5. Seabird Research at Cape Shirreff, Livingston Island, Antarctica, 2007-2008; submitted by Sarah E. Chisholm, Kevin W. Pietrzak, Aileen K. Miller and Wayne Z. Trivelpiece

5.1 Objectives:

The U.S. Antarctic Marine Living Resources (AMLR) program conducted its eleventh 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 2007-08. Cape Shirreff is a Site of Special Scientific Interest and long-term monitoring of predator populations are conducted in support of US participation in the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

The objectives of the seabird research program for the 2007-08 season, as part of the long-term monitoring efforts agreed upon at CCAMLR (2004), were as follows:

1. To estimate chinstrap (*Pygoscelis antarctica)* and gentoo penguin (*P. papua)* breeding population size (Standard Method A3, CCAMLR 2004);
2. To band 500 chinstrap and 200 gentoo penguin chicks for demography studies (Std. Method A4, CCAMLR 2004);
3. To determine chinstrap penguin foraging trip duration during the chick rearing stage of the reproductive cycle (Std. Method A5, CCAMLR 2004);
4. To determine chinstrap and gentoo penguin breeding success (Std. Methods 6a.b&c, CCAMLR 2004);
5. To determine chinstrap and gentoo penguin chick weight at fledging (Std. Method 7c, CCAMLR 2004);
6. To determine chinstrap and gentoo penguin diet composition, meal size, and krill length/frequency distribution (Std. Methods 8a,b&c, CCAMLR 2004); and
7. To determine chinstrap and gentoo penguin breeding chronology (Std. Method 9, CCAMLR 2004).

5.2 Results:

5.2.1 Breeding biology studies:

The penguin rookery at Cape Shirreff consisted of 19 sub-colonies of gentoo and chinstrap penguins during the 2007-08 breeding season. We conducted nest censuses for gentoos on December 10, 2007 and for chinstraps on December 1, 2007, approximately 1 week after mean clutch initiation for each species. Mean clutch initiation for gentoo penguins was the latest observed in 11 years of study. A total of 610 gentoo penguin nests were counted. This is the lowest count observed in 11 years of study (Figure 1): 22% lower than the 2006-07 count and 19% lower than the previous 10-year mean. A total of 3,032 chinstrap penguin nests were counted, which was also the lowest count observed in 10 years of study (Figure 2): 33% lower than the 2006-07 count and 51% lower than the previous 10-year mean. This count represents the tenth continuous year of decline of the chinstrap penguin breeding population at Cape Shirreff. The low nesting counts for both species appeared to be, at least in part, a result of unusually deep snow cover and frequent snow storms around the time of egg-laying; some penguins may have forgone breeding due to the conditions, while other penguins' nests failed in few days after initiation and before censuses were conducted.

Chick censuses were conducted for gentoo penguins on February 19, 2008 and for chinstrap penguins on February 12, 2008, approximately one week after mean crèche for each species. The gentoo penguin count was 544 chicks. This count is 43% lower than the 2006-07 count and 45% lower than the previous

11-year mean (Figure 1). The chinstrap penguin count was 1135 chicks (Figure 2), which is 79% lower than the 2006-07 count and 84% lower than the previous 11-year mean.

Based on census data, overall gentoo penguin fledging success was 0.89 chicks/nest. This is 33% lower than the previous 10-year mean. Overall chinstrap penguins fledging success was 0.37 chicks/nest, which is 66% lower than the previous 10-year mean.

Reproductive success 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 formation. Because chick mortality is typically low following crèche, these numbers also serve as an estimate of fledging success.

Based on data from our reproductive study, gentoo penguins fledged 0.56 chicks/nest and chinstrap penguins fledged 0.23 chicks/nest. This low reproductive success for both species is also likely explained by high snow cover and inclement weather during clutch initiation and incubation causing numerous nest failures: 54% of gentoo penguins and 75% of chinstrap penguin nests did not hatch any chicks.

Thirteen nests selected for the gentoo penguin reproductive study failed before one pair member was banded, making it impossible to measure the success of their second clutches. For this reason, an additional 13 gentoo penguin nests that initiated clutches later than average (and were presumably second clutches) were added to the study plots. Reproductive success at these nests was 1.0 chicks/nest.

Nests of known-age penguins that initiated clutches were also followed to crèche. Fourteen known-age gentoo penguin nests (by definition, one member of the pair is of known age) fledged 0.36 chicks/nest. Eighteen known-age chinstrap penguin nests fledged 0.11 chicks/nest.

A sample of 100 gentoo and 250 chinstrap penguin chicks was banded for future demographic studies. This is half the number of chicks normally banded each year at Cape Shirreff: fewer chicks were banded due to the unusually low number of chicks in the colonies. 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. 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 departure. Alternatively, gentoo penguin chicks are weighed 85 days after their mean clutch initiation date, which is approximately the age when other *Pygoscelis* chicks fledge. A sample of gentoo penguin chicks was weighed on February 24, 2008 and had an average mass of 4,242g (n = 128; S.D. = 805). This is comparable to the previous 10-year mean. Chinstrap penguin fledglings were caught on the beaches just before fledging - between February 20 and 29, 2008 - and had an average mass of 3,053g (n = 115; S.D. = 319). This is slightly lower (3%) than the previous 11-year mean.

5.2.2 Foraging ecology studies:

Diet samples were collected from 20 gentoo and 40 chinstrap penguins between January 11 and February 9, 2008. Adults were captured at nest sites upon their return from foraging trips, to assure they were feeding chicks. The total stomach contents were collected using the wet-offloading technique (Wilson 1984). Antarctic krill (*Euphausia superba*) was present in all but one sample and comprised the majority of diet in 90% of samples. Fish was the next largest component and squid and other marine invertebrates represented <1% of penguin diets.

In the 2007-08 season, 100% of the gentoo penguin diet samples contained evidence of fish, while in the previous 10 years of study only 73% of gentoo diet samples contained evidence of fish. This is the second consecutive year of our study in which all gentoo penguin diet samples contained evidence of fish. In contrast, 32% of chinstrap penguin diet samples contained evidence of fish which is comparable to the previous 10-year average of 30%. Fish represented 27% of the gentoo penguin diet by mass and <1% of the chinstrap penguin diet by mass.

A sub-sample of 50 individual Antarctic krill from each diet sample were measured and sexed to determine length and sex frequency distributions of the krill selected by foraging penguins. Krill in gentoo penguin samples were larger on average (46mm) than krill in chinstrap penguin samples (41mm) (Figure 3). Penguin diets consisted of 18% juvenile krill (those less than 36mm in length), 42% male kirll and 40% female krill (Figure 4).

The average chick meal mass for chinstrap penguins was 565g; this is 7% lower than the previous 10-year mean of 609g. The average age of chinstrap chicks from which diet samples were taken was 3.4 weeks, less than the previous 10-year mean of 3.8 weeks. The ratio of fresh to digested portions in the chinstrap penguin's diet samples was comparable to the previous nine 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 18 adult chinstrap penguins during the chick rearing phase in order to determine their foraging trip durations. Colony attendance was logged between January 6, 2008 and March 3, 2008 using a remote receiver and data collection computer. Mean foraging trip duration was 12.4 hours (n = 18; S.D. = 2.1). This was longer than the average foraging trip duration of 10.95 hours observed in 2006-07.

Gentoo and chinstrap penguins were also instrumented with satellite transmitters (PTTs) to provide geographic data on adult foraging locations during the chick rearing period. Sixteen PTTs were deployed on eight gentoo penguins in late January and on eight chinstrap penguins in early January during the brooding phase for each species. Fifteen PTTs were deployed on seven gentoo penguins and eight chinstrap penguins in mid February during the crèche phase for both species. PTT data are awaiting analysis.

Time-depth recorders (TDRs) were also attached to chinstrap and gentoo penguins to collect penguin diving behavior data during the chick-rearing period. The first round of TDRs was deployed on eight gentoo penguins in late January and on 11 chinstrap penguins in early-to-mid January while these adults were brooding chicks. A second round of TDRs was deployed on seven gentoo penguins and seven chinstrap penguins in mid February during the crèche phase when nests were unattended because both parents forage simultaneously. Dive data are awaiting analysis.

5.2.3 Other seabirds

The breeding success of all skuas at Cape Shirreff and nearby Punta Oeste was followed. There were 24 skua pairs holding territories, all of which were brown skuas (*Catharacta lonnbergi*) with the exception of one pair that are likely hybrid, brown-South Polar skuas (*C. maccormicki*). Clutches were initiated by 19 pairs and overall fledging success was 0.26 fledglings/pair. This is the lowest fledging success observed in 11 years of study; it is 64% lower than the previous 10-year average.

The reproductive performance of kelp gulls (*Larus dominicanus*) nesting on Cape Shirreff was also followed throughout the season. Thirty two nests were initiated and overall fledging success was 0.56 fledglings/pair.

5.3 Conclusions:

Our eleventh complete 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 and reproductive success of both gentoo and chinstrap penguins were significantly below the 10-year average. These parameters were negatively affected by poor nesting conditions and inclement weather during clutch initiation and incubation. High snow cover inhibited the construction of adequate nest bowls and high winds and snow drift resulted in the failure of many nests before nest censuses were conducted and in the weeks following censuses. This explains the low population counts and poor reproductive success. Fledging weights of both species were comparable to the previous 10-year average.

Diet composition of both species was comparable to previous seasons; all gentoo penguin samples contained fish and chinstrap penguin samples contained a relatively high proportion of juvenile krill. Total chick meal mass of chinstrap penguins was slightly lower than the previous 10-year mean but it is unclear if this can be explained by the fact that samples were collected from adults with younger chicks. The mean foraging trip duration of chinstrap penguins was slightly longer than observed in 2006-07. The foraging location and diving behavior data collected with PTTs and TDRs should assist in interpreting the foraging trip data.

5.4 Acknowledgements:

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5.5 References:

CCAMLR (2004) CCAMLR Ecosystem Monitoring Program: standard methods. CCAMLR, Hobart

Wilson RP (1984) An improved stomach pump for penguins and other seabirds. J Field Ornithol 55:109–112

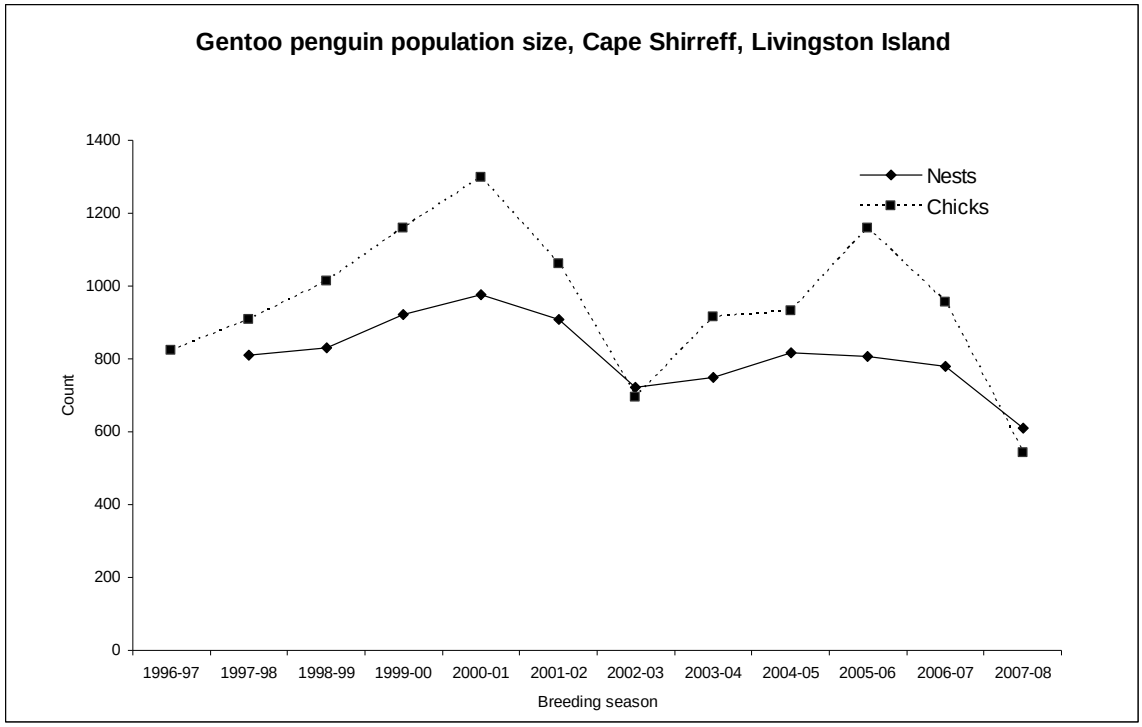

Figure 5.1. Gentoo penguin population size at Cape Shirreff, Livingston Island, Antarctica, 1996-97 to 2007-08.

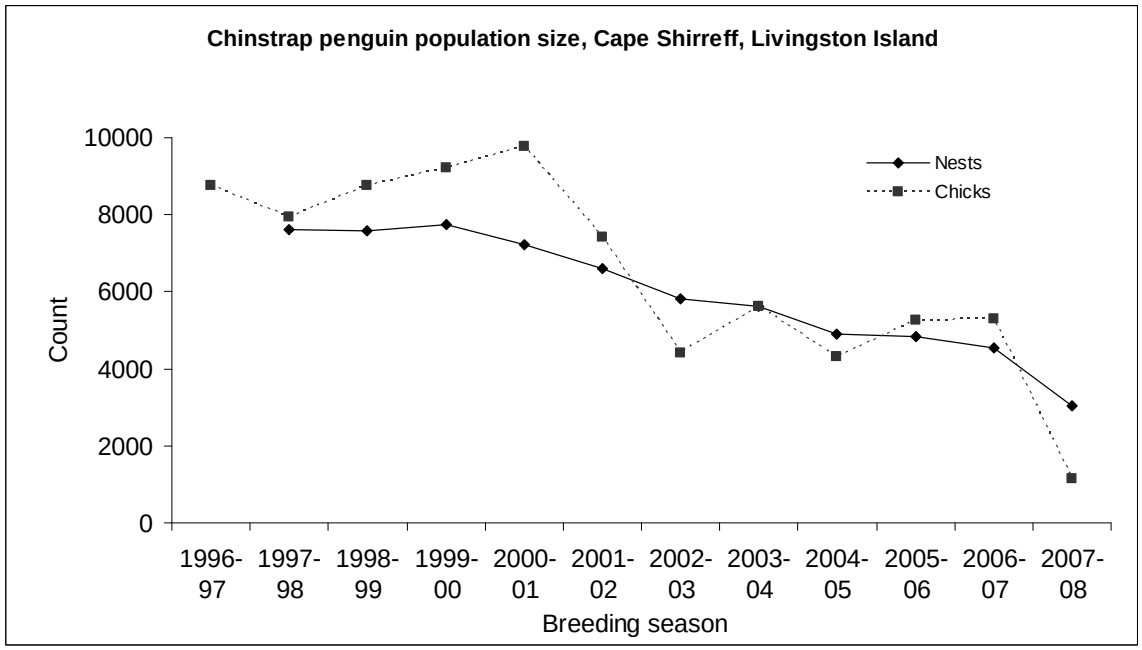

Figure 5.2. Chinstrap penguin population size at Cape Shirreff, Livingston Island, Antarctica, 1996-97 to 2007-08.

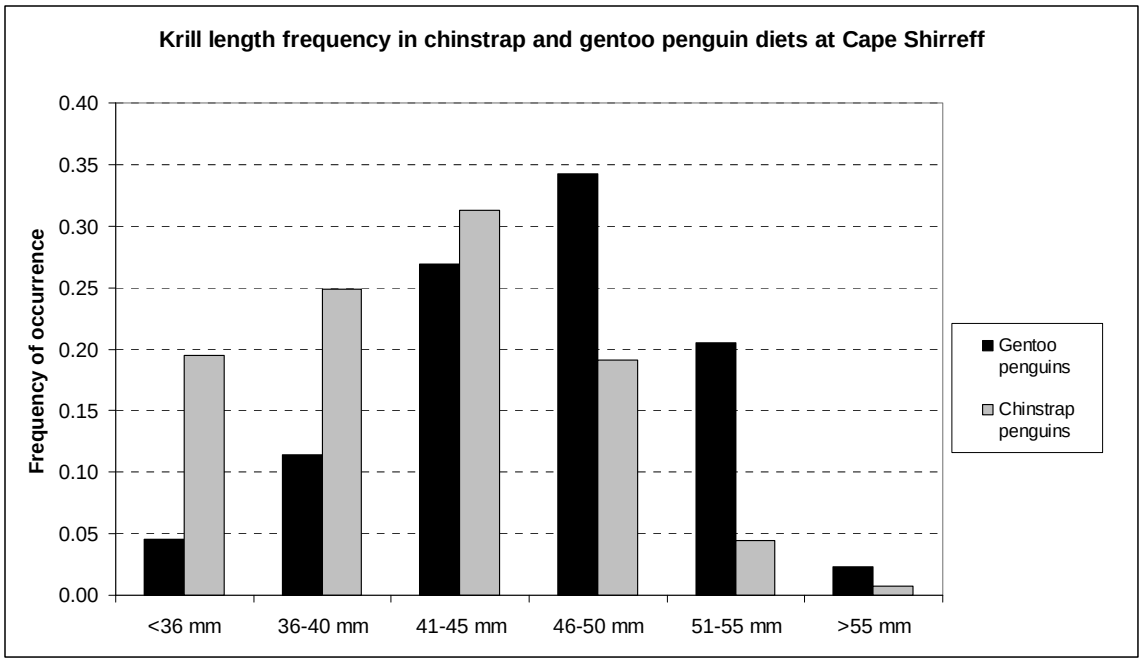

Figure 5.3. Krill length frequency distribution in gentoo and chinstrap penguin diet samples at Cape Shirreff, Livingston Island, Antarctica, 2007-08.

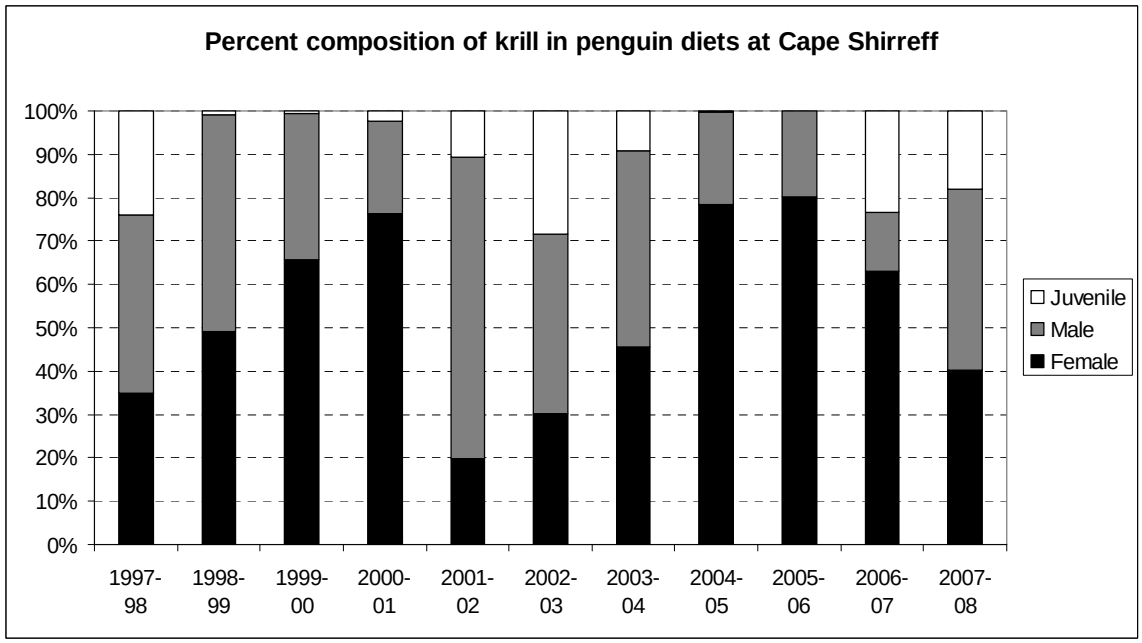

Figure 5.4. Percent composition of Antarctic krill (*Euphausia superba*) in gentoo and chinstrap penguin diet samples at Cape Shirreff, Livingston Island, Antarctica, 1997-98 to 2007-08.

UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

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Objectives, Accomplishments and Tentative Conclusions

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Amy M. Van Cise

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U.S Department of Commerce
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Southwest Fisheries Science Center
Antarctic Ecosystem Research Division
8604 La Jolla Shores Drive
La Jolla, California, U.S.A. 92037

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The U.S. Antarctic Marine Living Resources (AMLR) program provides information needed to formulate U.S. policy on the conservation and international management of resources living in the oceans surrounding Antarctica. The program advises the U.S. delegation to the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), part of the Antarctic treaty system. The U.S. AMLR program is managed by the Antarctic Ecosystem Research Group located at the Southwest Fisheries Science Center in La Jolla.

Inquiries should be addressed to:

Antarctic Ecosystem Research Group
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, California, USA 92037

Telephone Number: (858) 546-5600
E-mail: Amy.VanCise@noaa.gov