AMNWR 2021/03

TUFTED PUFFIN MONITORING AT EAST AMATULI ISLAND, ALASKA DURING 1995-2018

Arthur B. Kettle

Key words: Alaska, Barren Islands, chick diet, East Amatuli Island, *Fratercula cirrhata,* Gulf of Alaska, population trend, productivity, reproductive success, tufted puffin

U.S. Fish and Wildlife Service
Alaska Maritime National Wildlife Refuge
95 Sterling Highway, Suite 1
Homer, AK 99603

October 2021

Cite as: Kettle, A. B. 2021. Tufted Puffin monitoring at East Amatuli Island, Alaska during 1995-2018. U.S. Fish and Wildlife Service Report, AMNWR 2021/03. Homer, Alaska

TABLE OF CONTENTS **Page**

INTRODUCTION

The Alaska Maritime National Wildlife Refuge (AMNWR, or "Refuge"; administered by the U.S. Fish and Wildlife Service [FWS]) conducts annual ecological monitoring at nine sites throughout Alaska (Figure 1). The objective of this long-term monitoring program is to collect baseline status and trend information for a suite of seabird species representing piscivorous and planktivorous trophic guilds, including key species that serve as indicators of ecosystem health. Members of these guilds include surface-feeders and divers that forage in both nearshore and offshore waters. By comparing the seabird data with environmental conditions and information from other sites, ecosystem processes may be better understood. The data also provide a basis for directing management and research actions, and for assessing effects of management.

East Amatuli Island, within the AMNWR, has been a Refuge-funded annual monitoring site since 2000 (except in 2012 and 2015 when Refuge budget cuts precluded monitoring at this site; e.g. Kettle 2019). During the previous years 1993-1999, selected seabird species were monitored annually for oil spill damage assessment and recovery by the Refuge with funding from the *Exxon Valdez* Oil Spill Trustee Council (Roseneau et al 1996, 1997, 1998, 1999). Because of the vulnerability of the common murre (*Uria aalge*) to mortality from floating oil and because many murre carcasses were found on beaches in the Barren Islands and other areas after the 1989 spill, murre productivity and population monitoring received focused attention during those years. However, tufted puffins were also monitored. During 1993-1994, as USFWS technicians at East Amatuli, I and Margaret Blanding collected some tufted puffin data in order to continue work we previously conducted as technicians with the University of Washington. During 1995-1999, some puffin monitoring work was included in a multi-colony comparison project called the Alaska Predator Ecosystem Experiment (APEX), funded by the *Exxon Valdez* Oil Spill Trustee Council's marine research program. Tufted puffin monitoring continued during the annual AMNWR monitoring site work that began in 2000.

Earlier, University of Washington (UW) personnel (including me) studied tufted puffins (*Fratercula cirrhata*) at East Amatuli as part of post-*Exxon Valdez* oil spill biological work during 1990-1992. UW personnel also worked with tufted puffins during general biological studies conducted in 1976-1981. The work during 1976-1979 was reported in Manuwal (1980), Manuwal and Boersma (1977), and other publications (Amaral 1977; Pierce and Simons 1986). AMNWR personnel established four survey transects in in tufted puffin burrow habitat in 1986 (Nishimoto 1987).

This report presents methods and results from AMNWR monitoring of tufted puffins at East Amatuli Island during the period 1995-2018; some cliff counts from 1993-1994 are also included. The monitoring goals were to obtain indices of reproductive effort and success, population trend, chick diet, and chick growth. Results from chick growth monitoring and chick size will be presented in a future publication.

Any corrections or changes to the data presented in this report will be archived at the AMNWR headquarters in Homer, Alaska. Updates to the summary results from future monitoring work will be included in AMNWR annual reports.

STUDY AREA

East Amatuli Island (58°55' N, 152°10' W) is one of the seven Barren Islands, located between the Kodiak archipelago and the Kenai Peninsula (Figures 2, 3, and 4). The islands range in size from 10 to 2,800 ha, totaling about 4,000 ha. Geologically, the islands are a continuation of the Kenai Peninsula and are of mixed origin (from the map by Wilson et al. 2009). They are generally steep and tall, ranging to an elevation of

650 m. Among the eighteen species of seabirds that breed on the islands are about 75,000 pairs of fork-tailed storm-petrels (*Oceanodroma furcata*; Manuwal 1980), 25,000 pairs of black-legged kittiwakes (*Rissa tridactyla*; A. B. Kettle, AMNWR, unpublished data), 3,400 pairs of glaucous-winged gulls (*Larus glaucescens*; Manuwal 1980), 50,000 pairs of common murres (Roseneau et al. 2000), and 70,000 pairs of tufted puffins (Manuwal 1980).

Of the Barren Islands group, East Amatuli Island contains the highest seabird abundance. The island provides ledges physically suitable for cliff-nesting birds and contains substrate suitable for burrow-nesters. While the North American river otter (*Lontra canadensis*) is common across the Barren Islands, other population-limiting mammalian seabird predators, such as the northern red-backed vole (*Myodes rutilus*, present on West Amatuli and Ushagat islands) and the Arctic ground squirrel (*Spermophilus parryii*, present on Ushagat Island) are absent from East Amatuli.

Most of East Amatuli is comprised of steep slopes along an east-west spine ranging up to 470 m. Lower elevations are dominated by grasses and sedges; higher elevations by crowberry (*Empetrum nigrum*) and other maritime tundra plants.

High marine productivity around the Barren Islands provides seabird foraging habitat. Steep local bathymetry, the location at the entrance to Cook Inlet with its large tides and currents, the surrounding Alaska Coastal Current, and the strong winds of the area are water-mixing factors that contribute to this productivity.

Most of the tufted puffins on East Amatuli nest in long (about 1.5 arm-lengths) soil burrows; some nest in crevices among boulders. Presumably because of predation pressure from river otters, the burrow habitat consists of slopes gentle enough for soil retention surrounded by slopes that are steeper—perhaps steep enough to discourage otter travel. Much of the boulder habitat is atop peaks and ridges.

METHODS

Puffin Indices

Reproductive performance

During 1995-1998, tufted puffin productivity data were obtained from three permanently staked polygonal study plots established in 1993 (Plots AC, BC, C, totaling 794 m^2) and a set of four 3-m-wide strip transects ("FWST", lengths=13.5, 13.5, 35, and 37 m--totaling 270 m^2) established in 1986 by FWS crews for monitoring burrow count and occupancy (see Nishimoto 1987). During 1998, five new permanently staked polygonal productivity plots (OC, GC, EF, SF, and UEVR) similar in size to the original plots were added.

In the three productivity plots that were also growth-rate study plots (AC, BC, and C; [growth rate results will be presented in a future publication]), until 2016 burrows were first searched for signs of use and for nestlings during mid-July to early August, when most chicks were about 1 week old. We waited until then to search burrows because earlier checks can result in desertion of eggs and chicks by adults (Pierce and Simons 1986 and my observations). We used first observations of prey in flying puffins' bills (prey destined for chick meals) as an indicator for estimating when to start searching for chicks.

Plots OC, GC, EF, SF, and UEVR were checked during the first three weeks of August. During 2017 and 2018 burrows in all plots were first searched during 19-23 August and 22-24 August, respectively.

Before the start of fledging (the fledge-start period was estimated from chick growth monitoring), for all plots we counted "used" burrows (burrows with signs of use that season), unused burrows, and nestlings. Signs of burrow use were: (1) an egg or chick, (2) trampled and cleared vegetation, (3) guano from adults or chicks, (4) eggshell, (5) nest-padding material, (6) dropped fish, and (7) disturbed soil.

Because most burrows exceeded an arm's length, we used a 35-cm-long flexible handmade hoe-shaped tool to search for and retrieve nestlings. We could reach the end of most burrows. When we could not, we used the presence of thick, sticky guano inside or just outside the burrow as an indicator of chick presence. Because our search methods across years were similar (thereby reducing sampling bias), I have included all burrows (not just those with certain nest content) in the productivity index calculations.

Data analysis for reproductive performance

To measure reproductive output, I used two methods. For single-egg species (as is the tufted puffin), a common measure of whole-season reproductive performance is the proportion of sampled eggs that produced fledglings. Since we did not start with egg observations, however, for indices of productivity I substituted *Burrows* (and also *Burrows used*) for eggs. Since in some years we did not follow the fates of all nestlings through fledging, I substituted for fledglings the number of chicks we found in the plots.

To identify productivity trend and patterns and their associations with environmental correlations, this report summarizes and compares reproductive effort and output using these burrow and chick counts. As an index of breeding effort, I used the proportion of *Burrows used* to all *Burrows*. To indicate productivity, I used (1) the proportion of *Burrows* that contained *Chicks* and (2) the proportion of *Burrows used* that contained *Chicks*. While *Chicks / burrows* may include many burrows where there was not a breeding attempt, I included the metric because it avoids the somewhat subjective "*used*" classification method employed in the field for the *Burrows used* group.

Since the monitoring plots have fixed borders, other possible measures of reproductive effort or performance could be simply the absolute number of *Burrows used* or *Chicks* in the plots. However, observer disturbance and disturbance by river otters apparently artificially reduced the number of burrows in the monitoring plots though the years (see Population trend below). Therefore, while absolute counts of chicks and active burrows are presented in tables and charts in this report, I have not used those results to indicate natural trend or for comparison with environmental variables. I report these numbers separately for the older set of plots and the newer set because the plot sets had different rates of visitation by the field crews (plots AC, BC, C were regularly visited for growth rate measurements) and different monitoring year ranges.

It's possible that the ratio *Burrows used / burrows* in the study plots does indicate a natural pattern, and I have treated the ratio as if it does. However, growth-monitoring burrows (which are a subset of the study plots) were always in the *used* category, were visited more often, and were more likely to have a side-entrance dug than were inactive burrows. If these *used* burrows are more likely to collapse than are others, this could artificially bias the *Burrows used / burrows* ratio through time.

Population trend

To assess population trend, an obvious possible method--counting roosting adult puffins at the surface near their burrows--is difficult because the birds attend the surface only intermittently among days, and only during part of the breeding season. This type of count varies greatly between hours, days, and parts of the

nesting season. Therefore, counts of burrows themselves in study plots has commonly been used as a measure for population trend; this is one of the methods we used at East Amatuli Island.

However, after many consecutive years of burrow monitoring during the 1990s and 2000s it became apparent that our activities in the plots were negatively affecting the number of burrows we found. Burrows occasionally collapsed or otherwise becoming unsuitable for occupation. Activities with negative effects on the burrows included: (1) digging an artificial "shortcut" lateral excavation (the entrance was then covered with plywood) in order to find and retrieve chicks too deep to reach through the main entrance--these burrows were, over time, more likely to collapse; (2) inadvertent occasional burrow-crushing as we moved through the plots; (3) establishment of human paths that seemed to encourage exploration by predatory river otters--we observed river otters following our trails to study burrows and then excavating the burrows and eating chicks. All of these activities contributed to burrow loss through the years. Once a burrow became unused, generally it was not used again in following years, and eventually it disappeared.

Therefore, while burrow absolute counts are presented in tables and charts in this report, I have not used the results to indicate natural trend or in comparisons with environmental patterns.

Several times each monitoring year (range 4-25 times) we opportunistically counted with binoculars adult puffins in nine plots where puffins attended the surface near their burrows. Two [AC and BC] of these nine were also productivity monitoring plots. Most counts were made between 10:30 and 16:30. Although among-day variability in these counts was high, because of the problems with the burrow counts I have nonetheless included the binocular counts in this report as another measure of population trend.

To look for across-years trend in these binocular counts I selected those made during the period of highest and most consistent counts: 10-30 August. This period was determined from time-lapse analysis for the years 2014-2018. Of the 21 years with counts, in six years not all plots were counted during this date span. To use the data as fully as possible, I used the following method to summarize the counts: (1) For each plot, each year, I averaged the counts made during 10-30 August. (2) For each plot I found the among-year maximum of its annual means. (3) For each year, I summed the mean counts across plots. (4) I summed the among-year maximum means for all plots counted that year. (5) I divided the plot-means sum by the maximum-means sum. This proportion-of-maximum-means-sum was calculated using (1) all plot-count means available and (2) only plot-count means calculated from at least three counts made during 10-30 August.

Beginning in 2014 we deployed time-lapse cameras to periodically photograph tufted puffins on the surface in burrow habitat. This method allows us to obtain more counts of roosting birds and to better quantify count variability. Results from this method are not included in this report but will be used in the future to further quantify attendance variability and for monitoring population trends (and possibly productivity trends) in tufted puffins at this location.

Chick diet

During 1995-2017, samples (a "sample" was a bill-load, comprised of prey "items") of prey brought to puffin chicks by adults were collected by "screening" burrows in areas separate from the productivity/population monitoring plots. During the nestling period, for each screening session we blocked burrows for approximately 3.5 hours with entrance-size squares of 1/4-inch-mesh stiff steel screen. This occurred approximately every 7-10 days. In some years we also screened burrows on nearby West Amatuli Island.

Prey items were identified in the field using taxonomic keys and field guides and then cleaned, weighed (to 0.01 g), measured (fork length to 0.1 mm), and frozen. Percentage of the summed all-samples weight was calculated for taxonomic categories of prey: capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus)*, Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), prowfish (*Zaprora silenus*), pink salmon (*Oncorhynchus gorbuscha*), larval fish, squid, crustacea, and others (see Table 7). We also calculated for each prey type the percentage by number of all prey items and percentage by frequency of occurrence among screen samples. We included samples found at unscreened burrows—in both the screening areas and the productivity plots. But we did not include samples found by chance away from burrows—these samples would probably be biased toward larger, more-visible prey species, and toward partial samples.

Biomass is the primary measure used for statistical comparisons in this report. For these analyses I have used the six most prevalent prey categories: *Osmerid* (all osmerid samples have been identified as capelin; therefore I also use the term *Capelin*), *Salmonid* (all identified samples have been pink salmon), *Gadid* (mostly pollock and pacific cod), *Sand lance*, *Prowfish*, and *Unidentified larval fish*.

Beginning in 2017, we reduced the effort spent on screening burrows and replaced it with a photographic method of obtaining chick diet data. We photographed chick meals in adults' bills as the birds flew past an observation point on a headland near puffin habitat. We did this to (1) reduce disturbance to the nesting habitat and nesting birds (the limited availability of screening areas required repeat visits); (2) reduce effects on numbers of roosting birds in our time-lapse photographs of the habitat (the camera views overlap with the screening areas); (3) increase diet sample sizes (repeated screening of an area results in fewer sample returns over time); and (4) better sample entire bill-loads (screening often returns just partial loads). In 2018 this successful method replaced screening entirely. Species composition and frequency of occurrence from this method are reported here. Analysis of the images for biomass calculations (using prey item lengths estimated from comparisons with bill length), has begun but is not yet complete.

Comparison among puffin indices

The productivity and chick diet pooled-years results were compared statistically, both between the indices themselves and with environmental variables. I considered the binocular counts of roosting puffins (a potential source of population trend data) to be too variable and sparse for this type of comparison. For productivity comparisons I used the dataset with the longest monitoring history—that for the older set of plots AC, BC, C, and FWST.

The breeding and diet parameter results were compared with each other to examine which factors appeared to vary independently and which covaried. I used correlation analysis with significance levels ("hmisc" package in "R": "rcorr" function; type="pearson", Harrell et al. 2020; significance level 0.05).

These and the environmental comparisons were exploratory—for observing patterns and forming initial inquiries. Because of the large number of comparisons made, some significant correlation results would be expected to occur randomly. In addition, some of the data series contain temporal autocorrelation, so that some consecutive-time-unit significant results (especially consecutive months of sea temperature) may not be independent from each other; I have not analyzed autocorrelation here.

Correlation analysis of the chick diet data needs an additional measure of caution. Because they are compositional data (each diet category is a proportion of the whole collection), the categories of prey are not independent from each other—for a given set of prey types, an increase in one type must by definition be offset by a decrease in at least one of the other prey types. Were there only two prey types, it wouldn't

make sense to look for a correlation between the two. But with three or more prey categories, exploring patterns of the birds' use of the types through time may be useful, so I have included those results here.

Comparison among monthly environmental indices and
Comparison of annual puffin indices with monthly environmental indices

To search for environment correlates of puffin reproductive success and chick diet, I compared the reproductive and diet indices with environmental indices. I chose environmental indices that both had adequate time-series length and seemed fundamental to changes in the physical environment: sea-surface temperature (SST) anomaly and an atmospheric pressure index. Because environmental changes occur within each year, and because I was interested in effects on components of productivity and diet that occur at various times of each breeding season (and pre-breeding season), I used monthly values of the environmental indices.

Uncertain whether local or broader-scale SST would be more important, I used several SST datasets. These datasets were from: (1) dataloggers we deployed at Amatuli Cove, East Amatuli Island; (2) a NOAA tide station at Seldovia (Station 9455500, 55 km north of East Amatuli [eleven consecutive plus one other months of erroneous data were replaced with data from an adjacent sensor operated by the Kachemak Bay Research Reserve]); (3) the University of Alaska "GAK1 Mooring" outside Resurrection Bay (near Seward); and (4) NOAA Buoy 46001, 324 km southeast of Kodiak. For each of these datasets the anomaly from the among-years mean for each month was calculated; this monthly anomaly was the index used for comparisons. The station locations are shown in Figure 2.

I also used the Pacific Decadal Oscillation monthly index, defined as:

"...the leading PC [principal component] of monthly SST anomalies in the North Pacific Ocean, poleward of 20N. The monthly mean global average SST anomalies are removed to separate this pattern of variability from any 'global warming' signal that may be present in the data" (Mantua 2017).

When this index has a high positive value, SST is generally high along the west coast of North America from Alaska to the equator, and cool in the central North Pacific. When the index is strongly negative, the opposite spatial SST pattern occurs. This is illustrated in Appendix 7.

The atmospheric pressure index used was the North Pacific Index (NPI), defined as:

"The...area-weighted sea level pressure over the region 30°N-65°N, 160°E-140°W. The NPI is defined to measure interannual to decadal variations in the atmospheric circulation. The dominant atmosphere-ocean relation in the North Pacific is one where atmospheric changes lead change in sea surface temperatures by one to two months." This definition and the NPI dataset are from Hurrell et al. 2020.

These six monthly environmental variables were first tested for associations between themselves using correlation analysis with significance levels ("rcorr" function, type="pearson", in "hmisc" package in R, significance level 0.05).

I used the same correlation analysis and significance levels to compare the monthly environmental values with the breeding parameters.

To see whether environmental changes during the two years before the breeding year were important, in addition to testing correlation with matched-year monthly environmental variables and breeding

parameters, the tests were repeated with time-“lagged” breeding parameters—the breeding parameter values were paired with environmental values from the previous year, and from two years previous.

RESULTS AND DISCUSSION

Among-year patterns in puffin indices

Reproductive performance

In the four plots with the longest monitoring history (AC, BC, C, and FWST) and the five newer plots (OC, GC, SF, EF, and UEVR) counts of *Burrows* and *Burrows used* declined through the years (Figures 8 and 9; Tables 5 and 6). As stated in the Methods section, it’s likely that human observer effects played a role in these declines.

The proportion of *Burrows used* varied among years, between about 0.2 and 0.8 *Burrows used* per all burrows (Figure 5; Tables 5 and 6). Across years, the proportion exhibited a slight declining trend, but this was not significant (“lm” and “summary” functions in R, significance level 0.05).

The absolute number of *Chicks* found in the plots declined through the years in both plot sets (Figure 11; Tables 5 and 6). The number of chicks would be affected by the decline in the number of burrows. As stated in Methods, to try to control for this, I calculated as an alternative productivity index the proportion of *Burrows* with *Chicks*.

This proportion varied across years, from about 0.1 to about 0.5 *Chicks / burrows* (Figure 6; Tables 5 and 6). The index decreased steeply during 1995-1998, then increased and stayed high to the mid-2000s, and then gradually declined (there were no data for three of the later years [2012 and 2015-2016], however). 1998 (a strong-El Niño year) and 2013-2014 stood out as low-value years.

The proportion of *Chicks* to just the *Burrows used* followed a similar pattern overall (Figure 7; Tables 5 and 6). This proportion varied from about 0.2 to 0.9. Among the earlier years, 1998 was particularly low, and among all the years 2009 was high.

Population trend

As stated above, the number of *Burrows* found in the four plots with the longest monitoring history has declined dramatically through the period. This pattern is evident in both the four older plots (AC, BC, C, and FWST) and the five newer plots (OC, GC, SF, EF, and UEVR; Figure 8, Table 5).

The number of *Burrows used* had a steeper and more consistent decline than did the number of burrows classified as *not used* (Figures 9 and 10; Tables 5 and 6). During the 1998 strong-El Niño period there was a spike in the number of borrows not used.

This decline in burrow counts was not reflected by the binocular-aided counts of adult puffins roosting at the surface (Figures 12-14; Appendix 5). Most of the binocular counts were from plots not subject to in-person burrow-counting visits. The binocular counts were highly variable. With the variability in mind, however, whether represented by mean counts or a maximum count from each year, the counts did not show evidence of the decline shown by the number of burrows in the plots. This result seems to agree with

our impression that researcher activities have at least contributed to the decline of burrows in the study plots.

Chick diet

Fish comprised more than 90 percent of the mass of chick diet samples in all years (Figure 17; Table 9). Among years, *Capelin* was generally the prey type with the highest biomass in chick diet samples; the biomass proportion varied among years. In some years the biomass proportion of *Capelin* was close to 90 percent; in other years the *Salmonid*, *Gadid*, or *Sand lance* categories showed biomass higher than *Capelin*.

The pink salmon in samples were much larger than other fish types, and therefore were high in biomass relative to composition. Other categories represented consistently were *Larval fish, Cephalopod*, and very small *Crustacea*. *Prowfish* were seen in some years. There was a single year (2014) with juvenile *Sebastes* rockfish (*Scorpaenidae*) in chick diet samples—these fish comprised ten percent of the sampled biomass that year.

At East Amatuli Island, the diet of tufted puffin chicks is much more diverse than that for common murres. In most years during 1995-2013 more than 90 percent of murre chick diet composition was capelin (Kettle 2017). Tufted puffins may be less selective than murres in the prey they collect for their chicks; or may forage in locations or depths with more diverse prey availability.

Results from correlation tests

These correlation test results are summarized from the annotated correlation tables in Appendix 2. The annotated tables were in turn derived from the numeric tables in Appendices 3, 4, 9, and 10. It may be useful to view Appendix 2 while reading this section.

As stated in Methods, the correlation tests were exploratory—for observing patterns and forming initial inquiries. Because of the large number of comparisons made, some significant results would be expected to occur randomly. In addition, some of the series contain temporal autocorrelation, so that some consecutive-time-unit significant results (especially consecutive months of sea temperature) may not be independent from each other; I have not analyzed autocorrelation here.

Correlation analysis within breeding parameters and chick diet

The two chicks/burrows productivity parameters (*Chicks / burrows* and *Chicks / burrows used*) were significantly associated with each other.

The *Chicks / burrows used* index was negatively associated with a higher proportion of *Gadid* in chick diets. There was correlation across years in this relationship—there was significance with the previous-year *Gadid* values and with the 2-years-previous values.

The proportion of *Capelin* biomass in chick diets was negatively associated with the same-year proportion of *Salmonid*, *Gadid*, and *Prowfish*.

Comparisons between environmental variables

Most of the SST indices (including the PDO) were strongly positively correlated with each other for most months (see Appendices 9 and 10). The least similar pair in the comparisons was Buoy 46001 and the GAK1 mooring. The NPI was not strongly correlated with the SST indices for most months; the few significant correlations were negative.

Comparisons of breeding parameters and chick diet with environmental variables

The two productivity indices (*Chicks / burrows* and *Chicks / burrows used*) were negatively correlated with same-year April SST at Buoy 46001. C*hicks / burrows used* was also negatively correlated with same-year April *Seldovia SST* and *PDO*. Warmer spring SST in these measures in April was statistically associated with reduced productivity.

The biomass proportion of *Capelin* in chick diet was negatively associated with same-year PDO in the months August through November. Although most of these months were after the breeding season, on the numeric correlation table (Appendix 4), earlier months' PDO values were similarly associated--but not at the 0.05 significance level. According to the numeric correlation tables (Appendix 4), this association occurred for other SST measures also--but not at the 0.05 significance level.

There was also agreement among some SST indices of higher *Capelin* proportions with higher SST during spring or summer one year previous to the chick diet year. It's possible (and in several ways conjectural) that warmer water is positively associated with early stages of capelin growth—and that this contributes to chick diets the next year.

Salmonid in chick diets showed some results opposite that of *Capelin*. Keeping in mind the proportions caveat (by definition a higher proportion of one diet component will cause a lower proportion of one or more other components, if the components list is consistent) and the high correlation between the various SST indices themselves, *Salmonid* was a higher proportion of chick diet biomass when same-year *Seldovia SST* was higher in July and October. Higher *Salmonid* proportion was significantly related to lower one-year-previous spring SST at some locations. The correlation table (
Appendix **4**) shows agreement at insignificant levels for similar months, for some of the other SST measures.

Gadid in chick diets showed same-year correlation results somewhat similar to those for *Salmonid*: Several same-year months' SST indicators showed positive same-year correlation with *Gadid* in the diets. Most of these months were after the breeding season, but the numeric correlations table (Appendix 4) shows congruous patterns for earlier months, at insignificant levels. There were not significant results for tests with previous-years SST, as there was for *Salmonid*.

There were some significant correlations between seabird and SST indices for same-year, post-breeding-season months. While it may seem that SST anomalies measured after the breeding season could not affect birds' breeding performance or chick diet during the breeding season, it's possible that the effects occurred before the breeding season at a location south of areas of the selected SST datasets (or, for the PDO, in just a southern portion of the dataset range). Perhaps the birds' pre-breeding activities, or conditions for later prey availability, occurred in the south. The water mass (or the conditions that cause the changes in SST) could then have moved north and been first detected there after the breeding season. Another possibility is that statistically non-significant SST anomalies affect the birds' breeding performance

or prey availability during the breeding season, but then the same SST anomalies become stronger (and statistically significant) after the breeding season.

SUMMARY

Reproductive performance, chick diet, and population trend

The number of *Burrows* in the visited plots declined through the monitoring years. There was a steeper decline in *Burrows used* than in unused burrows.

Repeated visits through the years to tufted puffin burrow plots may have contributed to or caused the decline in the number of burrows in those plots. This decline prevented the use of a simple and direct index of productivity: the number of chicks produced each year in a set of fixed plots. We are currently testing methods of monitoring tufted population trend, productivity, and diet that do not require burrow visits. Hopefully these methods will provide good long-term options for tufted puffin monitoring at this site.

During the 1998 strong-El Niño year there was a spike in the number of borrows not used and a sharp dip in *Chicks / burrows* and *Chicks / burrows used*. Perhaps this event, which warmed water deeply in the Gulf of Alaska in the winter months, contributed to the low number of breeding attempts and chicks during the summer.

The proportion of burrows used did not show a significant overall trend. While the absolute counts of *Burrows* and *Burrows used* declined, the proportion of burrows used each year did not.

The proportion of burrows with chicks was highest at the start (1995-1996) and middle (1999-2009) of the span of burrow-monitoring years (1995-2018). Some individual years of warmest SST appeared to have the lowest chicks/burrows values—but this association was not consistent enough through the other years to make overall correlation results significant. Perhaps there is association for just the unusually warm years.

Capelin was the largest biomass component of chick diet samples. Other major components were S*and lance*, *Salmonid* (all pink salmon), and *Gadid* (mostly walleye pollock). There were no obvious overall trends in proportion among the diet categories.

At East Amatuli Island, the diet of tufted puffin chicks is more diverse than that for common murres.

There was significantly more *Capelin* when there was less *Salmonid*, *Gadid*, and *Prowfish*. There was more *Prowfish* when there was more *Gadid*.

There was less *Gadid* in years when the *Chicks* / *Burrows used* index was higher.

Correlation between environmental indices

There was overall positive correlation among the SST indices. It's interesting to find SST synchrony among the PDO index, the mooring on the continental shelf near Kodiak, the mooring in a cove at East Amatuli Island, and the pier in Seldovia Bay.

The North Pacific Index was not strongly associated with the SST indices.

Correlation of reproductive performance and diet with environmental indices

There was some indication that warmer spring SST at some locations was associated with lower *Chicks / burrows* values.

Higher late-summer values for the Pacific Decadal Oscillation (PDO)—among the SST indicators used, that with the largest overall geographic range in the North Pacific—were associated with lower chick-diet proportion of *Capelin*. The *Gadid* association was opposite that of *Capelin* for similar PDO months: higher PDO was associated with higher proportion of *Gadid* in chick diets. If this is a real, mechanistic association, it could be significant for tufted puffins—capelin are more energy-rich than gadids are. Perhaps this association is related to the lower *Chicks* / *Burrows used* values found in years of higher chick-diet *Gadid* proportion and higher SST for some SST datasets.

Future work

These preliminary analyses and summary results will be examined in more detail in future publications.

ACKNOWLEDGMENTS

Edgar ("Ed") P. Bailey, as a U.S. Fish and Wildlife employee, in 1974 and 1975 made the first quantitative reconnaissance of seabirds in the Barren Islands (Bailey 1975, 1976) and assisted the University of Washington (UW) with establishing their East Amatuli field camp in 1976.

In the 1970s and early 1980s, University of Washington faculty and students established the field camp and some of the study areas, made initial surveys of the seabirds and their habitat, and began the first biological studies of seabirds at East Amatuli Island. Dr. Boersma returned to the island in 1990 and continued some of these studies through 1993.

Alaska Maritime NWR seabird monitoring work at East Amatuli during 1993-1999 was funded by *Exxon Valdez* Oil Spill Trustee Council projects 93049, 94039, 95039, 95163-E, 95163-J, 96163-J, 97163-J, 98163-J, 99163-J, and 00163-J (Roseneau et al. 1995, 1996a, 1996b, 1997, 1998, and 1999). Alaska Maritime NWR biologist Dave Roseneau was the Principal Investigator for these projects (except 95163-E). Vernon Byrd also assisted with these projects. Technicians Margi Blanding and Stephanie Zuniga assisted greatly during these years with plot establishment and mapping, data collection and organization, protocol documentation, field season preparation, and field camp maintenance.

Through the years, excellent vessel transportation of crew and gear was provided by the M/V *Kittiwake II,* the M/V *Waters*, Homer Ocean Charters, Alaska Coastal Marine, and USFWS's R/V *Tiglax*. Northwind Aviation and Steller Air provided occasional floatplane service, and Maritime Helicopters provided helicopter transportation.

The staff at the Alaska Maritime National Wildlife Refuge provided planning, logistical, and communications support.

Aaron Christ, Brie Drummond, and Marc Romano provided very helpful reviews of the report.

Thanks to all of the many Biological Science Technicians and volunteer field assistants (listed in Appendix 1) who helped with East Amatuli Island tufted puffin monitoring through the years.

REFERENCES

Amaral, M. J. 1977. A comparative breeding biology of the tufted and horned puffins in the Barren Islands, Alaska. M. Sc. Thesis, University of Washington, Seattle WA.

Bailey, E. P. 1975. Breeding bird distribution and abundance in the Barren Islands, Alaska. U.S, Fish and Wildlife Service Report, AMNWR 75/15. Homer, Alaska.

Bailey, E. P. 1976. Breeding bird distribution and abundance in the Barren Islands, Alaska. Murrelet 57:2-12.

Harrell, F. E. Jr, with contributions from Charles Dupont and many others. 2020. Hmisc: Harrell Miscellaneous. Version 4.4-2. URL: http://CRAN.R-project.org/package=Hmisc.

Hurrell, J. W. & National Center for Atmospheric Research Staff (Eds). Last modified 14 Aug 2020. "The Climate Data Guide: North Pacific (NP) Index by Trenberth and Hurrell; monthly and winter." Retrieved from: https://climatedataguide.ucar.edu/climate-data/north-pacific-np-index-trenberth-and-hurrell-monthly-and-winter.

Kettle, A. B. 2017. Common murre monitoring at East Amatuli Island, Alaska during 1993-2014. U.S. Fish and Wildlife Service Report, AMNWR 2017/11. Homer, Alaska.

Kettle, A. B. 2019. Biological monitoring at East Amatuli Island, Alaska in 2018. U.S. Fish and Wildlife Service Report, AMNWR 2019/13. Homer, Alaska.

Mantua, N. 2017. The Pacific Decadal Oscillation (PDO). <http://research.jisao.washington.edu/pdo/>. PDO dataset from < http://research.jisao.washington.edu/pdo/PDO.latest>.

Manuwal, D. A. 1980. Breeding biology of seabirds on the Barren Islands, Alaska. Unpublished report, U.S. Fish and Wildlife Service, Office of Biological Services, Anchorage, Alaska.

Manuwal, D. A. and P. D. Boersma. 1977. Dynamics of marine bird populations on the Barren Islands, Alaska. Pp. 294-420 *in* Environmental assessment of the Alaskan Continental Shelf. Annual reports of principal investigators, vol. 4. Boulder, Colorado, NOAA, Environmental Research Laboratory.

National Oceanic and Atmospheric Administration. 2021. The Pacific Decadal Oscillation. https://www.ncdc.noaa.gov/teleconnections/pdo/.

Nishimoto, M, K. Thounhurst, and S. Kirkhorn. 1987. The status of fork-tailed storm-petrels and other seabirds at East Amatuli Island during 1986. U.S. Fish and Wildlife Service Report, AMNWR 1987/05. Homer, Alaska.

Pierce, D. J. and T. R. Simons. 1986. The influence of human disturbance on tufted puffin breeding success. The Auk 103:214-216.

R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Roseneau, D.G, A.B. Kettle, and G.V. Byrd. 1996. Barren Islands seabird studies, 1995. Unpublished annual report by the Alaska Maritime National Wildlife Refuge, Homer, Alaska for the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska (APEX Project 96163J). 34 pp.

Roseneau, D.G, A.B. Kettle, and G.V. Byrd. 1997. Barren Islands seabird studies, 1996. Unpublished annual report by the Alaska Maritime National Wildlife Refuge, Homer, Alaska for the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska (APEX Project 96163J).

Roseneau, D.G, A.B. Kettle, and G.V. Byrd. 1998. Barren Islands seabird studies, 1997. Unpublished annual report by the Alaska Maritime National Wildlife Refuge, Homer, Alaska for the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska (APEX Project 97163J).

Roseneau, D.G, A.B. Kettle, and G.V. Byrd. 1999. Barren Islands seabird studies, 1998. Unpublished annual report by the Alaska Maritime National Wildlife Refuge, Homer, Alaska for the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska (APEX Project 98163J).

Roseneau, D.G, A.B. Kettle, and G.V. Byrd. 2000. Common murre population monitoring at the Barren Islands, Alaska, 1999. Unpublished annual report by the Alaska Maritime National Wildlife Refuge, Homer, Alaska for the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, Alaska (APEX Project 99144).

Wilson, F. H., C. P. Hults, H. R. Schmoll, P. J. Haeussler, J. M. Schmidt, L. A. Yehle, and K. A. Labay (compilers). 2009. Preliminary Geologic Map of the Cook Inlet Region, Alaska, Including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak 1:250,000-scale quadrangles. Open-File Report 2009-1108. U.S. Department of the Interior, U.S. Geological Survey.

FIGURES AND TABLES

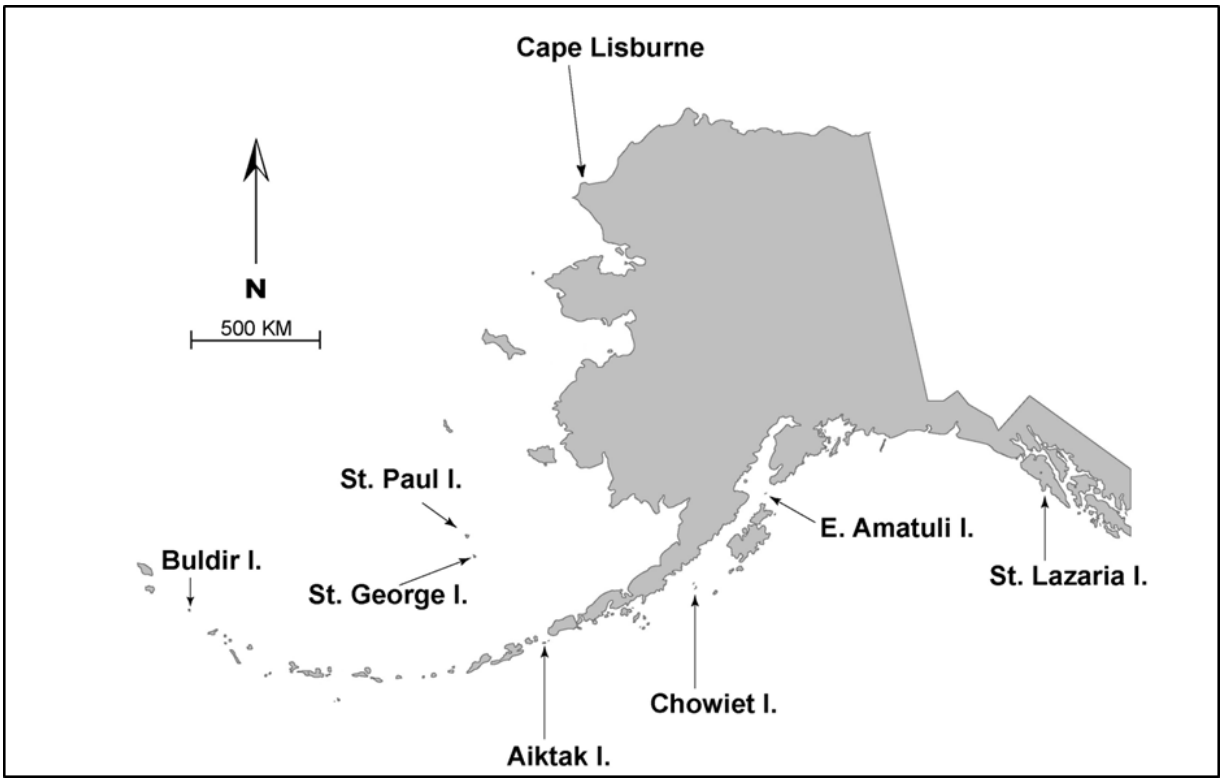


Figure 1. Location of East Amatuli Island and other annual monitoring sites across the Alaska Maritime National Wildlife Refuge.

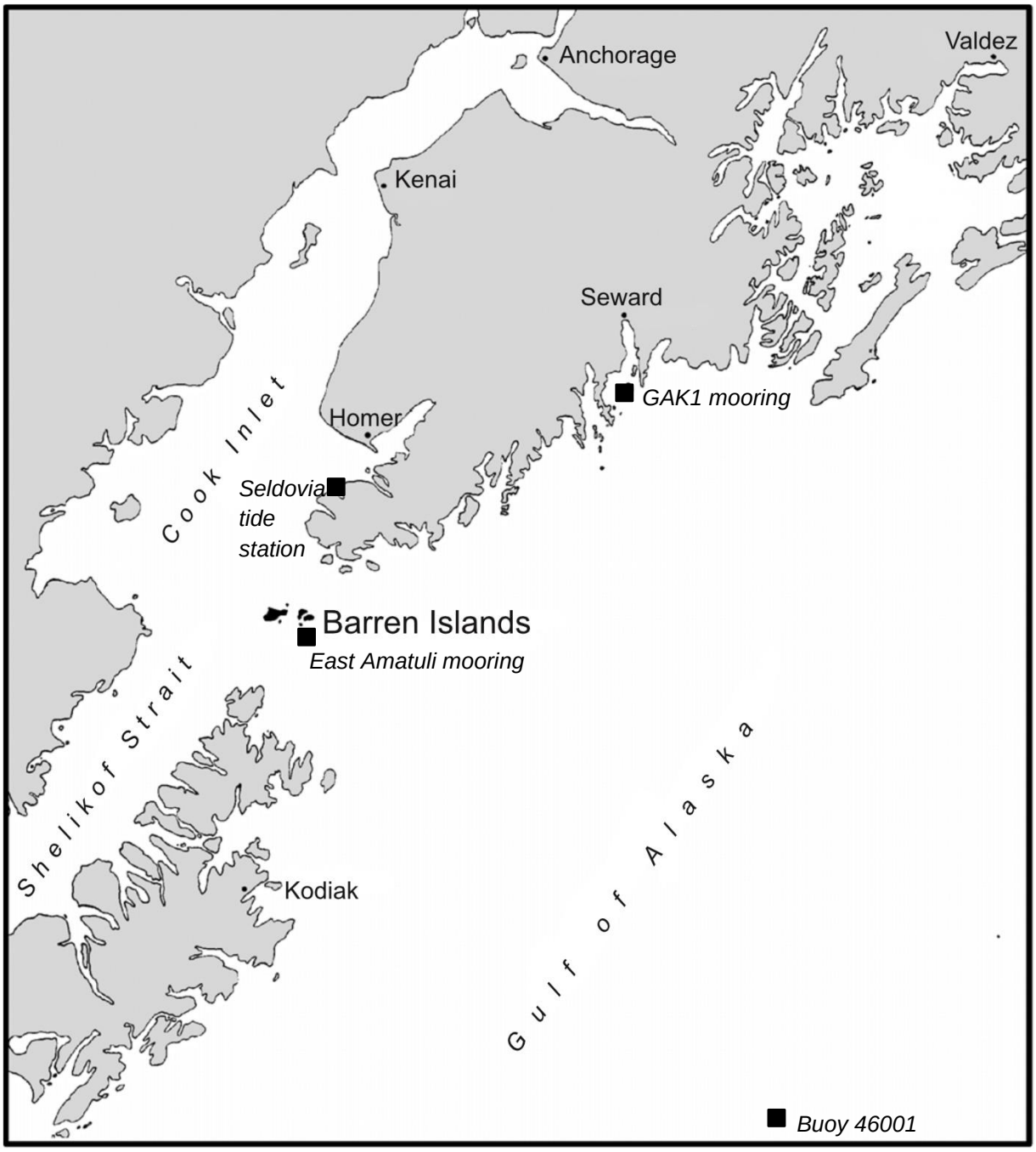


Figure 2. Location of the Barren Islands, Alaska and sea-surface temperature sensor locations (black squares).

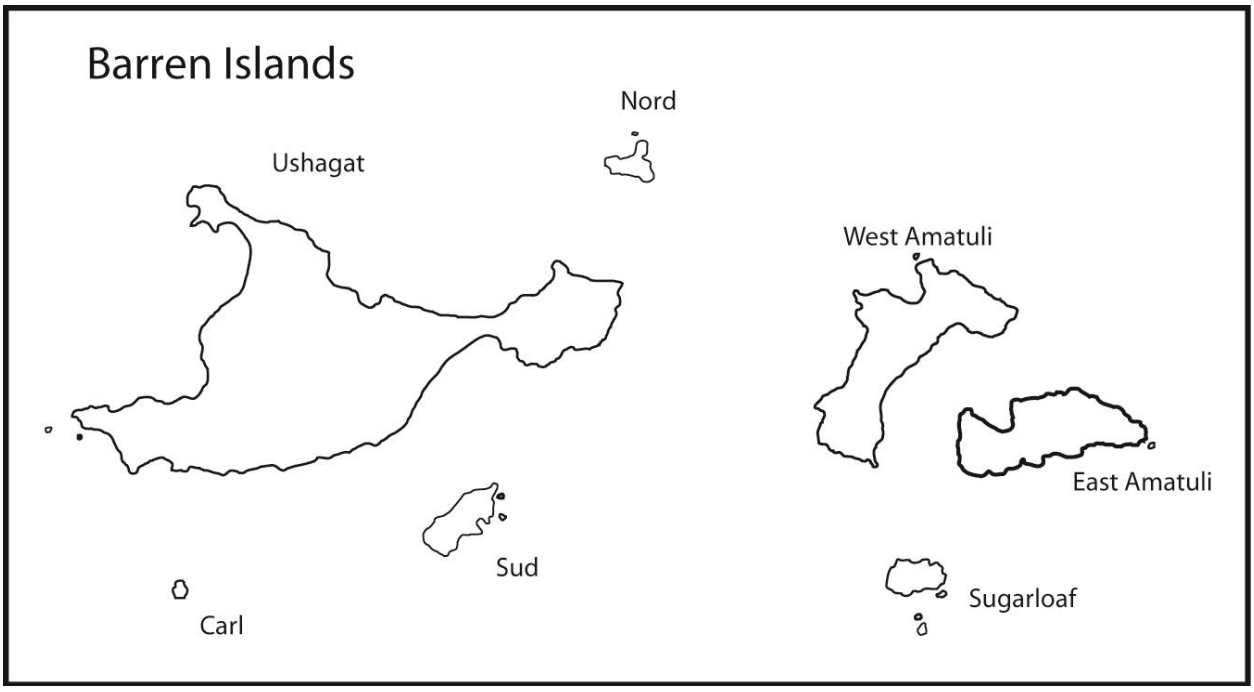


Figure 3. Map of the Barren Islands group.

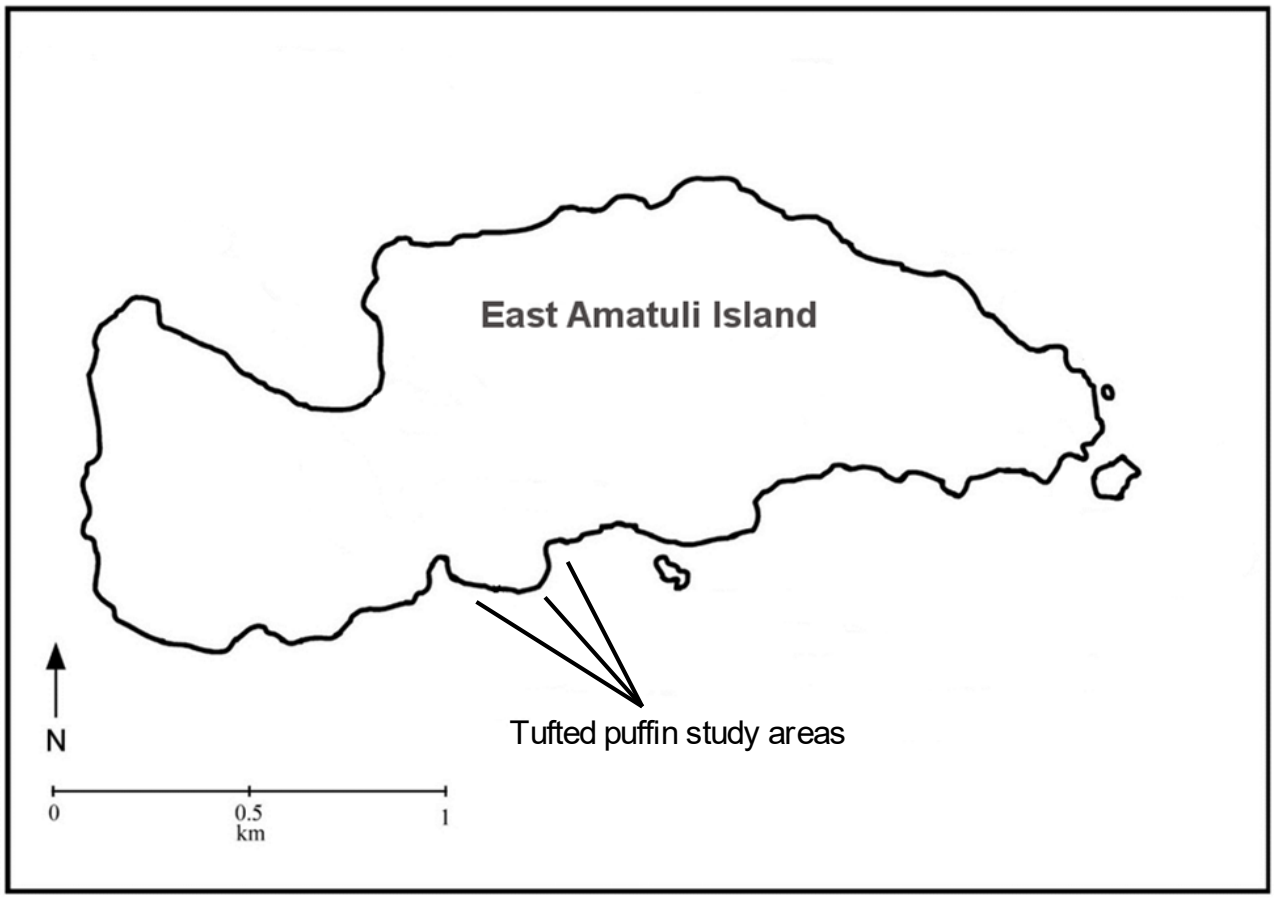


Figure 4. East Amatuli Island, showing locations of tufted puffin monitoring areas.

Table 1. Breeding, diet, population, and environmental index descriptions, terms used in the text, and terms used in the Appendix correlation tables.

Term used in text	Parameter description	Term used in Appendix tables
Burrows	All burrows in study plots	-
Burrows used	Study plot burrows classified as “Used this season”	-
Burrows used / Burrows	Proportion of all burrows classified as used	-
Chicks / burrows	Chicks in the study plots divided by the number of burrows found	ch/burr
Chicks / burrows used	Chicks found in the study plots divided by the number of used burrows found	ch/burr_u
Osmerid, Capelin	Percentage by weight of osmerids (has been all capelin) in chick diets	osmerid
Salmonid	Percentage by weight of salmonids (has been all pink salmon) in chick diets	salmonid
Gadid	Percentage by weight of gadids (pollock and cod) in chick diets	gadid
Sand lance	Percentage by weight of ammodytids (sand lance) in chick diets	ammodytid
Prowfish	Percentage by weight of zaprorids (prowfish) in chick diets	zaprorid
Larval fish	Percentage by weight of larval fish (mostly unidentified) in chick diets	larval_fish
Lag 0	In a comparison of biological or environmental indices, one index is matched with an index from the same year	lag0
Lag 1	In a comparison of biological or environmental indices, one index is matched with an index from the previous year	lag1
Lag 2	In a comparison of biological or environmental indices, one index is matched with an index from two years previous	lag2
For comparisons using environmental indices (for index descriptions see Methods and Figure 2):		
Seldovia SST	Sea surface temperature (SST) at the NOAA tide measurement station in Seldovia, Alaska	Seldovia SST
Amatuli SST	Sea surface temperature (SST) at Amatuli Cove, East Amatuli Island, Alaska	Amatuli SST
GAK1 SST	Sea surface temperature (SST) at the GAK1 oceanographic mooring near Seward, Alaska	GAK1 SST
46001 SST	Sea surface temperature (SST) at the NOAA oceanographic mooring east of Kodiak Island, Alaska	46001 SST
PDO	The Pacific Decadal Oscillation index	PDO
NPI	The North Pacific Index	NPI

Table 2. Monitoring years at East Amatuli Island, Alaska for tufted puffin breeding parameters used in this report. Parameters are explained in Methods and

Table 1. Checkmarks show years monitored.

Parameter	Year																							
	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Chicks / burrows	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓
Chicks / burrows used	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓
Chick diet	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	-	✓	✓

Table 3. Environmental variables used in this report for comparison with tufted puffin breeding parameters, and the number of months of data available for each year.

Variable	Year																							
	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Seldovia SST monthly anomaly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	9	11	12
NOAA buoy 46001 SST monthly anomaly	12	12	12	12	12	12	12	12	12	9	12	11	5	12	12	12	12	12	12	12	12	12	12	12
GAK1 moored buoy SST monthly anomaly	-	-	-	10	1	12	12	12	9	8	12	12	12	12	12	12	12	12	12	12	12	12	12	12
East Amatuli Island SST monthly anomaly	-	3	3	7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
North Pacific Index (monthly)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Pacific Decadal Oscillation (monthly)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	9

Table 4. Environmental variables used for comparison between themselves in this report, and the number of months of data available for each year.

Variable	Year																																			
	76	77	78	80	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Seldovia SST monthly anomaly	12	9	8	7	12	12	12	12	12	12	12	12	12	11	12	8	7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
NOAA buoy 46001 SST monthly anomaly	6	12	10	11	12	12	12	7	12	12	12	12	9	12	12	12	8	12	12	12	12	12	12	12	12	12	9	12	12	7	12	12	12	12	12	12	12
GAK1 moored buoy SST monthly anomaly	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	1	12	12	12	12	8	12	12	12	12	12	12	12	12	12	2
East Amatuli Island SST monthly anomaly	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	9
North Pacific Index (monthly)	-	-	-	-	-	-	-	-	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Pacific Decadal Oscillation (monthly)	-	-	-	-	-	-	-	-	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

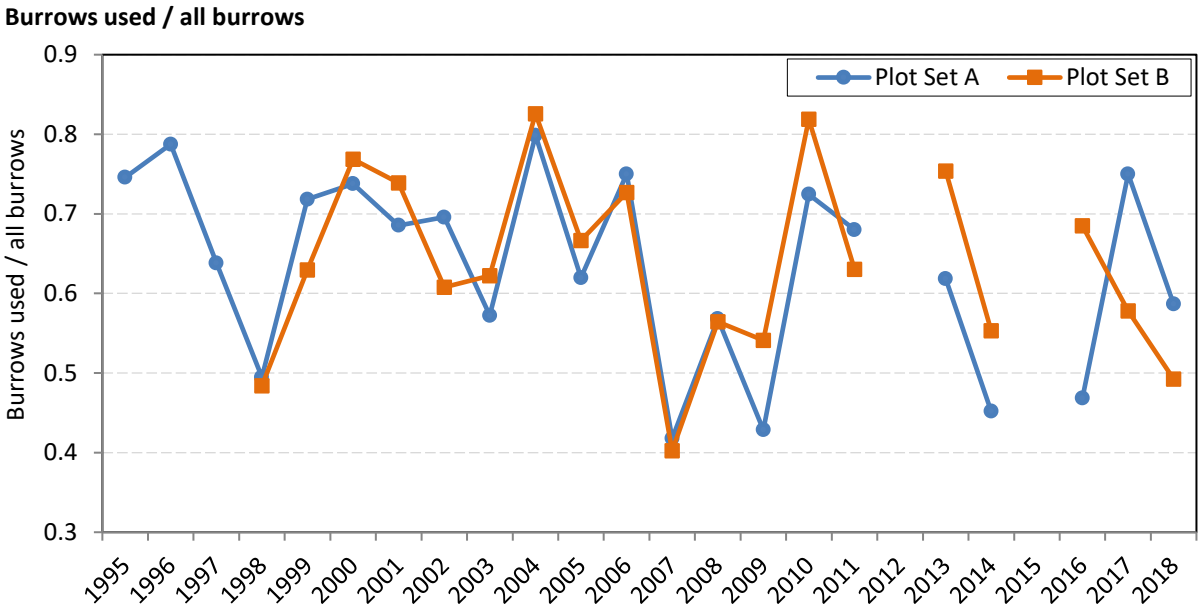


Figure 5. The proportion of burrows counted that were categorized as “Used” in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

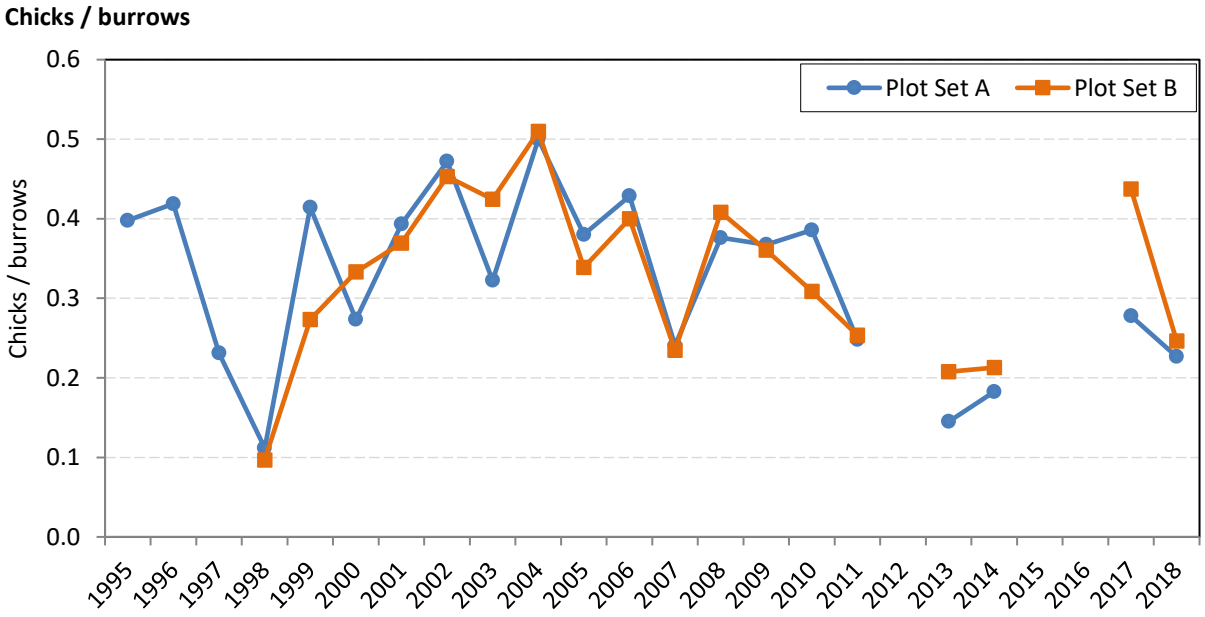


Figure 6. The proportion of burrows counted that contained chicks in plots at East Amatuli Island, Alaska. Each point is the number of chicks summed across plots divided by the summed number of burrows. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

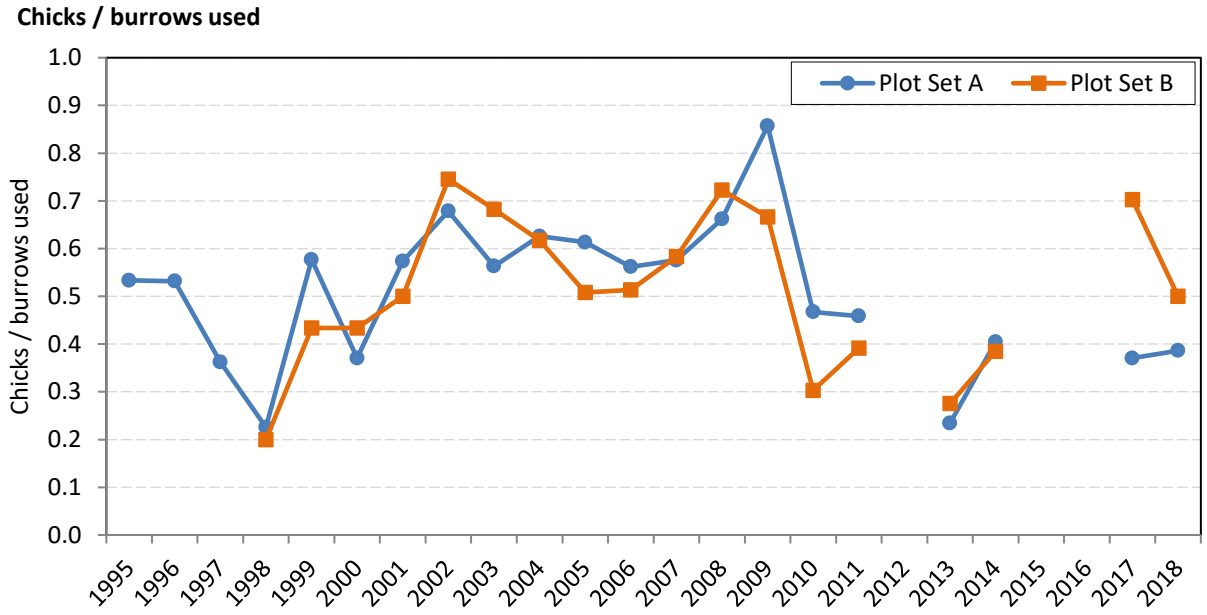


Figure 7. The proportion of used burrows that contained chicks in plots at East Amatuli Island, Alaska. Each point is the number of chicks summed across plots divided by the summed number of used burrows. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

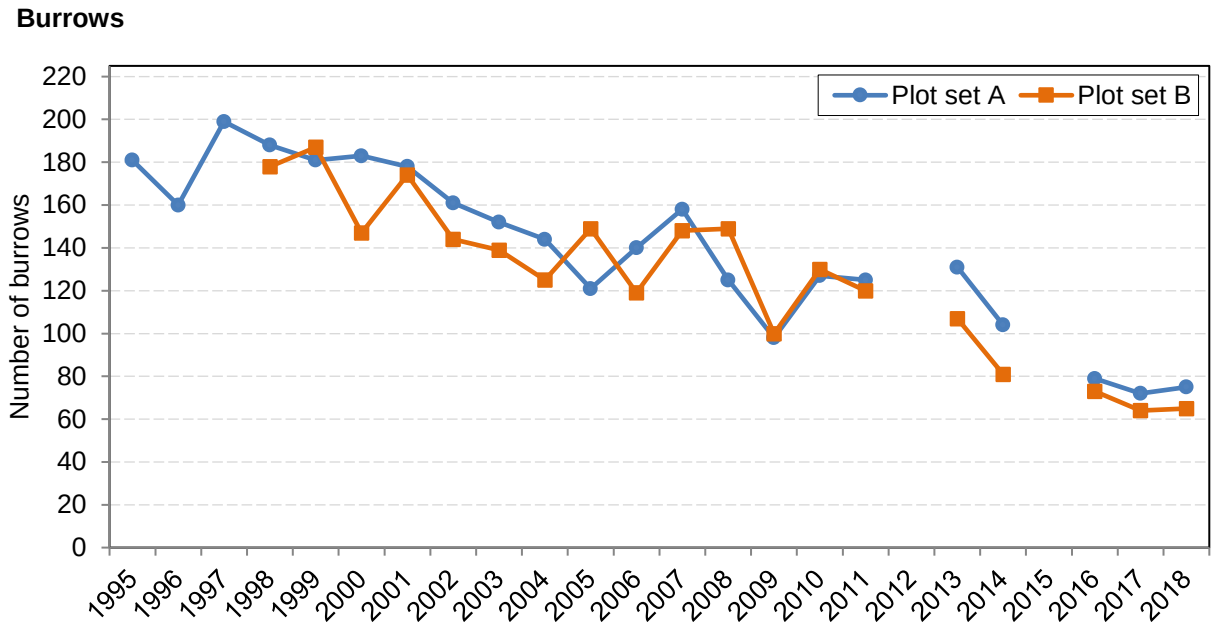


Figure 8. Number of tufted puffin burrows counted in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

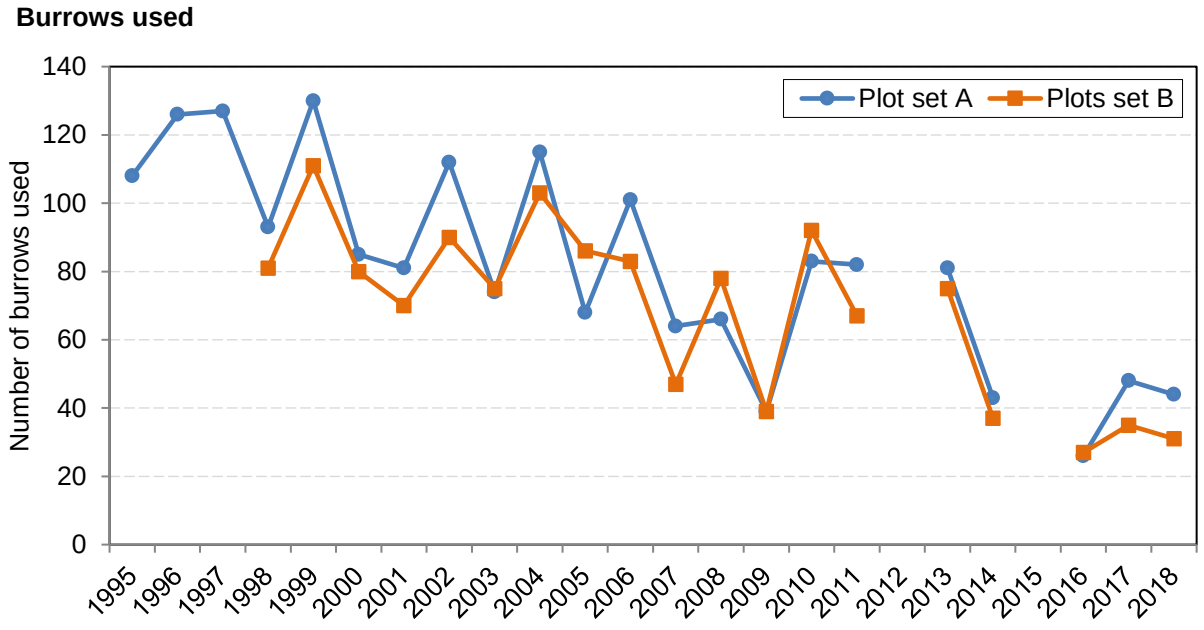


Figure 9. Number of tufted puffin burrows classified as “Used” in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

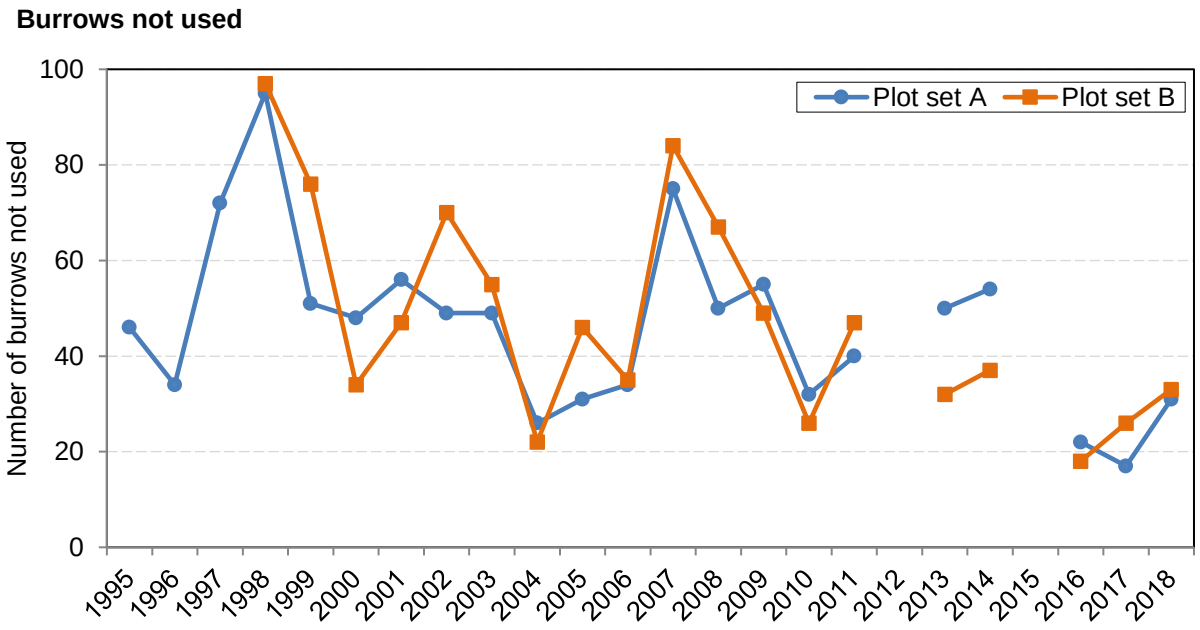


Figure 10. Number of tufted puffin burrows classified as “Not used” in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

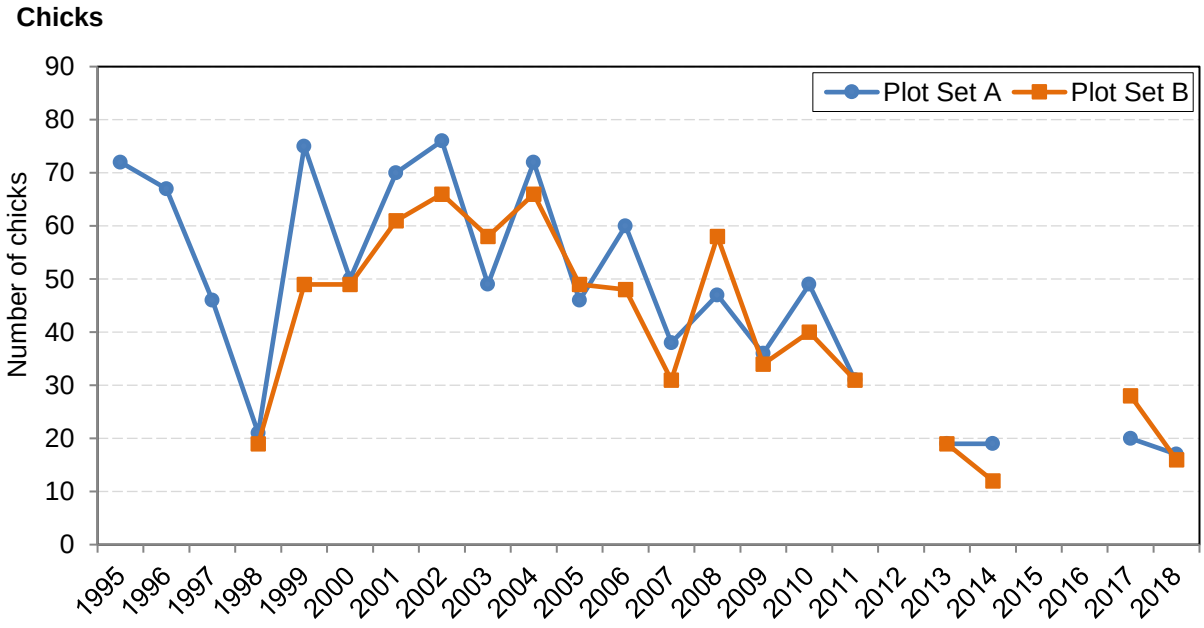


Figure 11. Number of tufted puffin chicks in plots at East Amatuli Island, Alaska. Plot Set A is comprised of plots AC, BC, C, and FWST; Plot Set B is comprised of plots OC, GC, SF, EF, and UEVR.

Table 5. Summary results from burrow searches in plots AC, BC, C, and FWST at East Amatuli Island, Alaska. This plot group has the longest monitoring history at this location.

Year	All Burrows	Burrows used	Burrows not used	Chicks	Used/ all burrows	Not used/ used burrows	Chicks/ all burrows	Chicks/ burrows used
1995	181	135	46	72	0.75	0.34	0.40	0.53
1996	160	126	34	76	0.79	0.27	0.48	0.60
1997	199	127	72	46	0.64	0.57	0.23	0.36
1998	188	93	95	21	0.49	1.02	0.11	0.23
1999	181	130	51	75	0.72	0.39	0.41	0.58
2000	183	135	48	50	0.74	0.36	0.27	0.37
2001	178	122	56	70	0.69	0.46	0.39	0.57
2002	161	112	49	76	0.70	0.44	0.47	0.68
2003	152	87	49	49	0.57	0.56	0.32	0.56
2004	144	115	26	72	0.80	0.23	0.50	0.63
2005	121	75	31	46	0.62	0.41	0.38	0.61
2006	140	105	34	59	0.75	0.32	0.42	0.56
2007	158	66	75	38	0.42	1.14	0.24	0.58
2008	125	71	50	47	0.57	0.70	0.38	0.66
2009	98	42	55	36	0.43	1.31	0.37	0.86
2010	127	92	32	43	0.72	0.35	0.34	0.47
2011	125	85	40	39	0.68	0.47	0.31	0.46
2012	-	-	-	-	-	-	-	-
2013	131	81	50	19	0.62	0.62	0.15	0.23
2014	104	47	54	19	0.45	1.15	0.18	0.40
2015	-	-	-	-	-	-	-	-
2016	79	37	22	-	0.47	0.59	-	-
2017	72	54	17	20	0.75	0.31	0.28	0.37
2018	75	44	31	17	0.59	0.70	0.23	0.39

Table 6. Summary results from burrow searches in plots OC, GC, SF, EF, and UEVR at East Amatuli Island, Alaska.

Year	All Burrows	Burrows used	Burrows not used	Chicks	Used/ all burrows	Not used/ used burrows	Chicks/ all burrows	Chicks/ burrows used
1995	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-
1998	178	81	97	19	0.46	1.20	0.11	0.23
1999	187	111	76	49	0.59	0.68	0.26	0.44
2000	147	80	34	49	0.54	0.43	0.33	0.61
2001	174	70	47	61	0.40	0.67	0.35	0.87
2002	144	90	70	66	0.63	0.78	0.46	0.73
2003	139	75	55	58	0.54	0.73	0.42	0.77
2004	125	103	22	66	0.82	0.21	0.53	0.64
2005	149	86	46	49	0.58	0.53	0.33	0.57
2006	119	83	35	44	0.70	0.42	0.37	0.53
2007	148	47	84	31	0.32	1.79	0.21	0.66
2008	149	78	67	58	0.52	0.86	0.39	0.74
2009	100	39	49	34	0.39	1.26	0.34	0.87
2010	130	92	26	34	0.71	0.28	0.26	0.37
2011	120	67	47	30	0.56	0.70	0.25	0.45
2012	-	-	-	-	-	-	-	-
2013	107	75	32	19	0.70	0.43	0.18	0.25
2014	81	37	37	12	0.46	1.00	0.15	0.32
2015	-	-	-	-	-	-	-	-
2016	73	27	18		0.37	0.67	-	-
2017	64	35	26	26	0.55	0.74	0.41	0.74
2018	65	31	33	16	0.48	1.06	0.25	0.52

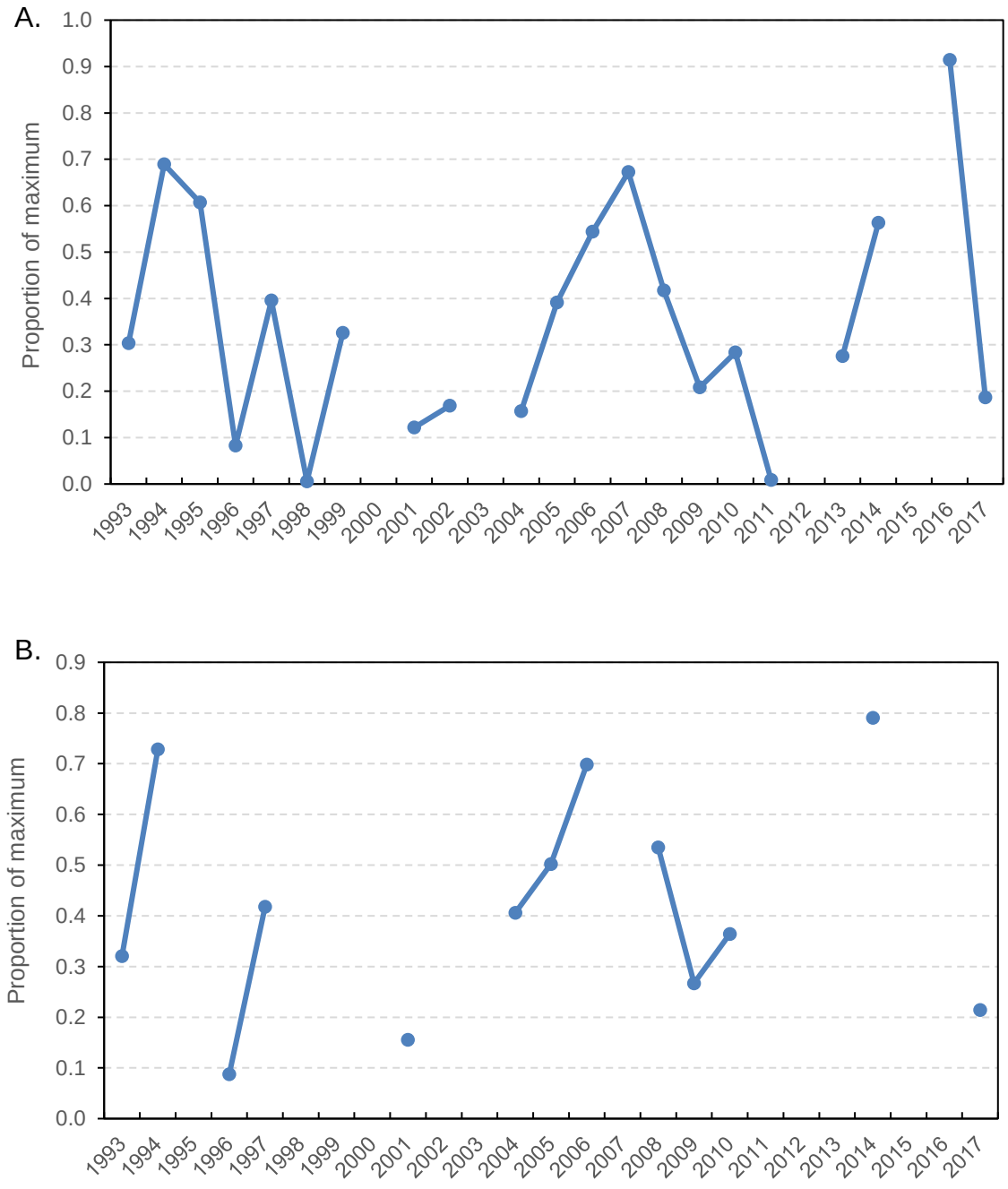


Figure 12. Summary of binocular counts of tufted puffins at the surface on nine plots at East Amatuli Island, Alaska. Details of the summary procedure are in the Methods section. This procedure was used because not all plots were counted in all years. First, for each plot, each year, the average of all counts made during 10-30 August was calculated. Next, for each plot, the among-year maximum of these means was identified. Then, for each year, the sum of the means was divided by the sum of the maxima for the plots counted. Points in chart (A) represent all plot-count means; chart (B) uses only plot-count means calculated from at least three counts.

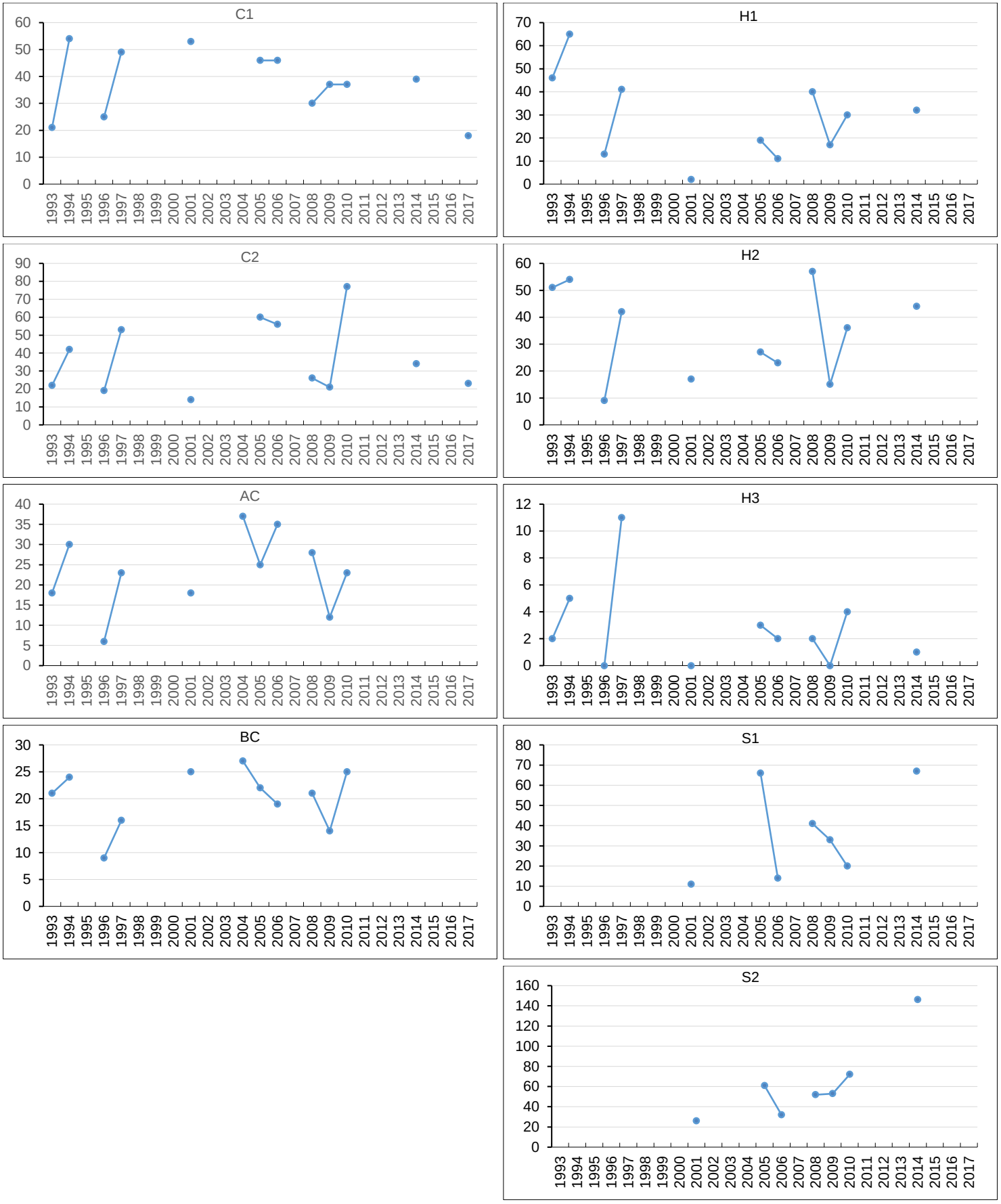


Figure 13. Annual maximum count of adult tufted puffins at the surface in nine plots at East Amatuli Island, Alaska. Limited to counts made during 10-30 August. Plot-years with fewer than three counts within this date range were excluded.

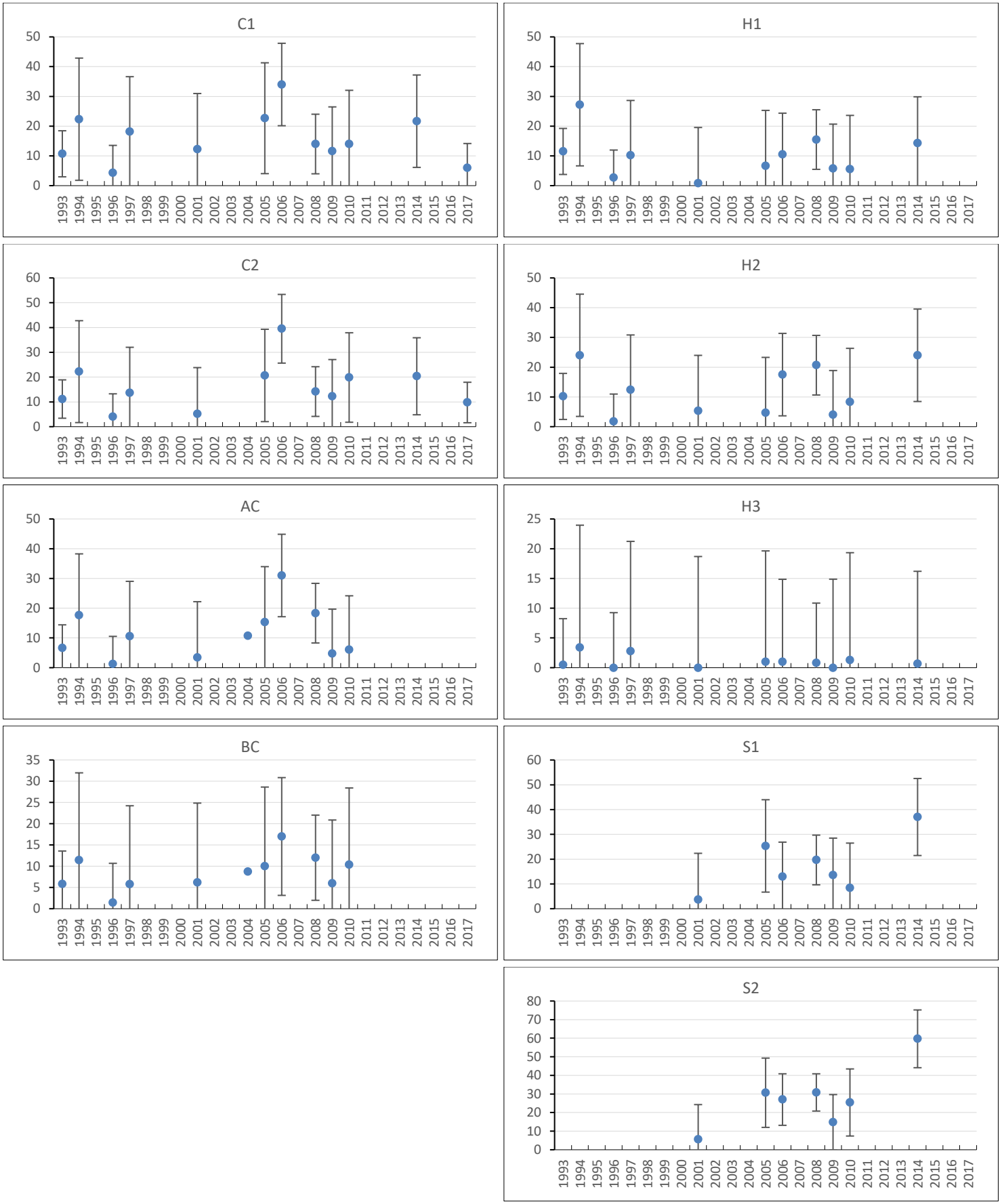


Figure 14. Annual mean count of adult tufted puffins at the surface in nine plots at East Amatuli Island, Alaska. Counts were made with binoculars. Limited to counts made during 10-30 August. Plot-years with fewer than three counts within this date range were excluded. Error bars show one standard deviation.

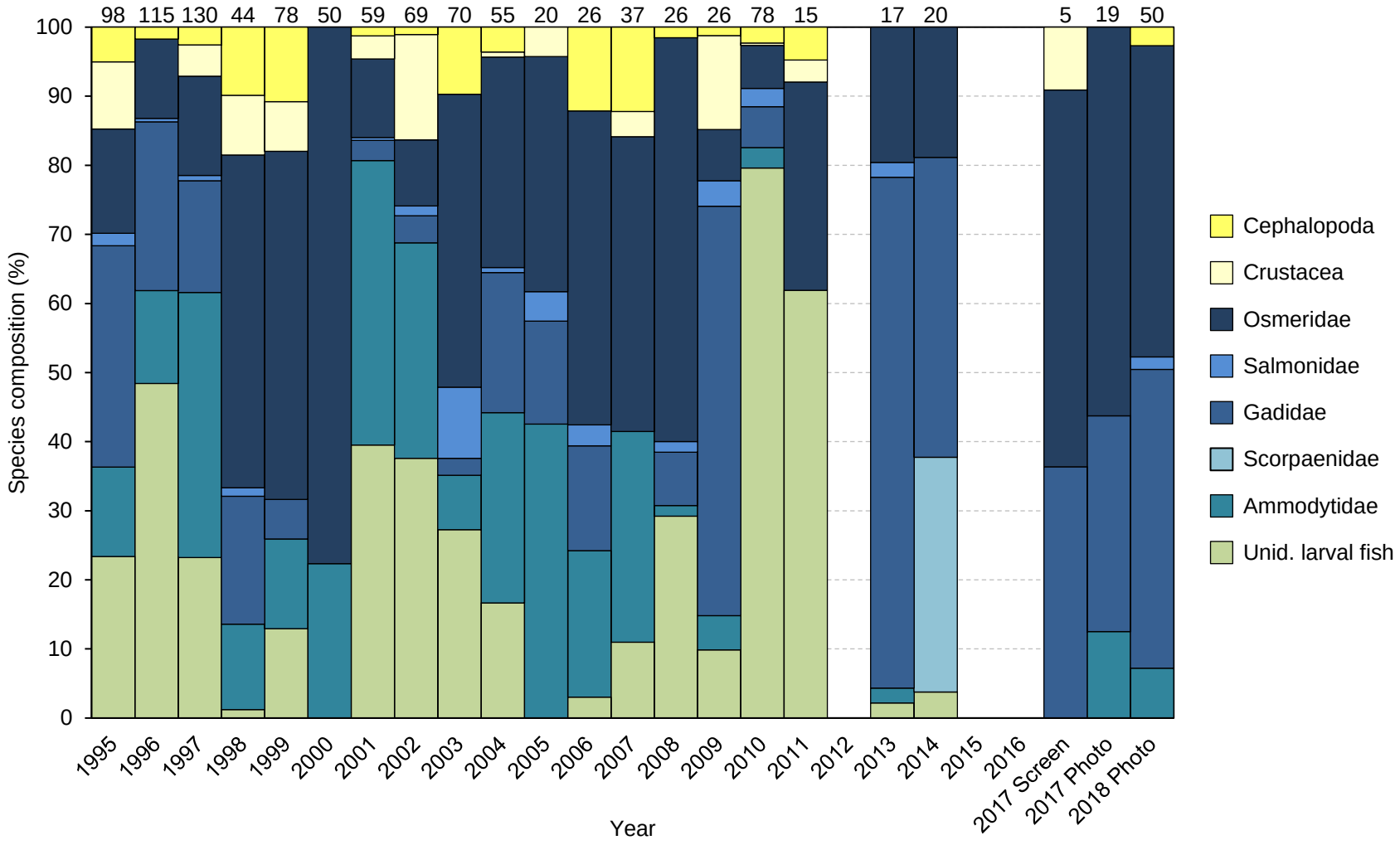


Figure 15. Prey composition (for each prey type, percentage of the total number of prey items of all types) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults. Sample sizes (“bill loads”) are above columns. Prey categories with less than 5 percent composition in all years are omitted. Data were not collected in 2012, 2015, and 2016.

Table 7. Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
No. samples	98	115	130	44	78	50	59	69	70	55	20	26	37	26	
No. items	296	417	520	81	146	104	245	283	170	141	47	33	83	65	
Invertebrates	**13.9**	**1.7**	**6.9**	**18.5**	**17.1**	**-**	**4.5**	**16.3**	**10.6**	**4.3**	**4.3**	**12.1**	**15.7**	**1.5**	
Cephalopoda	**4.7**	**1.7**	**2.5**	**9.9**	**10.3**	**-**	**1.2**	**1.1**	**9.4**	**3.5**	**-**	**12.1**	**12.0**	**1.5**	
Decabrachia	**4.7**	**1.4**	**2.3**	**8.6**	**8.9**	**-**	**1.2**	**1.1**	**8.8**	**3.5**	**-**	**12.1**	**2.4**	**1.5**	
Unid. squid	4.7	1.4	2.3	8.6	8.9	-	1.2	1.1	8.8	3.5	-	12.1	2.4	1.5	
Octopodidae	**-**	**0.2**	**0.2**	**1.2**	**0.7**	**-**	**-**	**-**	**0.6**	**-**	**-**	**-**	**9.6**	**-**	
Unid. octopus	-	0.2	0.2	1.2	0.7	-	-	-	0.6	-	-	-	9.6	-	
Unid. cephalopod	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	
Crustacea	**9.1**	**-**	**4.4**	**8.6**	**6.8**	**-**	**3.3**	**15.2**	**-**	**0.7**	**4.3**	**-**	**3.6**	**-**	
Euphausiaceae	**-**	**-**	**-**	**-**	**4.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.6**	**-**	
Unid. euphausiid	-	-	-	-	4.1	-	-	-	-	-	-	-	3.6	-	
Unid. crustacean	9.1	-	4.4	8.6	2.7	-	3.3	15.2	-	0.7	4.3	-	-	-	
Unid. larval invertebrate	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	
Unid. invertebrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fish	**85.8**	**98.3**	**93.1**	**81.5**	**82.9**	**100.0**	**95.5**	**83.7**	**89.4**	**95.7**	**95.7**	**87.9**	**84.3**	**98.5**	
Osmeridae	**14.2**	**11.3**	**14.0**	**48.1**	**47.9**	**76.9**	**11.0**	**9.5**	**41.2**	**29.8**	**34.0**	**45.5**	**42.2**	**58.5**	
Hypomesus pretiosus	-	-	-	-	0.7	-	0.8	-	-	-	-	-	-	-	
Mallotus villosus	14.2	11.3	14.0	48.1	47.3	76.9	10.2	9.5	41.2	29.8	34.0	45.5	42.2	58.5	
Salmonidae	**1.7**	**0.5**	**0.8**	**1.2**	**-**	**-**	**0.4**	**1.4**	**10.0**	**0.7**	**4.3**	**3.0**	**-**	**1.5**	
Oncorhynchus gorbuscha	1.7	0.5	0.8	1.2	-	-	0.4	1.4	10.0	0.7	4.3	3.0	-	1.5	
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Myctophidae	**-**	**0.7**	**-**	**-**	**-**	**-**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. laternfish	-	0.7	-	-	-	-	0.4	-	-	-	-	-	-	-	
Gadidae	**30.1**	**24.0**	**15.8**	**18.5**	**5.5**	**-**	**2.9**	**3.9**	**2.4**	**19.9**	**14.9**	**15.2**	**-**	**7.7**	
Microgadus proximus	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	
Gadus macrocephalus	4.1	0.5	0.2	2.5	-	-	-	0.4	-	-	-	3.0	-	-	
Theragra chalcogramma	25.3	23.5	15.6	16.0	4.8	-	2.9	3.2	1.8	19.9	14.9	12.1	-	7.7	
Unid. gadid	0.7	-	-	-	0.7	-	-	-	0.6	-	-	-	-	-	
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Hexagrammidae	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Ophiodon elongatus	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	
Cottidae	**0.3**	**0.2**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. sculpin	0.3	0.2	-	-	0.7	-	-	-	-	-	-	-	-	-	

(rows continued next page)

Table 7 (continued with additional rows). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples (“bill-loads”) were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
Cyclopteridae	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unid. lumpsucker	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liparidae	**0.7**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid snailfish	0.7	-	-	-	0.7	-	-	-	-	-	-	-	-	-	
Zaproridae	**4.4**	**0.2**	**-**	**-**	**-**	**-**	**-**	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	
Zaprora silenus	4.4	0.2	-	-	-	-	-	0.4	-	-	-	-	-	-	
Ammodytidae	**12.2**	**13.2**	**37.5**	**12.3**	**12.3**	**22.1**	**40.0**	**31.1**	**7.6**	**27.0**	**42.6**	**21.2**	**30.1**	**1.5**	
Ammodytes hexapterus	12.2	13.2	37.5	12.3	12.3	22.1	40.0	31.1	7.6	27.0	42.6	21.2	30.1	1.5	
Pleuronectidae	**-**	**0.7**	**1.3**	**-**	**2.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. flatfish	-	0.7	1.3	-	2.1	-	-	-	-	-	-	-	-	-	
Unid. larval fish	22.0	47.5	22.7	1.2	12.3	-	38.4	37.5	26.5	16.3	-	3.0	10.8	29.2	
Unid. fish	-	-	1.0	-	0.7	1.0	2.4	-	1.8	2.1	-	-	1.2	-	
Unid. eggs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 7 (continued with additional years). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo
No. samples	26	78	15	0	17	20	0	0	5	12	50
No. items	84	306	64	-	46	54	-	-	11	32	112
Invertebrates	**14.3**	**2.6**	**7.8**	**-**	**-**	**-**	**-**	**-**	**9.1**	**-**	**2.7**
Cephalopoda	**1.2**	**2.3**	**4.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.7**
Decabrachia	**1.2**	**2.0**	**4.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.7**
Unid. squid	1.2	2.0	4.7	-	-	-	-	-	-	-	2.7
Octopodidae	**-**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	-	0.3	-	-	-	-	-	-	-	-	-
Unid. cephalopod	-	-	-	-	-	-	-	-	-	-	-
Crustacea	**13.1**	**0.3**	**3.1**	**-**	**-**	**-**	**-**	**-**	**9.1**	**-**	**-**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-	-	-
Unid. crustacean	13.1	0.3	3.1	-	-	-	-	-	9.1	-	-
Unid. larval invertebrate	-	-	-	-	-	-	-	-	-	-	-
Unid. invertebrate	-	-	-	-	-	-	-	-	-	-	-
Fish	**85.7**	**97.4**	**92.2**	**-**	**100.0**	**100.0**	**-**	**-**	**90.9**	**100.0**	**97.3**
Osmeridae	**7.1**	**6.2**	**29.7**	**-**	**19.6**	**18.5**	**-**	**-**	**54.5**	**56.3**	**44.6**
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-
Mallotus villosus	7.1	6.2	29.7	-	19.6	18.5	-	-	54.5	56.3	44.6
Salmonidae	**3.6**	**2.6**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**-**	**1.8**
Oncorhynchus gorbuscha	3.6	2.0	-	-	-	-	-	-	-	-	-
Unid. salmonid	-	0.7	-	-	2.2	-	-	-	-	-	1.8
Myctophidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	-	-	-	-	-	-	-	-	-	-
Gadidae	**57.1**	**5.9**	**-**	**-**	**73.9**	**42.6**	**-**	**-**	**36.4**	**31.2**	**43.0**
Microgadus proximus	-	-	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	1.2	-	-	-	-	1.9	-	-	-	-	-
Theragra chalcogramma	53.6	5.9	-	-	73.9	40.7	-	-	36.4	-	4.5
Unid. gadid	2.4	-	-	-	-	-	-	-	-	31.2	38.4
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**33.3**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	33.3	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-	-	-
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-	-	-

(rows continued next page)

Table 7 (continued with additional rows). Prey composition (for each prey type, percentage of the total number of prey items) in diets of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples (“bill-loads”) were collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photos	2018 photos
Cyclopteridae	**-**	**-**	**1.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	1.6	-	-	-	-	-	-	-	-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-	-	-
Liparidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	-	-	-	-	-	-	-	-	-	-	-
Zaproridae	**2.4**	**-**	**-**	**-**	**-**	**1.9**	**-**	**-**	**-**	**-**	**0.9**
Zaprora silenus	2.4	-	-	-	-	1.9	-	-	-	-	-
Ammodytidae	**4.8**	**2.9**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**12.5**	**7.1**
Ammodytes hexapterus	4.8	2.9	-	-	2.2	-	-	-	-	12.5	-
Pleuronectidae	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	0.7	-	-	-	-	-	-	-	-	-
Unid. larval fish	9.5	79.1	60.9	-	2.2	3.7	-	-	-	-	-
Unid. fish	1.2	-	-	-	-	-	-	-	-	-	-
Unid. eggs	-	-	-	-	-	-	-	-	-	-	-

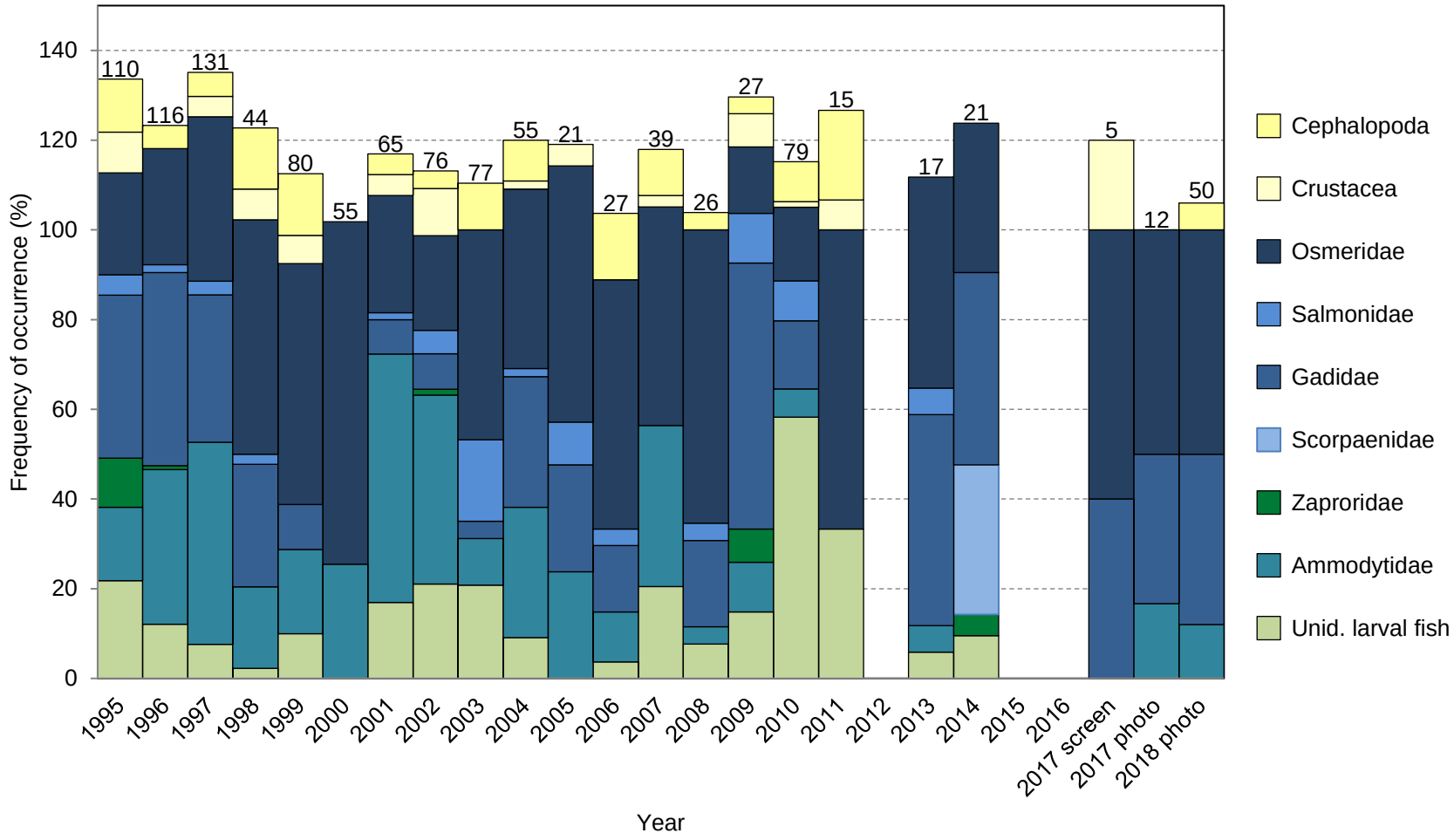


Figure 16. Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Sample sizes (“bill loads”) are above columns. Prey categories with less than 10 percent frequency in all years are omitted. Data were not collected in 2012, 2015, and 2016.

Table 8. Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
No. samples	110	116	131	44	80	55	65	76	77	55	21	27	39	26	
Invertebrates	**17.3**	**5.2**	**9.2**	**18.2**	**17.5**	**-**	**9.2**	**14.5**	**11.7**	**10.9**	**4.8**	**14.8**	**10.3**	**3.8**	
Cephalopoda	**11.8**	**5.2**	**5.3**	**13.6**	**13.8**	**-**	**4.6**	**4.0**	**10.4**	**9.1**	**-**	**14.8**	**10.3**	**3.9**	
Decabrachia	**11.8**	**4.3**	**4.6**	**11.4**	**11.3**	**-**	**4.6**	**3.9**	**9.1**	**9.1**	**-**	**14.8**	**5.1**	**3.8**	
Unid. squid	11.8	4.3	4.6	11.4	11.3	-	4.6	3.9	9.1	9.1	-	14.8	5.1	3.8	
Octopodidae	**-**	**0.9**	**0.8**	**2.3**	**1.3**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**5.1**	**-**	
Unid. octopus	-	0.9	0.8	2.3	1.3	-	-	-	1.3	-	-	-	5.1	-	
Unid. cephalopod	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	
Crustacea	**9.1**	**-**	**4.6**	**6.8**	**6.3**	**-**	**4.6**	**10.5**	**-**	**1.8**	**4.8**	**-**	**2.6**	**-**	
Euphausiaceae	**-**	**-**	**-**	**-**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.6**	**-**	
Unid. euphausiid	-	-	-	-	2.5	-	-	-	-	-	-	-	2.6	-	
Unid. crustacean	9.1	-	4.6	6.8	5.0	-	4.6	10.5	-	1.8	4.8	-	-	-	
Unid. larval invertebrate	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	
Fish	**94.5**	**99.1**	**100.0**	**90.9**	**88.8**	**98.2**	**92.3**	**88.2**	**88.3**	**90.9**	**100.0**	**81.5**	**97.4**	**100.0**	
Osmeridae	**22.7**	**25.9**	**36.6**	**52.3**	**53.8**	**76.4**	**26.2**	**21.1**	**46.8**	**40.0**	**57.1**	**55.6**	**48.7**	**65.4**	
Hypomesus pretiosus	-	-	-	-	1.3	-	1.5	-	-	-	-	-	-	-	
Mallotus villosus	22.7	25.9	36.6	52.3	52.5	76.4	24.6	21.1	46.8	40.0	57.1	55.6	48.7	65.4	
Salmonidae	**4.5**	**1.7**	**3.1**	**2.3**	**-**	**-**	**1.5**	**5.3**	**18.2**	**1.8**	**9.5**	**3.7**	**-**	**3.8**	
Oncorhynchus gorbuscha	4.5	1.7	3.1	2.3	-	-	1.5	5.3	18.2	1.8	9.5	3.7	-	3.8	
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Myctophidae	**-**	**2.6**	**-**	**-**	**-**	**-**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. laternfish	-	2.6	-	-	-	-	1.5	-	-	-	-	-	-	-	
Gadidae	**36.4**	**43.1**	**32.8**	**27.3**	**10.0**	**-**	**7.7**	**7.9**	**3.9**	**29.1**	**23.8**	**14.8**	**-**	**19.2**	
Microgadus proximus	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	
Gadus macrocephalus	7.3	0.9	0.8	4.5	-	-	-	1.3	-	-	-	3.7	-	-	
Theragra chalcogramma	29.1	42.2	32.1	25.0	8.8	-	7.7	6.6	2.6	29.1	23.8	11.1	-	19.2	
Unid. gadid	1.8	-	-	-	1.3	-	-	-	1.3	-	-	-	-	-	
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Hexagrammidae	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Ophiodon elongatus	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	
Cottidae	**0.9**	**0.9**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. sculpin	0.9	0.9	-	-	1.3	-	-	-	-	-	-	-	-	-	

(rows continued next page)

Table 8(continued with additional rows). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples (“bill loads”) collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
Cyclopteridae	**0.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unid. lumpsucker	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liparidae	**0.9**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid snailfish	0.9	-	-	-	1.3	-	-	-	-	-	-	-	-	-	
Zaproridae	**10.9**	**0.9**	**-**	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	
Zaprora silenus	10.9	0.9	-	-	-	-	-	1.3	-	-	-	-	-	-	
Ammodytidae	**16.4**	**34.5**	**45.0**	**18.2**	**18.8**	**25.5**	**55.4**	**42.1**	**10.4**	**29.1**	**23.8**	**11.1**	**35.9**	**3.8**	
Ammodytes hexapterus	16.4	34.5	45.0	18.2	18.8	25.5	55.4	42.1	10.4	29.1	23.8	11.1	35.9	3.8	
Pleuronectidae	**-**	**1.7**	**3.1**	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. flatfish	-	1.7	3.1	-	1.3	-	-	-	-	-	-	-	-	-	
Unid. larval fish	21.8	12.1	7.6	2.3	10.0	-	16.9	21.1	20.8	9.1	-	3.7	20.5	7.7	
Unid. fish	-	-	2.3	-	1.3	1.8	6.2	-	2.6	5.5	-	-	2.6	-	
Unid. eggs	-	-	0.8	-	-	-	1.5	-	-	-	-	-	-	-	

Table 8 (continued with additional years). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo
No. samples	27	79	15	0	17	21	0	0	5	12	50
Invertebrates	**3.7**	**7.6**	**20.0**	**-**	**-**	**-**	**-**	**-**	**20.0**	**-**	**6.0**
Cephalopoda	**-**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6.0**
Decabrachia	**-**	**1.3**	**-**	**-**	**-**	**-**	-	-	-	-	6.0
Unid. squid	-	-	-	-	-	-	-	-	-	-	-
Octopodidae	**7.4**	**1.3**	**6.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	-	-	-	-	-	-	-	-	-	-	-
Unid. cephalopod	-	-	-	-	-	-	-	-	-	-	-
Crustacea	**7.4**	**1.3**	**6.7**	**-**	**-**	**-**	**-**	**-**	**20.0**	**-**	**-**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-	-	-
Unid. crustacean	7.4	1.3	6.7	-	-	-	-	-	20.0	-	-
Unid. larval invertebrate	-	-	-	-	-	-	-	-	-	-	-
Fish	**96.3**	**92.4**	**100.0**	**-**	**100.0**	**100.0**	**-**	**-**	**100.0**	**100.0**	**98.0**
Osmeridae	**14.8**	**16.5**	**66.7**	**-**	**47.1**	**33.3**	**-**	**-**	**60.0**	**50.0**	**50.0**
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-
Mallotus villosus	14.8	16.5	66.7	-	47.1	33.3	-	-	60.0	50.0	50.0
Salmonidae	**11.1**	**6.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Oncorhynchus gorbuscha	11.1	6.3	-	-	-	-	-	-	-	-	-
Unid. salmonid	-	2.5	-	-	5.9	-	-	-	-	-	-
Myctophidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. laternfish	-	-	-	-	-	-	-	-	-	-	-
Gadidae	**59.3**	**15.2**	**-**	**-**	**47.1**	**42.9**	**-**	**-**	**40.0**	**33.3**	**38**
Microgadus proximus	-	-	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	3.7	-	-	-	-	4.8	-	-	-	-	-
Theragra chalcogramma	55.6	15.2	-	-	47.1	38.1	-	-	40.0	-	4.0
Unid. gadid	3.7	-	-	-	-	-	-	-	-	33.3	36.0
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**33.3**	**-**	**-**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	33.3	-	-	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-	-	-
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-	-	-

(rows continued next page)

Table 8 (continued with additional rows). Frequency of occurrence of prey types (percentage of samples containing each prey type) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples (“bill loads”) collected from burrow screening or found at burrows during chick growth and productivity monitoring, or (in 2017 and 2018) were identified from photographs of flying adults.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017 screen	2017 photo	2018 photo
Cyclopteridae	**-**	**-**	**6.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	6.7	-	-	-	-	-	-	-	-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-	-	-
Liparidae	-	-	-	-	-	-	**-**	**-**	**-**	**-**	**-**
Unid snailfish	-	-	-	-	-	-	-	-	-	-	-
Zaproridae	**7.4**	**-**	**-**	**-**	**-**	**4.8**	**-**	**-**	**-**	**-**	**2.0**
Zaprora silenus	7.4	-	-	-	-	4.8	-	-	-	-	2.0
Ammodytidae	**11.1**	**6.3**	**-**	**-**	**5.9**	**-**	**-**	**-**	**-**	**16.67**	**12.0**
Ammodytes hexapterus	11.1	6.3	-	-	5.9	-	-	-	-	16.67	12.0
Pleuronectidae	**-**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	2.5	-	-	-	-	-	-	-	-	-
Unid. larval fish	14.8	58.2	33.3	-	5.9	9.5	-	-	-	-	-
Unid. fish	3.7	-	-	-	-	-	-	-	-	-	-
Unid. eggs	-	-	-	-	-	-	-	-	-	-	-

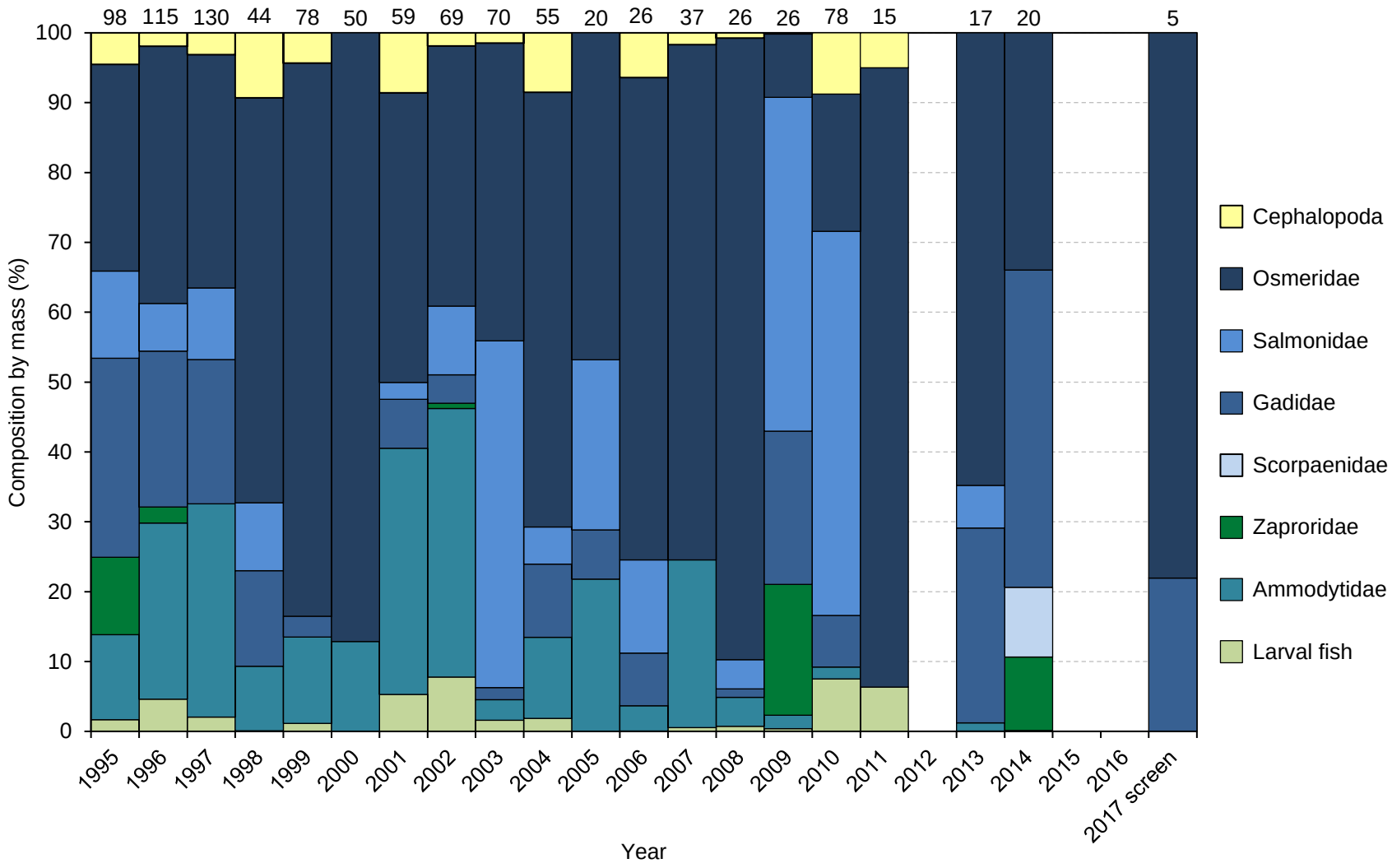


Figure 17. Biomass of prey types (for each prey type, percent of total sample mass) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Sample sizes ("bill loads") are above columns. Prey categories with less than 5 percent mass in all years are omitted. Data were not collected in 2012, 2015, and 2016. Biomass estimation from photographs in 2017 and 2018 is not yet complete.

Table 9. Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017 and 2018 is not yet complete.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
No. samples	98	115	130	44	78	50	59	69	70	55	20	26	37	26	
Total mass (g)	940.4	794.8	950.7	376.9	604.0	547.0	296.9	495.2	775.3	427.8	202.1	232.6	265.5	343.9	
Invertebrates	**4.7**	**1.9**	**3.5**	**9.5**	**4.5**	**-**	**8.7**	**2.6**	**1.5**	**8.4**	**0.2**	**6.4**	**1.9**	**0.8**	
Cephalopoda	**4.5**	**1.9**	**3.1**	**9.2**	**4.2**	**-**	**8.4**	**1.9**	**1.4**	**8.3**	**-**	**6.4**	**1.7**	**0.8**	
Decabrachia	4.5	1.8	3.0	8.9	3.1	-	8.4	1.9	1.4	8.3	-	6.4	0.4	0.8	
Unid. squid	4.5	1.8	3.0	8.9	3.1	-	8.4	1.9	1.4	8.3	-	6.4	0.4	0.8	
Octopodidae	**-**	**0.1**	**0.1**	**0.3**	**1.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.3**	**-**	
Unid. octopus	-	0.1	0.1	0.3	1.1	-	-	-	-	-	-	-	1.3	-	
Unid. cephalopod	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Crustacea	**0.2**	**-**	**0.4**	**0.3**	**0.3**	**-**	**0.3**	**0.7**	**-**	**0.1**	**0.2**	**-**	**0.2**	**-**	
Euphausiaceae	**0.2**	**-**	**0.4**	**0.2**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.2**	**-**	
Unid. euphausiid	0.2	-	0.4	0.2	0.3	-	-	-	-	-	-	-	0.2	-	
Unid. crustacean	-	-	-	0.1	-	-	0.3	0.7	-	0.1	0.2	-	-	-	
Unid. larval invertebrate	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	
Unid. invertebrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fish	**95.3**	**98.2**	**96.2**	**90.3**	**94.4**	**100.0**	**91.3**	**97.5**	**98.4**	**91.7**	**99.8**	**93.5**	**98.0**	**99.2**	
Osmeridae	**29.8**	**36.1**	**33.1**	**57.7**	**75.9**	**86.8**	**40.8**	**37.0**	**42.4**	**60.9**	**46.7**	**69.0**	**73.6**	**89.0**	
Hypomesus pretiosus	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	
Mallotus villosus	29.8	36.1	33.1	57.7	75.9	86.8	40.3	37.0	42.4	60.9	46.7	69.0	73.6	89.0	
Salmonidae	**12.3**	**6.7**	**10.1**	**9.7**	**-**	**-**	**2.4**	**9.8**	**49.3**	**5.2**	**24.3**	**13.3**	**-**	**4.2**	
Oncorhynchus gorbuscha	12.3	6.7	10.1	9.7	-	-	2.4	9.8	49.3	5.2	24.3	13.3	-	4.2	
Unid. salmonid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Myctophidae	**-**	**0.6**	**-**	**-**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. laternfish	**-**	**0.6**	**-**	**-**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Gadidae	**28.0**	**21.9**	**20.4**	**13.6**	**2.8**	**-**	**6.9**	**4.1**	**1.8**	**10.3**	**7.0**	**7.5**	**-**	**1.2**	
Microgadus proximus	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	
Gadus macrocephalus	6.0	2.4	0.4	3.8	-	-	-	0.9	-	-	-	3.8	-	-	
Theragra chalcogramma	20.6	19.5	20.0	9.8	2.6	-	6.9	2.2	1.4	10.3	7.0	3.7	-	1.2	
Unid. gadid	1.4	-	-	-	0.2	-	-	-	0.4	-	-	-	-	-	
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. *Sebastes* rockfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Hexagrammidae	**-**	**-**	**-**	**-**	**0.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Ophiodon elongatus	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	
Cottidae	**-**	**1.0**	**-**	**-**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. sculpin	-	1.0	-	-	2.2	-	-	-	-	-	-	-	-	-	

(rows continued next page)

Table 9 (continued with additional rows). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017 and 2018 is not yet complete.

Prey	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	(cont.)
Cyclopteridae	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Eumicrotremus orbis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Unid. lumpsucker	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liparidae	**0.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid snailfish	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	
Zaproridae	**11.0**	**2.3**	**-**	**-**	**-**	**-**	**-**	**0.7**	**-**	**-**	**-**	**-**	**-**	**-**	
Zaprora silenus	11.0	2.3	-	-	-	-	-	0.7	-	-	-	-	-	-	
Ammodytidae	**12.0**	**24.9**	**30.2**	**9.2**	**11.9**	**12.8**	**34.7**	**38.2**	**2.9**	**11.4**	**21.8**	**3.6**	**23.9**	**4.1**	
Ammodytes hexapterus	12.0	24.9	30.2	9.2	11.9	12.8	34.7	38.2	2.9	11.4	21.8	3.6	23.9	4.1	
Pleuronectidae	**-**	**0.2**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Unid. flatfish	-	0.2	0.3	-	-	-	-	-	-	-	-	-	-	-	
Unid. larval fish	1.7	4.5	2.0	0.1	1.1	-	5.2	7.7	1.6	1.8	-	0.1	0.5	0.7	
Unid. fish	-	-	0.1	-	-	0.4	1.2	-	0.4	2.1	-	-	-	-	
Unid eggs	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	

Table 9 (continued with additional years). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017 and 2018 is not yet complete.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. samples	26	78	15	0	17	20	0	0	5
Total mass (g)	296.8	689.5	86.2	-	204.7	118.9	-	-	52.7
Invertebrates	**0.5**	**8.7**	**5.4**	**-**	**-**	**-**	**-**	**-**	**0.1**
Cephalopoda	**0.1**	**8.7**	**4.9**	**-**	**-**	**-**	**-**	**-**	**-**
Decabrachia	**0.1**	**8.5**	**4.9**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. squid	0.1	8.5	4.9	-	-	-	-	-	-
Octopodidae	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. octopus	-	0.2	-	-	-	-	-	-	-
Unid. cephalopod	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Crustacea	**0.4**	**<0.01**	**0.5**	**-**	**-**	**-**	**-**	**-**	**0.1**
Euphausiaceae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. euphausiid	-	-	-	-	-	-	-	-	-
Unid. crustacean	0.4	<0.01	0.5	-	-	-	-	-	0.1
Unid. larval invertebrate	-	-	-	-	-	-	-	-	-
Unid. invertebrate	-	-	-	-	-	-	-	-	-
Fish	**99.5**	**90.8**	**94.6**	**-**	**100.0**	**100.0**	**-**	**-**	99.9
Osmeridae	**9.0**	**19.5**	**87.0**	**-**	**64.8**	**34.0**	**-**	**-**	78.0
Hypomesus pretiosus	-	-	**-**	**-**	**-**	-	**-**	**-**	-
Mallotus villosus	9.0	19.5	87.0	-	64.8	34.0	-	-	78.0
Salmonidae	**47.6**	**54.6**	**-**	**-**	**6.1**	**-**	**-**	**-**	**-**
Oncorhynchus gorbuscha	47.6	45.1	-	-	-	-	-	-	-
Unid. salmonid	-	9.5	-	-	6.1	-	-	-	-
Myctophidae	**-**	**-**	**-**	**-**	**-**	-	**-**	**-**	-
Unid. laternfish	-	-	-	-	-	-	-	-	-
Gadidae	**21.9**	**7.4**	**-**	**-**	**27.9**	**45.4**	**-**	**-**	**21.9**
Microgadus proximus	-	-	-	-	-	-	-	-	-
Gadus macrocephalus	0.3	-	-	-	-	1.8	-	-	-
Theragra chalcogramma	20.3	7.4	-	-	27.9	43.6	-	-	21.9
Unid. gadid	1.3	-	-	-	-	-	-	-	-
Scorpaenidae	**-**	**-**	**-**	**-**	**-**	**10.0**	**-**	**-**	**-**
Unid. *Sebastes* rockfish	-	-	-	-	-	10.0	-	-	-
Hexagrammidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ophiodon elongatus	-	-	-	-	-	-	-	-	-
Cottidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. sculpin	-	-	-	-	-	-	-	-	-

(rows continued next page)

Table 9 (continued with additional rows). Biomass of prey types (for each prey type, percent of mass of all samples) in the diet of tufted puffin chicks at East and West Amatuli islands, Alaska. Samples ("bill-loads") collected from burrow screening or found at burrows during chick growth and productivity monitoring. Biomass estimation from photographs in 2017 and 2018 is not yet complete.

Prey	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cyclopteridae	**-**	**-**	**1.4**	**-**	**-**	**-**	**-**	**-**	**-**
Eumicrotremus orbis	-	-	1.4	-	-	-	-	-	-
Unid. lumpsucker	-	-	-	-	-	-	-	-	-
Liparidae	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid snailfish	-	-	-	-	-	-	-	-	-
Zaproridae	**18.7**	**-**	**-**	**-**	**-**	**10.5**	**-**	**-**	**-**
Zaprora silenus	18.7	-	-	-	-	10.5	-	-	-
Ammodytidae	**1.9**	**1.7**	**-**	**-**	**1.2**	**-**	**-**	**-**	**-**
Ammodytes hexapterus	1.9	1.7	-	-	1.2	-	-	-	-
Pleuronectidae	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Unid. flatfish	-	0.1	-	-	-	-	-	-	-
Unid. larval fish	0.4	7.5	6.2	-	0.1	0.1	-	-	-
Unid. fish	-	-	-	-	-	-	-	-	-
Unid eggs	-	-	-	-	-	-	-	-	-

APPENDICES

Appendix 1. Field crew members (Biological Science Technicians and volunteers) at East Amatuli Island, Alaska during tufted puffin monitoring years 1993-2014. ABK was present as field team leader each year except 2014.

Year	Field crew			
1993	Mary Jensen	Margi Blanding	-	-
1994	Kurt Johnson	Margi Blanding	-	-
1995	Stephanie Zuniga	Mitch Eaton	Bill Stahl	Margi Blanding
1996	Stephanie Zuniga	Carrie Alley	Jon Maletta	Margi Blanding
1997	Stephanie Zuniga	Lena Wilensky	John Hoover	Margi Blanding
1998	Stephanie Zuniga	Gavin Brady	Tammy Steeves	Margi Blanding
1999	Erica Sommer	Jessica Bussler	Chris Wrobel	Margi Blanding
2000	Courtney Redmond	Kyra Riley	Darren Moe	Julie Snorek
2001	Jessica Bussler	Mari Ortwerth	Michelle Wada	-
2002	Rachael Orben	Greg Thomson	Amie Baton	-
2003	Kelly Wallis	Michelle Schuiteman	Jeremy Mizel	-
2004	Wendy Fair	Valerie Steen	Marcy Okada	-
2005	Joshua Boadway	Kelly Boadway	Laura Kennedy	-
2006	Kathryn Peiman	Emily Weiser	Megan McClellan	-
2007	Trevor Watts	Meaghan Conway	Leah Yandow	-
2008	Emily McKeever	Gina Peters	Kathryn Frens	-
2009	Amy Kearns	Kristina Raum	Frank Mayer	-
2010	Sarah Bastarache	Abram Fleishman	Sarah Youngren	-
2011	Sarah Youngren	Margaret Lambert	Dan Rapp	-
2013	Sonia Kumar	Serina Brady	Charles Ylijoki	-
2014	Naomi Bargmann	Stephanie Winnard	-	-
2016	Georgia Lukas	Dana Nelson	-	-
2017	Rachael Barda	Jaclyn Lucas	-	-
2018	Maya Frydman	Shelley Hall	-	-

Appendix 2. Annotated results tables compiled from the correlation tables in Appendices 3 and 4.

The correlation tests were exploratory—for observing patterns and forming initial inquiries. Because of the large number of comparisons made, some significant results would be expected to occur randomly. In addition, some of the series contain temporal autocorrelation, so that some consecutive-time-unit significant results (especially consecutive months of sea temperature) may not be independent from each other; I have not analyzed autocorrelation here.

Because this report is exploratory in purpose, for comparisons among various puffin and environmental indices I have listed results in various permutations so that patterns can be seen. I list result tables by puffin index and also by environmental parameter.

Comparison among puffin indices, listed by productivity index

The data years for each productivity index are shown in Table 2. The correlation results listed and discussed in the following breeding parameter sections are from Appendix 3. Except where noted, the results use all the data-years during 1995-2018 that were available for the tests.

Caveat for chick diet results: Chick diet correlation results need to be viewed with the caveat stated in Methods: The diet data are compositional and therefore are not independent from each other—an increase in one diet category across years must be offset by a decrease in at least one of the other species, if the species group is consistent. In addition, there may be significant but unidentified joint relationships that aren't seen when looking at individual species.

Chicks / burrows results:
Correlation results table for *Chicks / burrows*:

Chicks / burrows

Parameter	No-lag correlation	Lag 1yr[a] correlation	Lag 2yr correlation	Years[b] in dataset
Chicks / burrows	x[c]	-[d]	-	21
Chicks / burrows used	pos[e]	-	-	21
Chick diet: Capelin	-	-	-	20
Salmonid	-	-	-	20
Gadid	-	neg	neg	20
Sand lance	-	-	pos	20
Prowfish	-	-	-	20
Larval fish	-	-	-	20

[a] "Lag 1yr" means that the values for the index in the table's title (in this case *Chicks / burrows*) is compared with the previous year's values for the row's index. In this case, each annual value for *Chicks / burrows* is matched for comparison with the previous year's *Chicks / burrows* value.
[b] Number of years.
[c] "x" means "Not applicable" (parameter correlated with itself).
[d] A dash means "no data"
[e] "pos" indicates a significant positive correlation; "neg" a negative correlation.

Appendix 2 (cont.)

Chicks / burrows discussion:

Chicks / burrows was positively correlated with *Chicks / burrows used*.

The index was negatively correlated with the previous year's *Gadid* values, and with two-years-previous *Gadid* and *Sand lance* values.

Chicks / burrows used results:

Chicks / burrows used

Parameter	No-lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	pos	-	-	21
Chicks / burrows used	x	-	pos	21
Chick diet: Capelin	-	-	-	20
Salmonid	-	-	-	20
Gadid	neg	neg	neg	20
Sand lance	-	-	-	20
Prowfish	-	-	-	20
Larval fish	-	-	-	20

Chicks / burrows used discussion

Chicks / burrows used was positively correlated with same-year *Chicks / burrows* values.

There was a negative correlation with *Gadid* in chick diets, for diet values from the same year, the previous year, and from 2 years previous.

Comparison among puffin indices, listed by chick diet category

(see the chick diet caveat above)

Capelin in chick diet results table:

Chick diet: Capelin

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	-	-	20
Chick diet: Capelin	x	-	-	20
Salmonid	neg	-	-	20
Gadid	neg	-	-	20
Sand lance	-	-	-	20
Prowfish	neg	-	-	20
Larval fish	-	-	-	20

Appendix 2 (cont.)

Capelin in chick diet discussion

The proportion of *Capelin* in chick diets (all the Osmerids identified were capelin) was negatively correlated with the proportion of *Salmonid*, *Gadid*, and *Prowfish*. The proportion of *Capelin* was not significantly associated with any of the other parameters or with any of the lagged-year values.

There is a general pattern of opposite results between C*apelin* and the other prey categories—in years when there is a higher proportion of *Capelin*, there is a lower proportion of at least some of the other categories.

Salmonid in chick diet results:

Chick diet: Salmonid

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	pos	-	20
Chick diet: Capelin	neg	-	-	20
Salmonid	x	-	-	20
Gadid	-	-	-	20
Sand lance	-	-	-	20
Prowfish	-	-	-	20
Larval fish	-	-	-	20

Salmonid in chick diet discussion

The same-year proportion of *Salmonid* in the chick diet was negatively correlated with the proportion of capelin in the diet. The category was also positively associated with previous-year *Chicks / used burrows* values. If this were a mechanistic relationship, it would mean that a higher proportion of salmonid in chick diets is somehow linked with higher *Chicks / burrows* the next year. On the other hand, spurious relationships can randomly occur with this analysis method.

Gadid in chick diet results:

Chick diet: Gadid

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	-	-	20
Chick diet: Capelin	neg	-	-	20
Salmonid	-	-	-	20
Gadid	x	pos	-	20
Sand lance	-	-	-	20
Prowfish	pos	-	-	20
Larval fish	-	-	-	20

Appendix 2 (cont.)

Gadid in chick diet discussion

As discussed above, the proportion of *Gadid* in the chick diets was negatively correlated with the two productivity ratios, for same-year values. As with *Salmonid*, the same-year proportion of *Gadid* in the chick diet was negatively correlated with the proportion of *Capelin* in the diet. In addition, the proportion of *Gadid* was positively correlated with the proportion of *Prowfish*. The proportion of *Gadid* was positively correlated with the proportion of *Gadid* in the previous year's diet.

Sand lance in chick diet results:

Chick diet: Sand lance

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	-	-	20
Chicks / burrows	-	-	-	20
Chicks / used burrows	-	-	-	20
Chick diet: Capelin	-	-	-	20
Salmonid	-	-	-	20
Gadid	-	-	-	20
Sand lance	x	-	-	20
Prowfish	-	-	-	20
Larval fish	-	-	-	20

Sand lance in chick diet discussion

The proportion of *Sand lance* in the diet was not significantly correlated with any other prey category, for any of the three years.

Prowfish in chick diet results:

Chick diet: Prowfish

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	-	-	20
Chicks / burrows	-	-	-	20
Chicks / used burrows	-	-	-	20
Chick diet: Capelin	neg	-	-	20
Salmonid	-	-	-	20
Gadid	pos	-	-	20
Sand lance	-	-	-	20
Prowfish	x	-	-	20
Larval fish	-	-	-	20

Appendix 2 (cont.)

Prowfish in chick diet discussion

Prowfish in chick diets was negatively associated with the same-year C*apelin* category and positively associated with same-year *Gadid*.

Larval fish in chick diet results:

Chick diet: Larval fish

Parameter	No lag correlation	Lag 1yr correlation	Lag 2yr correlation	Years[a] in dataset
Chicks / burrows	-	-	-	20
Chicks / burrows used	-	-	-	20
Chicks / burrows	-	-	-	20
Chicks / used burrows	-	-	-	20
Chick diet: Capelin	-	neg	-	20
Salmonid	-	-	-	20
Gadid	-	-	-	20
Sand lance	-	-	-	20
Prowfish	-	pos	-	20
Larval fish	x	-	-	20

Larval fish in chick diet discussion

The proportion of *Larval fish* in chick diets was not significantly associated with same-year proportions of the other prey categories. There were associations for previous-year *Capelin* (negative) and *Prowfish* (positive). If there are mechanistic causes for these associations, it would mean that a higher proportion of *Larval fish* in chick diets was somehow mechanistically associated with lower proportion of *Capelin* and higher proportion of *Prowfish* the previous year. Most of the larvae have been unidentified. But they do not appear to be prowfish larvae, and prowfish do not sexually mature in one year. There could be an indirect association, or the results could be spurious.

Chick diet summary—not lagged:

Diet group	Salmonid	Gadid	Sand lance	Prowfish	Larval fish
Osmerid	neg	neg	-	neg	-
Gadid	-	-		pos	-

A higher proportion of *Capelin* in chick diet was significantly correlated with lower proportions of *Salmonid*, *Gadid*, and *Prowfish*. A higher proportion of *Gadid* was positively correlated with proportion of *Prowfish*.

Comparisons between environmental variables

Data years for comparisons between environmental variables are shown in Table 4.

Results

All significant between-station sea-surface temperature monthly anomaly correlations were positive except one (between GAK1 and Buoy 46001 in September; Appendix 9).

Sea-surface temperature anomalies at the Seldovia tide station were most synchronized with those at Amatuli Cove—they were highly correlated for all months of the year. The station with the next-highest number of months with anomalies similar to those at Seldovia was Buoy 46001: only the September pairing was not significant. Comparison of Seldovia with GAK1 showed that August through October were the months with SSTs not significantly similar.

After its similarity to Seldovia's SST, East Amatuli's SST anomaly was next-most similar to that at Buoy 46001, with all but three months significantly correlated. Like results for Seldovia's SST, East Amatuli's SST anomaly was not synchronized with GAK1's during July through October.

Finally, Buoy 46001's SST anomalies were significantly correlated with GAK1's for just half the months of the year.

All significant correlations between the Pacific Decadal Oscillation (PDO) values and sea-surface temperature anomalies were positive (Appendix 10).

The PDO values were most similar to the pattern of Amatuli Cove's SST anomalies—only October's values were not significantly correlated. Next were Seldovia's SST (September and October were not significant) and Buoy 46001 (July and August were not significant), and then GAK1 (June through October were not significant). (Note, however, that Amatuli Cove's data-years available for comparison were fewer than those for Seldovia and Buoy 46001 [Appendix 10].)

The North Pacific Index (NPI) was much less synchronized with the other variables. All significant correlations were negative. The NPI and PDO values were significantly correlated for just four months, Seldovia SST three months, and Amatuli Cove and GAK1 for just January. Lagging the temperatures one, two, and three months behind the NPI (as suggested by the definition in *Methods*, "The dominant atmosphere-ocean relation in the North Pacific is one where atmospheric changes lead changes in sea surface temperatures by one to two months") did not increase the number of significant correlations.

Discussion

SST anomalies at Seldovia, Amatuli Cove, and Buoy 46001 were well synchronized with each other.

Anomalies at the GAK1 mooring station were less synchronized with the other stations, for the summer months and later.

Appendix 2 (cont.)

The PDO index was well synchronized with the SST station anomalies (except for GAK1 during the summer). This is logical, since the PDO is calculated from SSTs, and a positive PDO is formed partly from positive temperature anomalies in the Gulf of Alaska.

The NPI is calculated from atmospheric pressure values; apparently the pressure values didn't correlate tightly with SST anomalies in this area, for the time periods tested.

Comparisons of lagged and non-lagged tufted puffin indices with environmental variables, listed by environmental variable

Data years and months for each environmental variable used are shown in Table 3. Breeding parameter-environmental variable correlation tables are in Appendix 4.

Seldovia SST monthly anomaly compared with puffin indices--results:

Parameter	Month[a] no lag	Lagged one year[b]	Lagged two years	Years[c] in shared dataset
Chicks / burrows	-11[d]	-	-	20-22
Chicks / burrows used	-4	-	-	20-22
Chick diet: Capelin	-	+7,+8	+6,+7	18-19
Salmonid	+7,+10[e]	-	-	18-19
Gadid	-	-	-9	18-19
Sand lance	-10	-	-	18-19
Prowfish	-	-7	-1,-3	18-19
Larval fish	-	-	-	18-19

[a] Sign and month(s) (by month-of-year number) of significant correlation between SST anomaly and each breeding parameter.
[b] "Lagged one year" means that the values for the index in the table's title (in this case *Seldovia SST*) is compared with the previous year's values for the row's index. In the case of the first row, each monthly value for *Seldovia SST* is matched for comparison with the previous year's *Chicks / burrows* value.
[c] Number of years.
[d] A dash means "no data".
[e] A plus sign indicates a significant positive correlation; a minus sign indicates a negative correlation.

Seldovia SST monthly anomaly compared with puffin indices--discussion

Same-year *Seldovia SST* was negatively correlated with *Chicks / burrows* in November—after the breeding season. *Chicks / burrows used* was negatively correlated with same-year April *Seldovia SST*. The proportion of Salmonid in chick diets was higher in years when Seldovia SST was higher in July and October—although October is after the nestling season. The negative same-year correlation with *Sand lance* was for October—after the puffin breeding season. Higher SST during the previous and 2-years-previous summers was associated with a higher proportion of *Capelin* in chick diets. *Prowfish* was negatively correlated with SST the previous July and 2-years-previous January and March.

Appendix 2 (cont.)

Barrens (East Amatuli Cove mooring) SST monthly anomaly, puffin indices results:

Parameter	Month no lag[a]	Lagged one year	Lagged two years	Years in shared dataset
Chicks / burrows	-	-	-	17-19
Chicks / burrows used	-	-	-	17-19
Chick diet: Capelin	-	-	-	14-16
Salmonid	-	-	-	14-16
Gadid	+12	-	-8,-9	14-16
Sand lance	-	-	-	14-16
Prowfish	-	-	-1,-3	14-16
Larval fish	-	-	-	14-16

Barrens SST monthly anomaly, tufted puffin indices discussion

Barrens SST was not significantly associated with either productivity index.

Gadid in chick diet was positively associated with *Barrens SST* in December—after the breeding season. Two-years-previous SST was negatively associated with chick-diet *Gadid* (summer SST) and *Prowfish* (winter SST).

GAK1 SST monthly anomaly, tufted puffin indices, results:

Parameter	Month no lag[a]	Lagged one year	Lagged two years	Years in shared dataset
Chicks / burrows	-11	-	-	15-17
Chicks / burrows used	-	-	-11	15-17
Chick diet: Capelin	-	+5,+6	-	12-14
Salmonid	-	-5	-	12-14
Gadid	+11,+12	-	-	12-14
Sand lance	-	-	-	12-14
Prowfish	-	-	-3	12-14
Larval fish	-	-	-	12-14

GAK1 SST monthly anomaly, tufted puffin indices, discussion

The same-year correlations between *GAK1 SST* and *Chicks / burrows* and *Gadid* were after the breeding season (November and December). Previous-year *GAK1 SST* in spring and early summer was associated with more capelin (May and June) and less *Salmonid* (May) in chick diets.

Appendix 2 (cont.)

B46001 SST monthly anomaly, tufted puffin indices, results:

Parameter	Month no lag[a]	Lagged one year	Lagged two years	Years in shared dataset
Chicks / burrows	-4	-	-	19-21
Chicks / burrows used	-4	-	-	19-21
Chick diet: Capelin	-	+4	+7,+11	16-18
Salmonid	-	-3,-4	-	16-18
Gadid	+9	-	-	16-18
Sand lance	-	-	-	16-18
Prowfish	-	-	-	16-18
Larval fish	-	-	-3,-4	16-18

B46001 SST monthly anomaly, tufted puffin indices, discussion

Same-year April SST at Buoy 46001 was negatively associated with *Chicks / burrows* and *Chicks / burrows used*. The same-year *Gadid* result is for September--after the breeding season (most chicks fledge by the end of the first week of September). Previous-spring *B46001 SST*, was correlated with more *Capelin* and less *Salmonid* in chick diets. Higher SST was associated with two-years-later higher proportions for *Capelin* and lower proportions for *Larval fish*.

PDO monthly index, tufted puffin indices, results:

Parameter	Month no lag[a]	Lagged one year	Lagged two years	Years in shared dataset
Chicks / burrows	-	-	-	20-24
Chicks / burrows used	-4	-10	-	20-24
Chick diet: Capelin	-8,-9,-10,-11	+2,+4	-	20
Salmonid	-	-2,-3,-4	-	20
Gadid	+5,+9,+10,+11,+12	-	-	20
Sand lance	-	-	-	20
Prowfish	-	-	-	20
Larval fish	-	-	-1,-2,-4,-6	20

[a] Month(s) (by month-of-year number) with SST anomaly significantly correlated with each breeding parameter.

PDO monthly index, tufted puffin indices discussion

Results for the Pacific Decadal Oscillation index, which reflects SST over a broad area of the North Pacific, showed more consecutive months' significant correlation than did SST results for individual sites. Perhaps the PDO is more highly autocorrelated among years than are the other SST indices. Higher same-year April and May PDO was associated with lower *Chicks / burrows used* values. Same-year PDO was associated with lower proportion of capelin and higher proportion of gadids in chick diets, for several months in the summer and fall. Most of the months were after the puffin breeding season. In this case, same-year after-the-season SST could be mechanistically significant because SST in those months may be auto-correlated with the summer temperatures.

Appendix 2 (cont.)

Previous-year PDO had something of an opposite association—for capelin, previous-year February and April PDO was associated with more C*apelin* and with fewer *Salmonid*. As with Buoy 46001, there was negative association between *Larval fish* in chick diets and PDO values two years earlier.

NPI monthly index, tufted puffin indices, results:

Parameter	Month no lag[a]	Lagged one year	Lagged two years	Years in shared dataset
Chicks / burrows	-	-	-7	21-24
Chicks / burrows used	-7	-	-7,-12	21-24
Chick diet: Capelin	+10	-	-	20
Salmonid	-10	+3,-7	-	20
Gadid	-	-	-	20
Sand lance	-11	-	-3,+7,-12	20
Prowfish	+3	-	-4	20
Larval fish	-	-9	+1	20

NPI monthly index, tufted puffin indices, discussion

The North Pacific index had mixed results. There was a negative association between same-year July NPI and *Chicks / burrows used*. There was positive same-year association between March *NPI* and *Prowfish* in chick diets. The others significant associations were after the breeding season. Previous-years' NPI associations were mixed.

Comparisons of lagged and non-lagged tufted puffin indices with environmental variables, listed by puffin index

Chicks / burrows

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	20	-11	-	+12
Barrens SST	17	-	-	-
Buoy 46001 SST	19	-4	-	-
GAK1 SST	15	-11	-	-
PDO	20	-	-	-
NPI	21	-	-	-

Discussion: *Chicks / burrows* was negatively associated with same-year April *GAK1 SST*. The results for correlations with *Seldovia SST* and *Buoy 46001 SST* was for November--after the breeding season.

Appendix 2 (cont.)

Chicks / burrows used

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	20	-4	-	-
Barrens SST	17	-	-	-
Buoy 46001 SST	19	-4	-	-
GAK1 SST	15	-	-	-11
PDO	20	-4	-10	-
NPI	21	-7	-	-7,-12

Discussion: *Chicks / burrows used* was negatively associated with same-year April *Seldovia SST*, *Buoy 46001 SST*, and PDO values; and with July NPI.

Chick diet: Capelin

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	-	+7,+8	+6,+7
Barrens SST	16	-	-	-
Buoy 46001 SST	18	-	+4	+7,+11
GAK1 SST	14	-	+5,+6	-
PDO	20	-8,-9,-10,-11	+2,+4	-
NPI	20	+10	-	-

Discussion: *Capelin* in chick diets was negatively associated with same-year PDO index during Aug-Nov--higher PDO was associated with less capelin in chick diets. It's interesting that there were not significant results for the other measures of SST, since they are all related when compared with each other.

There was positive association for one-year-previous spring PDO but also for spring through summer for some of the local SST stations—previous-year higher spring or summer SST was associated with higher proportions of *Capelin* in chick diets the next year. This association was also apparent for two-years previous summer SST at Seldovia and GAK1.

Salmonid

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	+7,+10	-	-
Barrens SST	16	-	-	-
Buoy 46001 SST	18	-	-3,-4	-
GAK1 SST	14	-	-5	-
PDO	20	-	-2,-3,-4	-
NPI	20	-10	+3,-7	-

Discussion: There was association for chick diet S*almonid* and same-year *Seldovia SST*, but interestingly, not for any of the other SST indices. There was some agreement among the SST indicators for fewer salmonids in the diet after a year with cooler spring SST.

Appendix 2 (cont.)

Gadid

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	-	-	-9
Barrens SST	16	+12	-	-8,-9
Buoy 46001 SST	18	+9	-	-
GAK1 SST	14	+11,+12	-	-
PDO	20	+5,+9,+10,+11,+12	-	-
NPI	20	-	-	-

Discussion: For gadids, the positive association with same-year local SST (Barrens, Buoy 46001, and GAK1) was for months after the breeding season. PDO was positively associated with *Gadid* for several months, although just one of the months was before or during the breeding season. For PDO, the correlation coefficients for the other breeding season months were positive, but not significantly so (from Appendix **4**).

Two-years-previous fall SST at Seldovia and the Barrens was negatively associated with *Gadid* in chick diets.

Sand lance

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	-10	-	-
Barrens SST	16	-	-	-
Buoy 46001 SST	18	-	-	-
GAK1 SST	14	-	-	-
PDO	20	-	-	-
NPI	20	-11	-	-3,+7,-12

Discussion: The proportion of sand lance in chick diets had only two significant same-year correlation months—and they were both after the breeding season. The only other significant correlations were for 2-year lagged NPI, and these were of mixed sign.

Prowfish

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	-	-7	-1,-3
Barrens SST	16	-	-	-1,-3
Buoy 46001 SST	18	-	-	-
GAK1 SST	14	-	-	-3
PDO	20	-	-	-
NPI	20	+3	-	-4

Discussion: The proportion of prowfish in chick diets had few significant correlations with the environmental variables for same-year and Lag 1 year. There was negative association with two-years-previous Seldovia, Barrens, and Buoy 46001 SST—perhaps cooler SST results in fewer prowfish two years later (or

alternatively, because of the proportions caveat, a higher abundance of capelin [which is probably preferred for chick diets] results in a lower proportion of prowfish, regardless of the availability of prowfish).

Larval fish

Environmental parameter	Shared years in dataset (no lag)	Lag 0yr correlation[a]	Lag 1yr correlation	Lag 2yr correlation
Seldovia SST	19	-	-	-
Barrens SST	16	-	-	-
Buoy 46001 SST	18	-	-	-3,-4
GAK1 SST	14	-	-	-
PDO	20	-	-	-1,-2,-4,-6
NPI	20	-	-9	+1

Discussion: Results for *Larval fish* were somewhat similar to those for *Prowfish*—some negative correlation results for two-years-previous SST.

Appendix 3. Correlation results between tufted puffin biological parameters for the years 1995-2018. Parameter abbreviations are explained in Table 1. "Lag1" means that the tested parameter values are from the year previous to "Lag0"; "Lag 2" values are from two years previous. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation).

Biol. parameter	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
lag0_ch/burr	1 (0)/21	0.779 (0)/21	-0.116/20	0.153/20	-0.357/20	0.284/20	0.052/20	0.355/20
lag0_ch/burr_u	0.779 (0)/21	1 (0)/21	-0.25/20	0.348/20	-0.306/20	0.182/20	0.386/20	0.125/20
lag0_osmerid	-0.116/20	-0.25/20	1 (0)/20	-0.637 (0.003)/20	-0.473 (0.035)/20	-0.214/20	-0.587 (0.007)/20	-0.29/20
lag0_salmonid	0.153/20	0.348/20	-0.637 (0.003)/20	1 (0)/20	-0.069/20	-0.244/20	0.293/20	0.17/20
lag0_gadid	-0.357/20	-0.306/20	-0.473 (0.035)/20	-0.069/20	1 (0)/20	-0.214/20	0.594 (0.006)/20	-0.265/20
lag0_ammodytid	0.284/20	0.182/20	-0.214/20	-0.244/20	-0.214/20	1 (0)/20	-0.232/20	0.371/20
lag0_zaprorid	0.052/20	0.386/20	-0.587 (0.007)/20	0.293/20	0.594 (0.006)/20	-0.232/20	1 (0)/20	-0.182/20
lag0_larval_fish	0.355/20	0.125/20	-0.29/20	0.17/20	-0.265/20	0.371/20	-0.182/20	1 (0)/20
Biol. parameter	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
lag0_ch/burr	0.386/20	0.388/20	-0.209/17	0.416/17	-0.273/17	0.237/17	-0.127/17	0.09/17
lag0_ch/burr_u	0.409/20	0.41/20	-0.252/17	0.669 (0.003)/17	-0.301/17	-0.14/17	-0.032/17	0.192/17
lag0_osmerid	-0.096/20	0.119/20	0.095/17	-0.221/17	0.046/17	0.137/17	0.41/17	-0.518 (0.033)/17
lag0_salmonid	0.333/20	0.158/20	0.123/17	0.13/17	-0.159/17	-0.406/17	-0.217/17	0.399/17
lag0_gadid	-0.47 (0.037)/20	-0.519 (0.019)/20	-0.36/17	-0.025/17	0.635 (0.006)/17	0.008/17	0.047/17	0.1/17
lag0_ammodytid	0.277/20	0.239/20	-0.009/17	0.115/17	-0.231/17	0.262/17	-0.332/17	-0.018/17
lag0_zaprorid	-0.109/20	-0.243/20	-0.431/17	0.462/17	0.104/17	-0.068/17	-0.09/17	0.528 (0.029)/17
lag0_larval_fish	-0.076/20	-0.125/20	0/17	0.171/17	-0.229/17	0.034/17	-0.215/17	0.361/17
Biol. parameter	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
lag0_ch/burr	0.402/19	0.377/19	-0.083/16	0.048/16	0.11/16	-0.039/16	-0.255/16	0.034/16
lag0_ch/burr_u	0.406/19	0.469 (0.043)/19	-0.152/16	0.247/16	0.048/16	-0.29/16	0.127/16	0.227/16
lag0_osmerid	0.241/19	0.264/19	-0.397/16	0.282/16	0.258/16	0.079/16	0.219/16	0.211/16
lag0_salmonid	-0.112/19	-0.1/19	0.367/16	-0.222/16	-0.354/16	-0.01/16	-0.218/16	-0.024/16
lag0_gadid	-0.583 (0.009)/19	-0.621 (0.005)/19	0.377/16	-0.396/16	-0.088/16	-0.008/16	-0.277/16	-0.136/16
lag0_ammodytid	0.461 (0.047)/19	0.49 (0.033)/19	-0.122/16	0.124/16	-0.06/16	0.01/16	0.184/16	-0.236/16
lag0_zaprorid	-0.205/19	-0.239/19	0.184/16	-0.234/16	-0.009/16	-0.065/16	-0.109/16	0.318/16
lag0_larval_fish	-0.123/19	-0.215/19	-0.003/16	0.042/16	0.428/16	-0.279/16	-0.18/16	-0.304/16

Appendix 4. Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation).

Seldovia SST	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	-0.004/20	-0.134/20	-0.278/19	0.276/19	0.109/19	-0.118/19	-0.091/19	0.328/19
Feb	-0.359/21	-0.398/21	-0.249/20	0.333/20	0.025/20	-0.049/20	-0.235/20	0.129/20
Mar	-0.226/21	-0.39/21	-0.047/20	0.126/20	-0.069/20	-0.017/20	-0.327/20	0.121/20
Apr	-0.314/21	-0.478 (0.028)/21	-0.042/20	0.138/20	-0.003/20	-0.131/20	-0.299/20	0.077/20
May	-0.223/21	-0.32/21	-0.196/20	0.289/20	0.091/20	-0.14/20	-0.155/20	-0.025/20
Jun	-0.09/21	-0.21/21	-0.267/20	0.33/20	0.054/20	-0.007/20	-0.162/20	-0.003/20
Jul	0.16/21	-0.039/21	-0.248/20	0.448 (0.048)/20	-0.185/20	0.177/20	-0.305/20	-0.079/20
Aug	-0.007/21	0/21	-0.331/20	0.14/20	0.229/20	0.199/20	-0.049/20	-0.198/20
Sep	-0.052/21	0.085/21	-0.178/20	-0.096/20	0.348/20	0.073/20	0.119/20	-0.245/20
Oct	-0.145/21	0/21	-0.2/20	0.446 (0.048)/20	0.142/20	-0.455 (0.044)/20	0.248/20	-0.191/20
Nov	-0.486 (0.026)/21	-0.341/21	-0.394/20	0.02/20	0.366/20	0.297/20	0.113/20	0.005/20
Dec	-0.267/21	-0.129/21	-0.044/20	-0.075/20	0.269/20	-0.083/20	0.213/20	-0.181/20
Amatuli SST	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	0.097/17	-0.176/17	-0.271/16	0.295/16	0.112/16	-0.135/16	-0.151/16	0.229/16
Feb	0.025/17	-0.263/17	-0.221/16	0.323/16	-0.027/16	-0.03/16	-0.333/16	0.202/16
Mar	0.186/17	-0.198/17	-0.159/16	0.226/16	-0.096/16	0.083/16	-0.378/16	0.185/16
Apr	0.091/17	-0.171/17	-0.234/16	0.279/16	-0.006/16	0.016/16	-0.201/16	0.04/16
May	0.084/17	-0.14/17	-0.215/16	0.298/16	0.011/16	-0.035/16	-0.174/16	-0.102/16
Jun	0.001/19	-0.256/19	-0.233/18	0.212/18	-0.002/18	0.154/18	-0.258/18	-0.047/18
Jul	-0.015/20	-0.247/20	-0.266/19	0.063/19	0.165/19	0.282/19	-0.24/19	-0.101/19
Aug	-0.123/20	-0.062/20	-0.372/19	0.092/19	0.377/19	0.188/19	0.1/19	-0.306/19
Sep	-0.152/19	-0.054/19	-0.342/18	0.018/18	0.445/18	0.206/18	0.068/18	-0.304/18
Oct	-0.101/18	-0.014/18	-0.314/17	0.095/17	0.434/17	-0.088/17	0.192/17	-0.162/17
Nov	-0.447/18	-0.436/18	-0.346/17	0.066/17	0.361/17	0.164/17	0.028/17	0.023/17
Dec	-0.32/18	-0.22/18	-0.332/17	-0.049/17	0.501 (0.04)/17	0.135/17	0.299/17	-0.092/17
GAK1 SST	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	0.227/15	-0.127/15	-0.197/14	0.232/14	0.069/14	-0.057/14	-0.273/14	0.158/14
Feb	0.123/15	-0.217/15	-0.148/14	0.247/14	-0.037/14	-0.059/14	-0.369/14	0.165/14
Mar	-0.062/16	-0.325/16	-0.174/15	0.256/15	-0.015/15	-0.051/15	-0.328/15	0.004/15
Apr	-0.099/16	-0.38/16	-0.126/15	0.228/15	-0.057/15	-0.054/15	-0.349/15	0.024/15
May	-0.08/17	-0.267/17	-0.138/16	0.285/16	-0.127/16	0.007/16	-0.326/16	-0.035/16
Jun	-0.016/17	-0.14/17	-0.082/16	0.185/16	-0.202/16	0.182/16	-0.418/16	0.111/16
Jul	-0.106/17	-0.097/17	-0.393/16	0.255/16	0.239/16	0.052/16	0.041/16	0.082/16
Aug	-0.087/17	-0.084/17	-0.084/16	0.018/16	0.16/16	-0.064/16	-0.03/16	-0.033/16
Sep	-0.08/17	-0.042/17	0.121/16	-0.126/16	0.027/16	-0.098/16	-0.005/16	0.031/16
Oct	-0.414/16	-0.331/16	-0.034/15	-0.165/15	0.415/15	-0.255/15	0.168/15	0.052/15
Nov	-0.559 (0.024)/16	-0.464/16	-0.384/15	-0.065/15	0.767 (0.001)/15	-0.153/15	0.356/15	0.054/15
Dec	-0.429/17	-0.272/17	-0.37/16	-0.097/16	0.562 (0.023)/16	0.109/16	0.393/16	-0.065/16

Appendix 4 (cont.). Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation).

46001 SST	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	-0.045/20	-0.077/20	0.245/19	0.029/19	-0.002/19	-0.378/19	-0.187/19	-0.209/19
Feb	-0.277/19	-0.295/19	-0.047/18	0.294/18	0.095/18	-0.422/18	-0.161/18	0.067/18
Mar	-0.403/19	-0.422/19	-0.033/18	0.15/18	0.114/18	-0.244/18	-0.268/18	-0.049/18
Apr	-0.487 (0.035)/19	-0.494 (0.032)/19	-0.014/18	0.002/18	0.214/18	-0.18/18	-0.25/18	-0.127/18
May	-0.179/20	-0.169/20	-0.316/19	0.02/19	0.444/19	0.052/19	0.103/19	-0.135/19
Jun	-0.269/20	-0.211/20	-0.259/19	-0.068/19	0.291/19	0.342/19	-0.034/19	-0.102/19
Jul	-0.246/20	-0.159/20	-0.137/19	-0.208/19	0.354/19	0.187/19	0.05/19	-0.178/19
Aug	-0.246/21	-0.276/21	0.009/20	-0.266/20	0.272/20	0.171/20	-0.201/20	-0.173/20
Sep	-0.205/21	-0.245/21	-0.412/20	0.036/20	0.498 (0.025)/20	0.178/20	0.059/20	-0.034/20
Oct	-0.035/21	-0.053/21	-0.213/20	0.118/20	0.164/20	-0.076/20	0.143/20	0.03/20
Nov	-0.251/21	-0.187/21	-0.345/20	0.145/20	0.315/20	0.083/20	0.085/20	0.039/20
Dec	-0.294/20	-0.264/20	-0.254/19	0.036/19	0.346/19	-0.007/19	0.037/19	0.082/19
PDO	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	-0.022/21	-0.161/21	-0.268/20	0.286/20	0.057/20	0.08/20	-0.348/20	0.13/20
Feb	-0.138/21	-0.318/21	-0.208/20	0.226/20	0.118/20	0/20	-0.31/20	-0.061/20
Mar	-0.169/21	-0.393/21	-0.166/20	0.048/20	0.181/20	0.108/20	-0.261/20	-0.122/20
Apr	-0.224/21	-0.491 (0.024)/21	-0.186/20	0.014/20	0.312/20	0.071/20	-0.24/20	-0.073/20
May	-0.11/21	-0.309/21	-0.384/20	0.058/20	0.535 (0.015)/20	0.092/20	0.031/20	-0.119/20
Jun	-0.09/21	-0.166/21	-0.422/20	0.105/20	0.43/20	0.221/20	0.102/20	-0.168/20
Jul	0.007/21	-0.007/21	-0.39/20	0.064/20	0.379/20	0.281/20	0.176/20	-0.286/20
Aug	-0.056/21	0.037/21	-0.469 (0.037)/20	0.095/20	0.345/20	0.4/20	0.164/20	-0.145/20
Sep	-0.006/21	0.047/21	-0.522 (0.018)/20	0.028/20	0.633 (0.003)/20	0.226/20	0.439/20	-0.162/20
Oct	-0.036/20	-0.002/20	-0.568 (0.009)/20	0.216/20	0.606 (0.005)/20	0.01/20	0.433/20	-0.027/20
Nov	-0.216/20	-0.192/20	-0.475 (0.034)/20	0.083/20	0.573 (0.008)/20	0.138/20	0.249/20	-0.025/20
Dec	-0.096/20	-0.033/20	-0.367/20	-0.036/20	0.504 (0.023)/20	0.184/20	0.32/20	-0.15/20
NPI	lag0_ch/burr	lag0_ch/burr_u	lag0_osmerid	lag0_salmonid	lag0_gadid	lag0_ammodytid	lag0_zaprorid	lag0_larval_fish
Jan	0.05/21	0.15/21	0.397/20	-0.418/20	0/20	-0.035/20	0.161/20	-0.345/20
Feb	0.168/21	0.326/21	-0.066/20	0.135/20	-0.035/20	-0.117/20	0.271/20	0.215/20
Mar	0.077/21	0.278/21	-0.378/20	0.106/20	0.381/20	0.013/20	0.459 (0.042)/20	-0.023/20
Apr	0.106/21	0.156/21	0.05/20	0.126/20	-0.207/20	-0.153/20	0.079/20	0.15/20
May	-0.22/21	-0.176/21	0.055/20	0.09/20	0.054/20	-0.416/20	0.113/20	-0.016/20
Jun	-0.128/21	-0.271/21	0.264/20	-0.283/20	-0.144/20	0.081/20	-0.418/20	-0.017/20
Jul	-0.337/21	-0.495 (0.023)/21	-0.032/20	0.102/20	0.19/20	-0.284/20	-0.135/20	0.167/20
Aug	-0.196/21	-0.223/21	-0.341/20	0.236/20	0.094/20	0.053/20	0.157/20	0.125/20
Sep	0/21	0.031/21	0.172/20	-0.172/20	-0.089/20	0.094/20	-0.223/20	-0.184/20
Oct	-0.018/21	-0.182/21	0.568 (0.009)/20	-0.585 (0.007)/20	0.004/20	-0.067/20	-0.35/20	-0.379/20
Nov	-0.072/21	-0.12/21	0.04/20	0.389/20	0.213/20	-0.737 (0)/20	0.035/20	-0.282/20
Dec	-0.358/21	-0.334/21	0.313/20	-0.205/20	-0.018/20	-0.275/20	-0.315/20	0.107/20

Appendix 4 (cont.). Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation). This table shows results for "Lag1": the puffin parameter has been matched for comparison with the previous year's environmental index.

Seldovia SST	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	-0.115/22	-0.22/22	0.166/19	-0.199/19	-0.099/19	0.054/19	-0.065/19	0.133/19
Feb	0.089/23	-0.059/23	0.258/19	-0.322/19	-0.059/19	0.023/19	-0.224/19	0.087/19
Mar	0.004/23	-0.103/23	0.073/19	-0.21/19	-0.004/19	0.132/19	-0.034/19	-0.016/19
Apr	-0.089/23	-0.252/23	0.361/19	-0.439/19	-0.083/19	0.118/19	-0.275/19	0.004/19
May	-0.049/23	-0.251/23	0.336/19	-0.372/19	-0.101/19	0.079/19	-0.36/19	0.015/19
Jun	-0.017/24	-0.242/24	0.311/20	-0.329/20	-0.048/20	0.014/20	-0.331/20	-0.044/20
Jul	0.174/24	-0.004/24	0.515 (0.02)/20	-0.402/20	-0.265/20	0.039/20	-0.544 (0.013)/20	-0.13/20
Aug	-0.042/24	-0.153/24	0.482 (0.031)/20	-0.197/20	-0.322/20	-0.093/20	-0.422/20	-0.278/20
Sep	-0.101/24	-0.112/24	0.415/20	-0.114/20	-0.253/20	-0.158/20	-0.288/20	-0.228/20
Oct	-0.036/23	-0.137/23	0.234/19	0.034/19	-0.267/19	-0.274/19	-0.208/19	0.139/19
Nov	-0.071/23	-0.114/23	0.149/19	0.072/19	-0.26/19	-0.111/19	-0.337/19	0.118/19
Dec	-0.235/23	-0.234/23	-0.016/19	0.364/19	-0.338/19	-0.161/19	-0.201/19	0.017/19
Amatuli SST	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	-0.105/19	-0.266/19	0.238/15	-0.276/15	-0.197/15	0.198/15	-0.233/15	0.092/15
Feb	0.087/19	-0.059/19	0.181/15	-0.349/15	-0.062/15	0.268/15	-0.224/15	0.105/15
Mar	0.119/19	-0.046/19	0.125/15	-0.312/15	-0.042/15	0.294/15	-0.143/15	0.024/15
Apr	0.018/19	-0.197/19	0.352/15	-0.435/15	-0.114/15	0.257/15	-0.432/15	0.076/15
May	0.059/19	-0.158/19	0.367/15	-0.447/15	-0.108/15	0.225/15	-0.397/15	0.012/15
Jun	0.159/21	-0.087/21	0.371/17	-0.475/17	-0.13/17	0.281/17	-0.463/17	-0.037/17
Jul	0.067/22	-0.104/22	0.41/18	-0.407/18	-0.209/18	0.211/18	-0.443/18	-0.126/18
Aug	0.013/22	-0.121/22	0.275/18	-0.142/18	-0.078/18	-0.138/18	-0.252/18	-0.222/18
Sep	0.062/21	-0.048/21	0.272/17	-0.227/17	-0.036/17	-0.054/17	-0.146/17	-0.285/17
Oct	-0.088/20	-0.227/20	0.282/16	-0.135/16	-0.092/16	-0.1/16	-0.222/16	-0.166/16
Nov	0.021/20	-0.16/20	0.179/16	-0.211/16	0.024/16	-0.006/16	-0.258/16	0.009/16
Dec	-0.139/20	-0.241/20	-0.101/16	0.244/16	-0.038/16	-0.147/16	-0.147/16	-0.011/16
GAK1 SST	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	-0.074/17	-0.188/17	0.246/13	-0.247/13	-0.206/13	0.2/13	-0.183/13	-0.005/13
Feb	0.013/17	-0.139/17	0.418/13	-0.504/13	-0.195/13	0.301/13	-0.305/13	0.018/13
Mar	0.171/18	-0.002/18	0.346/14	-0.459/14	-0.223/14	0.341/14	-0.243/14	0.035/14
Apr	0.092/18	-0.1/18	0.464/14	-0.51/14	-0.225/14	0.287/14	-0.368/14	-0.044/14
May	0.137/19	-0.127/19	0.554 (0.032)/15	-0.517 (0.049)/15	-0.228/15	0.175/15	-0.475/15	-0.09/15
Jun	0.151/19	0.003/19	0.558 (0.031)/15	-0.386/15	-0.259/15	0.008/15	-0.317/15	-0.242/15
Jul	-0.076/19	-0.209/19	0.462/15	-0.217/15	-0.233/15	-0.134/15	-0.406/15	-0.05/15
Aug	-0.1/19	-0.108/19	0.353/15	-0.162/15	-0.256/15	-0.008/15	-0.149/15	-0.258/15
Sep	-0.06/19	-0.04/19	0.025/15	0.04/15	-0.229/15	0.136/15	0.038/15	-0.018/15
Oct	-0.38/18	-0.322/18	0.117/14	-0.214/14	-0.001/14	0.021/14	0.036/14	0.27/14
Nov	-0.361/18	-0.413/18	-0.026/14	-0.063/14	0.278/14	-0.199/14	-0.025/14	0.16/14
Dec	-0.08/19	-0.171/19	-0.178/15	0.326/15	-0.096/15	-0.074/15	-0.131/15	0.05/15

Appendix 4 (cont.). Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation). This table shows results for "Lag1": the puffin parameter has been matched for comparison with the previous year's environmental index.

46001 SST	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	-0.304/22	-0.373/22	0.313/18	-0.316/18	-0.047/18	0.03/18	-0.218/18	-0.201/18
Feb	-0.277/21	-0.389/21	0.379/17	-0.436/17	0.004/17	-0.086/17	-0.175/17	0.063/17
Mar	-0.26/21	-0.352/21	0.412/17	-0.514 (0.035)/17	-0.035/17	0.057/17	-0.21/17	-0.041/17
Apr	-0.287/21	-0.427/21	0.6 (0.011)/17	-0.526 (0.03)/17	-0.068/17	-0.094/17	-0.3/17	-0.278/17
May	-0.265/23	-0.384/23	0.246/19	-0.15/19	-0.028/19	-0.068/19	-0.284/19	-0.281/19
Jun	-0.321/23	-0.397/23	0.163/19	-0.111/19	0.04/19	-0.082/19	-0.261/19	-0.237/19
Jul	-0.228/23	-0.313/23	0.049/19	0.03/19	0.017/19	-0.065/19	-0.191/19	-0.21/19
Aug	-0.163/24	-0.232/24	-0.009/20	-0.063/20	0.156/20	-0.008/20	-0.025/20	-0.32/20
Sep	-0.212/24	-0.257/24	0.16/20	-0.131/20	0.136/20	-0.165/20	-0.21/20	-0.276/20
Oct	-0.124/24	-0.162/24	0.194/20	0.028/20	-0.112/20	-0.127/20	-0.241/20	-0.182/20
Nov	-0.265/24	-0.239/24	0.242/20	0.025/20	-0.047/20	-0.299/20	-0.289/20	-0.27/20
Dec	-0.346/23	-0.348/23	0.333/19	0.008/19	-0.101/19	-0.374/19	-0.279/19	-0.309/19
PDO	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	0.026/24	-0.058/24	0.373/20	-0.332/20	-0.111/20	-0.024/20	-0.145/20	-0.227/20
Feb	0.048/24	-0.085/24	0.445 (0.049)/20	-0.531 (0.016)/20	-0.077/20	0.107/20	-0.233/20	-0.199/20
Mar	0.075/24	-0.115/24	0.342/20	-0.488 (0.029)/20	-0.064/20	0.217/20	-0.249/20	-0.165/20
Apr	-0.082/24	-0.262/24	0.446 (0.049)/20	-0.622 (0.003)/20	0.071/20	0.129/20	-0.351/20	-0.263/20
May	-0.101/24	-0.265/24	0.201/20	-0.424/20	0.124/20	0.172/20	-0.257/20	-0.178/20
Jun	-0.167/24	-0.268/24	0.211/20	-0.279/20	0.018/20	0.089/20	-0.347/20	-0.18/20
Jul	-0.054/24	-0.167/24	0.23/20	-0.219/20	-0.076/20	0.114/20	-0.383/20	-0.251/20
Aug	-0.1/24	-0.182/24	0.128/20	0.083/20	-0.202/20	-0.029/20	-0.404/20	-0.187/20
Sep	-0.263/24	-0.308/24	-0.157/20	0.217/20	0.04/20	0.012/20	-0.264/20	-0.073/20
Oct	-0.389/24	-0.433 (0.035)/24	-0.097/20	0.151/20	0.089/20	-0.049/20	-0.329/20	-0.016/20
Nov	-0.296/24	-0.283/24	0.024/20	0.081/20	0.109/20	-0.158/20	-0.298/20	-0.132/20
Dec	-0.242/24	-0.235/24	-0.049/20	0.261/20	-0.086/20	-0.05/20	-0.379/20	-0.097/20
NPI	lag1_ch/burr	lag1_ch/burr_u	lag1_osmerid	lag1_salmonid	lag1_gadid	lag1_ammodytid	lag1_zaprorid	lag1_larval_fish
Jan	-0.065/24	0.116/24	-0.408/20	0.359/20	0.045/20	0.144/20	0.259/20	-0.005/20
Feb	-0.198/24	-0.124/24	-0.266/20	0.333/20	0.032/20	-0.096/20	0.111/20	0.194/20
Mar	-0.266/24	-0.087/24	-0.305/20	0.512 (0.021)/20	0.118/20	-0.28/20	0.162/20	-0.044/20
Apr	0.01/24	0.093/24	-0.256/20	0.372/20	-0.093/20	-0.131/20	0.344/20	0.217/20
May	-0.104/24	-0.089/24	0.253/20	-0.285/20	-0.069/20	0.086/20	-0.262/20	0.192/20
Jun	0.178/24	0.289/24	0.077/20	-0.325/20	0.145/20	0.182/20	0.297/20	-0.191/20
Jul	-0.074/24	-0.209/24	0.268/20	-0.451 (0.046)/20	0.266/20	-0.12/20	-0.042/20	-0.026/20
Aug	0.106/24	-0.005/24	0.228/20	-0.335/20	-0.127/20	0.227/20	-0.312/20	0.298/20
Sep	-0.158/24	-0.102/24	0.231/20	0.097/20	-0.152/20	-0.165/20	-0.154/20	-0.476 (0.034)/20
Oct	0.106/24	0.266/24	-0.084/20	-0.181/20	-0.031/20	0.412/20	0.32/20	-0.178/20
Nov	-0.218/24	-0.275/24	-0.036/20	-0.265/20	0.389/20	-0.133/20	0.25/20	-0.124/20
Dec	-0.294/24	-0.125/24	0.225/20	-0.134/20	0.13/20	-0.334/20	0.268/20	-0.265/20

Appendix 4 (cont.). Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation). This table shows results for "Lag2": the puffin parameter has been matched for comparison with the environmental index from two years previous.

Seldovia SST	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
Jan	-0.185/22	-0.242/22	0.314/18	0.028/18	-0.258/18	0.004/18	-0.518 (0.028)/18	-0.282/18
Feb	-0.053/22	-0.102/22	0.298/18	0.046/18	-0.212/18	-0.056/18	-0.221/18	-0.465/18
Mar	-0.081/22	-0.2/22	0.438/18	-0.082/18	-0.4/18	0.048/18	-0.609 (0.007)/18	-0.186/18
Apr	-0.133/22	-0.154/22	0.366/18	-0.132/18	-0.132/18	0.029/18	-0.371/18	-0.43/18
May	-0.14/22	-0.141/22	0.428/18	-0.212/18	-0.266/18	0.135/18	-0.392/18	-0.376/18
Jun	-0.049/23	-0.051/23	0.462 (0.046)/19	-0.314/19	-0.217/19	0.154/19	-0.4/19	-0.394/19
Jul	0.163/23	0.192/23	0.461 (0.047)/19	-0.351/19	-0.38/19	0.279/19	-0.325/19	-0.368/19
Aug	0.012/23	0.084/23	0.42/19	-0.17/19	-0.438/19	0.091/19	-0.189/19	-0.416/19
Sep	-0.12/23	0.035/23	0.266/19	0.17/19	-0.48 (0.038)/19	-0.124/19	-0.053/19	-0.367/19
Oct	-0.059/22	-0.057/22	0.435/19	-0.246/19	-0.232/19	0.052/19	-0.264/19	-0.201/19
Nov	-0.05/22	-0.126/22	0.137/19	0/19	-0.314/19	0.077/19	0.026/19	-0.127/19
Dec	0.043/22	-0.04/22	0.309/19	-0.207/19	-0.297/19	0.108/19	-0.161/19	0.057/19
Amatuli SST	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
Jan	-0.065/18	-0.148/18	0.468/14	-0.106/14	-0.343/14	0.103/14	-0.599 (0.024)/14	-0.346/14
Feb	0.015/18	-0.053/18	0.273/14	0.072/14	-0.252/14	0.057/14	-0.399/14	-0.408/14
Mar	0.036/18	-0.056/18	0.307/14	0.001/14	-0.412/14	0.279/14	-0.623 (0.017)/14	-0.251/14
Apr	0/18	0.014/18	0.348/14	-0.139/14	-0.169/14	0.144/14	-0.358/14	-0.441/14
May	-0.027/18	0.011/18	0.33/14	-0.167/14	-0.242/14	0.262/14	-0.349/14	-0.366/14
Jun	0.023/20	0.025/20	0.415/16	-0.296/16	-0.284/16	0.311/16	-0.398/16	-0.432/16
Jul	0.075/21	0.064/21	0.309/17	-0.223/17	-0.349/17	0.378/17	-0.321/17	-0.333/17
Aug	-0.003/21	0.047/21	0.435/17	-0.21/17	-0.493 (0.044)/17	0.232/17	-0.282/17	-0.265/17
Sep	-0.021/20	0.037/20	0.076/16	0.142/16	-0.559 (0.024)/16	0.373/16	-0.185/16	-0.194/16
Oct	-0.177/19	-0.099/19	0.456/15	-0.029/15	-0.402/15	-0.023/15	-0.372/15	-0.499/15
Nov	-0.058/19	-0.163/19	0.148/15	-0.106/15	-0.29/15	0.391/15	-0.255/15	-0.157/15
Dec	-0.064/19	-0.188/19	0.237/15	-0.243/15	-0.272/15	0.298/15	-0.256/15	0.058/15
GAK1 SST	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
Jan	0.013/16	-0.062/16	0.444/12	-0.071/12	-0.281/12	0.027/12	-0.556/12	-0.447/12
Feb	0.01/16	-0.026/16	0.276/12	0.016/12	-0.234/12	0.151/12	-0.393/12	-0.486/12
Mar	0.037/17	-0.039/17	0.385/13	-0.047/13	-0.487/13	0.319/13	-0.56 (0.047)/13	-0.315/13
Apr	0.052/17	-0.017/17	0.417/13	-0.193/13	-0.355/13	0.351/13	-0.501/13	-0.409/13
May	0.069/18	0.075/18	0.324/14	-0.257/14	-0.186/14	0.399/14	-0.321/14	-0.515/14
Jun	0.144/18	0.179/18	-0.06/14	-0.006/14	-0.006/14	0.39/14	-0.047/14	-0.471/14
Jul	-0.055/18	-0.072/18	-0.004/14	-0.163/14	0.052/14	0.333/14	-0.012/14	-0.294/14
Aug	0.036/18	0.016/18	0.011/14	0.008/14	-0.112/14	0.274/14	-0.131/14	-0.227/14
Sep	0.143/18	0.074/18	-0.125/14	0.187/14	-0.085/14	0.169/14	-0.185/14	0.06/14
Oct	-0.334/17	-0.366/17	0.086/13	0.132/13	-0.057/13	-0.232/13	-0.056/13	0.047/13
Nov	-0.401/17	-0.562 (0.019)/17	0.253/13	-0.105/13	-0.085/13	-0.192/13	-0.151/13	-0.031/13
Dec	-0.018/18	-0.208/18	0.357/14	-0.19/14	-0.337/14	0.074/14	-0.236/14	-0.021/14

Appendix 4 (cont.). Results of correlation analysis between annual biological parameters of tufted puffins and monthly anomaly of sea-surface temperature at locations in the Gulf of Alaska, the Pacific Decadal Oscillation index, and the North Pacific Index (see Methods and Figure 2) for the years 1995-2018. Parameter abbreviations are explained in Table 1. Results with greyed text have p-values ≥ 0.05. Significant results are presented as: correlation coefficient (p-value)/sample size in years. P-values < 0.001 are displayed as zeros. Peach cell fill: r < -0.35 (negative correlation); Green cell fill: r > 0.35 (positive correlation). This table shows results for "Lag2": the puffin parameter has been matched for comparison with the environmental index from two years previous.

46001 SST	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
	-0.038/21	0.021/21	0.379/17	-0.096/17	0.012/17	-0.189/17	-0.318/17	-0.422/17
Feb	-0.259/20	-0.23/20	0.337/16	-0.049/16	0.052/16	-0.169/16	-0.326/16	-0.484/16
Mar	-0.194/20	-0.143/20	0.393/16	-0.009/16	-0.059/16	-0.199/16	-0.305/16	-0.532 (0.034)/16
Apr	-0.248/20	-0.191/20	0.433/16	-0.195/16	-0.014/16	-0.093/16	-0.235/16	-0.636 (0.008)/16
May	-0.021/23	-0.054/23	0.431/19	-0.415/19	-0.015/19	-0.032/19	0.009/19	-0.423/19
Jun	0.033/23	0.073/23	0.456/19	-0.312/19	-0.038/19	-0.159/19	-0.017/19	-0.419/19
Jul	-0.034/23	-0.015/23	0.518 (0.023)/19	-0.094/19	-0.288/19	-0.212/19	-0.339/19	-0.419/19
Aug	0.024/24	-0.02/24	0.203/20	0.048/20	-0.195/20	-0.088/20	-0.13/20	-0.315/20
Sep	-0.121/24	-0.166/24	0.263/20	-0.237/20	-0.182/20	0.061/20	-0.047/20	-0.252/20
Oct	0.047/24	-0.02/24	0.361/20	-0.215/20	-0.146/20	-0.01/20	-0.269/20	-0.245/20
Nov	-0.093/24	-0.113/24	0.449 (0.047)/20	-0.258/20	-0.178/20	-0.142/20	-0.175/20	-0.373/20
Dec	-0.236/23	-0.29/23	0.353/19	-0.236/19	-0.127/19	-0.033/19	-0.192/19	-0.326/19
PDO	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
Jan	0.005/24	-0.008/24	0.297/20	-0.037/20	-0.136/20	-0.085/20	-0.167/20	-0.56 (0.01)/20
Feb	-0.086/24	-0.06/24	0.262/20	-0.079/20	-0.108/20	0.041/20	-0.147/20	-0.592 (0.006)/20
Mar	-0.02/24	-0.042/24	0.229/20	-0.158/20	-0.19/20	0.291/20	-0.236/20	-0.441/20
Apr	-0.119/24	-0.111/24	0.158/20	-0.329/20	0.075/20	0.302/20	0.01/20	-0.565 (0.009)/20
May	-0.139/24	-0.146/24	0.218/20	-0.303/20	-0.054/20	0.262/20	-0.078/20	-0.437/20
Jun	0.089/24	0.087/24	0.299/20	-0.32/20	-0.019/20	0.059/20	0.034/20	-0.445 (0.049)/20
Jul	0.232/24	0.222/24	0.141/20	-0.242/20	-0.012/20	0.171/20	0.131/20	-0.37/20
Aug	0.312/24	0.244/24	0.225/20	-0.169/20	-0.105/20	-0.025/20	0.12/20	-0.349/20
Sep	0.106/24	0.004/24	0.273/20	-0.222/20	-0.073/20	-0.061/20	-0.043/20	-0.252/20
Oct	0.012/24	-0.109/24	0.329/20	-0.315/20	0.092/20	-0.176/20	-0.052/20	-0.337/20
Nov	-0.051/24	-0.159/24	0.229/20	-0.208/20	-0.012/20	-0.126/20	0.023/20	-0.261/20
Dec	0.035/24	-0.026/24	0.265/20	-0.243/20	-0.13/20	-0.013/20	-0.026/20	-0.174/20
NPI	lag2_ch/burr	lag2_ch/burr_u	lag2_osmerid	lag2_salmonid	lag2_gadid	lag2_ammodytid	lag2_zaprorid	lag2_larval_fish
Jan	0.295/24	0.253/24	-0.335/20	0.031/20	0.154/20	0.069/20	0.335/20	0.614 (0.004)/20
Feb	-0.08/24	0.006/24	0.227/20	-0.034/20	0.043/20	-0.334/20	-0.131/20	-0.027/20
Mar	-0.04/24	-0.076/24	0.236/20	-0.023/20	-0.002/20	-0.51 (0.022)/20	-0.038/20	0.014/20
Apr	-0.021/24	-0.143/24	0.142/20	-0.006/20	-0.232/20	0.047/20	-0.493 (0.027)/20	0.423/20
May	-0.345/24	-0.294/24	0.063/20	0.077/20	-0.071/20	-0.173/20	-0.009/20	0.052/20
Jun	-0.096/24	-0.076/24	-0.076/20	0.354/20	-0.082/20	-0.22/20	0.059/20	-0.105/20
Jul	-0.461 (0.023)/24	-0.482 (0.017)/24	-0.155/20	-0.181/20	0.076/20	0.47 (0.036)/20	-0.22/20	0.092/20
Aug	-0.098/24	-0.091/24	0.124/20	-0.206/20	-0.001/20	0.139/20	-0.008/20	-0.057/20
Sep	0.093/24	0.135/24	0.207/20	-0.142/20	0.048/20	-0.324/20	0.18/20	-0.237/20
Oct	0.023/24	0.115/24	-0.3/20	0.384/20	-0.175/20	0.111/20	0.034/20	0.164/20
Nov	-0.259/24	-0.274/24	0.136/20	-0.299/20	0.238/20	0.083/20	-0.127/20	-0.139/20
Dec	-0.388/24	-0.411 (0.046)/24	-0.197/20	0.355/20	0.153/20	-0.457 (0.043)/20	0.231/20	0.02/20

Appendix 5. By-day binocular counts of adult tufted puffins on the surface in plots on East Amatuli Island, Alaska. Not all plots were counted on each day. To maximize the comparative use of the data, a "proportion of maximum" summary statistic has been calculated. The sum of plots counted in a day was divided by the sum of the among-year maximum count those plots.

Year: 1993	Plot[1]											Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	n	Sum[b]	year max[c]	max[d]
26-Jun-93	-	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-93	-	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-93	-	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-93	-	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-93	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-93	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-93	11	11	7	9	-	-	-	-	-	4	38	254	0.15
10-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-93	18	20	18	5	15	7	2	-	-	7	85	445	0.19
14-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-93	2	7	3	1	0	0	0	-	-	7	13	445	0.03
16-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-93	21	18	7	8	8	3	0	-	-	7	65	445	0.15
21-Aug-93	13	22	-	-	-	-	-	-	-	2	-	-	-
22-Aug-93	9	6	0	0	0	0	0	-	-	7	15	445	0.03
23-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-93	0	0	0	0	0	0	0	-	-	7	0	445	0.00
27-Aug-93	12	5	12	21	46	51	1	-	-	7	148	445	0.33
28-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-93	-	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-93	2	5	0	0	0	1	0	-	-	7	8	445	0.02
02-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-93	10	7	3	3	30	32	2	-	-	7	87	445	0.20
08-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-93	-	-	-	-	-	-	-	-	-	-	-	-	-
Census period mean (10-30 Aug):	11	11	7	6	12	10	1	-	-			Mean	0.12
Census period max (10-30 Aug):	21	22	18	21	46	51	2	-	-				
Among-year maximum count:	95	77	38	44	94	86	11	84	146			St. dev.	0.11

[1]Plots 1-9 have respective field names C1, C2, AC, BC, H1, H2, H3, S1, and S2.

Appendix 5 (cont.).

Year 1994	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-94	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-94	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-94	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-94	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-94	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-94	9	22	22	14	16	27	5	-	-	115	445	0.26
21-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-94	7	14	2	0	3	2	1	-	-	29	445	0.07
28-Jul-94	38	29	19	10	30	32	2	-	-	160	445	0.36
29-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-94	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-94	11	2	21	29	36	55	7	-	-	161	445	0.36
02-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-94	13	27	38	17	55	49	10	-	-	209	445	0.47
04-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-94	2	0	1	9	8	12	0	-	-	32	445	0.07
08-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-94	54	40	22	24	-	-	-	-	-	140	254	0.55
11-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-94	3	7	12	18	11	18	5	-	-	74	445	0.17
13-Aug-94	-	-	13	12	-	-	-	-	-	-	-	-
14-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-94	13	-	6	9	9	7	0	-	-	44	368	0.12
18-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-94	28	20	13	8	46	35	5	-	-	155	445	0.35
20-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-94	35	42	30	6	5	6	2	-	-	126	445	0.28
28-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-94	1	2	28	3	65	54	5	-	-	158	445	0.36
31-Aug-94	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-94	73	21	38	44	94	86	11	-	-	367	445	0.82
04-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-94	12	12	0	4	0	4	0	-	-	32	445	0.07
07-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-94	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	22	22	18	11	27	24	3	-	-		Mean	0.31
Census period max (10-30 Aug):	73	42	38	44	94	86	11	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.21

Appendix 5 (cont.).

Year 1995	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-95	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-95	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-95	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-95	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-95	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-95	95	71	-	-	19	18	0	-	-	203	363	0.56
14-Jul-95	22	9	22	31	7	19	0	-	-	110	445	0.25
15-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-95	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-95	3	1	-	-	8	0	-	-	-	12	352	0.03
03-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-95	34	20	33	32	48	49	1	-	-	217	445	0.49
19-Aug-95	0	2	0	0	2	5	0	-	-	9	445	0.02
20-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-95	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-95	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	17	11	17	16	25	27	1	-	-		Mean	0.27
Census period max (10-30 Aug):	95	71	33	32	48	49	1	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.25

Appendix 5 (cont.).

Year 1996	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-96	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-96	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-96	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-96	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-96	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-96	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-96	-	-	2	3	0	10	0	-	-	-	-	-
10-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-96	0	0	0	0	0	0	0	-	-	0	445	0.00
21-Aug-96	0	0	0	0	1	0	0	-	-	1	445	0.00
22-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-96	25	19	6	9	13	9	0	-	-	81	445	0.18
26-Aug-96	1	4	0	0	0	1	0	-	-	6	445	0.01
27-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-96	0	1	0	0	0	0	0	-	-	1	445	0.00
29-Aug-96	0	0	3	1	4	1	0	-	-	9	445	0.02
30-Aug-96	4	4	0	0	1	1	0	-	-	10	445	0.02
31-Aug-96	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-96	0	0	0	0	0	0	0	-	-	0	445	0.00
03-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-96	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	4	4	1	1	3	2	0	-	-		Mean	0.03
Census period max (10-30 Aug):	25	19	6	9	13	10	0	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.06

Appendix 5 (cont.).

Year 1997	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-97	0	1	0	0	0	0	0	-	-	1	445	0.00
27-Jun-97	0	0	0	0	0	1	0	-	-	1	445	0.00
28-Jun-97	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-97	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-97	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-97	39	-	-	-	-	-	-	-	-	39	95	0.41
05-Jul-97	0	0	0	0	0	1	0	-	-	1	445	0.00
06-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-97	0	3	0	0	0	0	0	-	-	3	445	0.01
08-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-97	0	0	1	0	1	0	0	-	-	2	445	0.00
10-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-97	0	0	0	0	0	0	0	-	-	0	445	0.00
12-Jul-97	38	36	13	0	9	4	0	-	-	100	445	0.22
13-Jul-97	34	50	8	0	17	29	3	-	-	141	445	0.32
14-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-97	15	31	4	1	-	-	-	-	-	51	254	0.20
16-Jul-97	8	4	13	4	9	11	1	-	-	50	445	0.11
17-Jul-97	1	0	0	0	0	0	0	-	-	1	445	0.00
18-Jul-97	13	25	6	0	2	4	0	-	-	50	445	0.11
19-Jul-97	5	6	11	2	1	0	1	-	-	26	445	0.06
20-Jul-97	23	17	15	3	32	15	0	-	-	105	445	0.24
21-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-97	50	60	25	8	12	5	2	-	-	162	445	0.36
23-Jul-97	0	0	0	0	1	0	0	-	-	1	445	0.00
24-Jul-97	26	39	8	1	1	1	0	-	-	76	445	0.17
25-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-97	35	17	12	5	17	12	1	-	-	99	445	0.22
27-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-97	0	0	1	0	0	3	0	-	-	4	445	0.01
29-Jul-97	17	7	7	4	4	6	1	-	-	46	445	0.10
30-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-97	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-97	15	5	11	5	0	11	3	-	-	50	445	0.11
11-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-97	17	9	5	7	0	6	0	-	-	44	445	0.10
14-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-97	49	53	23	16	41	42	11	-	-	235	445	0.53
16-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-97	10	1	14	1	10	3	0	-	-	39	445	0.09
27-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-97	0	0	0	0	0	0	0	-	-	0	445	0.00
29-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-97	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-97	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	18	14	11	6	10	12	3	-	-		Mean	0.13
Census period max (10-30 Aug):	50	60	25	16	41	42	11	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.15

Appendix 5 (cont.).

Year 1998	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-98	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-98	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-98	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-98	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-98	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-98	0	0	0	0	0	0	0	-	-	0	445	0.00
06-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-98	0	0	0	0	0	0	0	-	-	0	445	0.00
10-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-98	0	0	0	0	0	0	0	-	-	0	445	0.00
12-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-98	0	0	0	0	2	0	0	-	-	2	445	0.00
15-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-98	0	0	0	0	0	0	0	-	-	0	445	0.00
19-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-98	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-98	13	16	25	12	3	11	1	15	40	136	675	0.20
05-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-98	0	0	0	0	0	0	0	0	0	0	675	0.00
07-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-98	2	0	0	0	0	0	0	0	0	2	675	0.00
17-Aug-98	-	0	-	0	-	0	-	0	-	-	-	-
18-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-98	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-98	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	2	0	0	0	0	0	0	0	0		Mean	0.03
Census period max (10-30 Aug):	13	16	25	12	3	11	1	15	40			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.07

Appendix 5 (cont.).

Year 1999	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-99	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-99	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-99	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-99	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-99	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-99	0	2	0	0	0	0	0	0	0	2	675	0.00
10-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-99	47	44	8	0	1	2	0	9	19	130	675	0.19
12-Jul-99	44	9	6	5	0	2	0	26	29	121	675	0.18
13-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-99	16	30	4	1	3	4	0	10	18	86	675	0.13
21-Jul-99	0	0	0	0	0	0	0	0	0	0	675	0.00
22-Jul-99	0	0	1	2	1	0	0	0	0	4	675	0.01
23-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-99	21	29	0	0	1	0	0	15	25	91	675	0.13
27-Jul-99	0	1	-	-	0	0	0	0	0	1	593	0.00
28-Jul-99	1	0	3	0	1	5	0	4	12	26	675	0.04
29-Jul-99	30	32	13	8	9	6	-	-	-	98	434	0.23
30-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-99	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-99	13	26	9	5	5	16	1	26	13	114	675	0.17
13-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-99	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-99	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	13	26	9	5	5	16	1	26	13		Mean	0.10
Census period max (10-30 Aug):	47	44	13	8	9	16	1	26	29			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.09

Appendix 5 (cont.).

Year 2000	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-00	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-00	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-00	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-00	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-00	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-00	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-00	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-00	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	-	-	-	-	-	-	-	-	-		Mean	#DIV/0!
Census period max (10-30 Aug):	-	-	-	-	-	-	-	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	#DIV/0!

Appendix 5 (cont.).

Year 2001	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-01	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-01	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-01	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-01	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-01	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-01	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-01	2	4	0	0	0	0	0	0	0	6	675	0.01
13-Aug-01	53	14	18	25	1	17	0	11	26	165	675	0.24
14-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-01	13	5	-	-	2	7	0	-	-	27	363	0.07
17-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-01	1	0	0	0	0	0	0	0	0	1	675	0.00
22-Aug-01	5	8	0	6	1	7	0	8	2	37	675	0.05
23-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-01	0	0	1	1	0	1	0	1	0	4	675	0.01
26-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-01	12	5	2	5	2	5	0	2	-	33	529	0.06
31-Aug-01	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-01	-	-	1	8	-	-	-	-	-	-	-	-
02-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-01	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	12	5	4	6	1	5	0	4	6		Mean	0.06
Census period max (10-30 Aug):	53	14	18	25	2	17	0	11	26			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.08

Appendix 5 (cont.).

Year 2002	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-02	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-02	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-02	1	0	4	0	0	2	0	0	3	10	675	0.01
29-Jun-02	4	5	0	0	1	1	0	2	4	17	675	0.03
30-Jun-02	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-02	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-02	4	3	9	2	3	1	1	2	5	30	675	0.04
04-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-02	34	15	12	10	3	11	2	5	6	98	675	0.15
08-Aug-02	13	12	1	1	0	2	0	3	0	32	675	0.05
09-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-02	8	13	6	5	0	5	1	10	11	59	675	0.09
14-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-02	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-02	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	8	13	6	5	0	5	1	10	11		Mean	0.06
Census period max (10-30 Aug):	34	15	12	10	3	11	2	10	11			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.05

Appendix 5 (cont.).

Year 2003	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-03	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-03	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-03	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-03	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-03	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-03	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-03	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-03	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	-	-	-	-	-	-	-	-	-		Mean	#DIV/0!
Census period max (10-30 Aug):	-	-	-	-	-	-	-	-	-			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	#DIV/0!

Appendix 5 (cont.).

Year 2004	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-04	5	2	0	0	0	6	2	2	10	27	675	0.04
31-Jul-04	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-04	30	27	15	6	0	9	0	37	38	162	675	0.24
02-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-04	-	-	1	0	-	-	-	-	-	-	-	-
08-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-04	0	0	0	1	0	3	0	0	0	4	675	0.01
10-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-04	-	-	37	27	-	-	-	-	-	-	-	-
14-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-04	12	23	17	5	12	21	5	28	63	186	675	0.28
19-Aug-04	-	-	0	0	-	-	-	-	-	-	-	-
20-Aug-04	5	1	6	8	4	3	7	26	23	83	675	0.12
21-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-04	1	0	0	0	0	1	0	0	0	2	675	0.00
25-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-04	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	6	8	12	8	5	8	4	18	29		Mean	0.11
Census period max (10-30 Aug):	30	27	37	27	12	21	7	37	63			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.12

Appendix 5 (cont.).

Year 2005	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-05	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-05	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-05	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-05	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-05	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-05	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-05	9	6	25	5	12	0	0	17	13	87	675	0.13
08-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-05	16	12	16	9	16	0	3	66	51	189	675	0.28
13-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-05	15	12	24	11	0	1	0	5	11	79	675	0.12
15-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-05	45	31	25	11	19	27	3	53	61	275	675	0.41
21-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-05	46	60	24	22	5	0	0	28	61	246	675	0.36
25-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-05	0	0	0	0	0	0	0	0	0	0	675	0.00
27-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-05	14	9	3	7	0	0	0	0	0	33	675	0.05
30-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-05	14	20	3	2	0	0	0	0	0	39	675	0.06
02-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	23	21	15	10	7	5	1	25	31		Mean	0.18
Census period max (10-30 Aug):	46	60	25	22	19	27	3	66	61			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.15

Appendix 5 (cont.).

Year 2006	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-06	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-06	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-06	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-06	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-06	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-06	1	1	0	11	0	4	5	1	0	23	675	0.03
28-Jul-06	23	34	22	15	6	3	0	38	34	175	675	0.26
29-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-06	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-06	21	22	30	14	21	26	5	39	76	254	675	0.38
03-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-06	46	56	35	19	11	23	2	14	32	238	675	0.35
13-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-06	22	23	27	15	10	12	0	12	22	143	675	0.21
18-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-06	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-06	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	34	40	31	17	11	18	1	13	27		Mean	0.25
Census period max (10-30 Aug):	46	56	35	19	21	26	5	39	76			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.14

Appendix 5 (cont.).

Year 2007	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-07	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-07	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-07	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-07	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-07	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-07	6	17	8	1	6	15	2	20	10	85	675	0.13
29-Jul-07	0	0	0	0	0	0	0	0	0	0	675	0.00
30-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-07	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-07	17	7	5	4	10	12	0	15	39	109	675	0.16
09-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-07	21	23	28	13	4	7	0	35	20	151	675	0.22
22-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-07	15	13	23	16	21	48	5	63	116	320	675	0.47
27-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-07	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-07	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	18	18	26	15	13	28	3	49	68		Mean	0.20
Census period max (10-30 Aug):	21	23	28	16	21	48	5	63	116			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.18

Appendix 5 (cont.).

Year 2008	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-08	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-08	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-08	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-08	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-08	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-08	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-08	21	13	23	11	18	11	2	8	44	151	675	0.22
05-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-08	10	26	24	21	40	57	1	21	40	240	675	0.36
15-Aug-08	19	14	14	13	27	28	0	24	52	191	675	0.28
16-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-08	14	18	23	14	4	14	2	14	19	122	675	0.18
21-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-08	0	0	6	1	2	0	0	11	1	21	675	0.03
25-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-08	11	15	28	7	6	6	0	7	24	104	675	0.15
31-Aug-08	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-08	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	11	15	19	11	16	21	1	15	27		Mean	0.20
Census period max (10-30 Aug):	21	26	28	21	40	57	2	24	52			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.11

Appendix 5 (cont.).

Year 2009	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-09	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-09	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-09	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-09	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-09	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-09	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-09	16	28	17	13	17	9	1	14	21	136	675	0.20
02-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-09	37	21	8	13	17	15	0	23	53	187	675	0.28
13-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-09	11	21	1	3	3	0	0	12	12	63	675	0.09
21-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-09	2	0	3	0	0	0	0	0	0	5	675	0.01
23-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-09	8	18	12	14	9	5	0	33	8	107	675	0.16
26-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-09	0	1	0	0	0	0	0	0	1	2	675	0.00
28-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-09	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-09	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	12	12	5	6	6	4	0	14	15		Mean	0.12
Census period max (10-30 Aug):	37	28	17	14	17	15	1	33	53			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.11

Appendix 5 (cont.).

Year 2010	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-10	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-10	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-10	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-10	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-10	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-10	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-10	1	1	5	1	1	0	0	0	0	9	675	0.01
08-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-10	8	5	8	12	0	36	3	16	68	156	675	0.23
13-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-10	0	1	5	2	0	1	0	1	3	13	675	0.02
16-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-10	37	35	4	18	8	5	0	11	25	143	675	0.21
18-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-10	37	77	23	25	30	12	4	20	72	300	675	0.44
21-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-10	1	0	0	0	0	1	1	0	2	5	675	0.01
23-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-10	1	1	0	0	1	1	0	2	1	7	675	0.01
26-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-10	-	-	5	18	0	2	1	9	7	-	-	-
31-Aug-10	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-10	2	4	9	9	9	9	9	1	0	52	675	0.08
06-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-10	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-10	0	0	-	-	0	0	0	3	1	4	593	0.01
Mean during census period (10-30 Aug):	14	20	6	11	6	8	1	8	25		Mean	0.11
Census period max (10-30 Aug):	37	77	23	25	30	36	9	20	72			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.15

Appendix 5 (cont.).

Year 2011	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-11	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-11	3	5	1	2	0	1	0	0	0	12	675	0.02
31-Jul-11	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-11	0	0	0	0	0	0	0	0	0	0	675	0.00
02-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-11	2	23	21	3	13	19	0	32	54	167	675	0.25
05-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-11	0	2	0	0	0	0	0	2	1	5	675	0.01
22-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-11	0	0	0	0	0	0	0	0	1	1	675	0.00
27-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-11	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-11	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	0	1	0	0	0	0	0	1	1		Mean	0.05
Census period max (10-30 Aug):	3	23	21	3	13	19	0	32	54			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.11

Appendix 5 (cont.).

Year 2013	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-13	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-13	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-13	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-13	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-13	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-13	2	8	2	5	2	5	0	3	2	29	675	0.04
30-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-13	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-13	12	27	2	2	-	-	-	-	-	43	254	0.17
08-Aug-13	25	29	9	12	15	10	1	17	30	148	675	0.22
09-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-13	11	20	0	8	7	12	0	12	16	86	675	0.13
19-Aug-13	17	23	8	5	9	12	1	17	15	107	675	0.16
20-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-13	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-13	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	14	22	4	7	8	12	1	15	16		Mean	0.14
Census period max (10-30 Aug):	25	29	9	12	15	12	1	17	30			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.07

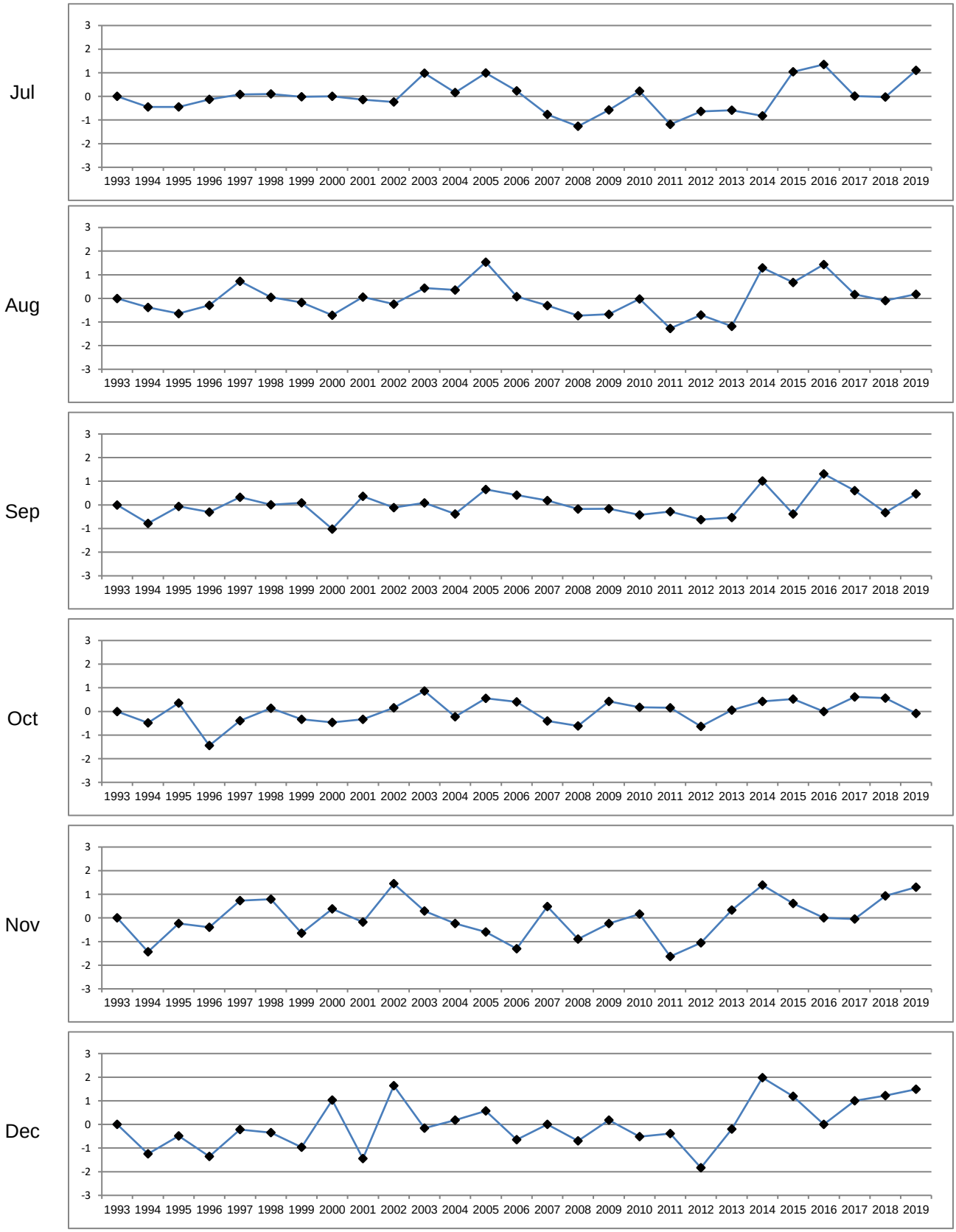
Appendix 5 (cont.).

Year 2014	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-14	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-14	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-14	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-14	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-14	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-14	0	0	-	-	0	0	0	0	0	0	593	0.00
20-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-14	1	0	0	0	0	0	0	0	0	1	675	0.00
27-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-14	0	0	0	0	8	14	6	28	39	95	675	0.14
31-Jul-14	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-14	33	18	-	-	-	-	-	-	-	51	172	0.30
05-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-14	18	38	-	-	-	-	-	-	-	56	172	0.33
07-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-14	17	14	0	0	4	7	0	3	8	53	675	0.08
11-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-14	9	13	-	-	-	-	-	-	-	22	172	0.13
19-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-14	-	-	-	-	7	21	1	41	25	-	-	-
22-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
24-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-14	39	34	20	19	32	44	1	67	146	402	675	0.60
28-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-14	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-14	0	0	0	0	2	0	0	5	16	23	675	0.03
04-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-14	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-14	0	0	0	0	0	0	0	0	0	0	675	0.00
Mean during census period (10-30 Aug):	22	20	10	10	14	24	1	37	60		Mean	0.16
Census period max (10-30 Aug):	39	38	20	19	32	44	6	67	146			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.19

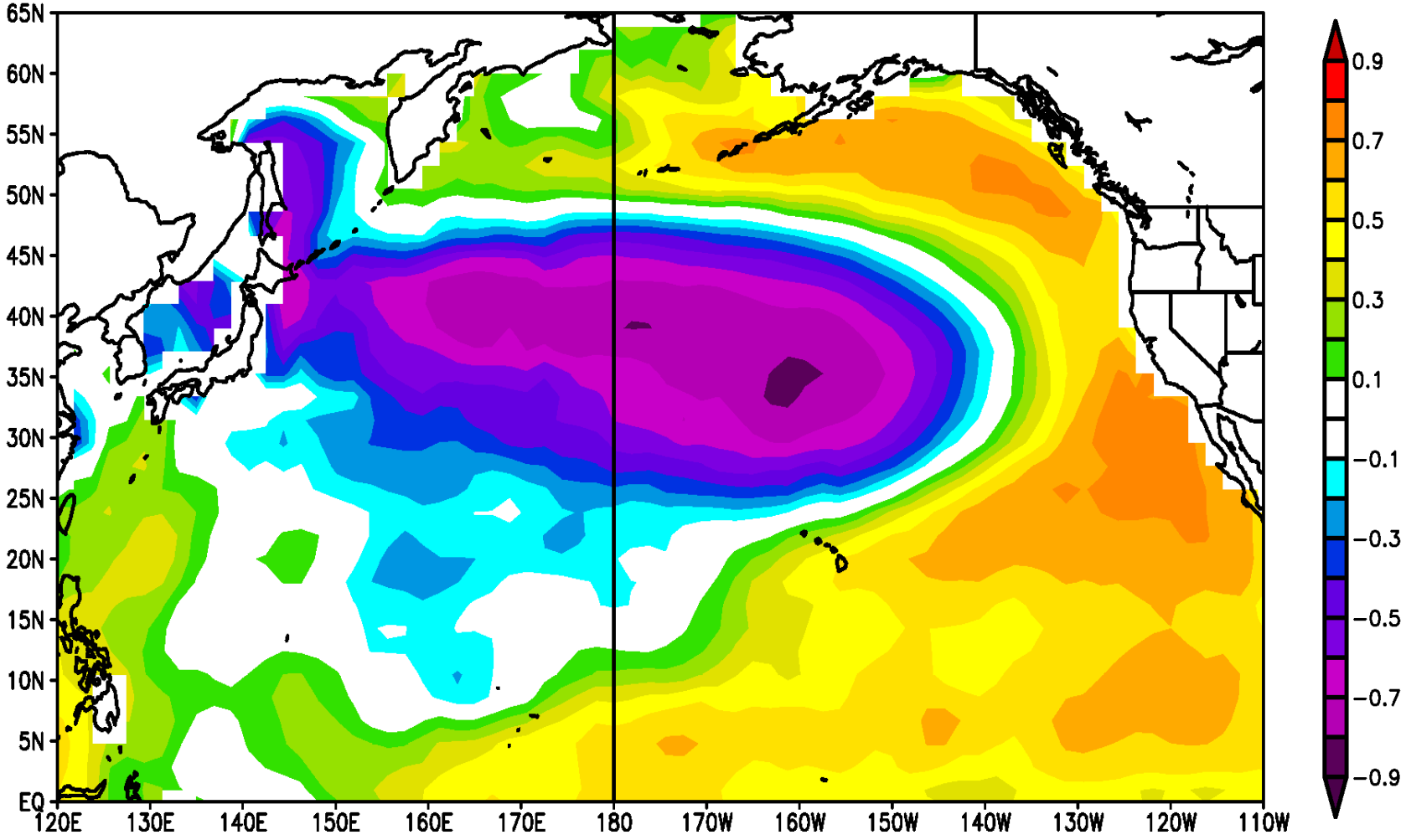
Appendix 5 (cont.).

Year 2017	Plot										Among-	Sum/
Date	1	2	3	4	5	6	7	8	9	Sum[b]	year max[c]	max[d]
26-Jun-17	-	-	-	-	-	-	-	-	-	-	-	-
27-Jun-17	-	-	-	-	-	-	-	-	-	-	-	-
28-Jun-17	-	-	-	-	-	-	-	-	-	-	-	-
29-Jun-17	-	-	-	-	-	-	-	-	-	-	-	-
30-Jun-17	-	-	-	-	-	-	-	-	-	-	-	-
01-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
02-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
03-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
04-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
05-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
08-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
09-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
11-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
12-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
13-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
14-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
15-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
17-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
18-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
23-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
24-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
25-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
26-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
27-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
29-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
30-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-17	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
02-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
03-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
04-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
05-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
06-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
07-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
08-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
11-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
12-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
13-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
14-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
15-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
17-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
18-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
19-Aug-17	0	1	1	0	25	39	4	25	3	98	675	0.15
20-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-17	2	1	0	0	0	0	0	0	2	5	675	0.01
22-Aug-17	4	14	-	-	-	-	-	-	-	18	172	0.10
23-Aug-17	18	23	-	-	-	-	-	-	-	41	172	0.24
24-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
26-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
27-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
28-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
29-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
30-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
31-Aug-17	-	-	-	-	-	-	-	-	-	-	-	-
01-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
03-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
04-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
05-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
06-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
07-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
08-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
09-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
10-Sep-17	-	-	-	-	-	-	-	-	-	-	-	-
Mean during census period (10-30 Aug):	6	10	1	0	13	20	2	13	3		Mean	0.12
Census period max (10-30 Aug):	18	23	1	0	25	39	4	25	3			
Among-year maximum count:	95	77	38	44	94	86	11	84	146		St. dev.	0.10

Appendix 6. Sea-surface temperature anomaly (ºC) at the NOAA tide station in Seldovia, Alaska—an example of the environmental indices used in this report.



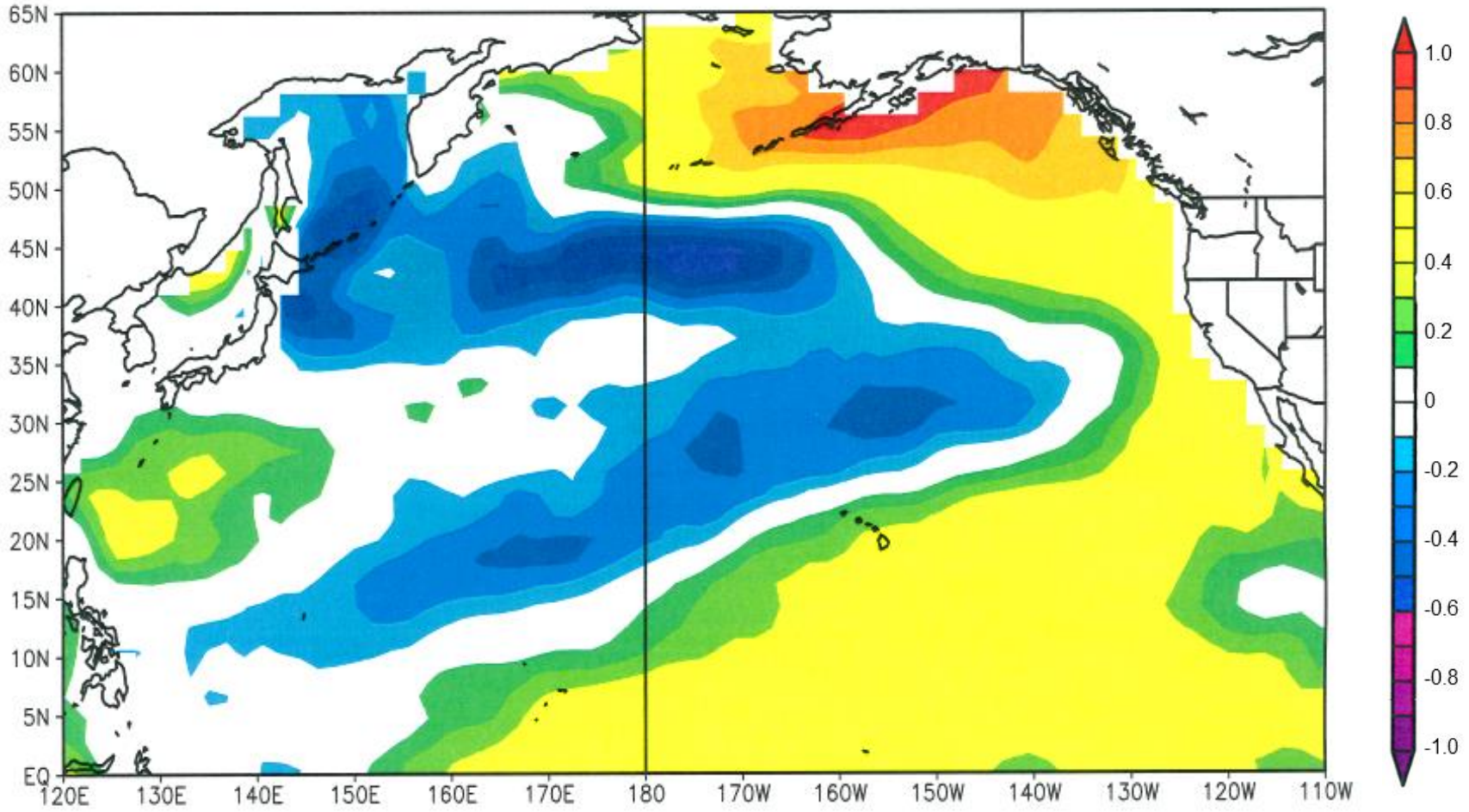
Appendix 6 (continued). SST anomaly (ºC) at the NOAA tide station in Seldovia, Alaska—an example of the environmental indices used in this report.



Jan to Dec: 1993 to 2014 Surface SST Seasonal Correlation w/ Jan to Dec PDO

NCEP/NCAR Reanalysis
NOM/ESRL Physical Sciences Division

Appendix 7. Map of correlation coefficient from comparison of gridded sea-surface temperature with PDO index values, 1993-2014. Positive PDO values occur with warm coastal water and cool water in the central North Pacific.



Jan to Dec: 1993 to 2014: Surface SST Seasonal Correlation w/ Jan to Dec Seldovia SST

NCEP/NCAR Reanalysis
NOM/ESRL Physical Sciences Division

Appendix 8. Map of correlation coefficient from comparison of sea surface temperature (SST) annual anomaly values at the NOAA tide station at Seldovia, Alaska with values gridded across the North Pacific, 1993-2014. This illustrates that SST anomaly in the central North Pacific tends to be opposite that at Seldovia.

Appendix 9. Correlation coefficient, sample size, p-value, and significance indicator for comparisons of sea surface temperature (SST) monthly anomaly at paired locations near East Amatuli Island, Alaska. Sample size is the number of years with data previous to and including 2014. Years for each dataset are shown in Table 4.

Seldovia and Amatuli Cove

Month	r	n	P	<0.5
Jan	0.930	16	<0.001	Y
Feb	0.914	16	<0.001	Y
Mar	0.889	16	<0.001	Y
Apr	0.901	16	<0.001	Y
May	0.937	16	<0.001	Y
Jun	0.894	17	<0.001	Y
Jul	0.705	18	0.001	Y
Aug	0.919	18	<0.001	Y
Sep	0.748	18	0.001	Y
Oct	0.681	16	0.004	Y
Nov	0.820	16	<0.001	Y
Dec	0.826	16	<0.001	Y

Seldovia and Buoy 46001

Month	r	n	P	<0.5
Jan	0.491	35	0.003	Y
Feb	0.688	33	<0.001	Y
Mar	0.65	34	<0.001	Y
Apr	0.7	33	<0.001	Y
May	0.576	33	<0.001	Y
Jun	0.613	34	<0.001	Y
Jul	0.363	37	0.027	Y
Aug	0.427	38	0.007	Y
Sep	0.177	36	0.303	-
Oct	0.468	35	0.005	Y
Nov	0.613	36	<0.001	Y
Dec	0.623	35	<0.001	Y

Appendix 9. (rows continued)

Seldovia and GAK1 mooring

Month	r	n	P	<0.5
Jan	0.93	14	<0.001	Y
Feb	0.915	14	<0.001	Y
Mar	0.83	14	<0.001	Y
Apr	0.917	14	<0.001	Y
May	0.949	15	<0.001	Y
Jun	0.556	15	0.031	Y
Jul	0.528	15	0.043	Y
Aug	0.29	15	0.294	-
Sep	0.252	15	0.365	-
Oct	0.146	14	0.618	-
Nov	0.707	14	0.005	Y
Dec	0.719	15	0.003	Y

Amatuli Cove and Buoy 46001

Month	r	n	P	<0.5
Jan	0.753	15	0.001	Y
Feb	0.747	14	0.002	Y
Mar	0.76	14	0.002	Y
Apr	0.696	14	0.006	Y
May	0.574	15	0.025	Y
Jun	0.452	16	0.079	-
Jul	0.433	17	0.082	-
Aug	0.621	18	0.006	Y
Sep	0.565	18	0.015	Y
Oct	0.258	16	0.336	-
Nov	0.557	16	0.025	Y
Dec	0.729	15	0.002	Y

Appendix 9. (rows continued)

Amatuli Cove and GAK1 mooring

Month	r	n	P	<0.5
Jan	0.951	14	<0.001	Y
Feb	0.964	14	<0.001	Y
Mar	0.947	13	<0.001	Y
Apr	0.926	13	<0.001	Y
May	0.933	14	<0.001	Y
Jun	0.627	15	0.012	Y
Jul	0.513	15	0.05	-
Aug	0.155	15	0.58	-
Sep	0.188	15	0.502	-
Oct	-0.065	14	0.824	-
Nov	0.567	14	0.035	Y
Dec	0.833	15	<0.001	Y

GAK1 mooring and Buoy 46001

Month	r	n	P	<0.5
Jan	0.705	13	0.007	Y
Feb	0.755	13	0.003	Y
Mar	0.812	13	0.001	Y
Apr	0.766	13	0.002	Y
May	0.487	14	0.077	-
Jun	0.265	14	0.359	-
Jul	-0.354	14	0.214	-
Aug	-0.326	15	0.236	-
Sep	-0.669	15	0.006	Y
Oct	-0.353	14	0.216	-
Nov	0.267	14	0.357	-
Dec	0.584	14	0.028	Y

Appendix 10. Correlation coefficient, sample size, p-value, and significance indicator for comparisons of monthly values for the Pacific Decadal Oscillation (PDO) and the North Pacific Index (NPI) with sea surface temperature (SST) monthly anomaly at locations near East Amatuli Island, Alaska. Sample size is the number of years with data previous to and including 2014; years are listed in Table 4.

PDO and Amatuli Cove mooring

Month	r	n	P	<0.5
Jan	0.748	16	0.001	Y
Feb	0.806	16	<0.001	Y
Mar	0.829	16	<0.001	Y
Apr	0.706	16	0.002	Y
May	0.746	16	0.001	Y
Jun	0.591	17	0.012	Y
Jul	0.592	18	0.01	Y
Aug	0.618	18	0.006	Y
Sep	0.567	18	0.014	Y
Oct	0.187	16	0.488	-
Nov	0.639	16	0.008	Y
Dec	0.768	16	0.001	Y

PDO and Seldovia

Month	r	n	P	<0.5
Jan	0.689	29	<0.001	Y
Feb	0.762	29	<0.001	Y
Mar	0.585	29	0.001	Y
Apr	0.453	29	0.014	Y
May	0.543	28	0.003	Y
Jun	0.499	30	0.005	Y
Jul	0.482	30	0.007	Y
Aug	0.442	30	0.014	Y
Sep	0.221	29	0.25	-
Oct	0.313	29	0.099	-
Nov	0.723	29	<0.001	Y
Dec	0.738	29	<0.001	Y

Appendix 10 (rows continued).

PDO and Buoy 46001

Month	r	n	P	<0.5
Jan	0.628	28	<0.001	Y
Feb	0.708	27	<0.001	Y
Mar	0.688	27	<0.001	Y
Apr	0.635	26	<0.001	Y
May	0.681	28	<0.001	Y
Jun	0.565	28	0.002	Y
Jul	0.242	29	0.206	-
Aug	0.346	30	0.061	-
Sep	0.477	30	0.008	Y
Oct	0.511	30	0.004	Y
Nov	0.851	30	<0.001	Y
Dec	0.825	29	<0.001	Y

PDO and GAK1 mooring

Month	r	n	P	<0.5
Jan	0.842	14	<0.001	Y
Feb	0.861	14	<0.001	Y
Mar	0.856	14	<0.001	Y
Apr	0.762	14	0.002	Y
May	0.683	15	0.005	Y
Jun	0.503	15	0.056	-
Jul	0.357	15	0.192	-
Aug	0.205	15	0.463	-
Sep	-0.237	15	0.395	-
Oct	-0.055	14	0.853	-
Nov	0.567	14	0.034	Y
Dec	0.608	15	0.016	Y

Appendix 10 (rows continued).

NPI and Seldovia

Month	r	n	P	<0.5
Jan	-0.548	20	0.012	Y
Feb	-0.257	20	0.275	-
Mar	-0.497	20	0.026	Y
Apr	0.037	20	0.876	-
May	0.096	20	0.688	-
Jun	-0.085	20	0.721	-
Jul	0.141	20	0.553	-
Aug	0.038	20	0.873	-
Sep	0.204	20	0.388	-
Oct	-0.527	20	0.017	Y
Nov	-0.409	20	0.073	-
Dec	-0.328	20	0.158	-

NPI and Amatuli Cove mooring

Month	r	n	P	<0.5
Jan	-0.691	16	0.003	Y
Feb	-0.15	16	0.579	-
Mar	-0.471	16	0.065	-
Apr	-0.204	16	0.448	-
May	-0.086	16	0.751	-
Jun	0.171	17	0.511	-
Jul	0.156	18	0.537	-
Aug	0.031	18	0.904	-
Sep	0.191	18	0.447	-
Oct	0.033	16	0.904	-
Nov	-0.201	16	0.455	-
Dec	-0.482	16	0.059	-

Appendix 10 (rows continued).

NPI and GAK1 mooring

Month	r	n	P	<0.5
Jan	-0.711	14	0.004	Y
Feb	-0.009	14	0.974	-
Mar	-0.479	14	0.083	-
Apr	0.012	14	0.968	-
May	-0.036	15	0.899	-
Jun	-0.045	15	0.875	-
Jul	0.451	15	0.092	-
Aug	0.462	15	0.083	-
Sep	-0.287	15	0.299	-
Oct	0.077	14	0.795	-
Nov	-0.249	14	0.391	-
Dec	-0.215	15	0.441	-

NPI and PDO

Month	r	n	P	<0.5
Jan	-0.638	20	0.002	Y
Feb	-0.349	20	0.132	-
Mar	-0.535	20	0.015	Y
Apr	-0.578	20	0.008	Y
May	-0.295	20	0.206	-
Jun	-0.014	20	0.952	-
Jul	-0.332	20	0.153	-
Aug	-0.042	20	0.861	-
Sep	-0.174	20	0.464	-
Oct	-0.441	20	0.052	-
Nov	-0.094	20	0.694	-
Dec	-0.445	20	0.049	Y