

## THE GENTOO PENGUIN AS A CANDIDATE SPECIES FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

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### Abstract

Based on dietary and other biological information collected over several years at Bird Island, South Georgia and at the South Shetland Islands (both within Integrated Study Regions (ISRs) of the CCAMLR Ecosystem Monitoring Program), we suggest (and provide a full bibliography of supporting literature) that the gentoo penguin meets the specified criteria qualifying species for inclusion in the CEMP. The extensive dependence of this species in these ISRs on *Euphausia superba*, (including in winter), its residence in the ISRs in winter and its early attainment of sexual maturity are all features of special relevance to the CEMP.

### Résumé

Les informations portant sur le régime alimentaire et la biologie, collectées sur plusieurs années à l'île Bird, en Géorgie du Sud, et aux îles Shetland du Sud (toutes deux dans les zones d'étude intégrée (ISR) du programme de contrôle de l'écosystème de la CCAMLR), nous amènent à suggérer (en présentant la bibliographie complète de la littérature de support) que le manchot papou répond aux critères spécifiés de sélection des espèces à inclure au CEMP. Le fait que cette espèce dépende largement d'*Euphausia superba* dans ces ISR (même en hiver), sa présence dans les ISR en hiver et sa maturité sexuelle précoce présentent un intérêt particulier pour le CEMP.

### Резюме

На основании данных по рациону и других биологических данных, собранных в течение нескольких лет на острове Берд, Южная Георгия, и Южных Оркнейских островах (оба участка находятся в пределах Районов комплексных исследований по Программе АНТКОМа по мониторингу экосистемы), мы предполагаем (и представляем полный список справочной литературы), что папуасский пингвин отвечает всем необходимым критериям включения видов в Программу СЕМР. Большая зависимость этого вида от *Euphausia superba* в данных районах комплексных исследований, (включая зимний период), обитание этого вида в Районах комплексных исследований в зимний период и раннее достижение этим видом половой зрелости - все это свидетельствует о его причастности к Программе СЕМР.

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## Resumen

Basándose en la información dietética y biológica recopilada durante varios años en la isla de los Pájaros, Georgia del Sur y en el archipiélago de Shetlands del Sur (ambas localidades están dentro de las Regiones de Estudio Integrados (ISRs)) del Programa de Seguimiento del Ecosistema de la CCRVMA), sugerimos que el pingüino papúa satisface el criterio especificado que califica a las especies para ser incluidas en el CEMP. La elevada dependencia de esta especie de *Euphausia superba* en estas ISRs, incluso en invierno, su residencia en las ISRs durante el invierno y su madurez sexual precoz, son todas características de especial importancia para el CEMP.

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### 1. INTRODUCTION

At the 1985 Meeting of the (*ad hoc*) CCAMLR Working Group on Ecosystem Monitoring, the criteria used to select predator species thought to be best suited for ecosystem monitoring were defined as:

- (i) specialist predators on the critical prey components identified;
- (ii) wide geographic distribution;
- (iii) importance in the ecosystem;
- (iv) feasibility of study (ease to approach, handle, observe);
- (v) knowledge of general biology; and
- (vi) availability of baseline data at one or more sites.

On this basis, the following species were selected as those most likely to be useful as indicators of changes in krill availability:

- crabeater seal;
- Antarctic fur seal;
- Adélie penguin;
- chinstrap penguin;
- macaroni penguin; and
- minke whale.

At the 1986 Meeting, Antarctic petrel and black-browed albatross were added. This was done despite the fact that the Antarctic petrel did not adequately meet criteria (i) - few published dietary data; krill certainly not the only significant prey, (v) - breeding biology largely unknown, or (vi) - no baseline data available; and that the black-browed albatross did not adequately meet criteria (i) - krill probably not main diet, except for South Georgia, with fish and squid also important, or (ii) - only in sub-Antarctic.

There are probably several additional species which meet the specified criteria better than the Antarctic petrel and black-browed albatross; pre-eminent amongst these is the gentoo penguin.

### 2. PROPOSAL

We suggest that the gentoo penguin more than adequately meets the CCAMLR criteria, especially in relation to the South Georgia and Antarctic Peninsula Integrated Study Regions,

and recommend that it should be incorporated into the CCAMLR Ecosystem monitoring Program (CEMP) as soon as appropriate standard methods and methods sheets can be prepared.

### 3. FULFILMENT OF CRITERIA

#### 3.1 Specialist Predator on Harvestable Prey

In seven seasons (and over 300 samples) of investigating summer diet, of adults feeding crèched chicks, at South Georgia, Antarctic krill (*Euphausia superba*) has averaged 71% by weight of the diet (Croxall *et al.*, 1988a and unpublished data). During the incubation and brooding periods, krill is an even more important component (95%+) of the diet (Williams, unpublished data). Only in one year (1985) did the proportion of *E. superba* fall below 65%. During the winters of 1987 and 1988, *E. superba* was also the main component (c. 90%) of the diet at South Georgia (Williams, in press). Similarly, at the South Shetland Islands, studies over several summers have confirmed that krill is the main (70%+) component of the diet (Jablonski, 1985; Trivelpiece *et al.*, 1987). In both localities, the rest of the diet is almost entirely fish. In most studies, certain individual penguins appear to feed chiefly on fish, at least during single foraging trips (Jablonski, 1985; Croxall *et al.*, 1988b).

At Marion Island and Macquarie Island, *E. superba* does not occur in gentoo penguin diets. In the chick-rearing season, several species of fish, *Euphausia valentini* and *Nauticaris marionis* are the main prey at Marion Island (LaCock *et al.*, 1984; Adams and Klages, 1989) and fish and *E. valentini* at Macquarie Island (Hindell, 1989).

#### 3.2 Geographical Distribution

Gentoo penguins are widely distributed at sub-Antarctic islands and on the Antarctic Peninsula breed south to 65°S. They are absent from the Antarctic Continent.

#### 3.3 Importance (in terms of prey consumption) to the Southern Ocean System

Gentoo penguins have the second smallest total breeding population (270 000 pairs) and the lowest estimated total biomass (3 160 tonnes) of any Southern Ocean penguin (Woehler, in press). However, there are substantial breeding populations in the South Georgia and Antarctic Peninsula Study Regions (a minimum of 80 000 to 100 000 pairs and c. 50 000 pairs respectively: Woehler, in press). Because the species is resident, these populations are likely to consume significant quantities of krill each year within the Integrated Study Regions.

#### 3.4 Feasibility of Study

At South Georgia and the South Shetland Islands, gentoo penguins are an easy species to work with. (At Indian Ocean islands, they are much more wary and difficult to observe and handle.) Being the largest of the pygoscelid penguins, they are particularly suitable for the deployment of recording and transmitting instruments.

#### 3.5 Knowledge of General Biology

Gentoo penguins have been quite extensively studied. The major (multi-year) studies of general breeding biology are: Trivelpiece *et al.* (1987) at the South Shetland Islands, Williams (1990) at South Georgia and Bost and Jouventin (in press) at the Crozet Islands; smaller-scale studies have been conducted at Marion Island (Williams, 1980) and Macquarie Island

(Robertson, 1986). Diet and foraging ecology have been studied at South Georgia (Croxall and Prince, 1980; Croxall *et al.*, 1988a and 1988b; Williams, in press; Williams and Rothery, in press), the South Shetland Islands (Volkman *et al.*, 1980 and unpublished; Jablonksi, 1985; Trivelpiece *et al.*, 1986), Marion Island (LaCock *et al.*, 1984; Adams and Wilson, 1987; Adams and Klages, 1989) and Macquarie Island (Robertson *et al.*; 1988, Hindell, 1989). Chick growth has been studied at South Georgia (Williams and Croxall, in press a, b), the South Orkney Islands (Despin, 1977) and the South Shetland Islands (Volkman and Trivelpiece, 1980).

### 3.6 Availability of Baseline Data

Data on breeding population size and breeding success are available annually since 1976 at Bird Island, South Georgia (Croxall *et al.*, 1988a; Williams, 1990), and in most years since 1976 at King George Island, South Shetland Islands (Trivelpiece *et al.*, 1987). For other sites within the Antarctic Peninsula Integrated Study Region, there are accurate counts of breeding populations, often dating back to the 1950s (Croxall and Kirkwood, 1979; Jablonski, 1984; Woehler, in press). Some baseline data also exist for Marion Island, the Crozet Islands, Heard Island and Macquarie Island (Wilson, 1983). The sections above on diet and general biology indicate that multi-year data are available for South Georgia and the South Shetland Islands for many other aspects of direct relevance to CCAMLR selected parameters (e.g., chick diet, foraging trip duration, demography).

## 4. ADDITIONAL CONSIDERATIONS

### 4.1 Resident Species

Gentoo penguins remain in the vicinity of their breeding colonies year-round and come ashore frequently during the non-breeding season (Williams, in press). There are few, if any, CEMP species which are readily accessible on land throughout the year.

### 4.2 Early Sexual Maturity

With typical ages of first breeding being at two and three years old (Williams, 1990), gentoo penguins have the shortest period of immaturity known in penguins. This minimizes the time over which parameters such as survival from fledging to breeding are calculated and thus improve the likely accuracy of such results. The short generation time also increases the likelihood of populations showing rapid and marked responses to environmental change.

## REFERENCES

- ADAMS, N.J. and N.T. KLAGES. 1989. Temporal variation in the diet of the gentoo penguin *Pygoscelis papua* at sub-Antarctic Marion Island. *Colonial Waterbirds* 12: 30-36.
- ADAMS, N.J. and M.-P. WILSON. 1987. Foraging parameters of gentoo penguins *Pygoscelis papua*, at Marion Island. *Polar Biology* 7: 51-56.
- BOST, C.A. and P. JOUVENTIN. In press. The breeding biology of the gentoo penguin on the Crozet Islands. *Ibis*.
- CROXALL, J.P. and E.D. KIRKWOOD. 1979. *The Distribution of Penguins on the Antarctic Peninsula and Islands of the Scotia Sea*. Cambridge: British Antarctic Survey.

- CROXALL, J.P. and P.A. PRINCE. 1980. The food of gentoo penguins *Pygoscelis papua*, and macaroni penguins *Eudyptes chrysolophus*, at South Georgia. *Ibis* 122: 245-253.
- CROXALL, J.P., R.W. DAVIS and M.J. O'CONNELL. 1988b. Diving patterns in relation to diet of gentoo and macaroni penguins at South Georgia. *Condor* 90: 157-167.
- CROXALL, J.P. T.S. MCCANN, P.A. PRINCE and P. ROTHERY. 1988a. Reproductive performance of seabirds and seals at South Georgia and Signy Island: Implications for Southern Ocean monitoring studies. In: SAHRHAGE, D. (Ed.). *Antarctic Ocean and Resources Variability*. Berlin: Springer-Verlag. pp. 261-285.
- DESPIN, B. 1977. Croissances comparées des poussins chez les manchot du genre *Pygoscelis*. *Comptes Rendus Hebdomadaire des Seances de l'Académie des Sciences, Paris (Série, D)* 285: 1135-1137.
- HINDELL, M.A. 1989. The diet of gentoo penguins *Pygoscelis papua* at Macquarie Island: winter and early breeding season. *Emu* 89: 71-78.
- JABLONSKI, B. 1984. Distribution and numbers of penguins in the region of King George Island, South Shetland Islands in the breeding season 1980/81. *Polish Polar Research* 5: 17-30.
- JABLONSKI, B. 1985. The diet of penguins on King George Island, South Shetland Islands. *Acta Zoologica Cracov* 29: 117-186.
- LACOCK, G.D., T. HECHT and N. KLAGES. 1984. The winter diet of gentoo penguins at Marion Island. *Ostrich* 55: 188-191.
- ROBERTSON, G. 1986. Population rise and breeding success of the gentoo penguin *Pygoscelis papua* at Macquarie Island. *Australian Wildlife Research* 13: 583-587.
- ROBERTSON, G., B. GREEN and K. NEWGRAIN. 1988. Estimated feeding rates and energy requirements of gentoo penguins, *Pygoscelis papua*, at Macquarie Island. *Polar Biology* 9: 89-93.
- TRIVELPIECE, W.Z., J.L. BENGTON, S.G. TRIVELPIECE and N.J. VOLKMAN. 1986. Foraging behaviour of gentoo and chinstrap penguins as determined by new radio-telemetry techniques. *Auk* 103: 777-781.
- TRIVELPIECE, W.Z., S.G. TRIVELPIECE and N.J. VOLKMAN. 1987. Ecological segregation of Adélie, gentoo and chinstrap penguins at King George Island, Antarctica. *Ecology* 68: 351-361.
- VOLKMAN, N.J. and W.Z. TRIVELPIECE. 1980. Growth in pygoscelid penguin chicks. *Journal of Zoology, London*, 191: 521-530.
- VOLKMAN, N.J., P. PRESLER and W. TRIVELPIECE. 1980. Diets of pygoscelid penguins of King George Island, Antarctica. *Condor* 82: 373-378.
- WILLIAMS, A.J. 1980. Aspects of the breeding biology of the gentoo penguin, *Pygoscelis papua*. *Gerfaut* 70: 283-295.
- WILLIAMS, T.D. 1990. Annual variation in breeding biology of gentoo penguins *Pygoscelis papua* at Bird Island, South Georgia. *Journal of Zoology, London*.
- WILLIAMS, T.D. In press. Winter diet of gentoo penguins *Pygoscelis papua* at South Georgia: an assessment of winter krill consumption. *Ibis*.

- WILLIAMS, T.D. and J.P. CROXALL. In press (a). Is chick fledging weight a good index of food availability in seabird populations? *Oikos*.
- WILLIAMS, T.D. and J.P. CROXALL. In press (b). Chick growth and survival in gentoo penguins *Pygoscelis papua*: the importance of hatching asynchrony and variation in food supply. *Polar Biology*.
- WILLIAMS, T.D. and P. ROTHERY. In press. Factors affecting variation in foraging and activity patterns of gentoo penguins *Pygoscelis papua* during the breeding season at Bird Island, South Georgia. *Journal of Applied Ecology*.
- WILSON, G.T. (Ed.). 1983. *Distribution and Abundance of Antarctic and Sub-Antarctic Penguins: A Synthesis of Current Knowledge*. Cambridge: SCAR.
- WOEHLER, E.J. (Ed.). In press. *The Distribution and Abundance of Antarctic and Sub-Antarctic Penguins*. Cambridge: SCAR.