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THE EFFECTS OF MONITORING PROCEDURES ON ADÉLIE PENGUINS

J. Clarke and K. Kerry
Australian Antarctic Division
Channel Highway, Kingston, Tas. 7050
Australia

Abstract

The effects of flipper bands, implanted tags, gastric lavage and external instrument attachment on the performance of Adélie penguins were investigated over three seasons at Béchervaise Island, Mac. Robertson Land, Antarctica. The return rates of birds carrying bands and/or implanted electronic transponders were compared to investigate the contribution of bands to bird mortality and to determine rates of band and tag loss. There was a slight reduction in return rates of birds banded for more than one season, but no evidence of band or tag loss over a single winter. The attachment of satellite tracking devices during the incubation period resulted in increased foraging trip durations and reduced breeding success. Attachment for single or multiple foraging trips post-hatching caused no significant increase in foraging trip durations. No reduction in fledging rates of chicks from nests of stomach-lavaged birds was detected over two breeding seasons. The implications of these findings for the CCAMLR Ecosystem Monitoring Program are discussed.

Résumé

L'effet des marques d'aileron, des sondes implantées, des lavages d'estomac et de la fixation externe d'instruments a été examiné sur trois saisons à l'île Béchervaise (terre Mac. Robertson, Antarctique). Les taux de retour des oiseaux porteurs de bagues ou de sondes électroniques implantées ont été comparés afin d'étudier l'influence du baguage sur la mortalité des oiseaux et de déterminer le taux de perte des bagues et des marques. Cet examen, s'il met en évidence une légère réduction du taux de retour des oiseaux bagués depuis plus d'une saison, n'indique pas de perte de bague ou de marque au cours d'un même hiver: La fixation de balises de suivi par satellite pendant la période d'incubation menait à une prolongation des sorties alimentaires et à une réduction du succès de la reproduction. La fixation d'instruments pour une seule sortie alimentaire ou pour plusieurs sorties consécutives après l'éclosion n'augmentait pas la durée de cette sortie. Une étude portant sur deux saisons de reproduction n'indique aucune réduction du taux d'émancipation des jeunes provenant de nids dans lesquels les parents avaient subi des lavages d'estomac. Les auteurs discutent les implications de ces découvertes pour le Programme de contrôle de l'écosystème de la CCAMLR.

Резюме

В течение трех сезонов на о-ве Бешервез, Земля Макробертсона, Антарктика, исследовались воздействия кольцевания, импланти-рования меток, промывания желудков и наружного прикреп-ления приборов на жизнедеятельность пингвинов Адели. В целях изучения роли колец в смертности птиц и определения степени потерь колец и меток сравнивались процентные доли возвращения птиц, оснащенных кольцами и/или имплантирован-ными электронными транспондерами. Было зарегистрировано некоторое сокращение доли возвращения птиц, носивших кольца более одного сезона; однако, доказательств потерь колец или меток в течение одной зимы не имелось. Прикрепление приборов спутникового слежения во время периода инкубации привело к увеличению продолжительности походов за пищей и к уменьшению репродуктивного успеха. Прикрепление на один или более походов за пищей по вылуплении птенцов не вызвало существенного увеличения продолжительности похода за пищей. Сокращения темпа оперения птенцов из гнезд птиц, подвергнутых промыванию желудка в течение двух сезонов размножения, зарегистрировано не было. Обсуждается значение этих исследований для Программы АНТКОМа по мониторингу экосистемы.

Resumen

Durante tres temporadas se estudiaron los efectos de las bandas de aleta, de las marcas implantadas, del lavado estomacal y de la fijación de instrumentos externos en los pingüinos adelia en la isla Béchervaise, Territorio de Mac Robertson, Antártida. Se comparó el índice de regreso de las aves con bandas y/o con respondedores electrónicos de posición con el objeto de determinar el aporte de las bandas a la mortalidad de aves y el índice de pérdida de marcas y bandas. Se constató una leve reducción en el índice de regreso de las aves que llevan bandas por más de una temporada pero no hubo evidencia de pérdida de éstas o marcas durante un solo invierno. La fijación de dispositivos para el rastreo por satélite durante el período de incubación resultó en un aumento de la duración de los viajes de alimentación y en una reducción del éxito de reproducción. La fijación de estos dispositivos para uno o varios viajes de alimentación realizados después de la puesta no causó un aumento significativo en la duración de estos viajes. Durante dos temporadas de reproducción no se detectó una reducción en el índice de emplumaje de los polluelos en aquellos nidos donde las aves fueron sometidas a un lavado estomacal. Se discuten las repercusiones de estos resultados para el Programa de la CCRVMA de Seguimiento del Ecosistema.

Keywords: Adélie penguin, CEMP, flipper bands, package attachment, stomach lavage, CCAMLR

INTRODUCTION

The CCAMLR Ecosystem Monitoring Program (CEMP) requires longterm monitoring of a number of parameters related to the reproductive success and foraging behaviour of Adélie penguins (*Pygoscelis adeliae*) in order to determine the range of natural variation present in minimally-disturbed populations and to enable the detection of changes due to fishery activities. Many of the specified standard monitoring methods involve direct handling of the birds and the use of techniques such as flipper banding, stomach lavage and instrument attachment (SC-CAMLR, 1991). Disturbance to individuals and colonies by these research activities may result in decreased breeding success, increased mortality or altered rates of immigration, emigration and recruitment, thus altering or biasing the very data we are attempting to collect.

The demographic studies recommended by CEMP involve the use of flipper bands, which have been shown to have detrimental effects on survival (Ainley *et al.*, 1983) and swimming efficiency (Culik *et al.*, 1993). Some types of bands can cause severe injury to the penguins wearing them (Sallaberry and Valencia, 1985) and band loss also is known to occur (Ainley and DeMaster, 1980). Measurements of other variables such as diet and foraging behaviour require intrusive manipulative procedures (e.g., stomach lavage and instrument attachment) which may have negative effects on the breeding success of the birds. The attachment of packages to the backs of penguins causes a significant increase in the drag of swimming birds which, in turn, results in decreased swimming speeds and increased energy expenditure (Culik and Wilson, 1991). The overall outcome tends to be an increase in foraging trip durations (Wilson *et al.*, 1989; Croll *et al.*, 1991) and a resultant decrease in foraging efficiency.

Attempts have been made to reduce disturbance to a minimum in the Adélie penguin colony being monitored at Béchervaise Island (67°36'S, 62°53'E) in Eastern Antarctica through the development of an automated weighing and identification system (Kerry *et al.*, 1993). This was designed to enable longterm collection of data for CEMP parameters, including weight on first arrival, incubation shift durations, age-specific annual survival and recruitment, foraging trip durations, breeding success and fledging weight, whilst minimising human presence. The system utilises implanted transponders for identification of individual birds. By using automatically-collected data from tagged banded birds over multiple seasons we are attempting to quantify rates of band loss and determine the effects of flipper bands on penguin 'performance' and mortality. In addition, we have used data from our automated system combined with manual observations to investigate the effects of instrument attachment on foraging behaviour and breeding success. We have also conducted research into the effects of gastric lavage of adult penguins on the survival of their chicks.

METHODS

Banding and Tagging

During the 1990/91 and 1991/92 breeding seasons, 432 adult penguins (from five colonies containing approximately 550 nests) were individually identified by means of either an electronic transponder tag (TIRIS™, Texas Instruments, USA), 30 mm long and 3 mm in diameter, implanted under the skin of the neck or by a conventional stainless steel flipper band. All birds were sexed by cloacal examination prior to tagging or banding. Males were banded on the left flipper and females on the right for ease of future sex identification. The bands were bilaterally symmetrical and therefore fitted either flipper; however, the number appeared upside down when the right flipper was used. Of the 432 penguins, 159 individuals were given both a band and a tag. Some of those tagged in 1991/92 had been banded the previous year and it was noted that their bands had opened by 1 to 2 mm. The gap was closed at the time of tag implantation. Return rates of banded and/or tagged birds were recorded from both automatically-collected data (from five colonies) and weekly manual observations of all nests on the island (approximately 1 700 nests) during the 1991/92 and 1992/93 breeding seasons.

Stomach Lavage

Two hundred adult Adélie penguins were stomach lavaged during chick rearing in the four years from 1989/90 to 1992/93 using the water-offloading method of Wilson (1984). Warm sea water was gently pumped into the stomach through a soft tube until it began to flow back out of the mouth or the bird started to regurgitate. The tube was then removed, the bird inverted over a bucket and firm pressure applied to the base of the stomach while massaging the throat with the fingers. Flushing was repeated until only clear water was vomited.

Only one member of each pair was flushed and no bird was used more than once. The nests of all birds flushed during chick rearing were monitored and the survival rates of chicks recorded. Control nests with chicks of similar size were chosen at the time of flushing and all nests were checked daily.

The flushing process was fairly easy to carry out on most birds; however, the occasional individual proved difficult to empty, especially when its stomach was full and the contents tightly packed. There was usually a certain amount of resistance from such birds to the passage of the tube, and in some instances the process was abandoned due to the danger of stomach injury. Over four seasons there have been two fatalities during the flushing process, which proved on post-mortem to be due to perforation of the stomach. Both birds had been difficult to empty and had tightly packed stomach contents.

Instrument Attachment

Platform transmitter terminals (PTTs) for satellite tracking, and time-depth recorders (TDRs) (Mk. 5, Wildlife Computers, Woodinville, Wa., USA) were deployed at various stages throughout the 1991/92 and 1992/93 breeding seasons. The packages containing the PTTs and batteries were neutrally buoyant and weighed 150 to 170 g with a frontal area of 800 mm^2. The TDRs were much smaller, weighing 50 g with a frontal area of 525 mm^2. Both types of device were attached, using glue and cable ties, as far to the rear of the penguin's back as possible to minimise drag. Velcro™ patches were used in the 1991/92 season for ease of removal and to allow greater flexing of the bird's back. The method of attachment was simplified to glue and cable ties alone during the second summer in an attempt to improve the streamlining of the package.

Instruments were attached to both male and female penguins during their long incubation-period foraging trips and at various stages throughout the brood and guard periods. Birds of known previous breeding history in good body condition (subjective assessment of fat reserves) were chosen as carriers. Selection of timid individuals was deliberately avoided. Birds were allowed to carry packages for one to five consecutive foraging trips and all nests were monitored daily throughout each season. Fledging rates and nest failures were recorded and comparisons made with the remainder of the colony.

RESULTS AND DISCUSSION

Effects of Flipper Bands

Table 1 shows that 63% of birds banded in 1990/91 were observed in the colony the following season and that 70% of all tagged

and/or banded birds present in 1991/92 returned the next year. When the second figure is broken down into birds banded in 1990/91 and those banded or tagged in 1991/92, we find a slightly lower return rate (64%) for non-recaptured birds banded for two years compared with the range of 72 to 75% for those tagged or banded for only one season, or whose bands had been tightened in 1991/92. This contrasts with the results of Ainley *et al.* (1983) who found that the survival rate of birds with new bands was 28% lower than that of birds with bands older than one year. However, the differences in return rates between our four groups of birds are not statistically significant ($\chi^2 = 2.74$, df = 3, N.S.) and the variation is similar to that between males and females each year. It is also possible that the subset of birds whose bands had not been tightened had spent less time in the colony than the other groups, resulting in a lower perceived return rate.

suggests that the gap found on bands in the field was probably due to birds prising the ring open with their beaks rather than to stress-relief of the metal. Recent initial results from the 1993/94 season have demonstrated the loss of bands from two tagged birds which had been banded two and three years previously, and also the failure of one implanted tag.

The disappearance of birds between successive seasons may not necessarily be due to mortality or loss of identification markers. It may also be explained by migration, failure of timid birds to return to the colony, or an inability to breed every year due to the energetic cost of successive attempts. The latter explanation is unlikely according to the findings of Chappell *et al.* (1993) that reproductive effort comprises only 5.3 to 6.2% of the annual energy budget of Adélie penguins. These authors suggest that reproductive

Table 1: Return rates of banded and/or tagged birds. Annual return rates (as numbers and percentages) for birds carrying bands only, tags only, and both bands and tags between the 1990/91-1991/92 and 1991/92-1992/93 breeding seasons.

	Total	Band not Tightened	Band Tightened	Male	Female
Birds banded in 90/91	267				
Returned 91/92	168	101	67	87	81
Returned 92/93	113	65	48	57	56
% Return 91/92	63				
% Return 92/93	67	64	72	66	69
	Total	Band and Tag	Tag Only	Male	Female
Banded/tagged 91/92	165	92	73	75	90
Returned 92/93	121	66	55	55	66
% Return 92/93	73	72	75	73	73
	Total			Male	Female
All birds present 91/92	333			162	171
Returned 92/93	234			112	122
% Return 92/93	70			69	71

Whether band loss and/or increased mortality occur after more than one year of band wear remains to be determined from future years' return rates of birds carrying tags and/or bands. There was no evidence of any over-winter band loss (or implanted tag failure) from 106 adult penguins carrying both forms of identification over a single year only. However, we did see obvious feather wear and slight band opening in the majority of adult birds carrying a band for one or more years, and on one occasion recaptured a bird with a wide open band, the end of which had penetrated the elbow joint. Closed stainless steel bands transferred at regular intervals between cold sea water and a -20°C freezer over several months did not show signs of opening. This

effort may instead be limited by the increased risk of predation by leopard seals associated with multiple foraging trips during chick rearing. We have noted that three females banded in 1990/91 returned in 1992/93 but were not observed in the intermediate season. The ages of these birds are unknown and it is possible that we failed to observe them, and perhaps others, if they appeared only briefly in the colony.

It is important to differentiate between penguin mortality and band loss in demographic studies in order to determine whether the bands themselves are affecting bird survival. Band loss in King penguins has been estimated at 22% during the first year after banding (Weimerskirch

et al., 1992) and mortality due to rebanding of Adélie adults assumed to be in the order of 28% (Ainley *et al.*, 1983). The banded population of Adélies studied by Ainley *et al.* (1983) declined 3% more rapidly than the unbanded population, and Culik *et al.* (1993) have shown that 24% more power is required by banded Adélie penguins swimming in a still-water tunnel compared to those without bands. These results suggest that the energetic cost of carrying a flipper band may be sufficient to compromise the survival of birds at sea. Double-banding studies have shown an 8 to 25% lower annual return rate for three species of pygoscelid penguins banded on both flippers compared to those carrying single bands only (Trivelpiece and Trivelpiece, pers. comm.), indicating an increased mortality rate in this group. Six to seven per cent of those that did return had lost one of their bands, showing that band loss occurs also. Band loss rates ranging from 0 to 12% were observed by Ainley and DeMaster (1980) for Adélie penguins carrying bands for up to 10 years.

The results of Ainley *et al.* (1983) and Culik *et al.* (1993) suggest that flipper bands may have undesirable effects (mortality and energetic costs) on the individuals carrying them, and cast some doubts upon the reliability of demographic data derived from studies (such as those recommended by CEMP) dependent on bands for identification of individuals. We have no evidence at present of increased mortality rates among banded birds, but we have demonstrated a 1% band loss from birds banded for two to three years. Although our use of stainless steel bands as compared to the aluminium bands used by Ainley *et al.* (1983) and Trivelpiece (pers. comm.) may lessen the incidence of band loss, some loss does still occur and the overall effects of bands on foraging efficiency may be important.

The use of alternative methods of permanent identification (such as the implanted transponders presently being tested) should be considered for use in future demographic studies, especially those used for longterm monitoring of populations. In addition, automated systems of tag detection reduce the need for human presence in the determination of bird return rates. The longterm reliability of implanted transponders versus bands has yet to be proven. We have found that a small proportion (approximately 1%) of tags is lost within a fortnight after injection, presumably prior to healing of the injection wound. Of the remainder, we have recent evidence (from 207 adult birds carrying both bands and tags by the end of the 1992/93 season) of one tag failing after nine months.

Thirty-four chicks carrying implanted transponders fledged from Béchervaise Island in February 1992. Of these birds, seven returned to the colony as two-year-olds (1993/94 summer). Ainley *et al.* (1983) reported that 30% of all Adélie fledglings that eventually returned to their natal colony first arrived in their second year. Given a similar return rate for two-year-olds at Béchervaise Island, we can expect to detect up to 23 in total of these tagged fledglings over the next four years. Such an overall rate of survivorship would well exceed that of 12 to 19% calculated by Ainley *et al.* (1983) using a banded population of chicks, and may be due (in part at least) to a reduction in the mortality rate of tagged versus banded fledglings.

Effects of Stomach Lavage

Adults were stomach-flushed during brooding from a total of 23 nests in 1992 (Table 2). A total of 25 chicks were creched from these nests (an average of 1.09 chicks per nest) while 17 control nests creched 17 chicks (1.00 per nest). The overall colony average was 1.06 chicks per hatched nest. In 1993, 28 chicks reached the late creche stage from the nests of 29 stomach-flushed birds, and exactly the same number of chicks survived from 29 control nests. This average of 0.97 chicks per nest was similar to the mean for the whole colony of 0.92 (Table 2).

Table 2:
Chicks fledged from stomach-lavaged birds. Numbers of chicks fledged per nest where one adult was stomach-flushed on a single occasion, compared to control nests and to the colony as a whole.

		Chicks Fledged/Nest	Nests
1992	Stomach flushed	1.09	23
	Controls	1.00	17
	Colony mean	1.06	151
1993	Stomach flushed	0.97	29
	Controls	0.97	29
	Colony mean	0.92	117

There is no evidence, therefore, that the collection of stomach samples from adult Adélie penguins adversely affects the survival to fledging of their chicks when carried out on one member of a pair once only during chick rearing, and these findings are in agreement with those of a similar study carried out at Shirley Island near

Casey (Robertson *et al.*, 1994). However, growth studies were not carried out on the chicks and it is possible that fledging weights were lowered sufficiently by the flushing procedure to compromise subsequent survival at sea. Missing a feed may be of greater significance towards the end of the breeding season when meals are larger and less frequent and when capture is more likely to cause an adult to cease returning to feed its chick earlier than it otherwise would.

Effects of Instrument Attachment

The attachment of PTTs (150 to 170 g) to six males and five females during the incubation period resulted in increased foraging trip durations for most birds, especially the females. Table 3 shows that 10 of the 11 trips were longer than the colony average, seven of these values falling greater than two standard deviations above the colony mean. Sixty per cent of the birds' nests failed in the first season and 66% in the second year, due mostly to sitting birds deserting prior to the return of their partners but also, in one instance, to newly hatched chicks dying of starvation. This compares with a mean colony nest failure rate over four years of 31% (range 10 to 52%). Two penguins were given 50 g time/depth recorders during the incubation period and both birds returned on time and fledged chicks. These results show that the large package is a significant burden during post-fasting foraging trips; however, the smaller instrument may have a lesser effect.

Attachment of PTTs for single foraging trips during chick rearing did not reduce fledging success (Table 4) or increase foraging trip duration (Table 5) compared to controls. The mean fledging success of 11 penguins carrying PTTs was 0.56 chicks fledged/chick hatched compared with an average of 0.50 for the whole colony. Twelve birds carried TDRs for one trip each; their nests fledged 0.52 chicks/chick hatched. In total, seven birds were given PTTs for two to five consecutive foraging trips during chick rearing. A lower fledging success resulted (0.31 fledged/hatched), compared to the other groups; however, this difference was not significant ($\chi^2 = 2.15$, df = 3, N.S.). The value of choosing strong birds was emphasised by one particular male who was burdened with both a PTT and a TDR for three consecutive journeys. Within a week he had made one short return trip of 5 km followed by two long journeys on the second of which he visited the edge of the continental shelf 110 km distant. Stomach lavage after the journey to the shelf edge produced large amounts of krill, and the bird and his mate eventually reared two healthy chicks.

Increases in foraging trip duration for package-carrying pygoscelid penguins have been reported (Wilson *et al.*, 1989; Croll *et al.*, 1991; Trivelpiece, pers. comm.), and travelling speed correlated with cross-sectional area of the devices (Wilson *et al.*, 1989). Larger devices create greater hydrodynamic effects and antenna-induced drag may also be significant. The importance of streamlining attached packages has been emphasised (Culik *et al.*, 1994), especially if the purpose of the instrumentation is to measure foraging trip durations (as is recommended by CEMP Standard Method A5). Correct shaping of 200 g back-mounted packages can reduce the power requirements of carrier penguins to a level which is only 6% greater than that of normal birds, as opposed to the 42% increase induced by a rectangular 35 g device (Culik *et al.*, 1994; Culik and Wilson, 1991).

There is a wide range of post-hatch foraging trip durations (5 to 187 hours) at Béchervaise Island due to variation in the birds' choices of feeding grounds. Recent studies (Kerry *et al.*, 1994) have shown that individual birds make both short and long foraging trips during chick rearing. The short trips of up to 30 km in range are to foraging grounds over the continental shelf. Birds return from these with fish and amphipods in their stomachs. On their long trips birds travel to points 80 to 130 km from the colony to feed mainly on adult krill (*Euphausia superba*). Juvenile *E. superba* and krill of other species, such as *E. crystallorophias*, are found in some stomach contents; the location of their capture appears variable. Due to the wide range in trip durations, the determination of significant effects of package carrying on time spent foraging requires large sample sizes. We have not been able to show any significant increase in foraging trip duration during chick rearing (Table 5), even when trips are separated on the basis of diet[1]. It is possible also that the attachment of a package *per se* is sufficient to cause a penguin to alter its foraging

[1] Mann-Whitney *U*-tests were used to compare trip durations of instrumented versus non-instrumented birds: for seven instrumented and eight non-instrumented birds eating *E. superba*, U=16.5, N.S.; for 10 instrumented and seven non-instrumented birds eating amphipods or fish, U=32.5, N.S.

Table 3: First male and female foraging trip durations during the incubation period. Individual trip durations of 11 birds carrying instrument packages over two seasons compared to mean colony values for each sex. Incidence of nest failure is indicated.

	Foraging Trip Duration (days)			
	1991/92		1992/93	
	Female	Male	Female	Male
Individuals	34*, 21**	23, 20*, 15*	26*, 36*, 19*	18, 15, non-return*
Colony mean	17	15	17	14
Colony SD:	2.34	2.11	3.78	1.96
n (colony)	164	151	122	117

* Nest failure due to late return of PTT carrier
** Chicks died from starvation

Table 4: Chicks fledged by package-carrying birds. Chicks fledged as a function of chicks hatched for nests of penguins carrying packages for a single or multiple foraging trips compared to the remainder of the colony.

	Incubating Nests	Chicks Hatched	Chicks Fledged	Fledged/Chick Hatched
No package	124	141	70	0.50
PTT (1 trip)	11	18	10	0.56
PTT (2-5 trips)	7	13	4	0.31
TDR (1 trip)	12	21	11	0.52

Table 5: Foraging trip duration in relation to diet for birds carrying packages and those without. Trip durations of stomach-flushed birds divided into two categories on the basis of diet: those with *E. superba* are presumed to have travelled to the continental shelf edge (110 km distant), while those with amphipods and/or fish are presumed to have foraged locally (within 30 km). The locations of capture of juvenile *E. superba* are unknown; thus the figures marked with an asterisk have not been included in computations of means or standard deviations, or used in statistical tests.

	Diet of *E. superba* (continental shelf edge trip)			Diet of Amphipods/Fish ('local' trip)		
	No Instrument	TDR	PTT	No Instrument	TDR	PTT
Duration (hrs)	83	108	78	32	36	22
	83	85	71	25	19	19
	67	69	65	17	17	17
	67	29*	52	16	13	17
	61		44*	14	9	10
	59			11		
	54			11		
	52					
Mean	66	87	67	18	19	17
SD	11.91	19.60	11.03	7.79	10.35	4.42

* Juvenile *E. superba*

behaviour and thus choose to make a shorter trip (to closer, though perhaps less plentiful, foraging grounds) than it otherwise would. Our data set is again too small to show whether or not such changes in behaviour occur.

Irritation is another effect of package attachment that may be significant in increasing foraging trip duration, especially during the incubation period when birds spend a percentage of their time resting on ice floes. We have noticed that some birds preen vigorously around the edges of their attached instruments prior to going to sea or upon their return to the colony. Feather damage apparent around the devices at removal indicates that some individuals spend a significant amount of time attempting to remove their burdens, perhaps at the expense of foraging.

CONCLUSIONS

The value of longterm monitoring in the study of population dynamics must be weighed against the costs to individuals and colonies and the effects of the methods themselves on the interpretation of data. Both satellite tracking and stomach lavage have the potential to cause injury to individuals but still provide valuable data, especially when the former is carried out over

short periods and the latter only once per bird. Mortality can be minimised by judicious selection of subjects and care in handling of birds. Automation of data collection where possible will also reduce the impact of human presence on colonies.

It is clear that care must be taken when interpreting data collected using intrusive techniques, especially when the information is required for part of a longterm monitoring study such as that set up by CCAMLR. In particular, analyses of demographic studies involving banding of penguins (CEMP Method A4) and studies of foraging duration using externally attached devices (CEMP Method A5) should take into consideration the potential adverse effects of the techniques used. Steps should be taken to minimise these by considering alternative procedures to flipper banding (e.g., implanted tags) and by streamlining packages as much as possible. Stomach lavage (CEMP Method A8) of birds with chicks appears not to affect reproductive success when carried out only once per nest. However, care must be taken to minimise stress and damage to individual birds. Further research into the effects of CEMP procedures on penguins and other species is recommended, both to minimise disturbance to these wild populations and to achieve greater confidence in the sensitivity of such monitoring techniques.

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Légendes des tableaux

Tableau 1: Taux de retour des oiseaux bagués ou marqués. Taux de retour annuels (nombre et pourcentage) des oiseaux porteurs de bagues uniquement, de marques uniquement, et à la fois de bagues et de marques entre les saisons de reproduction 1990/91 et 1991/92 et entre 1991/92 et 1992/93.

Tableau 2: Jeunes émancipés dont un parent a subi un lavage d'estomac. Nombre de jeunes émancipés par nid dont un adulte a subi un seul lavage d'estomac, par comparaison avec les nids contrôlés et avec toute la colonie.

Tableau 3: Durée de la première sortie alimentaire des mâles et des femelles pendant la période d'incubation. Durée de toutes les sorties alimentaires de 11 oiseaux porteurs d'instruments sur deux saisons par comparaison avec les valeurs moyennes de la colonie par sexe. Indication de l'incidence d'échec des nids.

Tableau 4: Jeunes émancipés dont un parent est porteur d'instruments. Jeunes émancipés en fonction des poussins éclos par nid de manchots porteurs d'instruments pour une seule, et pour plusieurs sorties alimentaires par comparaison avec le reste de la colonie.

Tableau 5: Durée des sorties d'approvisionnement en fonction du régime alimentaire des oiseaux porteurs d'instruments et des oiseaux qui n'en portent pas. Durée des sorties des oiseaux ayant subi un lavage d'estomac, en deux catégories basées sur le régime alimentaire : ceux ayant ingurgité *E. superba*, dont il est présumé qu'ils ont atteint le rebord du plateau continental (distant de 110 km), et ceux ayant ingurgité des amphipodes et/ou des poissons, dont il est présumé qu'ils se sont approvisionnés localement (dans un rayon de 30 km). L'emplacement de la capture de juvéniles d'*E. superba* est inconnu; de ce fait, les chiffres marqués d'un astérisque n'ont été pris en considération ni dans les calculs de moyenne ou d'écart-type ni dans les tests statistiques.

Список таблиц

Таблица 1: Процентная доля возвращения окольцованных и/или помеченных птиц. Ежегодные величины возвращения (в целых числах и в процентах) для птиц, носивших только кольца, только метки, и как кольца, так и метки в период между 1990/91-1991/92 и 1991/92-1992/93 сезонами размножения.

Таблица 2: Оперившиеся птенцы птиц, подвергнутых промыванию желудка. Количество оперившихся птенцов на гнездо, в котором одна взрослая птица была подвергнута промыванию желудка один раз по сравнению с контрольными гнездами и всей колонией.

Таблица 3: Продолжительность первого похода за пищей самки и самца во время периода инкубации. Продолжительность отдельных походов 11 птиц, оснащенных приборами в течение двух сезонов, по сравнению со средними значениями в одной колонии для каждого пола. Указаны случаи неудачных кладок.

Таблица 4: Птенцы, оперившиеся у птиц, носивших приборы. Оперившиеся птенцы как функция птенцов, вылупившихся на гнездо пингвинов, носивших приборы в течение одного или нескольких походов за пищей по сравнению с остальной частью колонии.

Таблица 5: Продолжительность походов за пищей относительно рациона птиц, носивших и не носивших приборы. Продолжительность походов за пищей у птиц, подвергнутых промыванию желудка, подразделенных на две категории на основании рациона: предполагается, что птицы, в рационе которых зарегистрирован вид *E. superba*, путешествовали до края

континентального шельфа (на отдалении 110 км), тогда как птицы, имевшие в желудке амфиподы и/или рыбу, кормились поблизости (в пределах 30 км). Местонахождение добычи молоди *E. superba* неизвестно; таким образом значения, отмеченные звездочкой, не были включены в расчеты средних значений или стандартных отклонений, или использованы в статистических исследованиях.

Lista de las tablas

Tabla 1: Indices de regreso de las aves con bandas y/o marcas. Indices de regreso anuales (en cifras y porcentaje) para las aves con bandas solamente, con marcas solamente, y con marcas y anillos, para las temporadas de reproducción entre 1990/91 y 1991/92 y entre 1991/92 y 1992/93.

Tabla 2: Polluelos de las aves sometidas al lavado estomacal que alcanzaron el emplumaje. Números de polluelos que alcanzaron el emplumaje por nido en donde un adulto fuera sometido al lavado estomacal en una sola ocasión, comparados con los nidos de control y con la colonia completa.

Tabla 3: Duración del primer viaje de alimentación de la hembra y del macho durante el período de incubación. Duración de los viajes individuales de 11 aves con instrumentos durante dos temporadas, comparados con la media de la colonia para cada sexo. Se indica la frecuencia del fracaso del nido.

Tabla 4: Polluelos emplumados de las aves con instrumentos. Número de polluelos que empluman en función del número de polluelos nacidos en nidos donde los pingüinos llevan instrumentos para uno o más viajes de alimentación, comparados con el resto de la colonia.

Tabla 5: Duración de los viajes de alimentación en relación a la dieta de los pingüinos con y sin instrumentación. Duración de los viajes de alimentación de las aves sometidas al lavado estomacal divididos en dos categorías en base a la dieta: se supone que aquellas con *E. superba* han viajado hasta el borde de la plataforma continental (una distancia de 110 km), mientras que aquellas con anfípodos y/o peces se han alimentado en zonas locales (dentro de 30 km). Se desconoce la ubicación de la captura de *E. superba* juveniles, por consiguiente, las cifras con asterisco no se han incluido en los cálculos de la media o desviación típica, ni se han utilizado en pruebas estadísticas.