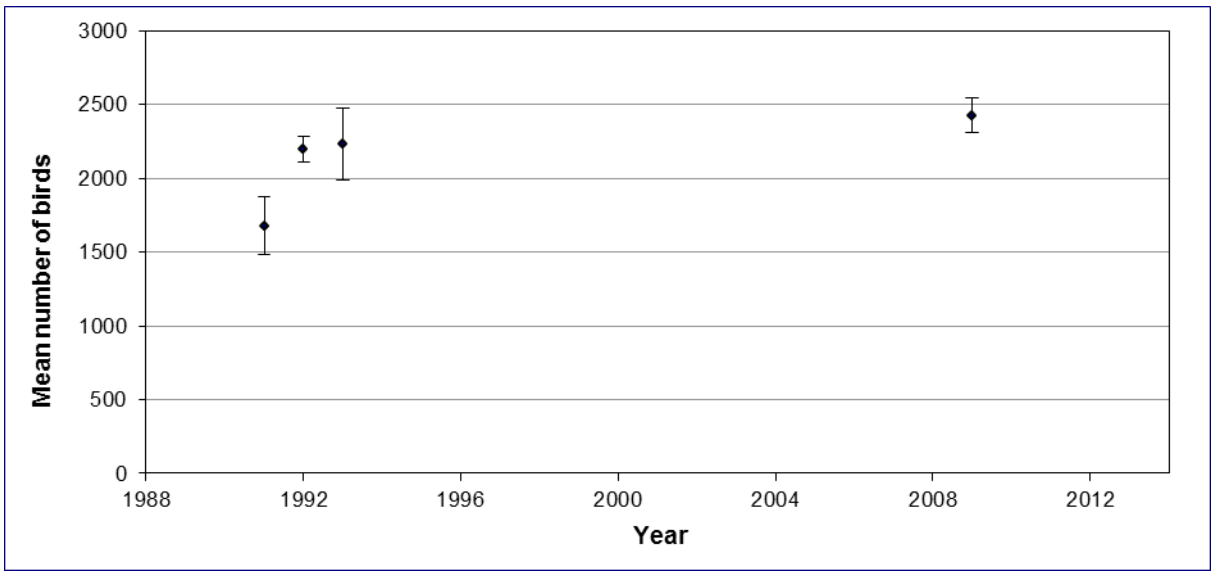

Figure 3. Mean number of black-legged kittiwakes counted at Cape Newenham, Alaska, 1991-2009. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

Common Murres

Cape Peirce: From 1990-2008, common murres were counted on 38 plots within the Cape Peirce colony; however, beginning in 2009, counts were only completed on the core plots, (plots 1-11 and 18) (Fig. 4). Plots were not counted in 2015. In 2017, the mean murre count (92 ± 141 SD) on the core plots was the second lowest number observed during monitoring. The lowest count was in 2016 (83 ± 152 SD) and the third lowest was in 2015 (1,680 ± 250 SD). The long-term average murre count is 2,764 birds (range = 83-4,563). A summary of the annual count data is contained in Appendix A, Table 2. Table 5 (Appendix A) summarizes the mean number of birds that were recorded by plot location.

Cape Newenham: Replicate counts for common murres were completed at Cape Newenham in 1991, 1992, 1993, and 2009 (Fig. 5). During this time, the mean number of birds averaged 5,815 (range = 4,964-6,790; Table 8, Appendix A).

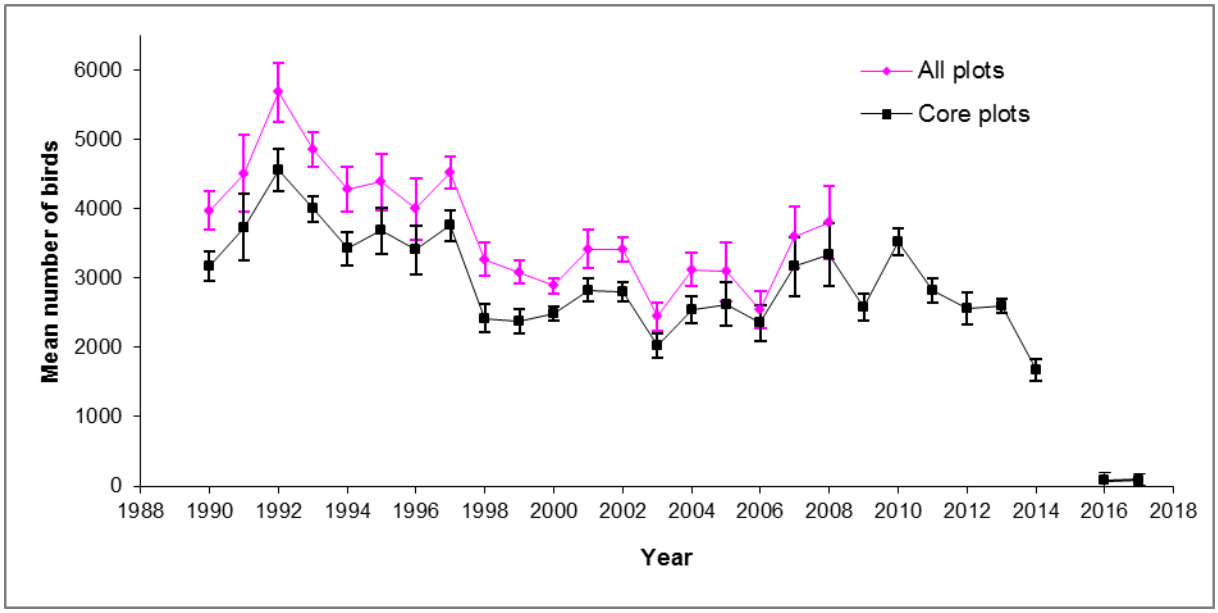

Figure 4. Mean number of common murres counted on all plots and a subset of core plots (excluding plots 12-15) at Cape Peirce, Alaska, 1990-2017. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

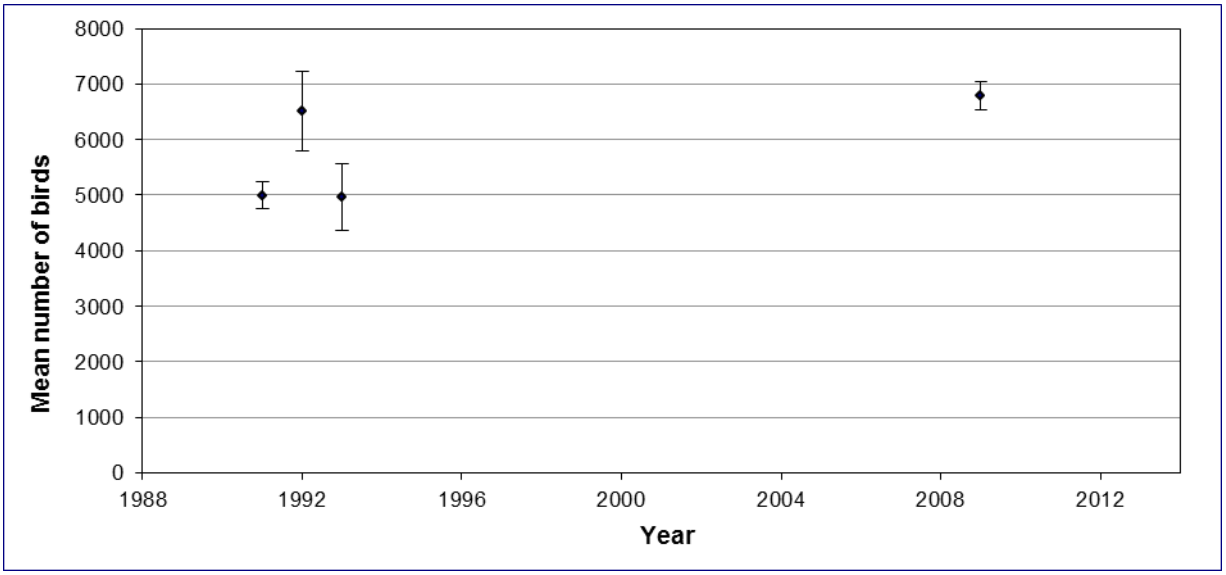

Figure 5. Mean number of common murres counted at Cape Newenham, Alaska, 1991-2009. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

Pelagic Cormorants

Cape Peirce: Pelagic cormorants were counted on 38 plots within the Cape Peirce colony, except from 2009-2017, when replicate counts were only completed on the core plots (Fig. 4). Plots were not counted in 2015. In 2017, the mean cormorant count (24 ± 9 SD) was the lowest number observed during monitoring. The second lowest count was in 2016 (31 ± 12 SD) and the third lowest was in 2005 (48 ± 8 SD). The average count of birds recorded in the core plots from 1990-2017 is 93 (range = 31-149). Appendix A contains a summary of all annual counts (Table 3) including the mean number of birds recorded by plot location (Table 6).

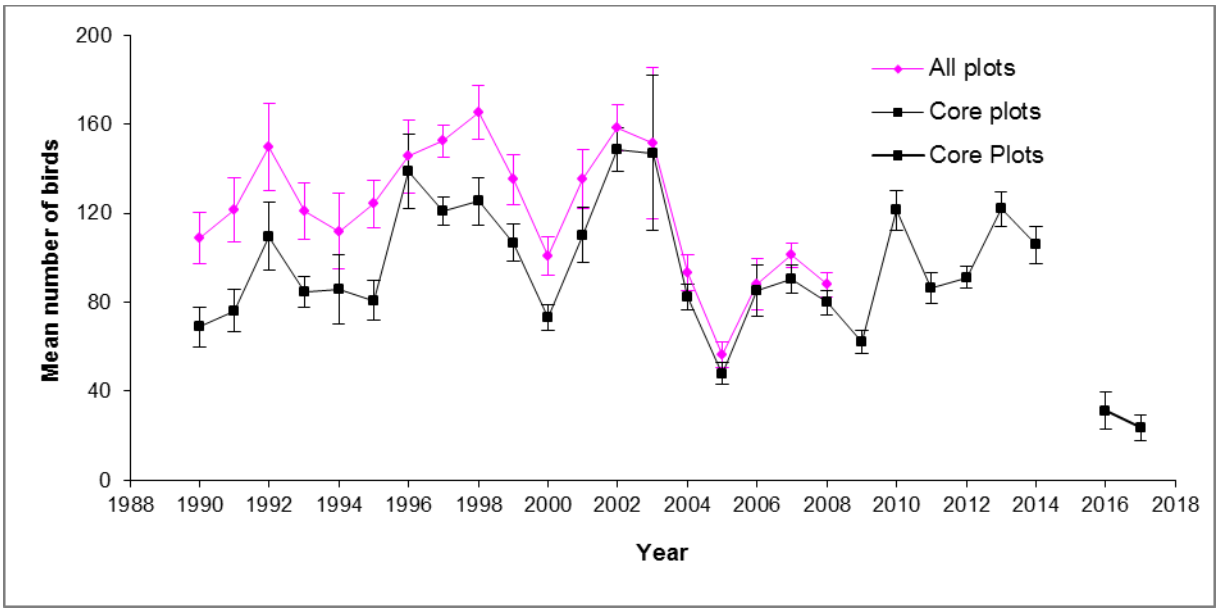

Figure 6. Mean number of pelagic cormorants counted on all plots and a subset of core plots (excluding plots 12-15) at Cape Peirce, Alaska, 1990-2017. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

Cape Newenham: Replicate counts were completed for pelagic cormorants at Cape Newenham in 1991, 1992, and 2009 (Fig. 7), with an average of 15 birds recorded per year (range = 5-30). The mean number of birds counted annual are summarized by plot location in Appendix A (Table 9).

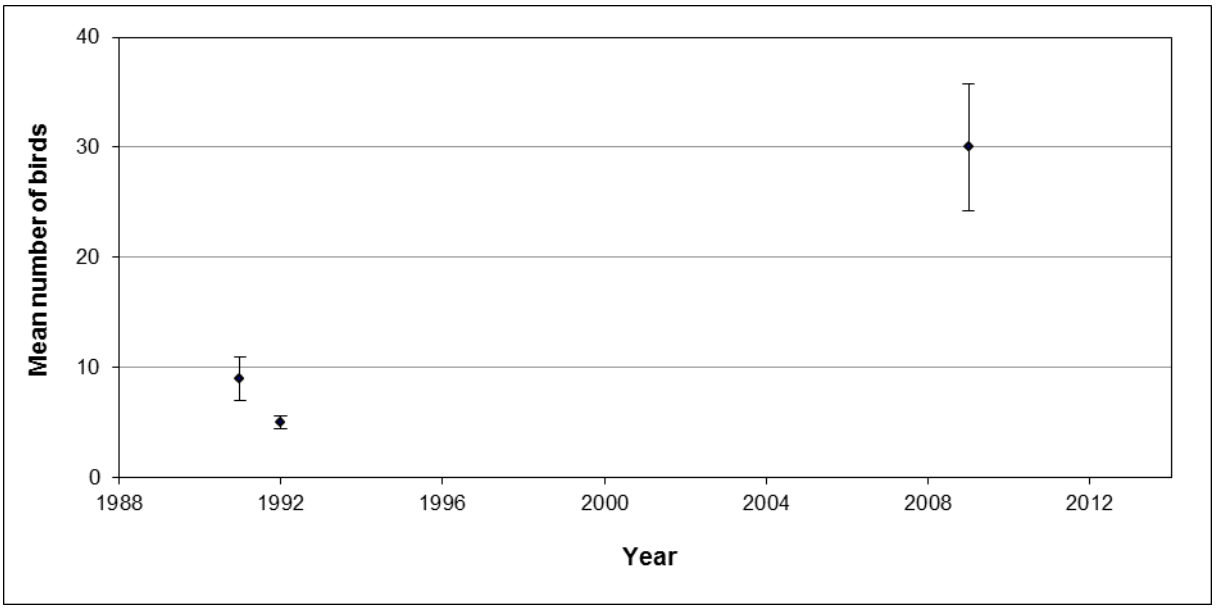

Figure 7. Mean number of pelagic cormorants counted at Cape Newenham, Alaska, 1991-2009. Counts represent the average of multiple replicate surveys bounded by 95% confidence intervals.

PRODUCTIVITY MONITORING

Black-legged Kittiwakes

Cape Peirce: The relative importance of egg loss, chick loss, and laying failure in determining the overall reproductive performance of black-legged kittiwakes at Cape Peirce varied greatly since 1990 (Fig. 8). In 2017, the overall productivity (the proportion of nests with fledged chicks to total nest starts) of kittiwakes was 0%, with laying failure of 53% and, egg failure of 47%. Complete reproductive failure also occurred in 1999, 2001, 2006, and 2016. In 2017, a total of 147 nest starts, 89 eggs, and no chicks were observed in 6 of the core plots and no follow up surveys were conducted. The average kittiwake laying success, egg success, and chick success from 1990-2007 was 63.8%, 76.4%, and 84.4% respectively. All productivity data have been summarized in Appendix A, including data on breeding chronology (Table 10), breeding performance (Table 13), and productivity by plot location (Table 16).

Cape Newenham: Productivity monitoring was completed at Cape Newenham from 1991-1997, during which time productivity averaged 33.9% (range = 9.4-58.5%).

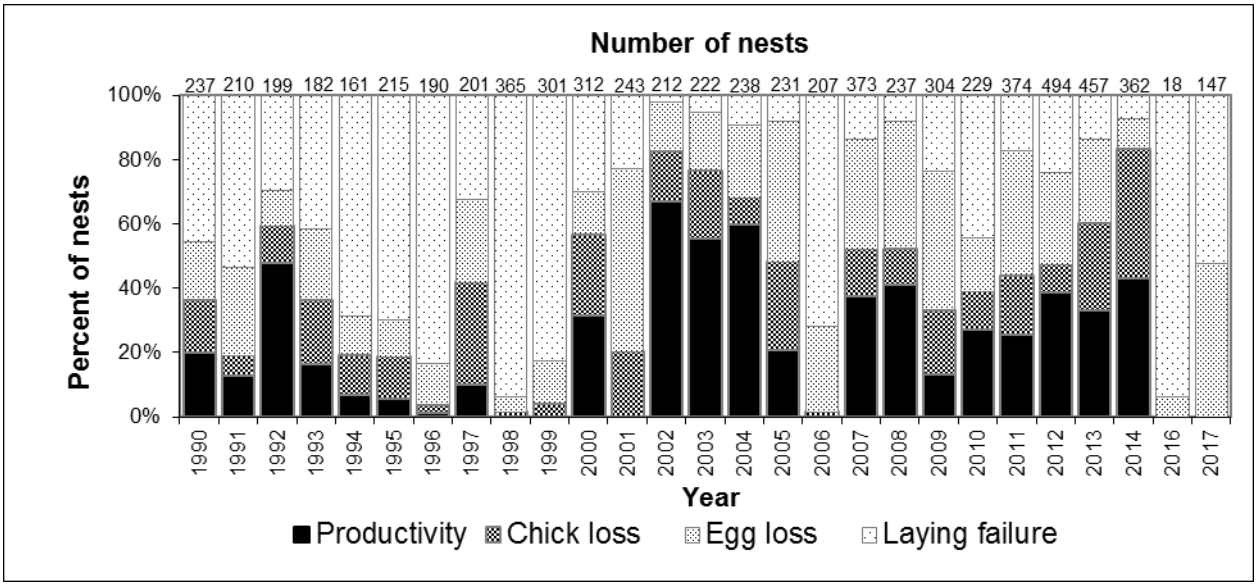

Figure 8. Reproductive performance of black-legged kittiwakes at Cape Peirce, Alaska, 1990-2017. Productivity is the proportion of nests with fledged chicks to total nest starts.

Common Murres

Cape Peirce: The annual reproductive performance of common murres has been variable since 1990, as rates of egg success and chick success have fluctuated over time (Fig. 9). Reproductive success is the proportion of fledged murre chicks to the number of eggs or incubation postures observed. In 2017, complete reproductive failure in common murres was observed at Cape Peirce. In 2016, no murres were observed in incubation or brooding postures. However, in 2017, 18 eggs were observed in three plots, though all eggs failed. Several times during productivity monitoring, murres on the plots would flush and

a single murre remained on the cliff. This bird often had an egg. The lone incubating murre would soon flush and we observed egg predation by common ravens (*Corvus corax*) nearly immediately in seven of the 18 eggs observed in this manner. Murres that remained on their egg after plot observations ended were then found to be absent the following day and no egg could be found. No follow up surveys were conducted to assess productivity. The average long-term reproductive success rate of murres at on the core plots since 1990 was 41.2% (range = 18.4-63.9%; excluding 2016 and 2017 data). Historically, an average of 56.6% of eggs that were laid successfully hatched and 85.8% of chicks that were hatched successfully fledged (average hatching and fledging success from 1990-2007). Due to a change in protocol after 2008, nesting failure observations were noted as unknown loss (Fig. 9). The annual productivity data for common murres has been summarized in Appendix A, including data on breeding chronology (Table 11), breeding performance (Table 14), and productivity by plot location (Table 17).

Cape Newenham: Intensive monitoring was completed at Cape Newenham in 1992, 1993, 1996, and 1997, when productivity at the site averaged 44.2% among years (range = 14.3-64.0%).

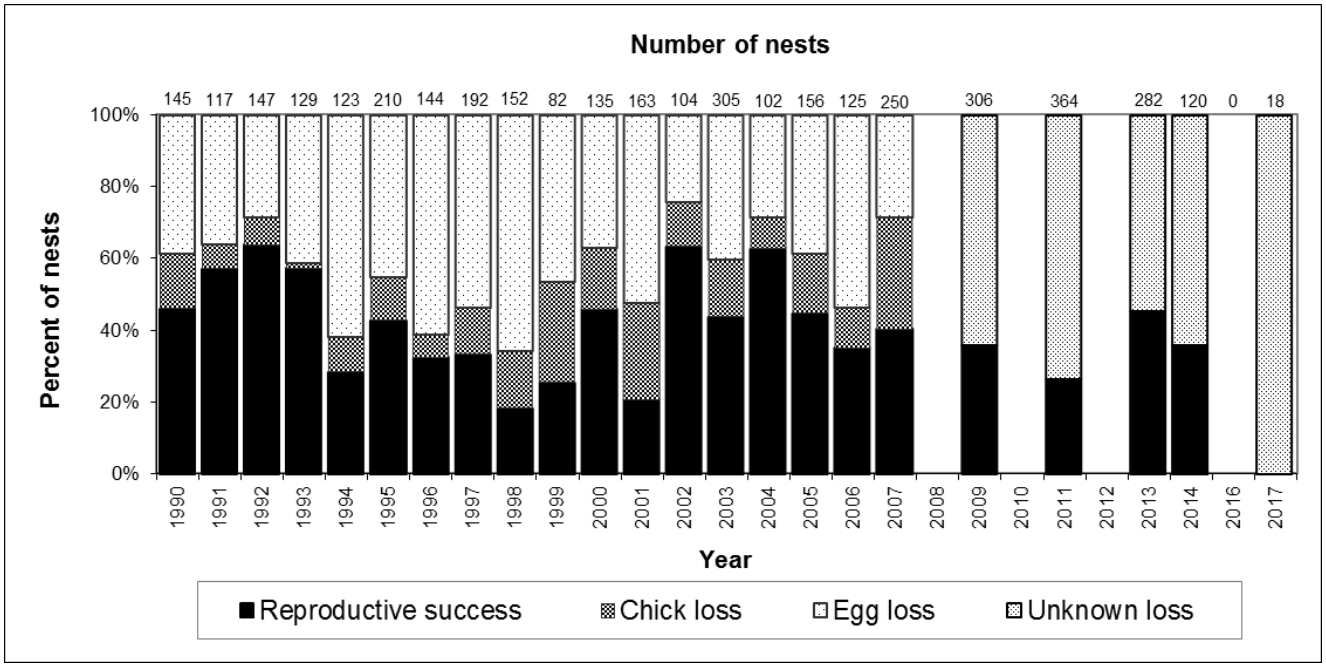

Figure 9. Reproductive performance of common murres at Cape Peirce, Alaska, 1990-2017. Reproductive success is the proportion of fledged murre chicks to the number of eggs or incubation postures observed. No murres were observed in incubation or brooding postures in 2016. Due to a change in protocol after 2008, nesting failure observations were noted as unknown loss.

Pelagic Cormorants

Cape Peirce: Pelagic cormorants experienced variable productivity rates from 1990-2014, with egg loss, chick loss, and laying failure fluctuating over time (Fig. 10). Productivity is the proportion of nests with fledged chicks to the total nest starts. In 2017, five cormorant nests were observed in one plot. All chicks disappeared during the observation period. This represents the first time complete reproductive failure has been observed at Cape Peirce during monitoring. The second lowest productivity observation occurred in 2005 (17.9%). Bald eagles (*Haliaeetus leucocephalus*) from a nearby nest, were observed taking

cormorant chicks out of the nests on three occasions. No follow up surveys were conducted. The long-term average productivity of this species is 53.2% (range = 17.9% - 83.1%), and long term average laying success, egg success, and chick success rates 77.4%, 87.1%, and 88.8% respectively from 1990-2014, excluding 2016 and 2017 data. Results of annual productivity monitoring are contained in Appendix A, including data on breeding chronology (Table 12), breeding performance (Table 15), and productivity by plot location (Table 18).

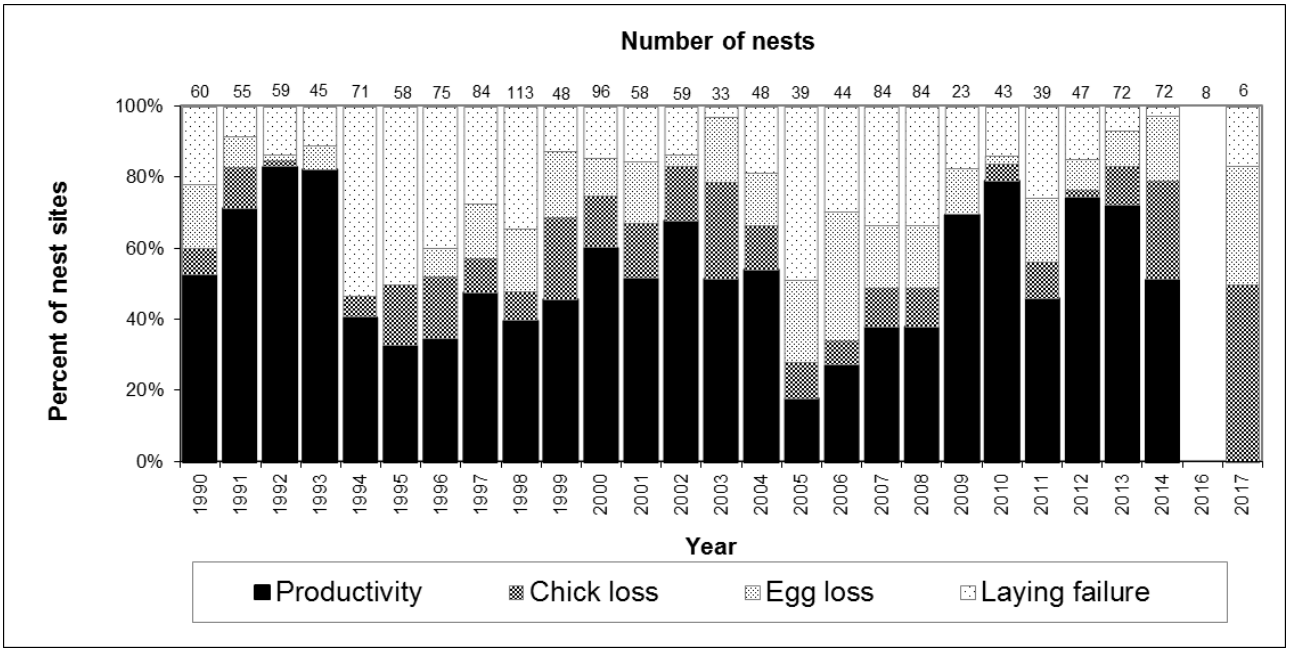

Figure 10. Reproductive performance of pelagic cormorants at Cape Peirce, Alaska, 1990-2017. Productivity is the proportion of nests with fledged chicks to total nest starts. In 2016, eight nests were observed, however productivity and nest fate were not observed. In 2017, all chicks disappeared during the observation period.

POPULATION AND PRODUCTIVITY PATTERNS AT CAPE PEIRCE

Given the few years of data collection at Cape Newenham, discussion of demographic patterns will be restricted to Cape Peirce alone.

Black-legged Kittiwakes

Population and productivity numbers in 2016 and 2017 were the lowest observed since the initiation of the seabird monitoring program at Cape Peirce. Productivity is the proportion of nests with fledged chicks to total nest starts. Black-legged kittiwakes, in 2017 exhibited complete laying failure with 147 potential nest starts, 89 eggs, and complete egg failure being observed. Kittiwakes have experienced productivity ≤ 0.1 in 10 of 25 years of sampling, including six consecutive years from 1994-1999. There have been several other average overall productivity periods ≤ 0.1 including 1994-1999, 2001, 2006, 2016 and 2017 (Fig. 11). No relationship was observed between mean annual population counts and average annual overall productivity ($R^2 = 0.03$, P=0.41; Fig. 12).

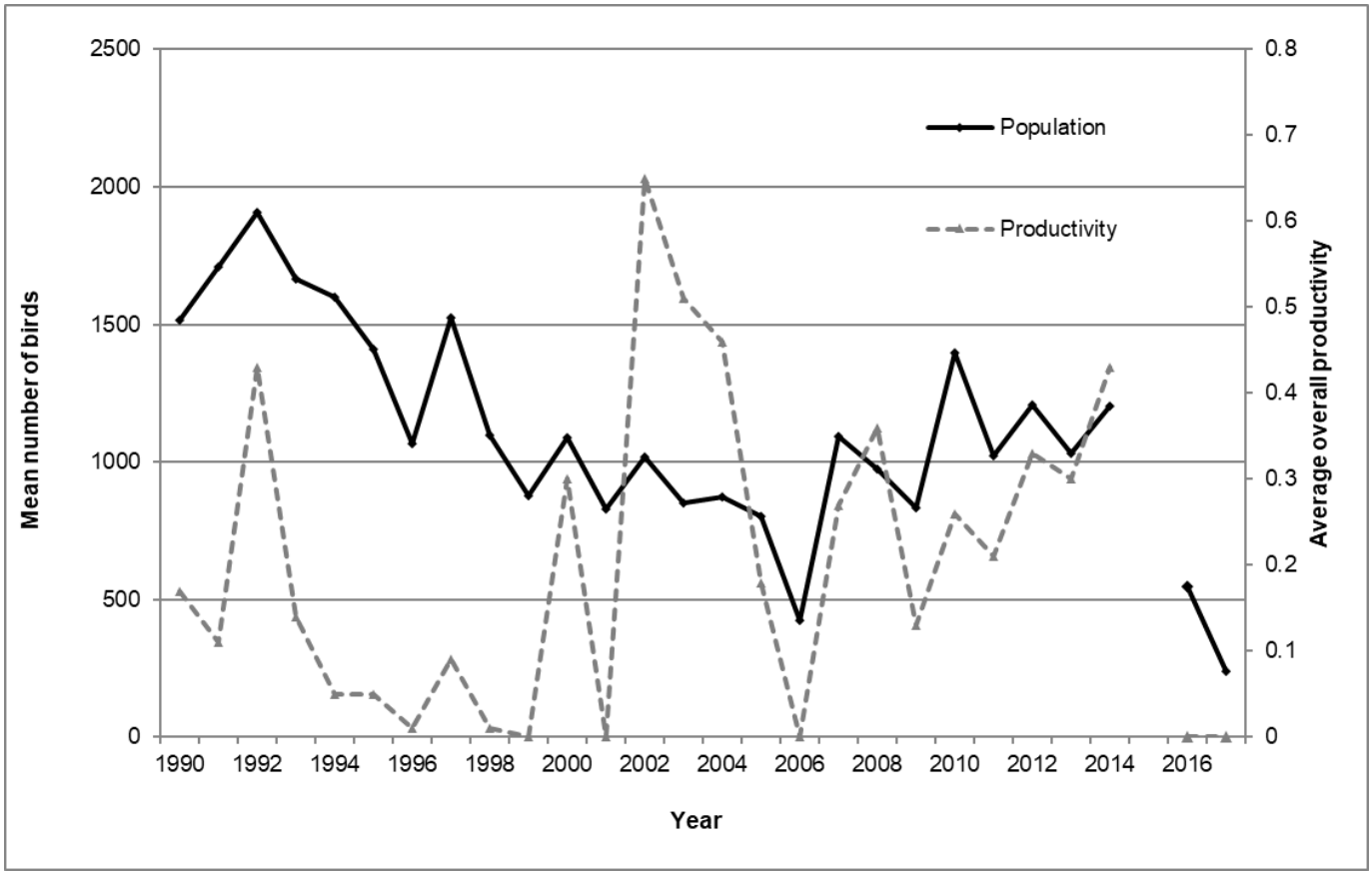

Figure 11. Annual population and productivity of black-legged kittiwakes on core plots at Cape Peirce, Alaska, 1990-2017. Overall productivity is the proportion of nests with fledged chicks to the total nest starts.

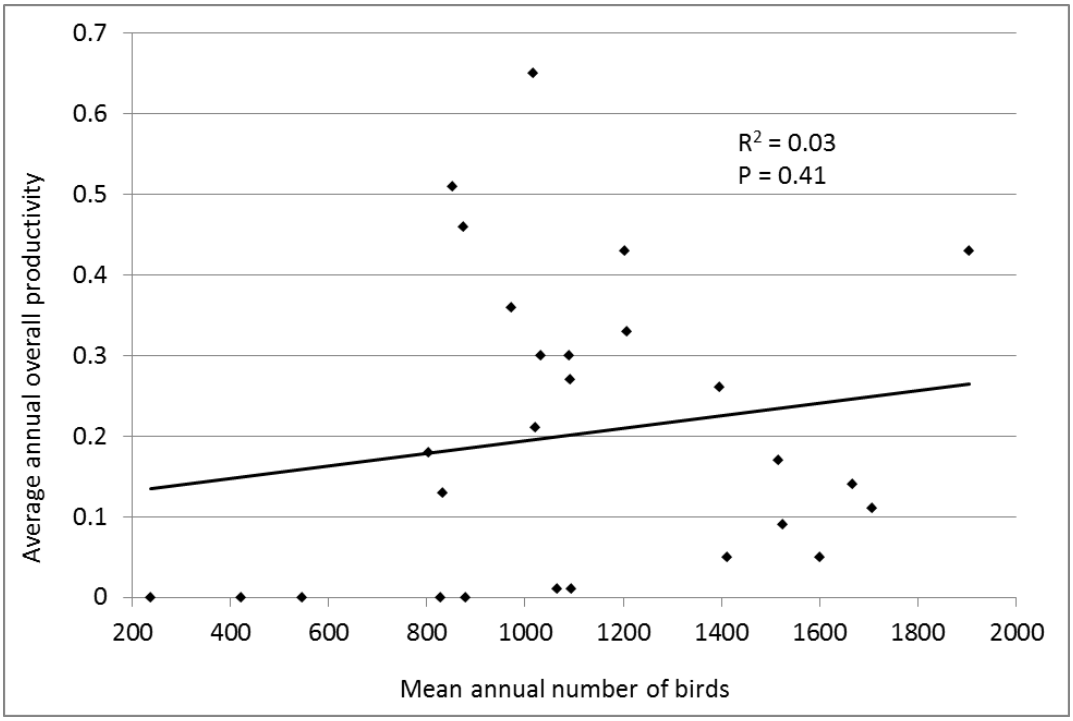

Figure 12. Regression of mean annual number of black-legged kittiwakes and mean annual overall productivity on core plots at Cape Peirce, Alaska, 1990-2017. Overall productivity is the proportion of nests with fledged chicks to the total nest starts.

Common Murres

The population count and reproductive success of common murres at Cape Peirce in 2017 was the lowest observed since the initiation of the seabird monitoring program. Birds were observed on the nesting ledges but flushed frequently. Eighteen eggs were observed as compared to zero in 2016. Prior to 2016 and 2017, murre reproductive success less than 0.20 was observed in 1998 and 2011 (Fig. 13). Reproductive success is the proportion of fledged murre chicks to the number of eggs or incubation postures observed. Peaks in murre reproductive success were observed in 1991 and 1992 concurrent with peaks in the population counts. However, another peak in reproductive success was observed in 2002 despite a population count less than 2800 (Fig. 13). A significant positive correlation between of mean annual number of common murres and mean annual reproductive success was observed (R^2 =0.52, P<0.01; Fig. 14).

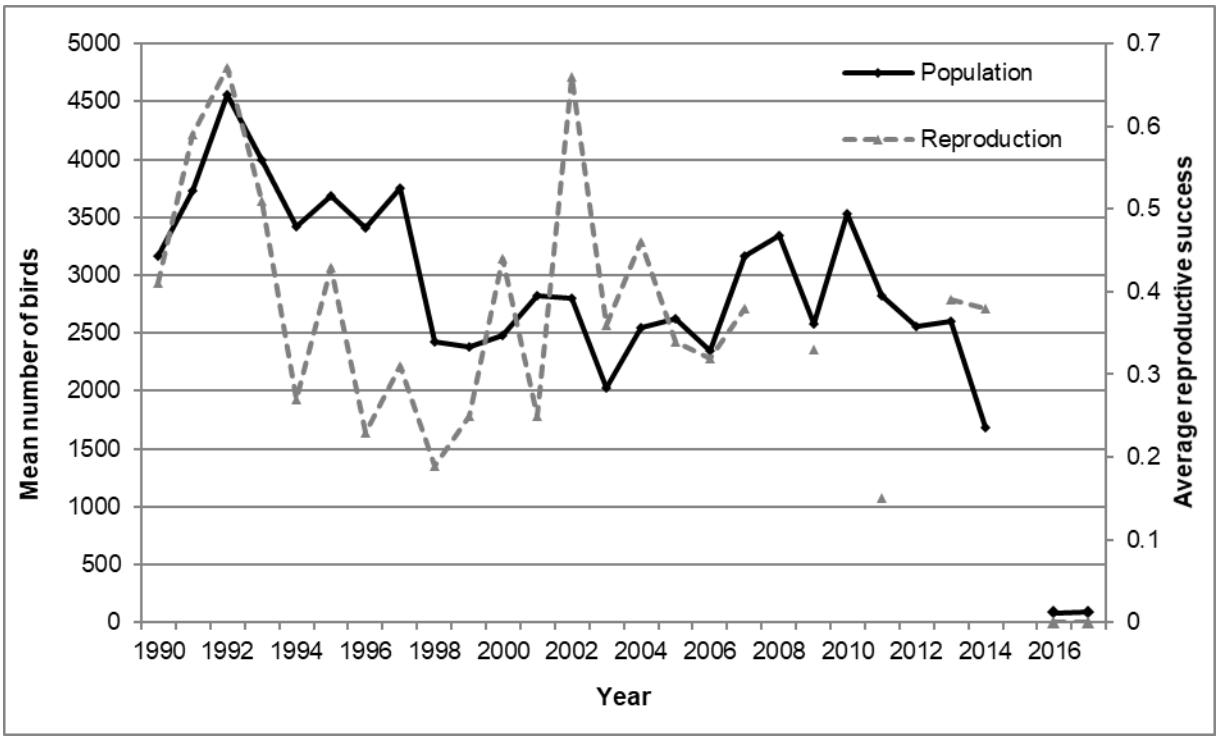

Figure 13. Annual population and reproductive success of common murres on core plots at Cape Peirce, Alaska, 1990-2017. Reproductive success is the proportion of fledged murre chicks to the number of eggs or incubation postures observed.

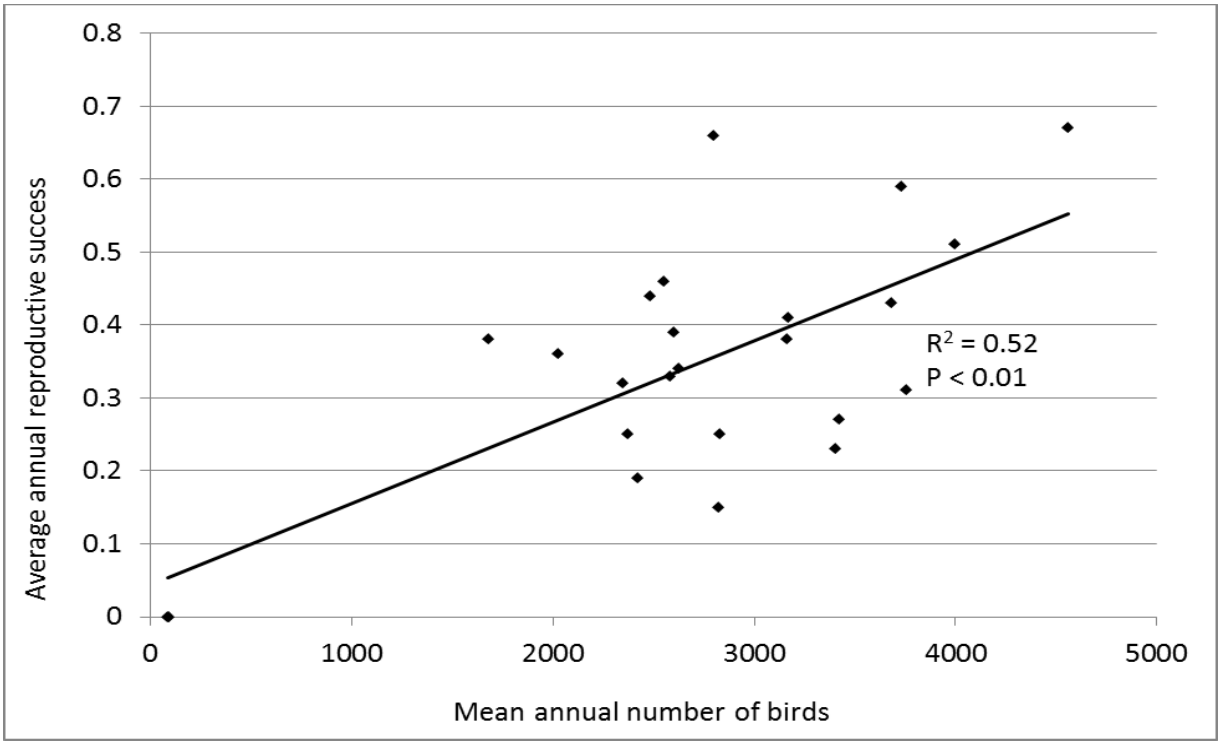

Figure 14. Regression of mean annual number of common murres and mean annual reproductive success on core plots at Cape Peirce, Alaska, 1990-2017. Reproductive success is the proportion of fledged murre chicks to the number of eggs or incubation postures observed.

Pelagic Cormorants

The pelagic cormorant population count and productivity in 2017 was the lowest observed since the initiation of the seabird monitoring program at Cape Peirce (Fig. 10). However, cormorant population counts and productivity have fluctuated since the beginning of the seabird monitoring program. Overall productivity is the proportion of nests with fledged chicks to the total nest starts. Several productivity periods ≤ 0.3 have been observed from 1995, 1996, 2005, 2006, 2008 and 2011 (Fig. 15). Population counts over 120 birds were observed to occur concurrent with both the productivity periods ≤ 0.3 from 1995-1996 and also periods of productivity >0.70 observed in 2002 and 2010 (Fig. 15). Cormorant productivity >0.70 was observed in 1991-1993, 2002, 2010, and 2013. A significant positive correlation between of mean annual number of cormorants and mean annual overall productivity was observed (R^2 =0.27, P=0.01; Fig. 16).

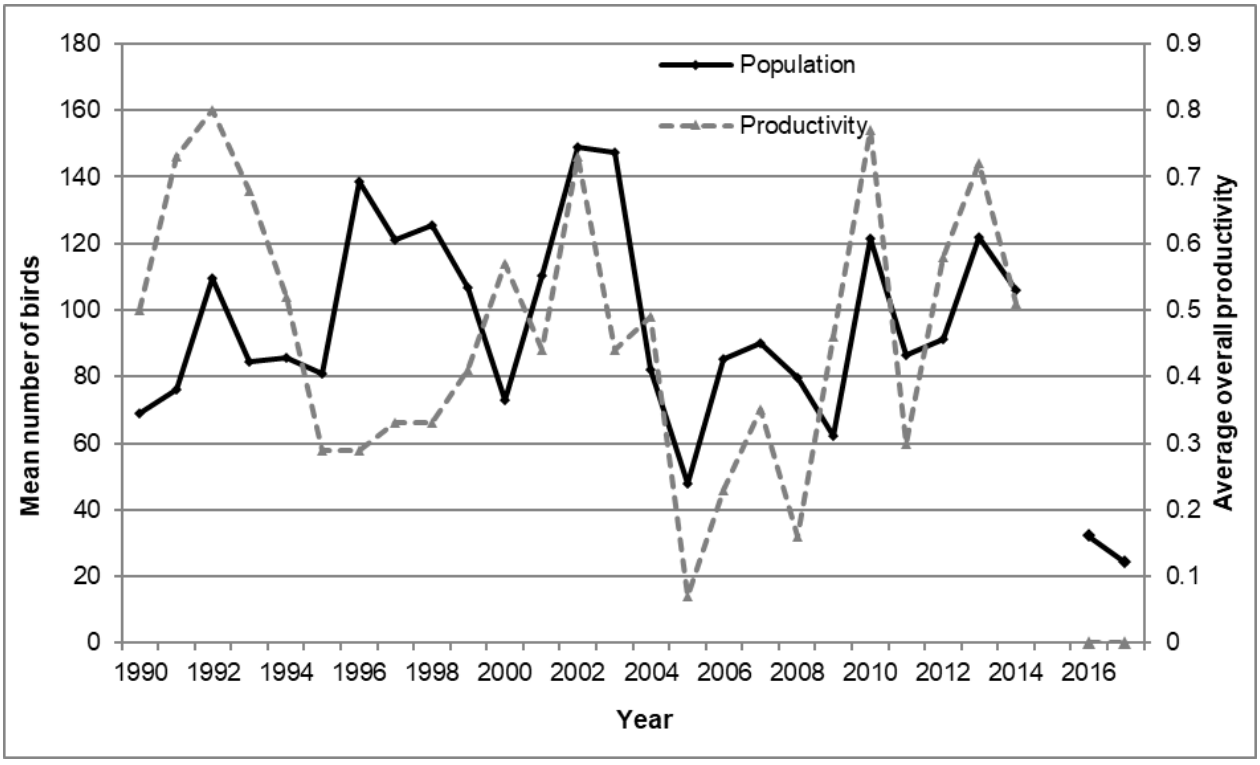

Figure 15. Annual population and productivity of pelagic cormorants on core plots at Cape Peirce, Alaska, 1990-2017. Overall productivity is the proportion of nests with fledged chicks to total nest starts.

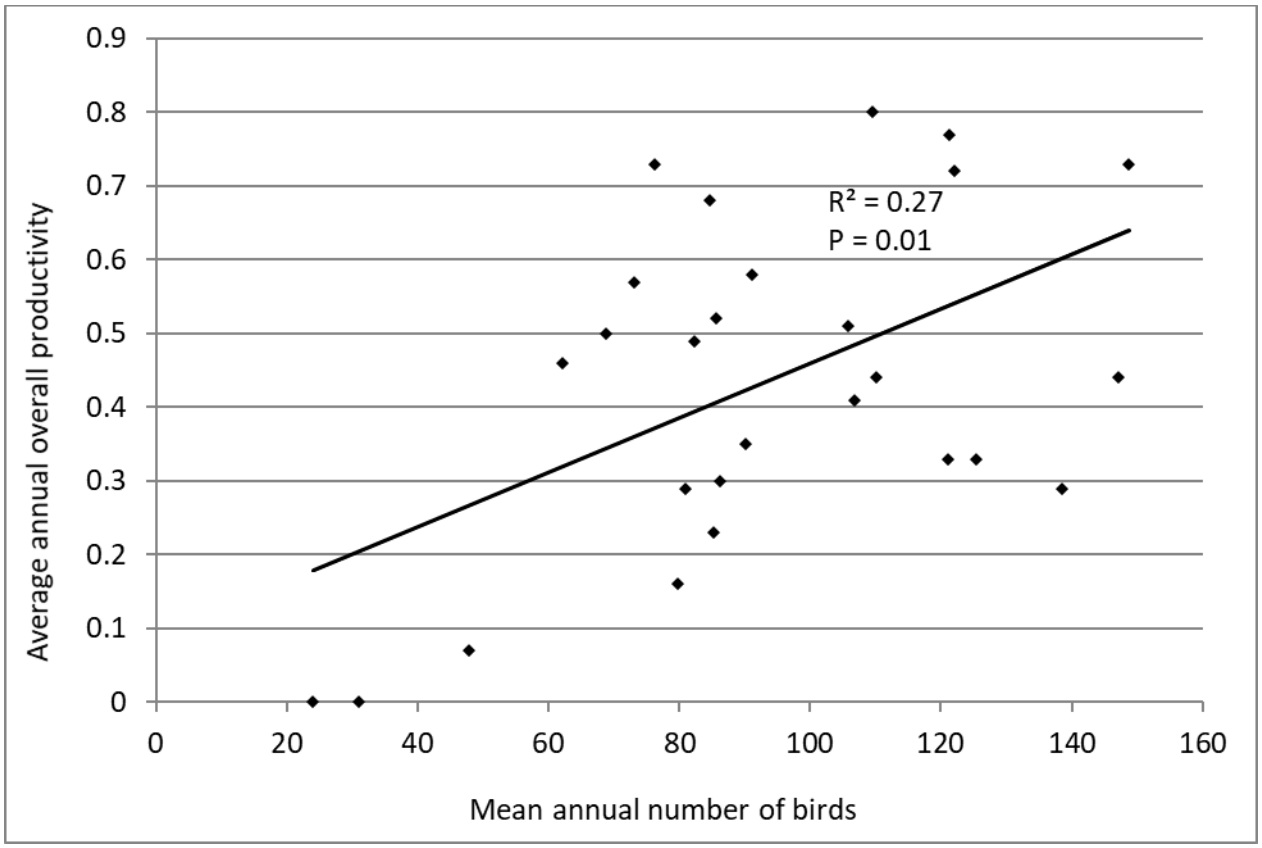

Figure 16. Regression of mean annual number of pelagic cormorants and mean annual overall productivity on core plots at Cape Peirce, Alaska, 1990-2017. Overall productivity is the proportion of nests with fledged chicks to the total nest starts.

THE SUITE OF SEABIRDS AT CAPE PEIRCE

Twenty-seven years of observations have revealed patterns in the seabirds monitored at Cape Peirce. All three species of seabirds monitored at Cape Peirce have concurrently experienced above and below average years. For example, 1992 was a relatively good year for seabird numbers. Kittiwake population counts were 64% above the mean population count from 1990-2016 (Fig. 17). Murre numbers were 53% above average and cormorant numbers were 12% above average. Other years with above average population counts for all three species include 1997 and 2010. In 2016 and 2017, population counts for all three species were below average. Other years in which all three species exhibited below average counts were 2000, 2004-2006, 2009 and 2011 (Fig. 17).

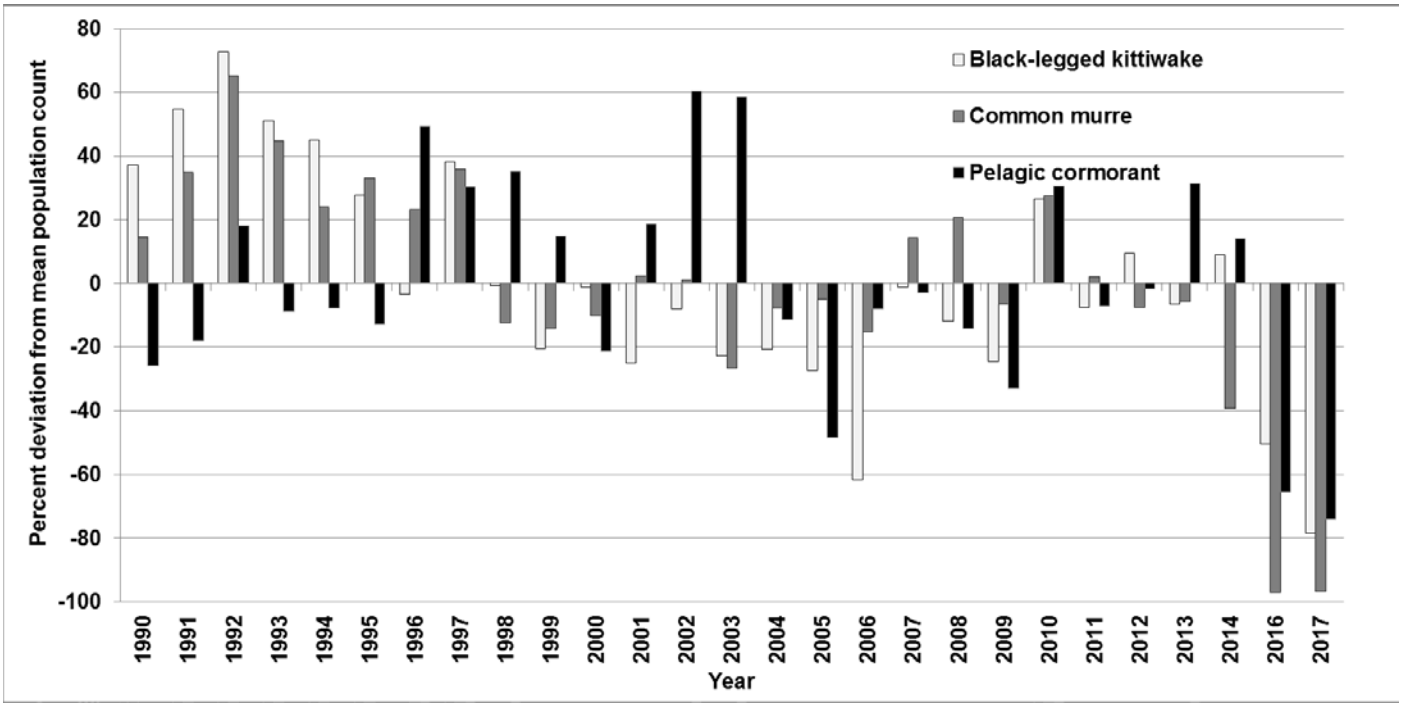

Figure 17. Annual population counts compared to the overall mean population counts of three seabird species monitored at Cape Peirce, Alaska, 1990-2017. Data were compiled from core plots.

The suite of seabirds at Cape Peirce has also experienced good reproductive years. For example, reproductive success of all three species in 1992 was above average (kittiwakes 105%, murres 85% and cormorants 70% above average; Fig. 18). Since 1990, kittiwake productivity has varied widely with peaks of reproductive success 210% higher than average (2002) and lows approaching -100% below average (1996, 1998, 1999, 2001, 2006, 2016). Reproductive success of kittiwakes was below average (< -50%) in 9 of 25 years, with cormorants and murres experiencing reproductive success less than 50% of average less frequently (3 and 2 of 25 years respectively; Fig. 18).

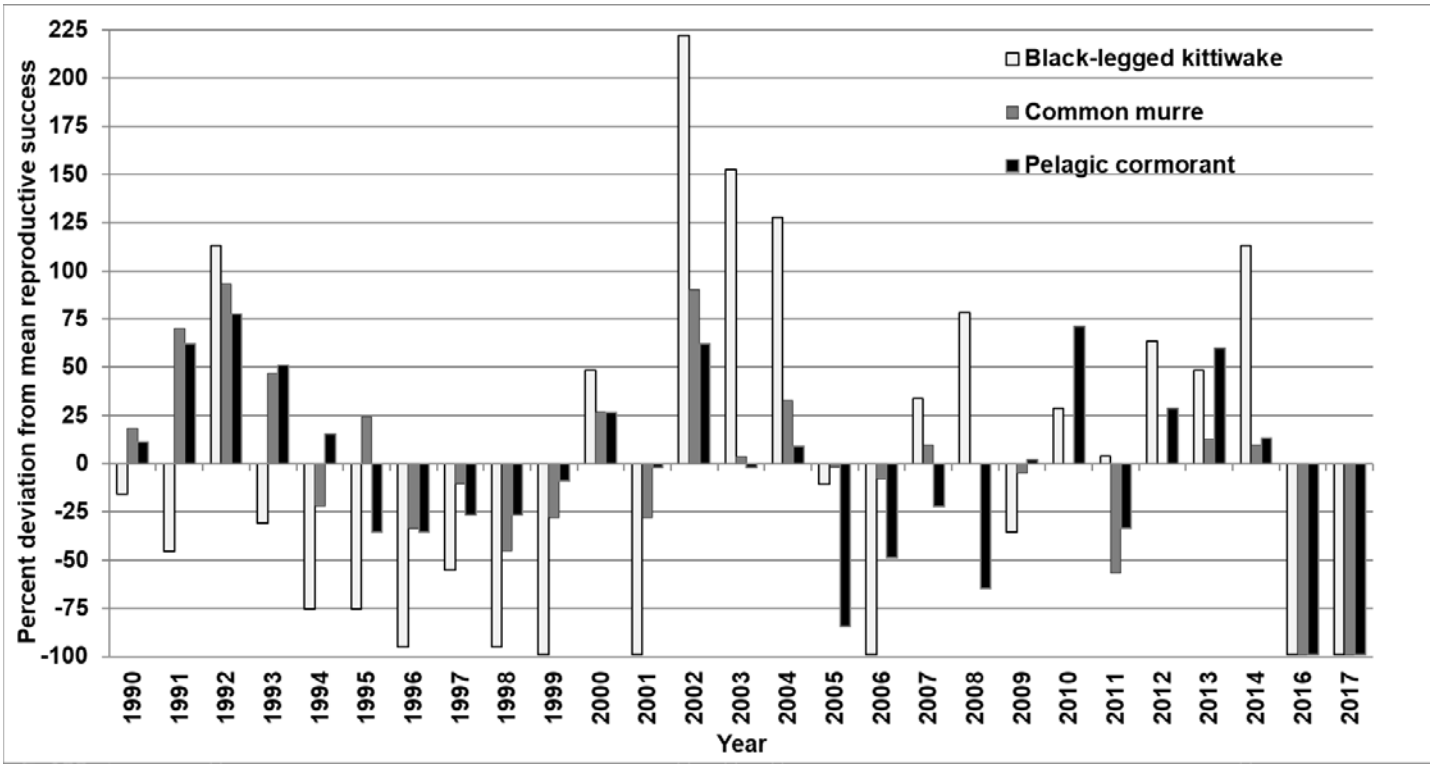

Figure 18. Annual reproductive success compared to the overall mean reproductive success of three seabird species monitored at Cape Peirce, Alaska, 1990-2017

FUTURE INVESTIGATIONS INTO POPULATION AND PRODUCTIVITY PATTERNS

Population and productivity dynamics of seabirds in nesting colonies can be influenced by spatial and temporal factors such as atmospheric pressure oscillations, regime shifts, sea surface temperature and mixing depth, tidal currents and oceanic gyres, sea ice coverage, algae bloom timing, abundance and movement of forage species, predator density, weather patterns, life history and other factors. Seabird population counts can be influenced by a number of factors which include true population changes and other variables such as birds utilizing other nesting sites (large scale) or changes in suitable ledge habitats within a survey plot (small scale). Correlation of seabird populations and productivity to terrestrial and oceanographic variables could provide insight into site specific ecological driving forces at the Cape Peirce colony. Future work should include such correlative assessments and also comparative evaluations with other seabird monitoring sites such as those on Round, Pribilof, and Bird Islands.

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Appendix A. Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 1. Summary of counts of black-legged kittiwakes on plots 18-11 at Cape Peirce, Alaska, 1990-2017.

Count	Year																											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
1	1,552	2,574	1,959	1,926	1,416	1,360	1,066	1,366	1,132	808	1,099	1,134	1,031	763	881	668	345	952	1,146	958	1,467	908	872	1,081	1,286	1,198	486
2	1,771	1,872	2,094	2,060	1,624	1,416	703	1,587	940	1,059	1,112	1,121	993	797	847	730	449	1,106	916	983	1,525	1,013	1,476	1,099	1,251	671	344
3	1,443	1,890	2,035	1,843	1,676	1,700	1,040	1,520	914	1,319	1,181	1,075	1,028	779	836	753	622	1,165	870	938	1,520	1,080	1,433	967	1,226	955	292
4	1,199	1,608	2,064	1,768	1,818	1,268	1,312	1,505	1,202	1,316	1,210	1,095	1,021	856	887	709	366	1,244	1,059	665	1,554	1,212	1,040	1,114	1,263	237	212
5	1,761	1,716	1,886	1,603	1,795	1,091	1,429	1,449	1,493	979	1,105	1,091	1,100	797	918	739	654	1,217	1,096	938	1,371	1,240	1,332	1,108	1,174	200	187
6	1,464	1,564	1,959	1,571	1,693	1,220	1,430	1,570	1,040	1,043	1,177	994	1,069	913	915	609	443	1,109	964	673	1,299	1,201	1,132	974	1,178	297	266
7	1,293	1,583	1,675	1,485	1,747	1,279	1,366	1,536	1,340	966	1,162	729	967	881	827	775	380	650	868	930	1,367	946	1,277	908	1,256	551	111
8	1,676	1,353	1,703	1,085	1,611	1,623	727	1,609	1,126	733	1,081	840	981	956	878	968	315	1,154	831	697	1,176	831	1,260	986	1,153	262	480
9	1,349	1,214	1,728	-	1,300	1,749	631	1,589	669	667	964	861	993	870	904	1,156	259	1,085	1,043	839	1,298	978	1,049	1,034	1,145	-	5
10	1,645	-	1,957	-	1,320	-	955	1,513	996	634	942	664	981	964	896	863	393	1,234	936	646	1,390	939	-	1,059	1,096	-	0
11	-	-	-	-	-	-	-	-	1,199	911	922	144	-	788	769	865	-	-	-	888	-	890	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	488	1,131	177	-	870	927	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	743	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	641	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Statistics																											
mean	1,515	1,708	1,906	1,668	1,600	1,412	1,066	1,524	1,096	879	1,091	827	1,016	853	874	803	423	1,092	973	832	1,397	1,022	1,208	1,033	1,203	546	238
n	10	9	10	8	10	9	10	10	11	14	12	12	10	12	12	11	10	10	10	11	10	11	9	10	10	8	10
S.D.	188	369	146	285	180	217	294	70	212	242	93	334	40	66	44	147	120	168	102	128	114	135	188	67	59	347	163
95% c.i.	117	241	90	197	112	141	182	43	125	127	53	189	25	37	25	87	75	104	63	76	71	80	123	42	37	241	101

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 2. Summary of counts of common murres on population plots 18-11 at Cape Peirce, Alaska, 1990-2017.

Count	Year																										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
1	3,124	4,111	3,831	3,443	2,384	2,914	2,745	4,316	2,572	1,792	2,463	2,472	2,465	1,858	1,812	1,890	2,585	4,283	3,005	2,338	3,451	2,543	1,680	2,624	1,239	472	5
2	2,733	5,107	4,707	4,276	3,345	4,149	2,464	4,211	2,431	1,563	2,456	3,282	2,544	1,502	2,060	2,077	2,602	2,745	4,650	2,611	3,244	2,572	2,339	2,783	1,887	0	8
3	3,184	3,618	5,229	4,306	3,329	4,350	3,143	4,134	2,619	2,429	2,561	2,885	2,984	1,602	2,387	1,916	2,185	3,669	3,852	2,689	3,223	3,256	2,892	2,706	1,750	124	133
4	2,554	4,696	5,031	4,241	3,444	3,987	3,171	3,654	2,436	2,930	2,728	3,037	2,982	2,116	2,615	3,299	2,733	3,644	4,295	2,424	3,731	2,768	2,552	2,765	1,844	0	7
5	3,076	2,939	4,734	3,869	3,579	2,813	4,251	3,138	2,785	2,394	2,408	2,354	3,181	1,584	2,728	3,509	2,842	2,387	3,395	1,944	3,871	3,321	2,853	2,495	1,957	0	196
6	3,337	3,129	4,766	4,038	3,701	3,632	4,051	3,403	1,858	2,567	2,478	2,664	2,711	2,238	2,575	3,250	2,012	3,005	3,611	2,624	3,414	3,092	2,575	2,628	1,533	0	466
7	2,885	3,190	4,317	3,898	3,886	3,348	3,378	3,441	1,957	2,492	2,601	2,675	2,682	1,946	2,531	2,430	2,895	1,924	2,823	2,339	3,784	2,503	2,790	2,290	1,276	36	10
8	3,618	3,772	3,874	3,927	3,549	4,049	3,349	3,917	2,090	2,493	2,563	2,892	2,999	2,092	2,375	2,285	1,926	2,723	2,345	2,710	3,421	2,759	2,733	2,582	1,621	32	98
9	3,568	3,027	3,642	-	3,561	3,908	3,282	3,583	2,380	2,423	2,826	2,947	2,811	2,355	2,658	2,730	1,908	3,689	2,811	3,250	3,060	2,889,	2,612	2,388	1,714	-	0
10	3,627	-	4,764	-	3,463	-	4,226	3,752	2,359	2,414	2,238	2,986	2,617	2,335	2,962	2,814	1,793	3,565	2,597	2,923	4,056	2,666	-	2,762	1,982	-	0
11	-	-	-	-	-	-	-	-	3,136	2,470	2,214	3,289	-	2,377	2,814	2,677	-	-	-	2,565	-	2,736	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	2,494	2,279	2,443	-	2,342	3,074	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	2,284	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	2,506	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Statistics																											
mean	3,171	3,732	4,563	4,000	3,424	3,683	3,406	3,755	2,420	2,375	2,485	2,827	2,798	2,029	2,549	2,625	2,348	3,163	3,338	2,583	3,526	2,822	2,558	2,602	1,680	83	92
n	10	9	10	8	10	9	10	10	11	14	12	12	10	12	12	11	10	10	10	11	10	10	9	10	10	8	10
S.D.	355	727	492	268	380	517	572	365	351	319	179	297	220	312	342	537	404	686	719	322	304	281	350	159	250	152	141
95% c.i.	220	475	305	185	236	338	354	227	207	167	101	168	136	177	194	317	250	425	446	191	189	174	229	98	155	105	87

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 3. Summary of counts of pelagic cormorants on population plots 18-11 at Cape Peirce, Alaska, 1990-2017.

Count	Year																										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
1	97	90	121	97	81	83	130	130	166	104	95	154	146	110	100	67	84	86	70	69	142	101	84	144	118	35	24
2	75	101	127	96	78	84	147	111	132	110	91	151	146	115	97	54	76	94	81	71	141	95	85	126	130	28	36
3	73	93	142	82	77	107	177	141	146	92	75	102	160	123	92	51	74	92	78	76	131	105	79	127	112	60	24
4	78	82	122	89	68	100	195	117	135	115	68	118	172	152	83	47	117	87	71	63	130	88	89	126	98	27	31
5	74	63	131	76	157	78	132	107	117	114	71	109	169	139	84	50	91	84	81	60	109	100	95	123	95	31	27
6	78	66	129	90	75	69	139	116	118	133	72	117	161	146	71	41	90	105	98	70	126	84	92	135	103	17	22
7	45	67	95	80	97	75	109	133	132	141	72	107	147	136	90	38	117	100	94	59	110	77	94	121	96	30	14
8	57	65	81	67	82	65	135	116	111	118	76	103	131	107	82	35	74	98	74	62	110	73	97	103	95	21	38
9	57	59	75	-	78	67	111	125	107	106	69	107	135	126	77	47	75	90	75	59	97	76	106	103	-	-	8
10	54	-	73	-	64	-	111	114	106	93	68	87	121	154	70	49	55	66	76	45	117	81	-	112	-	-	13
11	-	-	-	-	-	-	-	-	110	91	60	83	-	112	70	48	-	-	-	50	-	69	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	89	60	84	-	346	71	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Statistics																											
mean	69	76	110	85	86	81	139	121	125	107	73	110	149	147	82	48	85	90	80	62	121	86	91	122	106	31	24
n	10	9	10	8	10	9	10	10	11	14	12	12	10	12	12	11	10	10	10	11	10	11	9	10	8	8	10
S.D.	15	15	25	10	25	14	27	10	18	16	10	22	16	62	10	8	19	10	9	9	14	12	8	12	12	12	9
95% c.i.	9	10	15	7	16	9	17	6	11	8	6	12	10	35	6	5	11	6	5	5	9	7	5	8	8	8	6

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 4. Mean numbers of black-legged kittiwakes counted by year and plot location at Cape Peirce, Alaska, 1990-2017.

	Plot																																	
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11	12	13A	13B	14	15A	15B
2017	0	1	0	0	0	0	0	0	0	0	0	0	3	0	4	0	0	0	2	3	0	14	0	8	21	87	36	35	11	14						
2016	0	0	0	0	0	0	0	0	0	0	0	0	17	2	13	0	0	0	10	12	0	26	5	16	48	181	98	71	28	19						
2015																																				
2014	0	7	0	0	0	0	0	0	1	0	0	0	28	0	13	0	0	0	12	23	1	68	28	42	105	434	176	152	82	34						
2013	0	8	0	0	0	0	0	0	0	0	0	0	30	0	14	0	0	0	15	25	2	74	28	43	97	335	142	117	80	38						
2012	0	6	0	0	0	0	0	0	3	0	1	0	21	0	21	0	0	0	18	30	1	80	27	54	116	347	197	142	91	53						
2011	0	7	0	0	0	0	0	0	1	0	0	0	23	0	2	0	0	0	14	23	2	71	28	48	92	278	177	130	82	44						
2010	0	9	0	0	0	0	0	0	0	0	0	0	26	0	14	0	0	0	13	19	5	78	29	44	111	297	201	128	80	47						
2009	0	6	0	0	0	0	0	0	1	0	0	0	16	0	1	0	0	0	10	16	4	68	22	48	89	238	152	113	75	41						
2008	0	10	0	0	0	0	0	0	3	0	0	0	20	0	1	0	0	0	17	17	11	83	25	43	107	262	175	115	85	46	21	44	95	43	10	0
2007	0	10	0	0	0	0	0	0	1	0	0	0	26	0	1	0	0	0	29	24	6	90	24	41	115	278	191	125	88	45	24	36	89	49	13	0
2006	0	8	0	0	0	0	0	0	1	0	0	0	11	0	1	1	0	0	14	11	3	34	5	13	36	116	69	51	36	12	6	9	28	27	1	0
2005	0	11	0	0	0	0	0	0	0	0	0	0	36	0	1	0	0	0	21	19	6	59	17	30	63	201	143	82	76	36	15	21	82	45	14	0
2004	0	11	0	0	0	0	0	0	1	0	0	0	26	0	7	0	0	0	22	20	6	80	24	39	82	196	146	90	77	40	24	33	90	53	21	0
2003	0	12	0	0	0	0	4	0	2	0	0	0	34	0	10	0	0	0	15	0	13	85	33	39	78	192	129	95	75	38	31	30	90	47	40	0
2002	0	16	0	4	0	0	5	0	7	0	0	0	37	0	18	2	0	0	24	22	18	87	39	39	84	245	155	93	85	39	63	39	91	57	87	4
2001	0	13	0	2	0	0	3	0	7	0	0	0	32	0	18	5	0	0	23	19	15	74	32	31	68	202	112	79	65	33	39	40	70	38	65	5
2000	0	18	0	5	0	0	8	0	15	0	0	4	46	0	22	18	0	0	42	29	31	80	39	35	87	223	146	100	86	49	70	21	89	53	81	6
1999	0	10	0	2	0	0	3	0	9	0	0	3	33	0	15	17	0	0	39	27	29	55	25	14	55	175	97	74	70	30	52	51	47	33	53	4
1998	2	24	0	2	0	0	9	0	10	0	0	6	54	0	20	21	0	0	46	35	43	71	51	23	89	225	139	105	85	38	90	29	81	68	123	10
1997	3	34	0	5	0	0	22	0	31	0	0	15	110	0	38	38	0	0	74	52	91	129	79		138	222	154	113	111	65	124	105	141	77	159	22
1996	3	17	0	1	0	0	8	0	15	0	0	11	65	0	14	16	0	0	42	23	44	77	50	29	84	218	127	96	93	36	102	43	116	59	134	14
1995	4	26	0	5	2	0	19	0	18	0	0	16	74	0	21	25	0	0	56	26	58	121	69	39	107	273	174	110	111	57	150	113	149	62	190	22
1994	4	35	0	9	3	0	23	0	27	0	0	21	99	0	30	39	0	0	61	59	89	134	80	55	96	229	153	177	120	59	150	35	143	59	128	22
1993	4	34	0	9	4	0	40	0	26	2	0	21	117	0	38	52	0	0	70	64	26	142	101	60	122	239	195	114	124	64	157	85	159	73	146	25
1992	7	29	0	13	7	0	37	0	38	4	3	27	121	0	50	46	0	0	77	67	104	169	114	62	120	308	210	102	132	60	156	63	145	71	178	31
1991	8	25	0	11	6	0	36	0	32	4	6	21	98	0	39	32	0	0	60	63	88	156	131	56	108	253	196	93	122	62	142	70	188	68	170	34
1990	9	28	0	9	7	0	44	0	35	8	10	15	81	0	37	28	0	0	48	60	74	141	91	44	84	258	167	86	107	58	120	40	123	64	155	22

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 5. Mean numbers of common murres counted by year and plot location at Cape Peirce, Alaska, 1990-2017.

	Plot																																	
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11	12	13A	13B	14	15A	15B
2017	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	12	0	0	2	48	7	7	16	0						
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	51	1	29	0	0						
2015																																				
2014	0	0	0	0	0	0	0	0	0	0	1	0	12	0	6	0	0	0	9	0	9	90	27	13	97	714	129	368	206	0						
2013	0	0	0	0	0	0	0	0	0	0	7	0	41	0	14	0	0	0	53	2	32	182	99	30	114	1027	211	538	276	0						
2012	0	0	0	2	0	0	0	0	0	0	5	0	38	0	16	0	0	0	71	1	36	197	94	35	107	905	187	622	242	0						
2011	0	0	0	0	0	0	0	0	0	0	4	0	40	0	0	0	0	0	100	1	40	227	112	40	125	972	202	623	342	0						
2010	0	0	0	0	0	0	0	0	0	0	4	0	22	1	11	0	0	0	74	0	32	217	133	55	130	794	314	591	355	0						
2009	0	0	0	0	0	0	0	0	0	0	11	0	20	9	0	0	0	0	107	2	31	195	116	59	133	748	290	548	314	0						
2008	0	0	0	0	0	0	0	0	0	0	6	0	21	24	0	0	0	0	178	0	40	222	97	58	176	904	534	653	430	0	39	72	207	144	5	0
2007	0	0	0	0	0	0	0	0	0	0	6	0	18	12	0	0	0	2	126	9	29	168	111	51	173	868	742	548	299	0	42	79	158	139	7	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0	0	1	3	52	0	13	120	145	34	132	684	425	374	345	0	10	9	101	80	0	0
2005	0	0	0	0	0	0	0	0	0	0	13	0	24	28	1	0	4	11	185	0	46	142	149	47	126	669	480	339	361	0	66	106	173	121	0	0
2004	0	0	0	0	0	0	0	0	0	0	4	0	10	7	0	0	0	2	122	0	26	194	117	62	175	837	257	423	312	0	81	145	195	133	19	0
2003	0	0	0	0	0	0	2	0	0	0	1	0	29	25	1	0	3	5	94	0	41	132	146	65	186	522	242	304	229	0	35	102	120	156	5	0
2002	0	0	0	0	0	0	0	0	0	0	7	0	33	33	3	0	9	10	129	0	34	185	242	63	226	749	246	452	376	0	94	121	223	142	39	0
2001	0	0	0	0	0	0	0	0	0	0	4	0	29	26	0	0	2	6	117	0	33	176	269	57	243	733	318	470	347	0	76	134	201	129	50	0
2000	0	0	0	0	4	0	11	0	0	18	0	0	55	93	0	3	21	30	128	1	37	168	196	44	137	622	241	379	296	0	57	81	157	103	7	0
1999	0	0	0	0	2	0	11	0	0	0	19	1	41	72	0	2	10	19	130	0	39	170	228	25	130	738	138	383	339	0	128	105	199	152	19	0
1998	0	0	0	0	1	0	10	0	0	0	12	0	28	30	0	1	4	7	110	0	32	138	235	29	120	773	139	395	354	0	224	149	222	183	74	0
1997	0	0	0	0	16	0	20	5	0	0	62	3	125	213	0	1	29	49	224	2	85	287	359	60	207	1014	201	446	395	0	194	140	245	139	4	0
1996	0	0	0	0	18	0	27	4	0	0	56	0	84	158	0	0	29	52	188	3	80	302	293	40	179	859	199	404	431	0	177	3	210	144	56	0
1995	0	0	0	0	20	0	26	4	0	0	58	1	105	216	0	1	35	62	232	1	52	271	282	69	231	1017	195	892	375	0	200	132	199	128	41	0
1994	0	0	0	0	10	0	23	1	0	0	50	2	94	233	4	5	27	56	289	1	51	228	235	97	199	769	306	399	344	0	230	166	152	181	131	0
1993	0	0	0	0	24	0	43	0	0	0	49	5	98	237	0	3	26	52	278	9	40	257	318	80	282	1027	233	516	423	0	240	181	213	137	83	0
1992	0	0	0	0	11	0	50	15	1	7	60	6	122	266	0	0	31	53	272	0	101	319	365	101	368	1139	276	507	419	0	277	227	251	175	122	0
1991	0	0	0	0	7	0	18	0	0	11	45	3	101	203	18	1	22	41	208	1	81	267	295	81	265	954	276	415	421	0	203	158	206	129	78	0
1990	0	3	0	0	9	0	19	3	0	13	34	1	68	159	17	1	21	35	141	0	51	232	231	79	192	910	233	389	357	0	217	130	205	143	102	0

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 6. Mean numbers of pelagic cormorants counted by year and plot location at Cape Peirce, Alaska, 1990-2017.

	Plot																																	
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11	12	13A	13B	14	15A	15B
2017	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	16	4	1	0	0						
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	1	0	1	0	0	0	4	11	1	1	0	0						
2015																																				
2014	0	0	0	0	0	0	18	0	3	19	0	0	0	0	1	0	0	0	1	2	0	7	0	7	7	23	9	7	1	0						
2013	0	0	0	1	34	4	6	7	10	0	0	0	0	0	0	0	0	0	1	0	1	9	1	5	3	18	10	9	3	0						
2012	0	0	0	0	12	1	9	13	0	1	1	0	1	0	1	0	0	0	1	1	0	9	1	4	6	12	11	5	0	1						
2011	0	0	5	0	8	2	4	9	1	0	3	0	1	0	2	0	0	0	2	0	5	7	1	1	3	13	10	7	2	0						
2010	0	0	1	0	12	0	14	11	1	2	0	0	5	0	5	0	0	0	0	0	1	11	2	2	3	14	12	7	6	0						
2009	0	0	1	0	0	0	6	0	1	5	0	0	7	0	4	0	0	0	0	0	0	5	0	2	2	11	11	5	1	0						
2008	0	0	0	1	0	0	4	0	1	7	0	0	4	1	4	0	0	0	1	3	2	0	0	6	9	16	16	8	1	0	0	1	0	0	7	0
2007	0	0	0	0	0	0	3	0	4	0	0	0	0	0	0	0	0	0	3	1	5	0	0	10	12	21	17	11	2	1	0	0	0	0	11	0
2006	0	0	0	0	14	2	1	2	15	0	21	0	0	0	0	0	0	0	0	0	0	0	0	1	2	16	12	5	1	0	0	3	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	1	0	0	3	12	7	1	1	0	0	3	1	5	0	0
2004	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	20	0	5	8	26	12	6	3	1	5	5	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	1	3	0	2	0	0	0	5	0	4	6	3	14	13	45	20	8	4	0	3	13	0	7	3	0
2002	0	2	28	3	1	0	3	1	2	0	0	0	4	0	7	0	0	0	6	1	8	1	1	7	13	25	20	12	3	0	0	1	0	3	6	0
2001	0	1	0	3	10	0	0	1	3	0	0	0	3	0	4	0	0	0	2	0	3	2	0	14	10	24	16	12	1	0	0	1	0	7	17	0
2000	0	6	0	1	5	0	3	3	8	0	0	0	1	0	3	0	0	0	0	0	0	0	4	4	3	12	13	7	1	0	0	0	0	2	23	1
1999	1	3	0	3	26	5	3	12	2	9	0	0	1	0	1	0	0	0	0	1	0	0	0	7	8	13	9	4	0	0	0	4	0	0	18	7
1998	0	0	34	1	0	1	0	0	0	37	0	0	1	0	3	0	0	0	0	1	3	0	0	4	10	12	11	5	1	0	4	2	0	0	25	8
1997	2	3	28	2	1	0	2	0	2	0	0	6	5	0	2	4	0	0	0	0	0	4	6		22	11	13	8	0	0	0	13	0	1	17	0
1996	4	5		2	26	0	4	7	16	0	1	0	2	0	1	0	0	0	0	0	0	7	9	7	7	15	15	9	2	0	0	3	0	2	2	0
1995	0	0	0	0	6	0	1	2	0	0	19	1	1	0	0	0	0	0	0	0	0	4	4	12	3	10	10	7	1	0	17	2	0	5	8	12
1994	1	4	0	0	3	0	1	1	2	2	2	3	4	2	2	4	0	0	0	1	0	7	2	17	3	13	6	8	1	0	0	1	0	9	17	0
1993	0	1	0	0	2	0	7	1	1	0	1	2	2	0	2	1	0	0	0	0	0	12	3	17	5	12	8	8	1	0	1	10	0	6	20	0
1992	0	3	1	0	19	1	6	6	1	2	0	2	2	0	2	4	0	0	0	0	0	7	0	13	11	11	7	9	0	1	12	8	0	11	10	0
1991	0	3	0	0	7	1	6	1	5	0	0	1	3	0	3	2	0	0	2	0	0	2	0	12	5	9	6	8	1	0	7	3	0	10	22	3
1990	0	0	0	0	4	0	5	2	8	1	0	0	1	0	1	0	0	0	0	0	0	4	0	13	7	10	6	7	1	0	8	3	0	10	15	5

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 7. Mean number of black-legged kittiwakes counted by plot location, Cape Newenham, Alaska, 1991-2009.

		Plot																
Year	(n)	DC-1	DC-2	DC-3	DC-4	DC-5	RW-1	RW-2	RW-3	RW-4	EJ-1	EJ-2	EJ-3	EJ-4	OW-1	OW-2	OW-3	Total
2009	10	242	258	174	67	1	132	142	168	107	218	94	204	181	122	110	204	2,424
1993	7	157	228	131	79	0	153	157	198	142	162	110	164	182	127	105	135	2,230
1992	7	134	198	125	73	0	178	148	218	205	168	89	165	156	114	103	122	2,196
1991	5	146	237	131	68	0	102	132	172	129	57	59	127	32	105	79	100	1,676

(n) = sample size (number of counts)

Table 8. Mean number of common murres counted by plot location, Cape Newenham, Alaska, 1991-2009.

		Plot																
Year	(n)	DC-1	DC-2	DC-3	DC-4	DC-5	RW-1	RW-2	RW-3	RW-4	EJ-1	EJ-2	EJ-3	EJ-4	OW-1	OW-2	OW-3	Total
2009	10	278	2,628	724	386	85	120	226	270	50	162	197	97	32	52	81	1,402	6,790
1993	7	234	1,460	389	224	24	253	192	327	0	163	177	99	62	200	168	992	4,964
1992	7	247	1,855	645	384	106	336	222	595	93	186	240	103	60	238	208	992	6,510
1991	5	221	1,831	601	315	203	199	127	255	54	62	52	144	0	142	120	669	4,995

(n) = sample size (number of counts)

Table 9. Mean number of pelagic cormorants counted by plot location, Cape Newenham, Alaska, 1991-2009.

		Plot																
Year	(n)	DC-1	DC-2	DC-3	DC-4	DC-5	RW-1	RW-2	RW-3	RW-4	EJ-1	EJ-2	EJ-3	EJ-4	OW-1	OW-2	OW-3	Total
2009	10	4	0	1	23	2	0	0	0	0	0	0	0	0	0	0	0	30
1992	7	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	5
1991	5	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

(n) = sample size (number of counts)

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 10. Summary of historical data on the breeding chronology of black-legged kittiwakes at Cape Peirce, Alaska, 1995-2007.

	Year												
Parameter	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
First lay	6 June	5 June	7 June	6 June	7 June	29 May	9 June	26 May	22 May	31 May	1 June	9 June	1 June
Last lay	-	-	-	<11 July	19 July	24 June	3 July	25 June	21 June	8 July	12 July	1 July	7 July
Mean laying	16 June	14 June	17 June	16 June	29 June	6 June	17 June	5 June	1 June	10 June	9 June	17 June	23 June
First hatch	4 July	2 July	3 July	2-Jul	17 July	24 June	6 July	23 June	17 June	25 June	27 June	9 July	4 July
Last hatch	-	-	-	<6 August	31 July	20 July	24 July	15 July	11 July	24 July	25 July	15 July	26 July
Mean hatching	13 July	11 July	13 July	13-Jul	22 July	2 July	10 July	1 July	26 June	1 July	4 July	11 July	15 July
First fledge	-	-	-	>28 August	None fledged	3 August	None fledged	3 August	3 August	1 August	2 August	None fledged	10 August
Last fledge	-	-	-	>28 August	None fledged	7 September	None fledged	1 September	1 September	26 August	20 August	None fledged	29 August
Mean fledging	23 August	14 August	17 August	6 August	None fledged	20 August	None fledged	16 August	12 August	14 August	12 August	None fledged	20 August

- Dashes indicate insufficient data was collected. Data on breeding chronology were not collected after 2007.

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 11. Summary of historical data on the breeding chronology of commom murres at Cape Peirce, Alaska, 1995-2007.

	Year												
Parameter	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
First lay	4 June	5 June	<31 May	<12 June	9 June	8 June	13 June	31 May	1 June	6 June	6 June	16 June	5 June
Last lay	-	-	-	7 July	8 August	20 July	13 July	17 July	28 June	14 June	11 July	16 June	2 July
Mean laying	18 June	25 June	15 June	17 June	28 June	14 June	22 June	13 June	13 June	9 June	15 June	16 June	19 June
First hatch	9 July	14 July	10 July	15 July	29 July	10 July	15 July	9 July	8 July	8 July	9 July	15 July	11 July
Last hatch	-	-	-	6 August	18 August	20 July	2 August	10 August	30 July	16 July	25 July	6 August	8 August
Mean hatch	17 July	24 July	16 July	23 July	3 August	12 July	24 July	16 July	15 July	11 July	14 July	20 July	25 July
First fledge	24 July	29 July	25 July	1 August	18 August	24 July	2 August	29 July	25 July	24 July	7 August	31 July	28 July
Last fledge	-	-	-	-	-	26 August	1 September	31 August	28 August	23 August	11 August	24 August	16 August
Mean fledging	14 August	18 August	7 August	11 August	23 August	6 August	15 August	6 August	8 August	7 August	9 August	16 August	7 August

- Dashes indicate insufficient data. Data on breeding chronology were not collected after 2007.

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 12. Summary of historical data on the breeding chronology of pelagic cormorants at Cape Peirce, Alaska, 1995-2007.

	Year												
Parameter	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
First lay	<26 May	10 May	8 May	12 May	25 May	4 May	9 May	<7 May	6 May	9 May	14 May	26 May	10 May
Last lay	-	-	-	14 June	21 July	16 June	9 June	9 June	8 June	29 June	10 July	23 June	9 June
Mean laying	29 May	19 May	18 May	24 May	12 June	18 May	22 May	19 May	20 May	26 May	30 May	4 June	25 May
First hatch	12 June	9 June	6 June	11 June	7 June	3 June	8 June	5 June	5 June	8 June	14 June	25 June	14 June
Last hatch	-	-	24 July	14 July	4 August	20 July	10 July	3 July	9 July	10 July	15 July	10 July	11 July
Mean hatching	25 June	19 June	13 June	18 June	7 July	19 June	20 June	18 June	17 June	22 June	21 June	30 June	28 June
First fledge	-	30 July	28 July	29 July	27 July	25 July	30 July	29 July	25 July	23 July	1 July	31 July	30 July
Last fledge	-	-	-	-	-	18 August	23 August	17 August	28 August	25 August	17 August	19 August	29 August
Mean fledging	11 August	5 August	5 August	8 August	21 August	7 August	6 August	8 August	4 August	7 August	21 July	14 August	14 August

- Dashes indicate insufficient data. Data on breeding chronology were not collected after 2007.

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 13. Summary of the breeding performance of black-legged kittiwakes at Cape Peirce, Alaska, 1990-2017.

		Year																											
Parameter	Statistics	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
Laying	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	6	6
Success	mean	0.50	0.41	0.64	0.53	0.27	0.25	0.15	0.66	0.07	0.16	0.68	0.71	0.97	0.92	0.83	0.90	0.23	0.76	0.90	0.71	0.58	0.79	0.68	0.81	0.88	0.03	0.53
	95% c.i.	0.20	0.18	0.18	0.19	0.12	0.18	0.08	0.11	0.06	0.07	0.22	0.14	0.04	0.12	0.14	0.07	0.12	0.14	0.07	0.11	0.19	0.08	0.12	0.11	0.07	0.05	0.28
Clutch	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	-	-	-	-	-	-	-	-	-
Size	mean	1.34	1.14	1.55	1.33	2.23	1.71	1.18	1.27	1.07	1.10	1.49	1.45	1.59	1.66	1.62	1.37	1.03	1.35	-	-	-	-	-	-	-	-	-
	95% c.i.	0.15	0.10	0.15	0.17	0.69	0.44	0.14	0.10	0.09	0.09	0.18	0.13	0.08	0.24	0.24	0.08	0.05	0.10	-	-	-	-	-	-	-	-	-
Nesting	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	-	6
Success	mean	0.47	0.39	0.81	0.43	0.65	0.48	0.17	0.56	0.27	0.14	0.59	0.19	0.83	0.74	0.57	0.47	0.04	0.46	0.51	0.40	0.61	0.49	0.57	0.59	0.87	-	0.00
	95% c.i.	0.19	0.16	0.11	0.21	0.54	0.43	0.16	0.16	0.33	0.14	0.25	0.14	0.16	0.19	0.27	0.19	0.05	0.17	0.13	0.13	0.15	0.13	0.11	0.14	0.07	-	0.00
Hatching	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	-	-	-	-	-	-	-	-	-
Success	mean	0.36	0.16	0.60	0.32	0.24	0.30	0.16	0.46	0.25	0.13	0.45	0.14	0.56	0.49	0.42	0.37	0.04	0.36	-	-	-	-	-	-	-	-	-
	95% c.i.	0.14	0.05	0.11	0.18	0.15	0.22	0.16	0.12	0.32	0.13	0.20	0.10	0.12	0.12	0.20	0.16	0.05	0.13	-	-	-	-	-	-	-	-	-
Chick	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	-	-	-	-	-	-	-	-	-
Success	mean	0.40	0.56	0.71	0.34	0.32	0.22	0.13	0.24	0.33	0.00	0.43	0.00	0.72	0.67	0.64	0.25	0.00	0.62	-	-	-	-	-	-	-	-	-
	95% c.i.	0.21	0.26	0.06	0.21	0.26	0.13	0.26	0.14	0.65	0.00	0.13	0.00	0.09	0.13	0.04	0.15	0.00	0.10	-	-	-	-	-	-	-	-	-
Egg	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	-	-	-	-	-	-	-	-	-
Success	mean	0.15	0.20	0.42	0.14	0.09	0.06	0.02	0.10	0.17	0.00	0.19	0.00	0.41	0.31	0.26	0.13	0.00	0.23	-	-	-	-	-	-	-	-	-
	95% c.i.	0.10	0.13	0.09	0.13	0.08	0.06	0.04	0.06	0.33	0.00	0.10	0.00	0.11	0.10	0.13	0.09	0.00	0.10	-	-	-	-	-	-	-	-	-
Fledging	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	-	6
Success	mean	0.42	0.58	0.78	0.34	0.32	0.29	0.17	0.26	0.33	0.00	0.56	0.00	0.78	0.73	0.87	0.28	0.00	0.66	0.73	0.41	0.69	0.43	0.81	0.61	0.55	-	0.00
	95% c.i.	0.22	0.28	0.05	0.22	0.26	0.17	0.33	0.15	0.65	0.00	0.16	0.00	0.09	0.13	0.05	0.17	0.00	0.10	0.15	0.24	0.18	0.20	0.06	0.10	0.12	-	0.00
Reproductiv	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	-	6
Success	mean	0.22	0.23	0.63	0.18	0.21	0.09	0.03	0.13	0.17	0.00	0.32	0.00	0.66	0.52	0.49	0.19	0.00	0.31	0.38	0.19	0.43	0.27	0.46	0.35	0.48	-	0.00
	95% c.i.	0.14	0.14	0.10	0.15	0.16	0.09	0.06	0.08	0.33	0.00	0.17	0.00	0.18	0.16	0.24	0.13	0.00	0.13	0.13	0.15	0.15	0.15	0.10	0.09	0.09	-	0.00
Fledglings/	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	-	6
Nest Start	mean	0.20	0.13	0.48	0.16	0.07	0.06	0.01	0.10	0.01	0.00	0.31	0.00	0.67	0.55	0.61	0.21	0.00	0.38	0.41	0.13	0.27	0.26	0.39	0.33	0.40	-	0.00
	95% c.i.	0.12	0.07	0.16	0.10	0.05	0.05	0.01	0.06	0.01	0.00	0.16	0.00	0.19	0.18	0.24	0.13	0.00	0.12	0.12	0.09	0.12	0.12	0.09	0.09	0.07	-	0.00
Overall	n	11	11	10	10	10	13	13	12	13	15	12	10	6	8	11	8	11	15	14	11	11	11	13	14	14	6	6
Productivity	mean	0.17	0.11	0.43	0.14	0.05	0.05	0.01	0.09	0.01	0.00	0.30	0.00	0.65	0.51	0.46	0.18	0.00	0.27	0.36	0.13	0.26	0.21	0.33	0.30	0.43	0.00	0.00
	95% c.i.	0.12	0.07	0.16	0.10	0.05	0.05	0.01	0.06	0.01	0.00	0.16	0.00	0.19	0.18	0.23	0.13	0.00	0.12	0.12	0.09	0.12	0.12	0.09	0.09	0.09	0.00	0.00

- Dashes indicate where insufficient data was collected to calculate parameters.

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 14. Summary of the breeding performance of common murres at Cape Peirce, Alaska, 1990-2017.

		Year																										
Parameter	Statistics	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
Hatching	n	7	6	6	6	6	10	9	10	7	6	7	5	4	8	6	11	7	11	-	-	-	-	-	-	-	-	3
Success	mean	0.60	0.65	0.73	0.53	0.34	0.54	0.29	0.44	0.36	0.56	0.61	0.52	0.78	0.68	0.57	0.49	0.44	0.65	-	-	-	-	-	-	-	-	0.00
	95% c.i.	0.20	0.15	0.14	0.25	0.17	0.16	0.19	0.16	0.18	0.11	0.23	0.22	0.17	0.41	0.19	0.24	0.22	0.29	-	-	-	-	-	-	-	-	0.00
Fledging	n	7	6	6	6	6	10	9	10	7	6	7	5	4	8	6	11	7	11	-	-	-	-	-	-	-	-	3
Success	mean	0.63	0.89	0.90	0.95	0.83	0.70	0.78	0.70	0.46	0.47	0.72	0.38	0.81	0.62	0.77	0.64	0.67	0.62	-	-	-	-	-	-	-	-	0.00
	95% c.i.	0.32	0.09	0.13	0.06	0.24	0.17	0.22	0.18	0.26	0.29	0.21	0.28	0.20	0.17	0.31	0.28	0.31	0.30	-	-	-	-	-	-	-	-	0.00
Reproductiv	n	7	6	6	6	6	10	9	10	7	6	7	5	4	8	6	11	7	11	-	10	-	11	-	10	8	0 *	3
Success	mean	0.41	0.59	0.67	0.51	0.27	0.43	0.23	0.31	0.19	0.25	0.44	0.25	0.66	0.36	0.46	0.34	0.32	0.38	-	0.33	-	0.15	-	0.39	0.38	-	0.00
	95% c.i.	0.22	0.17	0.20	0.25	0.16	0.16	0.18	0.13	0.13	0.17	0.21	0.24	0.27	0.15	0.24	0.23	0.20	0.26	-	0.15	-	0.11	-	0.15	0.20	-	0.00

- Dashes indicate where insufficient data was collected to calculate parameters.

* No common murres were observed in incubation or brooding postures in 2016

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 15. Summary of the breeding performance of pelagic cormorants at Cape Peirce, Alaska, 1990-2017.

		Year																											
Parameter	Statistics	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2016	2017
Laying	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Success	mean	0.79	0.93	0.85	0.72	0.46	0.49	0.53	0.60	0.66	0.80	0.81	0.81	0.85	0.94	0.74	0.60	0.64	0.63	0.74	0.59	0.81	0.68	0.82	0.96	0.98	-	0.83
	95% c.i.	0.13	0.07	0.10	0.31	0.20	0.25	0.18	0.19	0.15	0.19	0.15	0.19	0.16	0.11	0.24	0.30	0.30	0.19	0.16	0.38	0.14	0.23	0.19	0.04	0.02	-	-
Clutch	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8.00	13	-	-	-	-	-	-	-	-	-
Size	mean	2.89	-	-	-	-	-	2.66	2.37	2.28	2.15	3.38	2.45	2.47	2.99	2.55	1.95	1.19	2.44	-	-	-	-	-	-	-	-	-
	95% c.i.	0.41	-	-	-	-	-	0.64	0.46	0.37	0.54	0.20	0.64	0.59	0.42	0.76	0.19	0.60	0.46	-	-	-	-	-	-	-	-	-
Nesting	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Success	mean	0.66	0.88	0.97	0.90	1.00	1.00	0.81	0.66	0.60	0.74	0.81	0.68	0.99	0.73	0.64	0.43	0.27	0.66	0.51	0.71	0.99	0.66	0.74	0.87	0.90	-	0.60
	95% c.i.	0.30	0.14	0.06	0.13	0.00	0.00	0.22	0.23	0.24	0.20	0.16	0.25	0.03	0.25	0.29	0.31	0.24	0.22	0.21	0.47	0.02	0.21	0.28	0.18	0.17	-	-
Hatching	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8.00	13	-	-	-	-	-	-	-	-	-
Success	mean	0.57	-	-	-	-	-	0.68	0.59	0.52	0.73	0.70	0.69	0.79	0.58	0.47	0.40	0.29	0.60	-	-	-	-	-	-	-	-	-
	95% c.i.	0.28	-	-	-	-	-	0.20	0.20	0.22	0.20	0.14	0.27	0.15	0.22	0.23	0.31	0.25	0.19	-	-	-	-	-	-	-	-	-
Chick	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	-	-	-	-	-	-	-	-	-
Success	mean	0.84	0.94	0.94	-	0.59	-	0.56	0.73	0.51	0.36	0.65	0.43	0.81	0.52	0.51	0.31	0.44	0.75	-	-	-	-	-	-	-	-	-
	95% c.i.	0.15	0.06	0.07	-	0.16	-	0.25	0.19	0.29	0.17	0.14	0.24	0.19	0.20	0.31	0.36	0.33	0.19	-	-	-	-	-	-	-	-	-
Egg	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	-	-	-	-	-	-	-	-	-
Success	mean	0.47	-	-	-	-	-	0.36	0.44	0.35	0.30	0.42	0.42	0.61	0.32	0.35	0.12	0.25	0.45	-	-	-	-	-	-	-	-	-
	95% c.i.	0.24	-	-	-	-	-	0.19	0.19	0.21	0.15	0.08	0.24	0.18	0.17	0.21	0.15	0.21	0.18	-	-	-	-	-	-	-	-	-
Fledging	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Success	mean	0.90	0.90	0.98	1.00	0.87	0.59	0.63	0.80	0.64	0.53	0.89	0.55	0.82	0.68	0.55	0.34	0.44	0.82	0.49	1.00	0.97	0.77	0.98	0.79	0.60	-	0.00
	95% c.i.	0.11	0.14	0.05	0.00	0.19	0.27	0.27	0.19	0.30	0.27	0.08	0.30	0.19	0.27	0.33	0.37	0.33	0.18	0.28	0.00	0.04	0.26	0.04	0.19	0.24	-	-
Reproductiv	n	8	7	8	9	9	7	10	15	11	11	10	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Success	mean	0.60	0.78	0.94	0.91	0.87	0.15	0.53	0.54	0.43	0.47	0.71	0.49	0.81	0.48	0.51	0.13	0.23	0.56	0.24	0.71	0.96	0.48	0.72	0.76	0.50	-	0.00
	95% c.i.	0.29	0.15	0.07	0.13	0.19	0.28	0.27	0.23	0.23	0.25	0.14	0.27	0.19	0.27	0.32	0.19	0.20	0.22	0.19	0.54	0.05	0.22	0.28	0.18	0.24	-	-
Fledglings/	n	8	7	8	9	9	7	10	15	11	11	11	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Nest Start	mean	1.15	2.14	2.10	1.89	0.75	0.67	0.73	1.00	0.87	0.75	1.21	1.19	1.39	1.15	1.23	0.33	0.55	0.79	0.44	1.43	1.19	0.87	1.74	1.64	1.01	-	0.00
	95% c.i.	0.48	0.36	0.38	0.89	0.42	0.42	0.33	0.44	0.40	0.35	0.33	0.70	0.39	0.50	0.63	0.16	0.40	0.45	0.20	0.88	0.24	0.38	0.59	0.44	0.56	-	-
Overall	n	8	7	8	9	9	7	10	15	11	11	11	10	10	7	8	7	8	13	13	6	8	10	10	11	9	-	1
Productivity	mean	0.50	0.73	0.80	0.68	0.52	0.29	0.29	0.33	0.33	0.41	0.57	0.44	0.73	0.44	0.49	0.07	0.23	0.35	0.16	0.46	0.77	0.30	0.58	0.72	0.51	-	0.00
	95% c.i.	0.24	0.15	0.10	0.33	0.22	0.17	0.16	0.18	0.21	0.22	0.15	0.26	0.20	0.23	0.32	0.09	0.20	0.18	0.12	0.41	0.14	0.17	0.26	0.18	0.24	-	-

- Dashes indicate where insufficient data was collected to calculate parameters.

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 16. Summary of the productivity of black-legged kittiwakes by plot location, Cape Peirce, Alaska, 1990-2017.

	Plot																												
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11
2017																						0.00		0.00	0.00	0.00			0.00	0.00
2016																						0.00			0.00	0.00	0.00	0.00	0.00	
2014		0.25											0.78		0.29				0.33	0.22		0.24	0.54	0.56	0.48	0.38	0.28	0.64	0.48	0.50
2013		0.38											0.30		0.17				0.00	0.38		0.54	0.48	0.20	0.15	0.36	0.40	0.45	0.37	0.06
2012		0.20											0.29						0.00	0.29		0.30	0.29	0.24	0.25	0.49	0.39	0.63	0.47	0.50
2011													0.07							0.47		0.19	0.00	0.00	0.00	0.40	0.37	0.55	0.19	0.10
2010													0.00							0.27		0.41	0.61	0.39	0.19	0.34	0.00	0.08	0.42	0.14
2009													0.00							0.07		0.31	0.40	0.00	0.00	0.11	0.16	0.08	0.33	0.00
2008		0.00											0.36						0.14	0.55	0.00	0.28	0.46	0.54	0.54	0.48	0.81	0.35	0.17	0.33
2007		0.17											0.00						0.00	0.00		0.14	0.44	0.22	0.53	0.58	0.49	0.58	0.19	0.19
2006													0.00						0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005																						0.04		0.00	0.00	0.27	0.21	0.42	0.04	0.48
2004		0.00											0.00		0.00					0.64		0.50	0.00	0.73	1.00	0.76	0.71	0.77		
2003													0.28								0.06	0.52		0.59	0.68	0.76	0.81			0.40
2002		0.29																				0.43		0.68	0.74	0.83				0.91
2001		0.00										0.00								0.00	0.00	0.00		0.00	0.00	0.00				0.00
2000		0.00										0.00			0.00						0.00	0.48	0.46		0.52	0.62	0.48	0.38		0.00
1999		0.00		0.00			0.00					0.00	0.00			0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00
1998		0.00					0.09						0.00			0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00
1997		0.21					0.00					0.00	0.00			0.07				0.09	0.00	0.00				0.35	0.10	0.20		0.10
1996		0.00		0.00			0.00					0.00	0.00			0.00				0.00	0.00	0.00				0.10	0.00	0.00		0.00
1995		0.00		0.00			0.00					0.00	0.00			0.00				0.00	0.00	0.00				0.35	0.05	0.15		0.05
1994		0.05		0.00			0.00					0.00	0.14			0.00				0.00	0.00	0.17								0.17
1993		0.22		0.00			0.00					0.00	0.00			0.44				0.00	0.29	0.32								0.09
1992		0.45		0.30			0.29				0.00	0.22	0.70			0.46				0.30	0.67	0.80								0.83
1991		0.10		0.00			0.00			0.00		0.00	0.24			0.25					0.25	0.29								0.00
1990		0.00		0.00			0.00				0.00	0.00	0.46			0.21				0.40	0.13	0.17								0.56

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 17. Summary of the reproductive success of common murres by plot location, Cape Peirce, Alaska, 1990-2017.

	Plot																											
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11
2017																						0.00				0.00			0.00	
2016*																														
2014													0.00									0.50		1.00	0.00	0.39	0.25	0.50	0.33	
2013													0.11								0.75	0.44	0.20	0.00	0.33	0.43	0.54	0.67	0.46	
2012																														
2011													0.00						0.00		0.00	0.20	0.00	0.20	0.10	0.60	0.30	0.30	0.00	
2010																														
2009													0.40								0.70	0.70	0.40	0.00	0.00	0.40	0.30	0.10	0.30	
2008													0.30	0.00							0.20	0.10	0.00	0.20	0.00	0.00	0.00	0.00	0.00	
2007													0.00						0.00		0.60	1.00	0.00	0.50	0.20	0.90	0.00	1.00	0.00	
2006																							0.38	0.00	0.00	0.76	0.25	0.52	0.33	
2005													0.00	0.00					0.00		0.00	0.00		0.20	0.33	0.58	0.94	0.88	0.76	
2004																			0.60		0.25		0.00	0.44	0.63	0.83				
2003																			0.41		0.25	0.65	0.00	0.38	0.36	0.60		0.20		
2002																						0.29		0.90	0.63	0.82		0.20		
2001																					0.67	0.19		0.04	0.00	0.34				
2000																					0.00	0.60	0.50	0.20	0.60	0.80	0.30			
1999																					0.56	0.17		0.00	0.08	0.42	0.25			
1998																					0.50	0.14	0.17	0.00	0.00	0.27	0.24			
1997											0.00			0.38			0.47	0.00			0.40	0.37			0.06	0.60	0.31	0.50		
1996											0.00			0.08				0.00			0.60	0.26			0.00	0.35	0.80	0.72		
1995											0.53			0.41			0.78	0.92			0.30	0.28			0.00	0.29	0.29	0.47		
1994											0.00			0.19			0.57	0.37			0.33	0.18								
1993											0.38			0.65			0.00	0.88			0.75	0.41								
1992											0.69			0.37			0.89	0.96			0.74	0.39								
1991											0.55			0.44			0.81	0.75			0.71	0.26								
1990							0.00				0.55			0.52			0.06	0.88			0.47	0.38								

* In 2016, common murres were present on many plots but no incubation or brooding postures were observed

Appendix A (continued). Results of population and productivity monitoring at Cape Peirce and Cape Newenham, Alaska.

Table 18. Summary of pelagic cormorant productivity by plot location at Cape Peirce, Alaska, 1990-2017.

	Plot																												
Year	18	1	2	2A	3A	3C	4	5A	5B	6A	6B	7A	7B	7C	7D	7E	7F	7G	7H	7.1 A	8	9	10A	10B	10C	10DEF	10G	10H	10I	11
2017																										0.00				
2016*																														
2014							0.40			0.12					0.00					0.00		1.00		1.00		0.63	0.50	0.83		
2013				0.00	0.71	1.00	1.00	0.67	0.67													0.43		1.00		0.69	0.78	1.00		
2012					1.00		0.60	0.75												0.00		0.75		0.00	0.00	0.80	0.88	1.00		
2011		0.50													0.00						0.33	0.50	0.00		0.00	0.45	0.63	0.60	0.00	
2010													0.50									0.78	1.00		0.50	0.73	0.89	0.80	1.00	
2009													0.00									1.00				1.00	0.75	0.00	0.00	
2008				0.00	0.00		0.00			0.20					0.67					0.00	0.00			0.40	0.00	0.36	0.14	0.25	0.00	
2007				0.00	0.00		0.50		0.00										0.00	1.00	0.00			0.40	0.29	0.27	0.63	0.64	0.00	
2006		0.00		0.00	0.00	0.00			0.20																	0.42	0.71	0.50		
2005											0.00											0.00		0.00	0.00	0.27	0.20	0.00		
2004		0.00		0.00																		0.86		0.00	0.33	0.72	1.00	1.00		
2003													0.00								0.67	0.00		0.67	0.50	0.73		0.50		
2002		1.00	0.62	0.50	0.00																			1.00	1.00	0.75	0.60	0.88	1.00	
2001		0.00	1.00		0.43															0.00	0.00			0.00	1.00	0.64	0.62	0.74		
2000		1.00	0.33		0.20										0.50						0.60			0.40		0.70	0.58	0.83		
1999		0.50		0.50	0.50		0.00			0.00										0.00				0.00	1.00	0.50	1.00	0.50		
1998			0.59	1.00	0.68	0.00				0.28												0.00		0.00	0.17	0.67	0.22	0.00		
1997		0.50	0.79	0.17	0.00	1.00	0.00						0.00			0.00						0.00	0.00		0.33	0.57	0.50	0.71		0.71
1996		0.67			0.33		0.00				0.00											0.57	0.00		0.09	0.50	0.42	0.29		
1995											0.18											0.00	0.00	0.45		0.56	0.38	0.50		
1994		0.33			0.00		0.00					0.50										0.75		0.69		0.70	0.13	0.55		
1993		0.00			0.00		0.60					1.00										0.80		1.00		0.75	1.00	1.00		
1992		0.67			0.67		0.75															0.80		1.00		1.00	0.67	0.86		
1991		0.50					0.80															1.00		0.71		0.43	0.80	0.86		
1990		0.00					0.60					0.00										0.70			0.70	0.50	0.50	1.00		

* In 2016, 8 cormorant nests were observed and 5 contained 3-4 chicks. No follow up survery were done to determine productivity.

ˆ In 2017, all observed cormorant chicks disapeared during productivity monitoring.

Appendix B. Coordinates of plot stakes and rope tie-in posts at Cape Peirce and Cape Newenham.

Cape Peirce

Observation pt.	Latitude (N)	Longitude (W)	Tie-in post	Latitude (N)	Longitude (W)
18	58° 34.335	161° 45.569	Yes	58° 34.331	161° 45.560
1	58° 34.323	161° 45.578	Yes	58° 34.321	161° 45.569
2	58° 34.295	161° 45.542	No	--	--
3	58° 34.264	161° 45.496	No	--	--
4	58° 34.152	161° 45.459	No	--	--
5	58° 34.043	161° 45.484	Yes	58° 34.042	161° 45.464
6	58° 33.941	161° 45.529	Yes	58° 33.939	161° 45.501
7	58° 33.663	161° 45.649	Yes	58° 33.668	161° 45.614
7.1	58° 33.514	161° 45.978	No	--	--
8	58° 33.505	161° 46.010	No	--	--
9	58° 33.370	161° 46.164	Yes	58° 33.344	161° 46.164
10	58° 33.343	161° 46.154	No	--	--
11	58° 33.329	161° 46.165	Yes	58° 33.335	161° 46.159
12	--	--	No	--	--
13	--	--	No	--	--
14	--	--	No	--	--
15	--	--	No	--	--

Cape Newenham

Observation pt.	Latitude (N)	Longitude (W)	Tie-in post	Latitude (N)	Longitude (W)
DC point (Zen)	58° 37.943	162° 07.223	Post # 1	58° 37.987	162° 07.094
			Post # 2	58° 37.974	162° 07.149
			Post # 3	58° 37.963	162° 07.197
			Post # 4	58° 37.951	162° 07.206
Radar west	58° 37.912	162° 05.947	Yes?	~58° 37.9	~162° 07.1
East jagged	58° 37.557	162° 01.141	Yes	58° 37.565	162° 01.129
Oracle west	58° 37.487	162° 00.824	Yes	58° 37.501	162° 00.722