Seabird Research at Cape Shirreff, Livingston Island, Antarctica

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Abstract

Land-based seabird data were collected during the 14th consecutive Antarctic breeding season at Cape Shirreff, Livingston Island. Main results include:

- The chinstrap population was estimated at 4127 nests, a 5% decrease from last year and 46% lower than the 15-year high of 7744 which occurred in the 1999/00 season;
- Mean fledgling masses of gentoo (4,971 ± 687.75 g, n = 175) and chinstrap penguins (3233 ± 313 g, n = 327) were higher than their respective long term means; and
- *Euphausia superba* was the main component of the penguin diet, but fish remains were identified in 90% of gentoo penguin diets and 33% of chinstrap penguin diets.

Introduction

The U.S. Antarctic Marine Living Resources (AMLR) Program conducted its fourteenth consecutive field season of land-based seabird research at the Cape Shirreff field camp on Livingston Island, Antarctica (62º 28'S, 60º 46'W) during the austral summer of 2010/11. Cape Shirreff is a Site of Special Scientific Interest and long-term monitoring of predator populations are conducted in support of U.S. participation in the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

We arrived at Cape Shirreff on 3 November 2010 via the National Science Foundation vessel R/V *Laurence M. Gould* and conducted research until camp was closed on 10 March 2011. The AMLR chartered vessel R/V *Moana Wave* provided logistical support for camp closure and transit back to Punta Arenas, Chile. The objectives of the seabird research program for the 2010/11 season were to collect the following long-term monitoring data (CCAMLR 2004):

1. To estimate chinstrap (*Pygoscelis antarctica*) and gentoo penguin (*P. papua*) breeding population size (Standard Method A3);
2. To band 250 chinstrap and 200 gentoo penguin chicks for demography studies (Std. Method A4);
3. To determine chinstrap and gentoo penguin foraging trip durations during the chick rearing stage of the reproductive cycle (Std. Method A5);
4. To determine chinstrap and gentoo penguin breeding success (Std. Methods A6a, b, and c);
5. To determine chinstrap and gentoo penguin chick weights at fledging (Std. Method A7c);
6. To determine chinstrap and gentoo penguin diet composition, meal size, and krill length/frequency distributions (Std. Methods A8a,b&c); and
7. To determine chinstrap and gentoo penguin breeding chronologies (Std. Method A9).

Methods

Breeding biology studies

The penguin rookery at Cape Shirreff consisted of 19 sub-colonies of gentoo and chinstrap penguins during the 2010/11 breeding season. We conducted nest censuses for gentoo penguins on 18 November 2010 and for chinstrap penguins on 27 November 2010, approximately one week after mean clutch initiation for each species. Chick censuses were conducted for gentoo penguins on 25 January 2011 and for chinstrap penguins on 8 February 2011, approximately one week after mean crèche.

Mean reproductive success was estimated from the census data and was also measured by following a sample of 50 pairs of breeding gentoo penguins and 100 pairs of breeding chinstrap penguins from clutch initiation through to crèche. Nests of known-age penguins that initiated clutches were also monitored during the breeding season and reproductive success was estimated according to Standard Method A6b.

Two hundred gentoo and 250 chinstrap penguin chicks were banded for future demographic studies with uniquely numbered stainless steel flipper bands. The banded chicks that survive and return to the colony as adults will be observed for age-specific survival and reproductive success.

Fledging weights were collected from gentoo and chinstrap penguin chicks as a measure of chick condition prior to their first winter of independence. Chinstrap penguin fledglings were caught on the beaches just before fledging. Gentoo penguin chicks are still provisioned by their parents after they begin making trips to sea, so it is not possible to obtain definitive fledging weights by catching and weighing chicks prior to depar-

ture. Alternatively, gentoo penguin chicks are weighed 85 days after their mean clutch initiation date, which is approximately the age when other *Pygoscelis* chicks fledge.

Foraging ecology studies

We collected diet samples from gentoo and chinstrap penguins. Adults were captured at their nest sites after returning from foraging trips, but prior to chick provisioning, to assure they were feeding chicks. Once captured, stomach contents were collected using the wet-offloading technique (Wilson 1984). From each diet sample, a sub-sample of 50 individual Antarctic krill were measured and sexed to determine length and sex frequency distributions of the krill selected by foraging penguins.

To measure foraging trip durations, diving behaviors while foraging, and spatial distributions at sea of foraging penguins, we used three different external electronic tagging technologies. Colony attendance and foraging trip durations were measured with radio telemetry. Radio tags were attached to gentoo penguins on 28 December 2010 and on 2 January 2011 for chinstrap penguins. For both species, the radio signals were recorded through 24 February 2011 using a fixed position remote receiver. Due to a power loss for the remote receiver on 24 January 2011, the telemetry data were analyzed in two batches, one prior to the power loss, and one after the power loss. This method was necessary to eliminate foraging trips that might have been incorrectly classified as greater than 24 hours due to returns and subsequent departures of tagged individuals while the receiver was without power. Once both time periods were analyzed separately, the results were combined for calculation of mean foraging trip durations across the breeding season.

Time-depth recorders (TDRs) were also attached to chinstrap and gentoo penguins to collect penguin diving behavior data during the chick-rearing period. In late December, three TDRs were deployed on gentoo penguins that were brooding chicks. In early January the same three TDRs were retrieved and deployed on chinstrap penguins that were brooding chicks. In late January one TDR was deployed on a gentoo penguin, and in early February two TDRs were deployed on chinstrap penguins during the crèche phase when nests are unattended and both parents forage simultaneously.

We instrumented both species with satellite transmitters (PTTs) to collect geographic data on adult foraging locations during the chick rearing period. Twelve PTTs were deployed, six on gentoo penguins and six on chinstrap penguins in late December and mid-January during the chick brooding phase for each species. During the crèche phase in late January and early February, twelve PTTs were again deployed, six on gentoo penguins and six on chinstrap penguins. The PTTs deployed during the brooding and crèche phase were retrieved after 8-10 days of deployment. We also entered the second year of a study focused on identifying overwinter distributions of gentoo and chinstrap penguins. We therefore deployed 15 PTTs on each species at the end of February to track individual foraging patterns for the duration of winter. At the time of writing, the dive and spatial distribution data are awaiting analysis.

Other seabirds

Reproductive success of the population of brown skuas (*Catharacta lönnbergi*) was estimated using methods similar to those described above for penguins (St. Method A6b). We also measured reproductive success of kelp gulls (*Larus dominicanus*) by counting occupied nests during the incubation period and chicks during the fledging period (St. Methods A6c).

Results

Breeding biology studies

A total of 834 gentoo penguin nests were counted (Figure 1), a 4% increase from last year. This count is 2.2% higher than the previous 13-year average of 816. A total of 4127 chinstrap penguin nests were counted. This is a 5% decrease from last year's census and 46% lower than the 14-year high of 7744. This census continues the general trend of decline in the chinstrap penguin breeding population at Cape Shirreff, while the gentoo population has remained stable.

The census of gentoo penguin chicks was 906 (Figure 1), a 1.1% decrease from the 2009/10 count and 5% lower than the previous 13-year mean. The census of chinstrap penguin

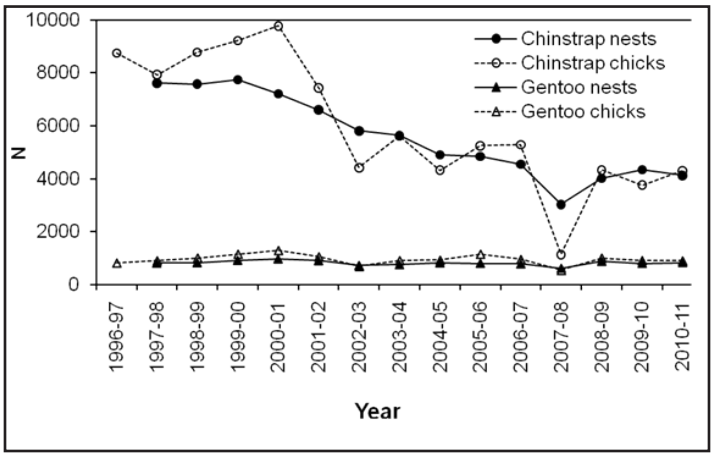

Figure 7. 1. Nest and chick census for gentoo and chinstrap penguins at Cape Shirreff, Livingston Island, Antarctica, 1996/97 to 2010/11.

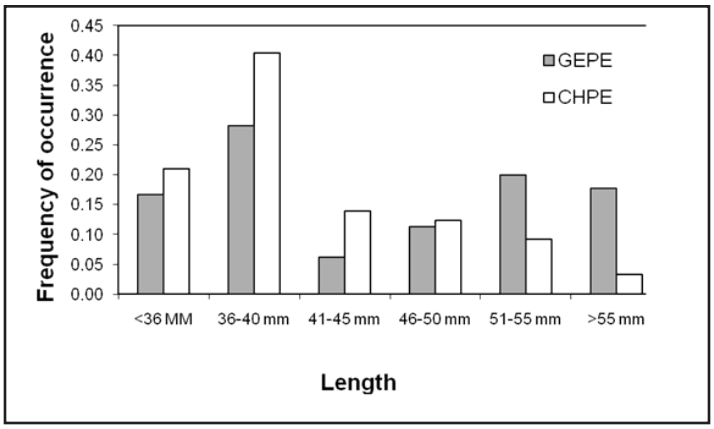

Figure 7.2. Krill length frequency distribution in gentoo and chinstrap penguin diet samples at Cape Shirreff, Livingston Island, Antarctica, 2010/11.

chicks was 4303 (Figure 2), 14% higher than the 2009/10 count and 30% lower than the previous 13-year mean of 6145.

Based on nest and chick census data, overall gentoo penguin reproductive success was 1.09 chicks•nest^{-1}. This is 7% lower than the previous 13-year mean of 1.17 chicks•nest^{-1}. Overall chinstrap penguin fledging success was 1.04 chicks•nest^{-1}. This is 3.4% higher than the previous 13-year mean of 1.01 chicks•nest^{-1}. Based on the reproductive study, gentoo penguins fledged 1.2 chicks•nest^{-1}, 2% lower than the long-term mean (1.22 chicks•nest^{-1}). Based on the reproductive study, chinstrap penguins fledged 1.0 chicks•nest^{-1}, 9% higher than the long-term mean (0.92 chicks•nest^{-1}).

Reproductive success of known-age gentoo penguins (where one member of the pair was of known age) was 0.74 chicks•nest^{-1} (n = 34 nests), while known-age chinstrap penguins also fledged 0.74 chicks•nest^{-1} (n = 61 known-age nests).

A sample of gentoo penguin chicks was weighed on 9 February 2011 and had an average mass of 4971 ± 687.75 g (n = 175). This is 18% higher than the previous 13-year mean. For chinstrap penguins, the fledging period occurred between 15 February and 22 February 2011. The fledglings had an average mass of 3233 ± 313 g (n = 327), 3% higher than the previous 13-year mean of 3144 g.

Foraging ecology studies

Diet samples were collected from 20 gentoo and 40 chinstrap penguins between 3 January and 8 February 2011. Antarctic krill (*Euphausia superba*) was present in all samples and comprised the majority of diet in 93% of samples. Fish remains (bones, otoliths, and flesh), present in 50% of all diets, represented the next largest component of the diet. Invertebrates other than *E. superba* represented <1% of penguin diets.

In gentoo penguin diet samples, 90% contained evidence of fish, higher than the 13-year average of 77% of gentoo diet samples with evidence of fish. Among chinstrap penguins, 33% of diet samples contained evidence of fish, which was also higher than the previous 13-year average of 30%. Identifiable remains of fish represented 22% of the gentoo penguin diet by mass and approximately 1% of the chinstrap penguin diet by mass.

The krill in gentoo penguin diet samples were slightly larger on average (47.6 ± 8.2 mm) than krill in chinstrap penguin samples (42.9 ± 6.3 mm). Large krill (> 50 mm) occurred more frequently in gentoo diets, while smaller krill (< 50 mm) occurred more frequently in chinstrap diets (Figure 2). Overall, penguin diets were composed of 20% juvenile krill (< 36 mm in length), 54% males and 26% females (Figure 3).

The average chick meal mass for chinstrap penguins was 541 g; this is 12% lower than the previous 13-year mean of 615 g. The ratio of fresh to digested portions in the chinstrap penguin diet samples was comparable to the previous 13 seasons. We only collected the fresh portion of diet samples from gentoo penguins, so chick meal mass was not evaluated.

Radio transmitters were deployed on 20 adult chinstrap and 19 adult gentoo penguins during the chick rearing phase. Mean foraging trip duration was 10.9 ± 2.2 hours (n = 20) for chinstraps and 12.1 ± 1.3 hours (n = 19) for gentoos. For chinstraps, mean foraging trip durations were over 2 hours shorter than the previous year.

Other seabirds

The breeding success of all skuas at Cape Shirreff and the adjacent Punta Oeste was monitored. In total, we counted 27 skua pairs holding territories, all of which were brown skuas (*Catharacta antarctica lonnbergi*) except one pair that was likely a pair of hybrid skuas (brown-South Polar skuas (*C. maccormicki*) mix). Clutches were initiated by 20 pairs and 15 chicks were fledged. The measure of

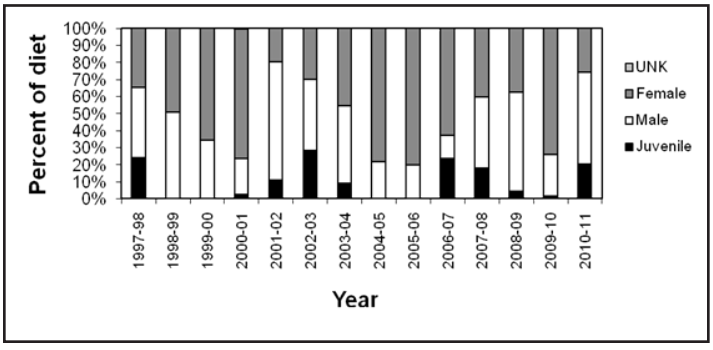

Figure 7. 3. Percent composition of Antarctic krill (*Euphausia superba*) in gentoo and chinstrap penguin diet samples at Cape Shirreff, Livingston Island, Antarctica, 1997/98 to 2010/11.

nest success (0.75 fledglings•pair^{-1}) was 12% higher than the previous 12-year average of 0.67 fledglings•pair^{-1}.

The reproductive performance of kelp gulls (*Larus dominicanus*) nesting on Cape Shirreff was also followed throughout the season. Fifty nests were initiated and overall fledging success was 0.68 fledglings•pair^{-1}.

Discussion

The 14th season of seabird research at Cape Shirreff allowed us to assess trends in penguin population size, as well as inter-annual variation in reproductive success, diet, and foraging behavior.

Breeding population counts of gentoo penguins have remained stable at Cape Shirreff over 14 years of study, while their reproductive success was lower than the long-term mean. Chinstrap penguin populations remain low relative to the long-term mean and, overall, the chinstrap breeding population at Cape Shirreff has declined by 47% from a high in 1999/00. Reproductive success of chinstrap penguins in 2010/11 was higher than the long-term mean and fledging weights for chinstrap and gentoo penguins were above average.

In general, diet composition of both species was dominated by Antarctic krill and was similar to previous seasons. Overall, the diet samples contained a relatively high proportion of male krill and there were similar amounts of juvenile and female krill seen this year. The interpretation of these diet patterns may be aided by analysis of foraging location and diving behavior data.

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