



Fifth International Penguin Conference

**Ushuaia, Tierra del Fuego, Argentina
6 – 10 September 2004**

Abstracts Book

*Edited by
Pablo Yorio
Flavio Quintana
Adrián Schiavini*

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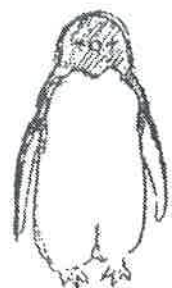
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THOMAS HATBERN

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Edited by
Pablo Yorio
Flavio Quintana
Adrián Schiavini

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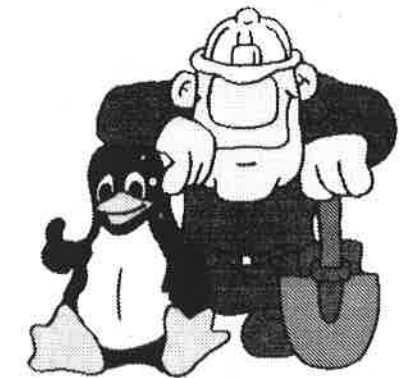
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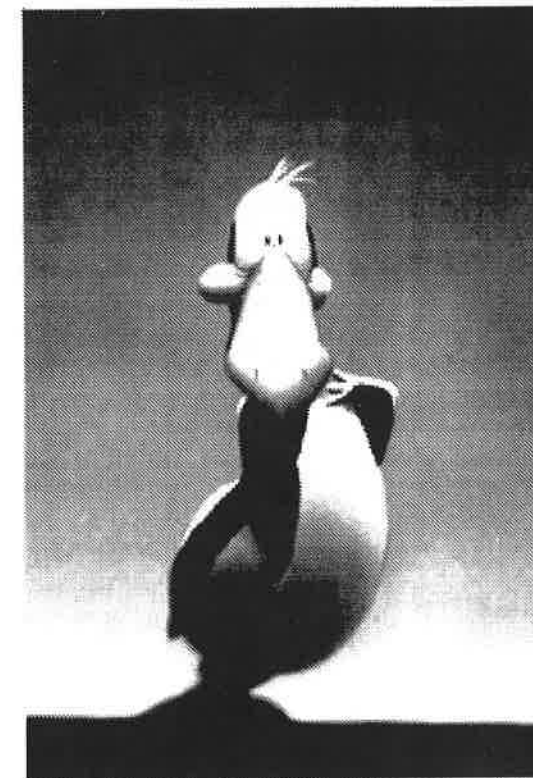
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ORAL PRESENTATIONS

HUMBOLDT PENGUIN *SPHENISCUS HUMBOLDTI* POPULATION IN CHILE: COUNTS OF MOULTING BIRDS, 1999-2004

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Regular counts of moulting Humboldt penguins *Spheniscus humboldti* have been made along the Chilean coast from Iquique (20°07'S) to Algarrobo (33°21'S), roughly 1800 km of coast, covering the main range and colonies of this species of penguin. The counts were conducted during February, when most penguins were ashore moulting, as recommended by the Population and Habitat Viability Assessment Workshop held in Olmue, Chile in 1998. From 1999 to 2004 counts were made at 29 to 31 localities, including colonies and roosting sites, and the estimated number of adult birds fluctuated from 25,490 to 34,321. Greatest numbers of moulting Humboldt penguin are concentrated on Chañaral (48%), Pan de Azúcar, Grande, Pájaros, Choros and Cachagua Islands and the former Pájaro Niño islet (Algarrobo). This research was done with the financial assistance of the Milwaukee County Zoo, the Zoological Society of Milwaukee, the Penguin TAG, the Humboldt Penguin SSP and Penguin Conference Japan for which we are grateful.

ENERGETIC COST OF CHICK PROVISIONING FOR ADÉLIE PENGUINS ON ROSS ISLAND, ANTARCTICA: FURTHER EVIDENCE FOR INTRASPECIFIC COMPETITION AND TOP-DOWN FORCING

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We studied the energetic cost of foraging trips for 40 Adélie Penguins (*Pygoscelis adeliae*) at Capes Bird and Crozier on Ross Island, Ross Sea, Antarctica, during the breeding seasons of 2000 and 2002. We used doubly labeled water to measure CO₂ production, and radio transmitters to precisely measure foraging trip duration. Foraging trips ranged from 0.8 to 6.7 days, with a mean of 2.7 ± 0.22 days. All but 6 birds gained mass during these trips, with a mean mass change of +424.0 ± 70.4 g per trip. Metabolic rate during these trips ranged from 2129 to 8581 kJ/day, with a mean of 5306 ± 201 kJ/day, and was significantly dependent on mass gain during the trip, the greater the mass gain, the higher the metabolic rate. Diet, colony, and trip duration did not significantly affect metabolic rate. Total energy expended during a trip ranged from 2195 to 38,063 kJ, with a mean of 14,774 ± 1392 kJ, and was significantly affected by diet, colony, and trip duration, but not by mass change during the trip. Several decades of research confirm that penguins at Cape Crozier may experience intraspecific competition as the breeding season progresses. Specifically, they switch prey from krill to silverfish, foraging distance and time away from the colony and depth of foraging dives increase, food loads decrease, and penguins from smaller colonies are excluded from foraging areas used by Crozier birds. Our results here, that total energy expended during a trip is dependent upon trip duration, imply that penguins breeding at Cape Crozier expend more energy to provision their chicks than penguins at other colonies on Ross Island. We believe this adds to the increasing evidence that intraspecific competition is a significant factor at large colonies, and that top-down forcing by predators causes changes in this ecosystem.

THREE-DIMENSIONAL FORAGING EFFORT OF BREEDING ADÉLIE PENGUINS IN RELATION TO SEX, COLONY, SEASON, AND TIME WITHIN SEASON

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Foraging locations and diving behavior of Adélie penguins (*Pygoscelis adeliae*) provisioning chicks were recorded at three Ross Island colonies ranging in population size by three orders of magnitude, 2000-2001 to 2003-2004. Foraging locations, determined using satellite transmitters, varied between and within season, and among colonies, but no consistent differences were apparent between males and females. Maximum distances to foraging locations of 51 individuals ranged from 1 - 156 km, with a mean of 44 km. Foraging trip distance was greatest and tended to increase as the season progressed at Cape Crozier, the largest colony, but not at the smaller colonies, Cape Bird and Cape Royds. Depths of foraging dives ranged from 6 - 138 m and durations ranged from 30 - 235 s. Diving behavior varied significantly with colony, breeding season, time within season, sex, individual, and light level, though colony differences were the most important. Dive duration and depth increased within seasons, especially at Cape Crozier. Results suggest that competition for food in some colony-seasons decreases food availability near colonies.

COPHYLOGENETIC RELATIONSHIPS OF PENGUINS AND THEIR CHEWING LICE

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Fahrenholz's rule suggests that parasites with few means of transferring between hosts should speciate in response to their hosts speciating and thus the phylogeny of the parasites should mirror the phylogeny of the hosts. Chewing lice are small, obligate ecto-parasites of birds and mammals living in the plumage or fur of their hosts. Lice are thought to have few means of transferring between host species as lice rely on close contacts that occur during mating or the brooding of chicks to transfer between hosts. Thus lice and their hosts should show a high degree of cospeciation, i.e. the speciation of the hosts causes speciation of the parasites, because of the close links between lice and their hosts. The chewing lice of gophers are a "textbook" example of almost perfect host-parasite cospeciation. We reconciled a phylogeny derived from the third domain of the mitochondrial 12S ribosomal rRNA and the mitochondrial cytochrome oxidase subunit 1 gene regions for 14 of the 15 species of chewing lice parasitising penguins to a penguin phylogeny estimated from four gene regions. We did not find perfect cospeciation. Genetic distances were used to evaluate support for the various cophylogenetic scenarios postulated from the analysis and suggested the most likely scenario is that there have been five cospeciation events, eight duplication events, 18 sorting events and four incomplete host switches in the louse lineage. The analysis was complicated by some louse species parasitising several species of penguins and the distribution of some of the multi-host louse species is possibly due to failure to speciate (parasites not speciating in response to their hosts speciating).

AN UNEXPECTED PATTERN OF MOLECULAR DIVERGENCE WITHIN THE LITTLE BLUE PENGUIN (*EUDYPTULA MINOR*) COMPLEX

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The taxonomy of *Eudyptula* penguins has been subjected to extensive revision. In 1976 the blue penguin, *E. minor* and the white-flipped penguin, *E. albosignata* were reclassified as a single species with six subspecies based on a morphometric analysis. Despite the later deletion of the *Eudyptula* subspecies, following allozyme analysis of some populations, the subspecies classification has persisted in some popular and scientific literature. Many also still believe the white-flipped penguin to be a distinct species. The taxonomy of *Eudyptula* penguins is not just of academic interest as numbers of the white-flipped form of *Eudyptula* breeding around Banks Peninsula, New Zealand have declined dramatically, likely due to human impacts. We used the sequences of three mitochondrial gene regions (small ribosomal subunit, cytochrome b and the control region) from the six hypothesised subspecies to examine relationships within *Eudyptula*. We found evidence of two unexpected clades: the first consisting of Otago, New Zealand and Australian populations, the second consisting of Northern, Cook Strait, Chatham Island and Banks Peninsula, New Zealand populations. We found little evidence that the white-flipped penguin was genetically distinct and we also found little support for the subspecies classification of *E. minor*.

IMPACT OF THE TREASURE SPILL ON SURVIVAL AND BREEDING OF AFRICAN PENGUINS AT ROBBERN ISLAND

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Following the "Treasure" oil spill in 2000 around 18,000 adult African penguins (*Spheniscus demersus*) were oiled, caught, transported to rehabilitation centres, rehabilitated, cleaned, and released back into the wild. Since that time we have invested a lot of effort into resightings of these birds. Most of this effort has been concentrated on Robben Island and much of the work carried out by Earthwatch volunteers. Overall about 50,000 resightings of Treasure birds have been reported. Over 11,000 individual birds have been seen at least once since their release on one of the offshore islands. We are still continuing to see "new" birds; in 2003 over 800 birds were seen for the first time and in the first few months of 2004 a further 150 were found. We can use these data to estimate annual survival rates for these birds. For example, the survival rate for the banded, oiled adults on Robben Island is estimated to be 91% which compares well with previous estimates: 88-96% at St Croix Is from 1976/77-1981/82; 69% at Dyer Is during 1979-85 (during a period of rapid colony decrease); 82-89% at Robben Is in 1993/94, (but only 75% in 1994/95, when ca 1000 birds died after being oiled in the Apollo Sea spill). Over 1,000 birds involved in the spill were juveniles; by following relative resightings of these birds we are able to look at the survival rate of birds of a known age. We present data that indicate that oiled birds breeding on Robben Island have poorer breeding success than un-oiled birds. At the time of the spill it was predicted that reduced breeding success might result from the extensive disruption of breeding pairs that was caused by the spill. If inexperience with breeding partners (rather than some long-term physiological impairment) is the reason for the reduced breeding success, we would expect breeding success of the oiled birds to improve year on year. This is being monitored.

DIFFERENCES IN BREEDING SUCCESS OF AFRICAN PENGUINS DEPENDING ON TYPES OF FLIPPER BANDS USED

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We have over the last four years been testing a range of designs of flipper bands made from silicone rubbers on African Penguins (*Spheniscus demersus*) on Robben Island. Each season we have studied three groups each of about 20 nests: one group had pairs of birds with no bands, the second group had birds with conventional steel bands and the third group pairs of birds with the new rubber bands. In each year we found that there was little significant difference in the breeding success of the three groups. In the first two years, we found that pairs with no bands had significantly lower breeding success. It may be that these birds were younger and less experienced breeders than those banded with metal bands. However, a large proportion of the birds on Robben Island in 2001 and 2002 had been banded in 2000 following the Treasure oil spill. We conclude that, if breeding success is used as a measure of the damage caused to African penguins by the wearing of flipper bands, then neither the currently used steel bands, nor any of the new rubber designs have been harmful during the 2001 to 2003 seasons.

THE MATING CONCERTO IN *E. MINOR*: SOCIAL AND GENETIC PATERNITY IN LITTLE PENGUINS

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The Little Penguin *Eudyptula minor* is a socially monogamous marine animal which breeds in loose colonies. Males dig, furnish and defend a nesting burrow in order to attract females for mating and breeding. Although Little Penguins form long-term pair bonds and co-operate in parental care, mate-switching occurs and extra pair copulations have been observed. Extra-pair fertilizations are common in other socially monogamous birds but have not been reported among Little Penguins. This study is designed to investigate the genetic reproductive success of male and female Little Penguins at a colony on Phillip Island in south-eastern Australia. Using a combination of microsatellite molecular markers, electronic and audio-visual monitoring and field experiments we are investigating the breeding ecology of over 100 pairs of Little Penguins. We describe paternity and reproductive success and report on several aspects of mating behaviour including mate-choice, copulation frequency and male attendance from the 2003-04 breeding season.

FORAGING RANGES AND MIGRATION ROUTES IN SOUTHERN HEMISPHERE ALBATROSSES; TOWARDS MPA'S FOR PELAGIC SEABIRDS

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Albatrosses are the bird family most threatened with extinction, with 19 of the 21 species now globally threatened and the remainder near-threatened. Their extensive foraging and migration in the marine environment places them at risk from fisheries interactions, particularly the longline fishing industry which kills many thousands of birds annually. The need for a network of Marine Protected Areas, particularly in the High Seas where many albatross species congregate, has been urgently identified by the IUCN. Until now, attempts to identify the at-sea distribution of threatened seabird species have been derived from distribution maps in field guides and regional handbooks. However, in terms of remote-tracking to reveal their at-sea distributions albatrosses are the most studied of all marine species. With this in mind, BirdLife International invited all holders of remote-tracking data for albatrosses and petrels to a Global Procellariiform Tracking Workshop, with the aim of identifying important foraging and migration areas for albatrosses and petrels. Although scientists have been tracking seabirds since 1990, to a large extent these studies have been taxonomically and geographically restricted. The development of a central database to integrate these studies will allow for the identification of key foraging areas and migration routes on regional, global and seasonal scales. Here we describe the interim results of the workshop. These illustrate how at-sea distribution data from remote-tracking studies of seabirds can contribute to the development of criteria for defining Important Bird Areas in the marine environment and current initiatives for the establishment of high seas Marine Protected Areas.

FLIPPER BANDING MAGELLANIC PENGUINS: DO BANDS REDUCE SURVIVAL?

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Researchers remain concerned over damage caused by bands. Many Antarctic penguins have died because of improper bands. We double banded 150 pairs of breeding Magellanic Penguins in October and November 1993 (during egg laying or early incubation) using one of three types of individually numbered identification. Individuals were double marked with either a band on each flipper or two mouse ear tags in the outer web of the left foot. Fifty pairs were double banded with Monel bands made by Gey Band and Tag Company, which are commonly used to band Antarctic penguins (Antarctic); 50 pairs with stainless steel bands made to researcher specifications by Lambourne (Stainless); and 50 pairs with Monel 1005-3 mouse ear tags (1cm long and 2mm wide) made by National Band and Tag Company (Webtag). Nests of banded birds were individually and permanently marked, and were within a 50 square meter area to facilitate thorough searching. Two to six people searched in and around the area for marked birds four to five times each year between October 1993 and February 2004. By January 1994, several of the Antarctic bands were 1mm open, or turned around on the flipper. In October 1995, we removed all Antarctic bands found: more bands were open or turned around on the flipper, and we found eight Antarctic banded penguins dead, some in their nests. In one case the Antarctic band had pierced the flipper. We found no penguins with Antarctic bands after 1995. In contrast, Stainless bands had not opened, turned around, or been lost. One penguin lost an improperly attached Webtag during the study. Clearly, all bands are not equal. In the 2003-2004 season we checked the area 4 times between October and February and found 13 penguins with double Stainless bands (9 males and 4 females), and 18 double Webtagged penguins (9 males and 9 females). After ten years, double Stainless banded breeding penguins had a 13% survival rate and double Webtagged breeding penguins 18%, which was not significantly different (chi-square = 0.49, P = 0.48).

THE AFRICAN PENGUIN: A RECIPE FOR PRODUCING FLEDGLINGS?

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One prevalent idea in avian ecology is that parental energy expenditure is substantially elevated during the breeding season so that reproductive success may be limited by the maximal daily energy that parents are able to expend whilst finding food for both themselves and their young. For seabirds this may especially be true because breeding and foraging areas are spatially separated and food abundance in pelagic habitats is low compared to most terrestrial habitats. The globally vulnerable African penguin (*Spheniscus demersus*) inhabits inshore marine waters and feeds mainly on pelagic fish such as Sardines (*Sardinops sagax*) and Anchovy (*Engraulis japonicus capensis*). These stocks are distributed over a narrow zone along the southern African coastline characterised by an intensive upwelling of deep nutrient-rich cold water: the Benguela ecosystem. The location and intensity of upwelling vary locally within and between years, which is likely to affect the birds' foraging costs and success and thereby breeding productivity. In this study we quantitatively establish such a link between the Benguela productivity and penguin reproductive success. The breeding colony of African penguins at Robben Island (33°49'S, 18°22'E) was studied between March and August 2004. Because parental budgets are intimately bound up with the energetic requirements of their growing young, chicks were followed from hatching to fledging at 5-day intervals to construct growth curves. Simultaneously satellite imagery measured sea surface temperature and phytoplankton density as a proxy for food availability and therefore parental feeding conditions. These data were then used to understand daily patterns in chick instantaneous growth rate and the number of fledglings produced. For a subset of chicks, daily energy expenditure (DEE) was measured using the doubly labelled water method and resting metabolic rate (RMR) was determined using a flow respirometer. Comparisons of DEE and RMR give insight in the energy chicks spend on thermoregulation and activity and can be used to calculate their metabolic scope. The obtained values are compared with those of other penguin species at other locations to study latitudinal gradients.

CAN PENGUINS WALK A STRAIGHT LINE?

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We followed 105 Magellanic penguins (*Spheniscus magellanicus*) at Punta Tombo, Argentina as they returned to their nests recording their GPS positions along the route, distance walked, total walking time, sex, and nest contents. Penguin routes are highly directional. We measured straightness by plotting the 4 or more GPS coordinates in decimal degrees on an XY graph for each penguin and used the r value to determine straightness (average r for all areas is 0.980, n= 82, routes with more than 4 coordinates used). Routes with more obstacles such as large bushes or rough topography had a smaller r values than routes without obstacles, though not statistically significant (Door 2 r = 0.977, Door 5 r = 0.979, Factura r = 0.982, ANOVA: F = 1.39, df = 2 and 74, F_α = 0.05 crit = 3.12). In areas with obstacles (e.g. large, dense bushes) penguins take longer to arrive at their nest than in unobstructed areas. Penguins passing through the area with the most obstacles, had a significantly slower average speed of 0.247 m/s, and than penguin that walked through two areas that had small bushes (average speed of

0.318 and 0.327 m/s, respectively), (ANOVA: $F = 10.86$, $df = 2$ and 74 , $p \ll 0.0001$). One path or a "highway" that penguins use to enter the colony enters a parking lot in the reserve and splits into two trails that penguins follow to travel inland. Penguins that use the trail and opening among the bushes end up in the same areas suggesting penguin pick routes that take them directly to their nesting areas. The penguin's speed of travel and the straightness of the route they took was similar regardless of their sex, the air temperature, or whether they had chicks.

AUTOMATIC RECOGNITION OF AFRICAN PENGUINS (*SPHENISCUS DEMERSUS*)

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At present when researchers want to identify individual penguins they use either flipper bands or in some cases transponders. In general, transponders are less useful as the bird carrying a transponder has to pass close enough to a reader before its presence can be noted. Flipper bands while much more visible are, possibly, harmful to the birds (the extent to which flipper bands harm penguins is still open to question, but it is widely believed there are at least some detrimental effects of wearing such bands). We have noted that all African penguins carry a pattern of black spots on their chests that do not change from season to season. Further, as far as we can tell no two penguins have exactly the same pattern. Indeed many zoos use the unique spot pattern as a means of identifying the individuals in their collections. Photographs taken at a particular nest site the Boulders colony in most years since 1997 show a bird with the same (unusual) plumage was present in each year. The pattern of spots is identical in each photograph. We have developed a computer system that can, from a digital image containing an African penguin that shows its chest, first find the penguin and distinguish it from the background, then find the chest and correcting for posture, map the pattern of spots. Once the unique data on the spot locations is stored, the computer can recognize the same bird from another image. The system is fully automated. We are using this penguin recognition system to develop a fully automated system that will be able to catalogue, identify and monitor individual African penguins using digital cameras strategically placed near routes to and from the sea, etc. If the system is fully used we estimate we should be able to automatically identify and record the movements of up to 100,000 individual African penguins and obviate the need for any further banding of this species.

APPROACHING CONSERVATION AT THE ECOSYSTEM LEVEL: THE CASE OF THE PATAGONIAN SEASCAPE

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The SW Atlantic Patagonian Seascape (PS; Patagonian Shelf Large Marine Ecosystem and shelf break areas) encompasses about 2,000,000 km² of temperate ocean. The system contains the Southern Hemisphere's largest shelf and is sustained by major ocean fronts such as the Falklands-Malvinas and Brazil currents and confluence. These waters supports charismatic top predators: Magellanic, rockhopper, gentoo, and king penguins, wandering, black-browed and royal albatrosses, southern right whales, elephant seals, sea lions and fur seals. The relevance of the system extends beyond residents to seasonal migrants coming from Antarctica, South Georgia, Gough, Tristan da Cunha and Diego Ramirez Islands and even New Zealand. From a conservation perspective, the breeding and feeding aggregations of some of these species constitute one of the greatest wildlife spectacles on Earth. The PS is exposed to unsustainable management and habitat degradation. Seabird bycatch in inshore gillnet fisheries and in offshore long-line and trawl fisheries is a major actual or potential contributor to regional

population declines, particular of penguins and albatrosses. Populations are declining. Maintaining ecological viability requires moving beyond single-species or taxon efforts towards an ecosystem approach to management that includes multiple jurisdictions, including international waters. A zoning strategy is urgently required, with priority-use zones and sectors under particularly precautionary management. Science must be at the foundation of the process. We report on an international cooperation effort to attempt to integrate data on top predators with oceanographic, jurisdictional and human-use information for the entire system. A Geographic Information System was created, containing over 170 data sets on the distribution and status of the regions habitats, resources and biodiversity. This has been used to develop a seascape species approach as a conceptual model for conservation planning. The vision is to use the data and approaches to define, in space and time, critical habitats, areas and processes as a basis for the development of a comprehensive system of environmental protection and sustainable management (e.g. including Marine Protected Areas, environmentally sensitive areas/special management zones etc), of the region's resources.

LITTLE PENGUINS AND LARGE BOATS: A STORY OF COEXISTENCE

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Within the last twenty years, a small colony of Little Penguins has established amongst a limestone retaining wall on Garden Island, Western Australia. This island is a base for the Royal Australian Navy and the colony is bordered on one edge by a wharf where large naval vessels dock. Cockburn Sound, a large embayment adjacent to the colony and through which the penguins must travel, is the busiest in Western Australia and one of the busiest in Australia. Apart from the naval vessels, it is extensively used by large ships associated with the eight major industries that have developed on the eastern shore such as an oil refinery, alumina refinery and fertilizer plant. Five commercial fishing industries operate within the Sound and it is also an important area for recreational use such as skiing, PWCs, recreational fishing and boating. From May 2001- Feb 2003 nest sites within the colony were studied weekly and night counts were conducted once a month. Various population parameters of the colony were assessed. Comparisons in annual cycle and breeding success were made between this colony and a representative group of the colony on Penguin Island, the largest one in Western Australia and less than 10 km south of Garden Island. The success of single clutches in the Garden Island colony averaged 78% over the three years, this was greater than that for Penguin Island. A higher proportion of penguins on Penguin Island only laid a single clutch. In 2003 41% of pairs successfully raised two clutches on Garden Island compared to less than 1% of the nestbox population on Penguin Island. At least two-thirds of the penguins arriving back at the Garden Island colony did so within 40 minutes after sunset. As Little Penguins are visual hunters, it is presumed that their arrival back at the colony soon after sunset indicated they were foraging close by. The ramifications of this will be discussed. Problems associated with studying such a cryptic colony as well as various management issues and recommendations for this colony will be discussed.

STABLE ISOTOPES OF CARBON AND NITROGEN AND THE TROPHIC ECOLOGY OF PENGUINS

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Stable isotope measurements of carbon ($^{13}C/^{12}C$, $\delta^{13}C$) and nitrogen ($^{15}N/^{14}N$, $\delta^{15}N$) in proteins have been used as dietary tracers in seabirds, and recent investigations also show that they have the potential for locating moulting areas of migratory species. $\delta^{13}C$ indicates inshore or benthic versus offshore or pelagic feeding preferences of predators, while $\delta^{15}N$ is an

indicator of trophic position of seabirds (^{15}N is preferentially incorporated into the tissues of the consumer from its diet, which results in a systematic enrichment in $\delta^{15}\text{N}$ with each trophic level). First, we determined diet-tissue discrimination factors of carbon and nitrogen in blood and feathers, which involve non-invasive sampling techniques, on three species of captive penguins feeding on known diets. Second, we investigated the effect of a long-term fast on $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in king penguin blood, because, as "professional" fasters, penguins are excellent models to study the effect of nutritional status of the animal on its tissue isotope ratios. Blood was progressively enriched in ^{15}N through the fast, which is in agreement with the hypothesis of birds "feeding on themselves" while in a situation of negative energy balance. Surprisingly, $\delta^{13}\text{C}$ was lower in the blood of fasting birds, suggesting that some carbon from the ^{13}C -depleted lipids had been incorporated in blood proteins. Finally, we tested the use of the isotopic method to gain information on resource partitioning and foraging areas within a guild of subantarctic diving animals. Blood samples, claws and food samples were collected from three species of penguins (kings, macaronis and rockhoppers) breeding in sympatry during summer at Crozet Islands. Preliminary analysis indicates that king penguins fed at a higher trophic level and further offshore than eudyptid penguins. The segregation operates not only in chicks (food analysis and blood stable isotopes), but also in adult penguins at different time-scales (short-term: blood isotopes; long-term: claw isotopes). To our knowledge, this study is one of the first to investigate the feeding ecology of adult penguins when they feed for themselves, not for their chicks, and its highlight the usefulness of stable isotopes to investigate the food and feeding ecology of seabirds, including penguins.

BREEDING PLASTICITY IN THE SMALLEST PENGUIN EUDYPTULA MINOR : ENVIRONMENTAL CONSTRAINS OR ADAPTIVE RESPONSE TO VARIATION IN FOOD SUPPLY

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Several studies on penguin foraging ecology debate whether variation in food delivered to chicks and adult foraging behaviour are a response to either an adaptive mechanism or to variations in food supply. We examined how little penguins adjust their foraging effort (= foraging trip duration), the duration of parental care and the amount of food delivered to their chicks (= meal mass) over five years of low and high breeding success. Continuous measurement of foraging trip duration was recorded using an automated penguin monitoring system (APMS, Australian Antarctic Division). Nests were checked and chicks weighed every 1-2 days during chick-rearing. Overall, chicks received 211 grams of food on average per day. Meal mass delivered to chicks varied according to chick age and between seasons. However, when chicks that fledged were analysed separately there was no seasonal difference in the meal mass. Parents made longer trips and consequently made fewer trips over the chick rearing stages in years of low breeding success. The duration of the foraging trip was twice as long in years of low breeding success than the year of highest breeding success. Parents on short trips brought 8% more food to their chicks than parents on long trips. The chick rearing period had the same duration for the five years (59 days). Within this period, however, the length of guard and post-guard stages were partitioned differently among years. The length of the guard stage was at least 25% longer and the post-guard stage up to 31% shorter in years of high breeding success, which resulted in heavier chicks (peak and fledging mass). Longer parental care during the guard stage may reduce the cost of chick temperature regulation at the early developmental stage allowing chicks to invest more energy into growth. Our results suggest that parental provisioning is an adaptive response to the individual needs of the growing chick since there was no difference in meal mass delivered to fledging chicks among years of low or high breeding success. However, little penguins do respond to seasonal variations by changing the duration of the parental care and the frequency and duration of foraging trips, probably to overcome changes in the food supply.

CALL DISCRIMINATION IN MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*)

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Vocalizations in Magellanic penguins (*Spheniscus magellanicus*) are a key component of mate selection, pair bonding, and parent-chick and agonistic interactions. Call discrimination is important in colonial nesting birds, and I predicted that Magellanic penguins should exhibit call discrimination. However, few studies have addressed the roles of vocalizations in the genus *Spheniscus* and on Magellanic penguins in particular, and the literature contains almost no experimental research on call discrimination in this genus. To test for the presence of call discrimination, I played previously recorded male display calls – used primarily by males for mate attraction – to incubating females using a computer running Syrinx software and a pre-amplified speaker placed approximately two meters from the subject's nest matched by ear to the loudness of the display call under natural conditions. These calls included randomized calls of a neighbor, a stranger, and the female's mate. All calls in each playback set were matched for length, clarity, and volume. After males relieved the females at the nest and assumed incubation duties, I played the same playback sequence to the males. To further explore call discrimination, I used a different call: the duet performed by breeding pairs. The pair duet is a bonding call, usually performed on reunion at the nest. I played randomized calls of a pair's own duet and that of a stranger pair to incubating males. I ranked individual responses to each playback using an ordinal scale of 0-7. Response categories included head orientation toward call source, response calls, movement toward call source, etc. I found that females discriminated between the display calls of mates versus strangers and mates versus neighbors, but not between calls of strangers and neighbors. Male discrimination response to display calls was weaker, but still significant. Male response to pair duets was strong, showing highly significant differences in response to their own duet versus a stranger pair's duet. The results of these playback experiments suggest that Magellanic penguins can discriminate between intraspecific individual calls.

CLIMATE, OILING AND TRENDS OF PENGUIN POPULATIONS IN SOUTH AFRICA AND AT THE PRINCE EDWARD ISLANDS

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Off western South Africa, numbers of African Penguins *Spheniscus demersus* increased from 1998 to 2002 (after a decrease that had persisted for about 70 years) and then decreased in 2003. The increases resulted from a high availability of food caused by exceptional recruitment of forage fish species after the ENSO event of 1997/98. The decrease in 2003 was most apparent at islands where large numbers of birds were oiled and breeding was severely disrupted in 2000, after the sinking of the *Treasure*. It is likely to have arisen from poor recruitment of first-time breeders to these penguin colonies in 2003. Four species of penguin breed at South Africa's subantarctic Prince Edward Islands: King Penguin *Aptenodytes patagonicus*, Gentoo Penguin *Pygoscelis papua*, Macaroni Penguin *Eudyptes chrysolophus* and Rockhopper Penguin *E. chrysocome*. There were large decreases in numbers of Gentoo and Rockhopper Penguins after 1995. Numbers of Macaroni Penguins probably also decreased. Reproductive success of these birds is thought to have been inadequate to maintain the populations and was probably influenced by a reduced availability of food close to the island where sea surface temperatures have increased. Other seabirds foraging close to the islands also decreased. Numbers of King Penguins, which forage far from the island, may have increased, perhaps as a result of an increased availability of myctophids.

FORAGING DECISIONS OF MACARONI PENGUINS AT SOUTH GEORGIA

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Macaroni penguins (*Eudyptes chrysolophus*) are an abundant predator around South Georgia; major colonies, such as the Bird Island colony, can contain up to 2.5 million pairs breeding each summer. Parents remain within the vicinity of the colony during the breeding season because of the pressure to protect and feed their growing chick. This is particularly the case during the guard stage, when the father guards the chick whilst the mother has the sole responsibility of providing it with regular meals. Antarctic krill (*Euphausia superba*) are the preferred prey-items during chick rearing and studies have shown that success at this stage is strongly dependent on the mother's ability to find them. A state dependent programming (SDP) model was created to examine the foraging decisions of the mother during the 23 days of the guard stage. The model was parameterised using available data on energetics and behaviour of macaroni penguins. Optimal foraging decisions were predicted under different scenarios of krill availability, reflecting their observed variability in space and time. Female macaroni penguins were predicted to travel to areas where the availability of krill was more reliable, even considering a relative increase in the energetic costs of travelling there. Within the context of South Georgia, this means that more females should head out to the shelf-break, where the krill are distributed in extensive, dispersed swarms that are easy to find, rather than remain in continental shelf waters, where krill swarms are relatively tight and hard to locate. These predictions agree with observations made with satellite tags and time depth recorders. The modelling approach has enabled predictions of how foraging in macaroni penguins may change under various scenarios of climate change, through impacts on krill abundance, the length of the productive season, and temperature. The approach has also highlighted areas where further targeted fieldwork may improve our understanding of penguin behaviour, such as the better parameterisation of chick growth rate.

POPULATION REGULATION IN LITTLE PENGUINS EUDYPTULA MINOR

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Although studies of seabirds have had a fundamental influence on development of theories of population regulation, the role and importance of potential factors regulating seabird populations remain unresolved. Here we examine the potential effects of the abundance and availability of breeding sites and food availability in the breeding season on populations of Little Penguins *Eudyptula minor* in south-eastern Australia. Correlations between population size on islands and available breeding area suggest that Little Penguins may be limited on smaller islands by area. On larger islands, nesting sites do not seem to be a limiting factor. Food supply is commonly thought to be a significant limiting factor regulating seabird populations but difficulty in measuring prey availability has meant that direct evidence is lacking. Little Penguins have very short foraging ranges and thus may be particularly likely to experience density-dependent food shortages when breeding. We found support for Ashmole's "halo effect" in that there was 1. an inverse relationship between colony size and mean mass of chicks near fledging; and 2. apparent depletion of prey within the daily foraging range of breeding penguins. However, more recent variations of this model (e.g. the "hungry horde", or "hinterland") do not explain the observed distribution and numbers of penguins breeding in Victoria. We conclude that intraspecific competition for both nesting sites and food during chick rearing may be involved in

the regulation of Little Penguin populations, and propose an elaboration of Ashmole's model in which the area available for nesting is combined with intraspecific competition for food during breeding as determinants of population size.

THE COURTSHIP AND INCUBATION BEHAVIOUR OF ERECT-CRESTED PENGUINS

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Erect-crested penguins (*Eudyptes sclateri*) are the least-studied of all penguins. Here we present the first detailed analysis of the breeding behaviour of these enigmatic penguins. All-occurrences sampling was used to record fighting, copulatory behaviours, egg-laying and egg loss in a study colony of 139 nests during the daylight hours from 29 September to 22 October. In addition, the behavioural states of birds in 19 nests in a sub-section of the colony were sampled using instantaneous scan sampling every 15 minutes over the same period. Measurements of adult penguins and their eggs confirmed a marked sexual dimorphism and an extreme egg-size dimorphism: characteristics that have been hypothesized as being associated with high levels of competition and fighting. However, contrary to the prevailing view of many crested penguins, erect-crested penguins do not exhibit high levels of fighting or competitive behaviours. While the behavioural repertoire of erect-crested penguins is similar to that of other penguins, frequencies of occurrence and activity budgets can be quite different. In part this probably reflects phylogenetic differences in breeding schedules but, in part, it is likely to reflect the differences that ecological factors play in determining life history strategies and, ultimately, behaviour.

HEART RATE RESPONSES OF INCUBATING AFRICAN PENGUINS TO PEDESTRIAN APPROACHES

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The behavioural responses of African Penguins (*Spheniscus demersus*) to humans have been variously described. Physiological responses to disturbance may, however, occur in the absence of overt behavioural indicators, providing valuable information regarding the sensitivity of wildlife to disturbance stimuli. Physiological changes in parameters such as heart rate have not yet been reported for African Penguins. As part of a broader study investigating the effects of ecotourism on this species, we measured heart rates of incubating birds in response to controlled pedestrian approaches. The study was restricted to incubating penguins with sheltered nest sites under *Tetragonia* shrubs on Dassen Island, Western Cape Province, South Africa. Real eggs were removed from nests and kept in an incubator for the duration of experiments. Artificial eggs containing FM transmitters were introduced into nests, and heart rates were recorded at a distance using FM receivers and dictaphones. Each nest was then approached twice by a single person on foot. An approach was terminated either when the approacher was first within sight of the breeding bird, or at five meters from the nest. Heart rates were monitored immediately following egg deployment, and before, during and after each approach. Nineteen penguins were approached. Heart rate increased significantly in response to being approached, with stronger responses recorded upon approach to 5 m than to the position in first sight of a bird. Heart rate increases were transitory, and heart rates dropped once the approacher retreated to a position out of sight of the birds. The heart rate responses of individual African Penguins were highly variable, suggesting that management of tourist visitation to breeding birds at Dassen Island should be precautionary.

EFFECT OF FLIPPER-BANDS ON THE FORAGING BEHAVIOR AND SURVIVAL OF ADÉLIE PENGUINS ON ROSS ISLANDKate Dugger¹, David G. Ainley², Grant Ballard³, Kerry J. Barton⁴¹ Oregon State University Department of Fisheries and Wildlife, 104 Nash Hall, Corvallis, Oregon 97331-3803 USA.² H.T. Harvey & Associates, 3150 Almaden Expressway, Suite 145, San Jose CA 95118 USA
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It has been proposed that penguins, banded on the flipper, exhibit significantly lower annual survivorship or incur higher energetic costs during at-sea travel than do unbanded individuals. We investigated these issues over a four-year period, austral summers 2000-01 to 2003-04, as part of a study of the ecology and breeding/foraging effort of Adélie Penguins (*Pygoscelis adeliae*) on Ross Island, Antarctica. We compared results between one group in which penguins were identified by a flipper band and an RFID tag and another group in which individuals were identified only by an RFID tag. The flipper bands were of the 'Boersma design,' which are more rounded than those used on Ross Island in studies during the 1960-70s. The RFID tags, approximately 1 x 14 mm in size, were injected under the skin of each penguin and were recorded remotely using a scanner. The latter was part of a system that also weighed each penguin whenever it arrived at or exited the study subcolony. In addition to comparing annual survivorship of these two groups, we also report on body mass changes, food load mass, and foraging trip duration of banded and un-banded penguins during the chick-provisioning period. If energetic costs of foraging are being affected by the bands, we would expect to see differences in the latter factors.

Return with similar weights but banded birds stay out longer → higher foraging effort?

LAI-D-BACK OR DISTRESSED? PENGUIN RESPONSES TO HUMAN DISTURBANCEUrsula Ellenberg¹, Philip Seddon¹, Thomas Mattern¹, Guillermo Luna-Jorquera², David Houston³, and Lloyd S. Davis¹¹ Zoology Department, University of Otago, PO Box 56, Dunedin, New Zealand.

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Penguins face ever increasing interest from humans, in the forms of tourism, research, and conservation management. Over the last two decades, there has been growing concern that human activity in the proximity of breeding sites may adversely affect penguin populations. But unlike the more overt human-induced impacts, such as habitat destruction and oil spills, the effects of human disturbance are less obvious and not easily assessed. Reviewing the literature, we consider the evidence for human disturbance induced impacts on penguins. Recent data obtained for Humboldt and Snares penguins will highlight two extremes in apparent stress response to human proximity. During 2001-2003 we studied the responses to human activity of Humboldt penguins in the Humboldt Penguin National Reserve (Chile), where the rapid development of wildlife-tourism has been largely uncontrolled. We found that variation in breeding success reflects the different disturbance regimes on the reserve's three islands. Heart rate telemetry experiments indicate that Humboldt penguins are extremely sensitive to the presence of humans; the average heart rate increase provoked by a person passing a nesting Humboldt penguin at a distance of 50m, is comparable to the maximum heart rate response observed in Gentoo, Adélie and Magellanic penguins when approached to 2-3m. In contrast, Snares penguins (Snares Islands, sub-Antarctic New Zealand) barely respond to human presence. Six weeks of intensive research during the 2003 breeding season, including handling of penguins and logger deployment had no measurable effect on breeding performance. Close proximity of humans caused no heart rate reaction in Snares penguins as long as the person stayed outside the colony. Even when researchers entered a colony during a direct experimental approach to within 2m, some penguins showed no significant heart rate change.

We consider some explanations for differential responses to human presence between penguin species, populations, and even individuals. A better understanding of the factors influencing the intensity of responses by penguins to human disturbance will provide a framework for assessment, and will be a basis for improved management of human activity in the proximity of penguin colonies.

A 9000-YEAR RECORD OF ADÉLIE PENGUIN OCCUPATION AND DIET IN THE WINDMILL ISLANDS, EAST ANTARCTICASteven D. Emslie¹ and Eric J. Woehler¹ Univ. of North Carolina, Dept. of Biological Sciences, Wilmington, NC 28403, USA.

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We investigated 17 abandoned penguin colonies in the Windmill Island, East Antarctica, in summer 2002-2003. Forty radiocarbon dates on penguin bone and eggshell from 13 of these sites indicate a continuous occupation by breeding penguins in this region for over 9000 years. Dietary remains from these sites include at least 23 taxa of cephalopods and teleost fish. Quantification of these remains indicate significant fluctuations in the relative abundance of two of the more common major prey taxa. The Antarctic silverfish (*Pleuragramma antarcticum*) was the most common teleost prey during all time periods represented by the ages of the sites, but preservational factors may explain a gradual decline in this species in increasingly older sites. The most common cephalopod in the sediments was the squid, *Psychroteuthis glacialis*, which occurred in low numbers in most sites except one (Site 75). An unusually large number of squid beaks preserved in this site, dating to approximately 5677-6089 B.P. (calibrated to calendar years before present), does not correlate with a decline in fish prey or to any known climatic events. The large number of abandoned colonies (>200) in the Windmill Islands may be due to population cycles in the past as well as low nest-site fidelity and movement by breeding penguins to new sites within this region.

MANAGEMENT PLAN FOR PUNTA TOMBO: A PARTICIPATORY EXPERIENCE TOWARDS THE CONSERVATION OF THE MAGELLANIC PENGUINPablo García Borboroglu^{1,2,3}, Alicia Tagliorette^{3,4,5}, Laura M. Reyes⁶ and Graham Harris^{2,3,4}¹ Consejo Nacional de Investigaciones Científicas y Técnicas CONICET. Centro Nacional Patagónico, Boul Brown s/nro. (9120) Puerto Madryn, Argentina.

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Punta Tombo (Chubut, Argentina) is home to the largest known Magellanic Penguin colony in the world, with approximately 150,000 pairs breeding over 310 ha. Currently, only half of the area of the colony is under legal protection. Since 1979, when the colony was declared Protected Area, tourist activity has increased annually from 5,000 to 60,000 visitors in 2003, with up to 1,400 visitors on peak days. Despite this strong increase in tourist visitation, no Management Plan has been installed to regulate activities and uses for Punta Tombo. In order to design a Management Plan for this area, a joint agreement was signed between the Chubut Tourism Secretary and the Project "Consolidation and Implementation of the Patagonian Coastal Zone Management Plan" (ARG/02/G31), developed by Fundación Patagonia Natural, UNDP and the Global Environmental Facility. There are 90 stakeholders involved in designing the Management Plan, representing more than 20 governmental, academic and private institutions, NGOs, international and national research associations and the landowner, who is a

crucial stakeholder. The process is organized in working groups (legal, environmental, socio-economic and cultural), with periodic meetings and general workshops. The first phase focused on finding background information and characterizing the area. Based on this, advantages and disadvantages for the effective management of the area were identified. The vision for Punta Tombo defined by consensus stated: "Punta Tombo is a protected area for the conservation of its natural and cultural resources, particularly its important Magellanic penguin population, aiming at ensuring benefits for present and future generations". According to IUCN management categories, category II has been proposed: Protected area managed mainly for ecosystem protection and recreation. The initial diagnosis highlighted the need to redesign the present protected area boundaries in order to incorporate a marine component and to enlarge the land sector. Zoning plans were prepared according to the provincial legal framework considering untouched, restricted, sustainable, buffer and rehabilitation zones. At present the management programs are under design. The strength of this Management Plan lies in its participatory approach, involving a great number of stakeholders, and the existence of more than 20 years of scientific research on Magellanic penguins. It should become the fundamental tool for the management and use of this area, assuring the conservation of this natural resource of global importance.

CHRONIC OIL POLLUTION PROBLEMS WITH MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*) ALONG THE ATLANTIC COAST OF SOUTH AMERICA

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In the Atlantic Ocean, Magellanic penguins migrate between Argentina and Brazil on routes that overlap with maritime traffic and petroleum development. We used the location and number of organizations dedicated to rehabilitate or survey oiled seabirds from Brazil to central Argentina to determine if petroleum pollution was a problem along the coast. We reviewed petroleum use in the area and used the concentration of rehabilitation-survey centers to suggest where petroleum pollution may be a problem. The northernmost limit where oiled penguins were found was Salvador (Brazil). From Salvador south to central Argentina there are 30 maritime main harbors (Brazil: 21, Uruguay: 1, Argentina: 8), 49 oil terminals (Brazil: 43, Uruguay: 1, Argentina: 5) and 17 offshore platforms (Brazil), out of 115 for the whole Brazilian coast. In the late 1990s, Brazilian oil production reached 1.6 million barrels per day (bbl/d), importing 600,000 bbl/d, mainly from Argentina and Venezuela. Argentina exported more than 800,000 bbl/d. Uruguay has no oil resources, importing 43,000 bbl/d. We found 25 organizations rehabilitating or surveying oiled seabirds, mainly Magellanic penguins, along 6500 Km of coastline. In Brazil, there are 14 organizations with most centers near the Rio de Janeiro-Santos coastal sector, the area with highest oil-related activities. Uruguay had two rehabilitation centers at Montevideo and one nearby Punta del Este, where the Uruguayan oil terminal is located. In Argentina, there are seven organizations. Few oiling activities are in the area where the rehabilitation centers are located (Buenos Aires Province) suggesting oil is either coming from sources related to other maritime activities or more likely that penguins are getting oiled to the south and by the time they migrate to northern Argentina and Brazil they are in poor condition and seek shore. The location of centers is likely a consequence of the higher human population. Marine pollution appears to be an important threat for seabirds along the Atlantic coast of South America as indicated by the 25 organizations and by the percentage of oiled penguins out of the total birds

rescued by three centers: Southern Brazil (1995-2003): 65,45% (358/547); Uruguay (2001-2002): 100% (245/245); Northern Argentina (1987-2003): 79,64% (1287/1616). To assess the magnitude of the problem cooperation among the centers in estimating species, number, age class and seasons when wildlife encounter petroleum pollution is needed.

REHABILITATION OF THREE PENGUIN SPECIES AT MAR DEL PLATA AQUARIUM FOUNDATION: A TEN YEARS CASUISTICAL REPORT

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The Rehabilitation Center, located in Mar del Plata, acts along 200 km of southern coastline of Buenos Aires Province. Since 1993 works on the rehabilitation of several penguin species, such as Magellanic penguin (*Spheniscus magellanicus*), Rockhopper penguin (*Eudyptes chrysocome*) and King penguin (*Aptenodytes patagonicus*). The aim of the present work is to analyze the reasons of arrival of such animals at the rehabilitation facility and its variations during a ten years study period (1993-2003). The amount of animals admitted (either carried by the people or recovered by center's staff) were 1578 *S. magellanicus*, 85 *E. chrysocome* y 21 *A. patagonicus*. Along the period of study the highest records of arrivals for *S. magellanicus* were during the month of May-June and July-August, in coincidence with the trophic migration of this species to the zone under surveillance. In the case of the other two species, the highest arrivals frequency were from July to September. Oil spills were the main arrival reason for *S. magellanicus* and *E. cretatus*, in the case of *A. patagonicus* it was only applicable for the year 2003. Additional arrival reasons were lesions, severe parasitosis, malnutrition and moult. A progressive increment in the number of arrived animals was noticed from 1993 to 1998. A significant decreasing amount of oiled birds was observed in 1999 and 2000, however the percentage of undernourished penguins increased in the same years. Rockhopper penguin entries increased in the years 2001 and 2003 (23 and 20 individuals respectively), being most of them oiled. Between 2002 and 2003 lower records of *S. magellanicus* were observed. Considering the results obtained we can assume that the great amount of undernourished animals recorded in 1999, might be related to a persisting effect of La Niña phenomenon, with a consequently lack of food availability. The presence of King Penguins in the summer season may be associated to these. It is important to notice that *E. cretatus* and *A. patagonica* were regularly present at the Buenos Aires Province coasts. From the obtained results it is possible to infer that penguins can be considered as good bio-indicators of marine ecosystem disturbances.

GENTOO PENGUIN BEHAVIOUR AND BREEDING SUCCESS IN AREAS OF HIGH AND LOW HUMAN ACTIVITY ON SUBANTARCTIC MACQUARIE ISLAND

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A key factor in determining wildlife responses to human activity is the degree to which animals have been previously exposed to human stimuli (Knight and Temple 1995). On subantarctic Macquarie Island (54°30'S 158°57'E), Gentoo penguins *Pygoscelis papua* breed in areas of low and high human activity, with the latter area characterised by an Australian Antarctic Program (AAP) station occupied year-round. Gentoo colonies located in areas of low human activity are only exposed to pedestrians, with visitation occurring as seldom as once during a breeding season. In contrast, Gentoo penguins breeding within AAP station boundaries are exposed to almost daily pedestrian activity plus regular vehicle operations. During the 2002 - 2003 austral summer we undertook a study investigating the behaviour and breeding success of Gentoo penguins in areas of high and low human activity. We used an experimental methodology to

determine behavioural responses of guarding Gentoo penguins exposed to pedestrian approaches, and an observational study to determine how much human activity contributed to the observed variation in breeding success of Gentoo penguins on Macquarie Island. Gentoo penguins breeding in areas of low human activity were found to have elevated behavioural responses to pedestrian visitation compared to Gentoo penguins breeding on station, and the breeding success of Gentoo penguins within AAP station boundaries was amongst the highest recorded on Macquarie Island for that season. Habituation, predator exclusion, and the relevance of findings for the management purposes are discussed.

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PREDATION BY THE LITTLE RAVEN *CORVUS MELLORI* ON THE NESTS OF LITTLE PENGUINS *EUDYPTULA MINOR* AT PHILLIP ISLAND, VICTORIA, AUSTRALIA

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This study investigated the breeding and feeding behaviour of the Little Raven *Corvus mellori* on the Summerland Peninsula, Phillip Island, Victoria, Australia, an area where it is the dominant corvid. The peninsula has a Little Penguin *Eudyptula minor* colony of about 13,000 breeding burrows. Little Ravens were observed destroying Little Penguin burrows and stealing eggs and chicks during the spring of 2000 and 2001. Previously the Little Raven had been thought to only consume eggs ejected from burrows by penguins. Field observations of Little Ravens were made at three sites from September to December 2003. Little Penguin burrow characteristics were investigated at three breeding sites to determine if they were correlated with predation rates. Little Raven's use of the Summerland Peninsula changed over the spring and summer period. These changes were related to food availability. Of the three sites studied in detail one was used mainly for feeding while and the other two for roosting. The amount of time Little Ravens spent foraging and on other activities such as roosting and preening did not vary throughout the study period. Of 389 Little Penguin burrows studied 79 were predated. The rate of predation varied from 17 to 21%. The shapes of burrows were categorized into five different types depending on their general character. Other characteristics investigated were length to back wall, width, entrance height and width, height of the burrow roof above the nest bowl, inner and outer roof vegetation and soil type. There were no statistical differences between predated and un-predated burrows for burrow shape or characteristic. The predation of Little Penguin burrows by Little Ravens will continue to be monitored.

BREEDING IN BINS: DO ARTIFICIAL BURROWS IMPROVE BREEDING SUCCESS OF AFRICAN PENGUINS (*SPHENISCUS DEMERSUS*) ON HALIFAX ISLAND, NAMIBIA?

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African penguins preferentially nest in burrows. After large-scale removal of guano from all of the penguin breeding islands in Namibia, penguins are generally forced to nest on the surface. This makes them vulnerable to disturbance and leaves eggs and small chicks susceptible to predation by Kelp gulls (*Larus dominicanus vetula*). In addition, nest contents of surface nests

are exposed to extreme weather conditions, such as flooding or excessive heat. Apart from a lack of food, the scarcity of quality nesting habitat is thought to be one of the main causes for the continued decline of the African penguin in Namibia. Halifax Island, Namibia, consists of a flat, sandy, central plain surrounded by rocky ridges and hills. Little guano is left on the island and burrowing potential is minimal. Several bushes growing along the ridges, scattered, isolated rocky overhangs and a few abandoned, disintegrating buildings on the island offer some protection for nesting penguins. Large numbers of Kelp gulls are present on the island, particularly during summer, when they breed on the island. During winter, hot, dry east winds from the desert occur frequently, causing temperatures to rise above 30°C. Rainstorms are uncommon. Penguins on Halifax Island breed throughout the year. Of the 550 breeding pairs, more than 85% breed on the surface, with the remainder breeding under bushes, boulders and in buildings. Between September 2001 and August 2002, 62 artificial burrows made from rubbish bin halves were set up on Halifax Island. Breeding success was compared for surface-, bush-, building-, and artificial burrow nests by monitoring them at weekly intervals. Preliminary results suggest that breeding success in artificial burrows was the highest and similar to that in bushes. Breeding success on surface colonies was higher than in buildings but lower than in artificial burrows or bushes. The success of artificial burrows appears to be design-dependent and site-specific. At breeding localities with characteristics similar to Halifax Island, these burrows could limit further decline of the species.

ANALYSIS OF SEQUENCE VARIATIONS OF THE MHC CLASSII GENE IN PENGUINS

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The MHC (the major histocompatibility complex) is known to have an important role in the immunity system of vertebrates and to display a highest degree of genetic polymorphism. By present, the human MHC was determined for the entire genomic sequence of 3.6 Mb. Furthermore, the MHCs in birds have been extensively studied, but the ocean birds including penguins have never been reported for MHC polymorphisms. We well understand that analysis of sequence variations of the penguins MHC is most important to clarify the evolutionary process of penguins so that the penguins may have evolved very uniquely from other birds. We have previously reported that several penguin species have a high degree of polymorphism on exon 2 of the MHC class II gene. In this study, we determined the complete sequences of exon 2 for application of MHC genetic polymorphism to molecular classification of species in this field. Here, we have focused on Humboldt penguins for which we could get enough sample number. We could determined the nucleotide sequences of 1.1 kb PCR products containing the exon 2, intron 2 and exon 3 segments of the DRB1 like gene. Two sets of primers were designed for amplification of each of complete exon 2 and 3 sequences from thus obtained 1.1kb sequence. These nucleotide sequences in exon 2 had at least 6 different alleles. Homology search showed 85% and 88% identity with DRB1 of *Gallus gallus* in exons 2 and 3. However, the intron 2 sequences appeared to be specific for penguin because low nucleotide identity could be observed when compared among other birds. Interestingly, unique nucleotide sequences specific for Humboldt penguins could be found, suggesting a possibility that each genera or species of penguins has acquired each specific sequence in the process of their evolution. These findings can be expected to be applied to other areas, such as subspecies discernment, and parentage test. Furthermore, species on the verge of extinction can be estimated to be keeping moderately polymorphisms. We are now planning to determine the exon 3 complete sequences and to analyze on exons 2 and 3 with different MHC haplotypes.

FISHERIES, LARGE AND SMALL AND THEIR POTENTIAL IMPACT ON HUMBOLDT PENGUINS IN PERU

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Peruvian Humboldt penguin (*Spheniscus humboldti*) populations in Peru are presently largely restricted south of 13°S, to a few selected sites along the southern coast of Peru. There are also a few hundred individuals in northern Peru but not much is known about these northern colonies. Relating the limited available information on Humboldt penguin (HP) distribution to more detailed information available for the large scale industrial and artisanal fisheries off Peru, here we try to identify potential refuges and conflict areas. Because the largest fishing effort focuses on small pelagic fish (the penguins' preferred prey) and deploys many very large curtain nets in areas likely to overlap penguin foraging areas, the potential for conflict between penguins and fisheries in Peru is great. Fortunately, the largest industrial fishing fleet and the largest number of artisanal fishermen are found north of 13°S. In Southern Peru, particularly around Punta San Juan where most HPs breed, fishing activities are relatively low. Further south, close to the border with Chile, recent border conflicts have led to an increase in industrial fishing effort and to new legislation allowing industrial scale fishing closer to shore (linked to competition for transboundary distributed resources). Luckily only around 200 HPs are found in this conflict area. However, if El Niño events or global climate changes induce individuals from more northerly locations to move south, they would then become exposed to greater risks than those to which they are now exposed at their present locations. A further cause of concern is the development of a new type of semi-legal fishery targeting small pelagic fish very close to shore areas. This type of fishery is rapidly expanding and invading areas traditionally used by the small scale artisanal fishery and penguins. Presently most of this fleet is still in northern Peru and just beginning to operate towards the south. Future research and conservation efforts should focus on evaluating penguin use of marine areas, changes in these patterns and colony displacements linked to warm events and how all these relate to fisheries use of space and resources.

DIFFERENCES IN EGG SIZE, SHELL THICKNESS, PORE DENSITY, PORE DIAMETER AND WATER VAPOUR CONDUCTANCE BETWEEN FIRST AND SECOND EGGS OF SNARES PENGUINS (*EUDYPTES ROBUSTUS*) AND THEIR INFLUENCE ON HATCHING ASYNCHRONY

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Brood reduction in birds is frequently induced by hatching asynchrony. Crested penguins (genus *Eudyptes*) are obligate brood reducers, but in contrast to most other birds, first-laid eggs are considerably smaller in size than second-laid eggs and, additionally, first-laid eggs hatch after their siblings. The mechanisms underlying this reversal in size and hatching order remain unclear. In this study, we tested whether second-laid eggs in Snares Penguins (*Eudyptes robustus*) have a higher eggshell porosity allowing them to maintain a higher metabolism throughout incubation and to hatch before their first-laid siblings. We investigated differences in egg size, shell thickness, pore density, pore diameter and water vapour conductance between first and second eggs within clutches and examined the influence of these shell characteristics on hatching asynchrony. First-laid eggs of Snares Penguins were approximately 78% of the size of the larger second eggs. Second-laid eggs had considerably thicker eggshells and more pores per cm² than first eggs, whereas pore diameter did not differ between eggs. Water vapour conductance was greater in second- (16.8 mg day⁻¹ torr⁻¹) than in first-laid eggs (14.9 mg day⁻¹ torr⁻¹). The difference in water vapour conductance between first- and second-laid eggs within clutches was related to hatching patterns. In nests where second eggs hatched before first-laid

eggs, second eggs had a considerably greater water conductance than their sibling, whereas in nests where both eggs hatched on the same day, the difference in water conductance between eggs was very small and in a few nests where small first eggs hatched before their larger sibling, they had a greater water conductance than their larger second-laid nestmate. Surprisingly few studies have investigated differences in shell characteristics between eggs within clutches and associated effects on hatching asynchrony. This study has demonstrated that such differences exist between eggs within clutches and that they can influence hatching patterns.

EFFECTS OF ARTIFICIAL EGGS ON PROLACTIN SECRETION, STEROID LEVELS, BROOD PATCH DEVELOPMENT, INCUBATION ONSET AND CLUTCH SIZE IN THE YELLOW-EYED PENGUIN

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Several studies have shown that the transition from egg laying to incubation behavior in birds is associated with changes in plasma levels of prolactin and steroid hormones. However, any effect of the tactile and visual input provided by eggs at initiating these hormonal changes has not been fully investigated in wild birds. A few days before yellow-eyed penguins, *Megadyptes antipodes*, started egg laying, we placed an artificial egg into their nests or under cages next to their nest. We then investigated the effect of the tactile and/or visual stimulus of such an artificial egg on prolactin secretion, steroid hormone levels (testosterone and progesterone), brood patch development, incubation onset and clutch size in these penguins. Prolactin levels rose in females in response to having an artificial egg in the nest, while they declined in males. Testosterone concentrations in males decreased to less than 10% of the levels prior to egg placement and were significantly lower than in control males. Brood patch width increased in both males and females. Additionally, an egg in the nest caused yellow-eyed penguin pairs to attend and sit prone on their nest more frequently. Females that initiated egg laying one or two days after placement of the artificial egg in the nest, laid a full clutch of two eggs, while most other females that were exposed to an artificial egg in their nest, laid only a single egg. In contrast, the visual stimulus of an artificial egg alone (that was placed under a cage) did not influence hormone levels, brood patch development, incubation behavior or clutch size. We have demonstrated that the tactile stimulation of an egg in the nest influences immediately prolactin and steroid hormone levels in yellow-eyed penguins. These hormonal changes initiated brood patch development and incubation onset and also terminated egg laying. We encourage further studies on other birds species taking such an experimental approach to investigate the influence of the nest and eggs in initiating this positive feed-back reaction between hormonal secretion, brood patch development and incubation onset simultaneously. Moreover, such experimental studies will widen our understanding of the endocrine mechanisms that regulate clutch size.

FORAGING BEHAVIOUR OF SNARES CRESTED PENGUINS – A MATTER OF ROLE ALLOCATION DURING BREEDING

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The offshore feeding Snares Crested penguin *Eudyptes robustus* is endemic to the subantarctic Snares Islands some 200km south of New Zealand's South Island. During breeding, Snares penguins exhibit distinct gender-dependent roles. After laying, both mates stay at the nest for two weeks before the male leaves on a two week foraging trip, after which the female leaves to

forage for four to nine days. The return of the female coincides with chick hatching. Until crèching, the female performs short-term trips and feeds the chicks while the male guards the nest and offspring. During the breeding seasons of 2002 and 2003 we examined foraging behaviour of male and female Snares Crested penguins using time-depth recorders (TDRs) to record dive depths and GPS-dive loggers that recorded depth and a bird's position. During the 3-day battery life of the GPS devices, three equipped males swam due east of the islands, moved up to 216Km away from the islands and dived on average 320 times per day (max depth: 101m). On three other males, TDRs recorded dive depths for entire foraging trips (10-14d, 294 dives day-1, max depth: 120.5m); data indicate increased dive activities during the second half of the trips. No GPS data was recovered for females on long-term trips, but trip lengths suggests shorter ranges than those determined for males. TDR data of two females on long-term trips (duration: 5d) indicate higher foraging effort (612 dives day-1, max depth: 107m). During chick guard, females performed short-term trips during which they foraged 40 to 60 km north and north-west of the islands, feeding in the productive waters of the Subtropical Front. These trips were either overnight (1086 dives trip-1, max depth: 99m) or daylight trips only (640 dives trip-1, max depth: 82m). Reflecting their different incubation routines, male and female Snares penguins exhibit different foraging strategies. While foraging in males is primarily a matter of self-sustenance, females additionally must assume the primary responsibility of finding food for the offspring.

THUGS AND BULLIES – PATTERNS OF AGGRESSION IN SNARES CRESTED PENGUINS

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Snares crested penguins are aggressive birds. While aggression during the early breeding season is often a result of competition for nest sites and mates (e.g. male-male fights) other forms of aggression observed during later stages of breeding are not as easy to comprehend (e.g. attacks on incubating females). Although the majority of agonistic behaviour occurs in the colonies (intra-colonial aggression) there are also regular cases of extra-colonial aggression that can be described as "beach bullying" or "forest ambushing". After clutch completion, the number of aggressive events is low as long as the majority of male penguins are still present at their nests. After most of the males have left their incubating partners to forage, the number of attacks directed towards single females increases markedly. During such attacks, single males or pairs attack an incubating female with at times severe pecks and flipper beating – often for no obvious reasons. The incubating females generally do not fight back but assume a defensive position to protect their clutch. Although attacks often have no severe consequences some assaults result in egg loss or nest abandonment. With the return of the males, the rate of aggression recedes in the colonies. Instead single aggressive birds are now increasingly observable at the penguin landing and along the forest paths to the colonies randomly attacking returning females. During the breeding season, 2003 we recorded aggressive behaviour in a Snares large penguin colony of approximately 1200 nest. The data show, that an equal number of attacks were staged by breeding and non-breeding birds. However, the severity and duration of the attacks were higher if the aggressor was a non-breeder. Furthermore, breeders often conducted short attacks to steal nest material, whereas attacks by non-breeders had generally no visible outcome. In most cases, the attacked females often got off lightly with loss of nest material at the worst. Nevertheless we found that assaults contribute significantly to egg loss. The lack of obvious gain for the aggressor makes it hard to explain attacks from an evolutionary viewpoint. In any case, such patterns of aggression have consequences for the Snares penguins' general breeding behaviour.

AN ASSESSMENT OF THE ANNUAL CENSUS AS A CONSERVATION TOOL FOR HUMBOLDT PENGUINS IN PERU

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Humboldt penguins (*Spheniscus humboldti*), once seen in the hundreds of thousands along the west coasts of Peru and Chile, are now considered "vulnerable" by IUCN and perhaps number about 40,000 individuals. During the Population and Habitat Viability Analysis (PHVA) workshop conducted in 1998, an international working group determined that a standardized census methodology should be used in both countries to refine the estimates of total population and to begin to document changes in numbers and patterns. Since 2000, standardized counts of Humboldt penguins have been undertaken annually in Chile (Araya et al) and almost annually Peru. The results from 5 years provide information that is important for conservation efforts with this species. The total counts range from 33,800 to 46,400 with as much as a 20-25% difference seen from one year to the next; in Peru alone differences in counts from one year to the next have been as great as 40%. Fluctuations in numbers at individual sites have also been documented. Given that the standardized methodology calls for censuses during the molt period and at approximately the same dates annually, variations could be due to variation in average date of molt, variations in locations used by the molting birds, or true variation in population numbers. Examination of these patterns certainly suggests that a count from any single year should not be considered a definitive indication of conservation status. In addition to building a database on numbers of Humboldt penguins, the annual censuses have also allowed biologists to visit sites throughout the range of the species on a regular basis and to document both conservation threats and opportunities at the various locations. Information is gathered on emerging threats that were undocumented at the time of the PHVA workshop. Continuation of the annual census will contribute significantly to our understanding of the biological patterns and conservation variables for this species. Nonetheless, the census is costly and time-consuming; moving forward, it will be important to assess the methodology as well as the investment for maximum conservation effectiveness.

PENGUINS USE A NOVEL CLASS OF PLUMAGE PIGMENTS TO COLOR THEIR FEATHERS YELLOW

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Yellow plumage colors in birds are usually thought to be due to the presence of carotenoid pigments. However, there are several other groups of pigments in animals that confer these same colors, including melanins, pterins, and flavins. We conducted the first tests of the biochemical nature of yellow plumage coloration in penguins. Using traditional methods for extracting and analyzing carotenoids from bird feathers, we detected no carotenoid pigments in the yellow feathers of wild-caught king, macaroni, and emperor penguins. Instead, these yellow pigments exhibited chemical properties distinct from any pigments previously described from bird feathers. They were soluble in mild acids and bases, fluoresced blue under ultraviolet (UV) light, and absorbed light maximally in the UV. These pigments appear to be most similar to the pterin pigments described from the wings of butterflies and the eyes of several birds (e.g. owls, pigeons, starlings, blackbirds). We discuss the implications of these findings in light of the recent evidence that penguins use these yellow color patches as sexual signals.

GROWTH OF LITTLE PENGUIN *EUDYPTULA MINOR* CHICKS IN RELATION TO HATCHING DATE, PARENTAL AGE, PARENTAL QUALITY AND MATE CHANGE

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We studied growth of Little Penguin chicks at Phillip Island, Australia, in five breeding seasons (1995-96, 2000-02). Among years, breeding dates varied by two months and chick survival varied from 15% to 90%. Chicks were weighed every 1-2 days from the end of the guard stage. Body-mass data were used to calculate five growth parameters for each of 228 chicks that survived to fledging: linear growth rate (days 13-36), peak mass, age at peak mass, mass and age at fledging (departure for the sea). Relative hatching date (hatching date relative to the mean for all chicks in the same year) advanced with increasing parental age. Most of the growth parameters were independently related to hatching date and parental age, being better (more rapid growth, higher peak and fledging masses) among chicks hatched earlier and chicks with older parents. Both relationships were curvilinear: chick growth parameters improved with parental age in the early years of breeding (ages 3-7 yr), levelled off around the median age of breeding (ages 8-10 yr), and declined significantly among older birds (ages 11-16 yr). Hatching date, linear growth rate, peak mass and age at peak mass were more closely related to the age of the female than the male parent, but mass at fledging was most closely associated with the age of the male. In 12 cases where parents are known to have changed mates between successive years, breeding was slightly later and growth parameters were better in the year after the change. All growth parameters varied markedly among years after controlling for other factors. Growth parameters of chicks raised by pairs that remained together for two or more years were less variable than those of other pairs breeding in the same years and matched for laying date. These findings suggest that reproductive performance in Little Penguins is most strongly influenced by year-to-year variations in food availability, although factors intrinsic to the parents (age and "quality") are important sources of variability within years.

SURVIVAL OF LITTLE PENGUIN *EUDYPTULA MINOR* CHICKS FROM FLEDGING TO BREEDING AGE IN RELATION TO HATCHING DATE AND PEAK MASS

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In the 33 years 1968-2001, 23,015 Little Penguins *Eudyptula minor* were banded at Phillip Island, Victoria, Australia, at about the time of peak mass, one or two weeks before fledging. By the end of the 2003 season, 770 had been found dead within two years of banding (mostly on beaches away from the breeding colony), and 2,237 had been found alive more than two years after banding (mostly as breeders in the colony). We used logistic analysis of covariance to analyse the dependence of recovery rates on banding date and mass at banding (proxies for hatching date and peak mass, respectively). The probability of being recovered dead before breeding age increased with increasing hatching date and decreased with peak mass; the probability of being found alive after breeding age showed the opposite trends. Using independently-derived estimates of demographic parameters, we estimate the dependence of survival to age 2 (first breeding) on hatching date and peak mass. The results also show variability in recovery rates from year to year, although it is not possible to distinguish fully between changes in survival rates and changes in encounter and reporting rates.

THE MOST FREQUENTLY REGISTERED DISEASES IN MAGELLANIC PENGUIN (*SPHENISCUS MAGELLANICUS*) IN A REHABILITATION CENTER IN THE PROVINCE OF BUENOS AIRES, ARGENTINA

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The Rehabilitation Center of the Mundo Marino Foundation (FMM) has been operating since 1987 as a pioneer Institution in rehabilitation and reinsertion into the natural environment of different bird species in Argentina. This retrospective study is based on data obtained from 1,616 Magellanic penguins (*Spheniscus magellanicus*) attended between 1987 and 2003. La FMM, San Clemente del Tuyú, Buenos Aires, Argentina, receives birds that are rescued in an area of approximately 160 kilometers from the north Buenos Aires coast (from 36°22'S/56°44'W to 37°15'S/56°58'W). On receiving each penguin in the quarantine area, an evaluation of its general condition and identification are made, a clinical history is prepared, and corresponding treatment is given according to the disease diagnosed. If the medical discharge coincides with the migration period, the bird is released within the study area. In reverse conditions the birds go to a maintenance area until the next migration period. If the bird die in rehabilitation or during the waiting time, the appropriate necropsy is performed. The primary disease first diagnosed have been represented by 79,6% of distinct degrees of oiling, 13,33% of paramyxovirus, 1,33% of hepatitis, 1,33% of enteritis, 2,68% of parasites, and 1,33% of diverse problems. Of the 79,6% affected by petroleum contamination, 5% died of that cause. Having survived the removing of oil, during their stay, the birds present other diseases, of which the following are the most important: Paramyxovirus 32,65%, hepatitis 6,12%, trauma 5,11%, parasites 5,10%, enteritis 4,08%, aspergillosis 5,11%, septicemia 2,04%, air sacculitis 1,02%, spleen problems 1,02%, various causes 6,12% and diseases not diagnosed 31,63%. There is a close relationship between the decrease in immunological responses in these birds produced by oiling and the outset of various illnesses. The results of the annual serological tests in the birds's natural habitat coincide with illnesses that appear under stressful conditions such as oiling. The test in the breeding colony and the results obtained from the birds that reach the FMM shows an indication of the sanitary conditions of the penguin population, been necessary the constant improving of the diagnostic techniques.

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MICROSATELLITE ANALYSIS OF GENETIC STRUCTURE BETWEEN LITTLE PENGUIN (*EUDYPTULA MINOR*) COLONIES IN SOUTH-EASTERN AUSTRALIA

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The Little Penguin (*Eudyptula minor*) is mainland Australia's only breeding species of penguin, with a patchy distribution along the southern coastline. The majority of breeding colonies are located in the Bass Strait region, the shallow (55 to 90 metres) water body that separates Tasmania from the Australian mainland. It is currently assumed that colonies within the area exist in a meta-population structure, i.e. a set of local populations connected by migrating individuals. The local populations usually inhabit isolated patches of resources, and the degree of isolation may vary depending on the distance between patches. Within this region, two colonies are known to have been recently established; Middle Island (south-western Victoria) and St Kilda (metropolitan Melbourne) colonies were first recorded in the 1950s and 1980s respectively. The Middle Island site (292 active burrows) and St Kilda (112 breeding sites) have both been recorded as exhibiting differences in morphometric traits and breeding success

Island (ca 21 000 pairs) (33 km, 575 min). The mean foraging range also differed significantly between mainland (20 km) and island colonies (8 km). The foraging area available to a central place foraging seabirds breeding on the mainland typically is less than that for seabirds breeding on islands, but the area per pair is greater for the Boulders mainland colony. We thus conclude that the greater foraging effort of Boulders birds reflects reduced prey availability in False Bay, and that recent slowing in growth at the colony probably is not a direct result of management actions to limit the spatial growth of the colony.

CORTICOSTERONE RESPONSES IN RELATION TO FASTING IN BREEDING ADELIE PENGUINS (*PYGOSCELIS ADELIAE*)

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Penguins naturally fast each year during breeding and again whilst moulting, and may lose more than 40% of body mass during a fast. Fasting in king (*Aptenodytes patagonicus*) and emperor (*Aptenodytes forsteri*) penguins has been divided into three phases, with a prolonged period of low daily body mass loss in phase II then an increased rate of body mass loss in phase III. Corticosterone, a metabolic hormone that promotes adjustments to fasting, increases during phase III in king and emperor penguins. The breeding of Adelie penguins (*Pygoscelis adeliae*) on Ross Island was disrupted in 2001 by a large iceberg (B15A) which stopped the normal movement of sea ice in the Ross Sea. Female penguins either returned late to relieve their mates at the end of the first incubation spell or did not return at all. We compared plasma corticosterone concentrations and corticosterone responses to handling between male Adelie penguins that were departing from the colony, females returning to the colony and incubating females to determine the effects of prolonged fasting on corticosterone in this species. Departing birds were lighter than returning or incubating birds (3.39 ± 0.09 cf. 4.16 ± 0.09 and 4.07 ± 0.08 kg). Plasma corticosterone concentrations were higher in departing than in returning or incubating penguins (6.89 ± 1.69 cf. 2.36 ± 0.42 and 1.08 ± 0.20 ng/ml). Corticosterone responses to handling were also greater in the departing penguins. Corticosterone concentrations were inversely correlated with body mass in departing penguins when birds were first picked up and after 30 min of confinement ($r^2 = 0.46$ and 0.56), but there were no relationships between these variables in the other penguins. Previous studies did not find a relationship between body mass and corticosterone in Adelie penguins, and the present results may reflect the unusual ice conditions when incubating birds fasted for longer than normal. This is the first report of corticosterone responses to handling during fasting in any species of penguin. In addition, the results indicate that corticosterone may be involved in the increased rate of body mass loss in phase III of fasting in the Adelie penguin.

MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*) ON THE BEACHES AT PUNTA TOMBO, CHUBUT, ARGENTINA

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Magellanic penguins (*Spheniscus magellanicus*) stand on the beaches during the breeding season but little is known about the age composition and breeding status of these birds. At Punta Tombo, (44° 02' S 65° 11' W), the largest breeding colony of Magellanic penguins in the world, over 55,000 penguins have been banded since 1983, most of them as chicks so their age

environmental temperature (the onset of summer season in the Southern Hemisphere) some penguins ran down, started with anorexia, decrease of body weight (in some cases up to 50%), dehydration and hemolytic anemia. The blood cytology studies showed refracting particles in the cytoplasm of the red cells. The necropsy revealed splenomegaly (up to 7cm in length), hepatomegaly, hydropericardium and subcutaneous edemas, among other lesions. The samples imprint from spleen, liver and kidney showed an intracellular parasite located in the cytoplasm of the erythrocytes displacing the nucleus. Histopathology studies revealed congestion of the haematopoietic organs, macrophages with hemosiderin and small round particles in the cytoplasm of erythrocytes. Bearing in mind the summer season and the hematological, cytological and histopathological results we were able to diagnose that the penguins were affected by Avian Malaria produced by a Protozoa hemoparasite belonging to the genus Plasmodium. In addition, there were important erythematous skin lesions around the eyes of the penguins –due to mosquito bites– which confirm the previous diagnosis. Finally, for regions with humid and hot climate that hold penguins in captivity we recommend periodical fumigations in the areas in order to decrease the mosquito population, considering that these insects are vectors of Plasmodium. It would also be useful to perform annual hematology test in order to identify the parasites and- if necessary- the instauration of antimalaric treatment.

MOVEMENTS OF SOUTHERN ROCKHOPPER PENGUIN (*EUDYPTES CHRYSOCOME CHRYSOCOME*) FROM STATEN ISLAND DURING THE WINTER DISPERSION IN RELATION TO OCEANOGRAPHIC FEATURES

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Seabirds show a strong association with oceanographic features expressed as fronts, sea surface height anomalies and water mass boundaries during their foraging movements while at sea. We characterized the movements and oceanographic habitats of southern rockhopper penguins from Staten Island during the winter dispersion. Ten birds were fitted with platform terminal transmitters in March 2002 and 15 in March 2003. Analyses of satellite telemetry data in conjunction with remotely sensed sea surface temperature (SST) and bathymetry revealed two main foraging areas: one situated to the north of Staten Island off the coast of Tierra del Fuego and the other one to the south of Staten Island in the vicinity of the Antarctic Polar Front. Sixteen out of 25 birds commuted between the two zones. In the area to the north of Staten Island birds used shallow coastal waters characterized by tidal fronts, which are well-known highly productive features. Moreover, penguins spent 47% of their time at sea in those areas. By contrast, the area to the south included pelagic waters (> 3000m) and penguins spent 43% of their time in those waters. This area, in the region of the Drake Passage, included the Polar Frontal Zone (PFZ), an important water mass with high phytoplankton concentration, especially in its southern and northern limits (polar front PF and sub-Antarctic front SAF, respectively). During March and April birds preferred water masses warmer than 8°C SST (along the Atlantic coast of Tierra del Fuego), although during April some birds also foraged in Antarctic waters (-2°C). From May to July penguins spent more than 50% of time in water masses between 4-6°C (PFZ based on the published and widely used locations of water masses and fronts). The individual movements were analysed together with SST, sea surface height anomalies and chlorophyll a images to identify the oceanographic features that penguins follow during their movements. Implications for the status and present conservation of this species in the southwest Atlantic Ocean are also discussed.

FORAGING LOCATIONS OF MAGELLANIC PENGUINS BREEDING AT PUNTA TOMBO, ARGENTINA

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We tracked breeding Magellanic Penguins (*Spheniscus magellanicus*) at Punta Tombo, Argentina (44°3'S, 65°13'W) using platform transmitter terminals (PTTs) from the 1996-1997 breeding season through 2003-2004. We followed adult penguins during three stages of the breeding season: 1) incubation, when mates alternate making long foraging trips, 2) early-chick rearing, when mates alternate making short foraging trips, and 3) late-chick rearing, when mates forage simultaneously. We deployed PTTs on 101 males and 57 females for a total of 195 deployments, and calculated the maximum distance traveled from Punta Tombo using Vincenty's inverse method. The maximum distance traveled by males and females were similar ($F = 0.98$, $p = 0.32$). Distance differed by stage of the breeding season ($F = 172.61$, $p < 0.001$) and year ($F = 4.36$, $p = 0.007$). Penguins traveled farthest during incubation, with averages by year from 321 km to 538 km. They stayed closest to the colony during the early-chick period, with averages from 81 km to 128 km. During the late-chick period, distances were intermediate, averaging 126 to 335 km. There was an increasing trend in maximum distance traveled among years during incubation ($F = 9.16$, $p = 0.03$). Using sea-surface temperature (SST) and chlorophyll-a data from NOAA/NASA satellites, we found that during incubation, foraging locations are determined by the distribution of relatively warm (11-15°C SST) coastal water inshore of the shelf-break fronts and the cold Malvinas (Falklands) Current. The primary prey of Magellanic penguins in this area, the Argentine anchoita (*Engraulis anchoita*), is migratory, arriving in the region in October-November from waters off Brazil. The foraging locations of penguins during the early-chick and late-chick stages are associated with tidal-mixing fronts, which are well developed along the coast of Chubut by December. Anchoita aggregate near these fronts to spawn in areas of high productivity. During December when penguins are constrained to short trips to feed their chicks every 1-2 days, the fronts are generally well developed near the coast at Punta Tombo. By January, the frontal areas usually move farther offshore to the northeast, but by this time the chicks are left alone and penguins can reach the frontal areas and return before the chicks starve.

POPULATIONS FLUCTUATIONS OF PYGOSCELID PENGUINS DURING 1994-2004, IN ARDLEY ISLAND, SOUTH SHETLAND ISLANDSMaría José Roselló¹ and José Valencia²¹ Facultad de Cs del Mar, Universidad de Valparaíso, Chile. ✉ mjrosello@hotmail.com² Instituto Antártico Chileno, Punta Arenas, Chile.

This study is the result of field work done on Ardley Island (62°13' LS; 58°55' LW) – Fildes Peninsula, King George Island, South Shetland Islands. This island hosts nesting colonies of three penguin species of genus *Pygoscelis*: *P. antarctica*, *P. adeliae* y *P. papua*. The importance of these seabirds, components of the Antarctic ecosystem, is that they are around 80% of the total biomass of birds present in the continent. Ardley Island also has one of the largest reproductive colonies of Gentoo penguins censused on the South Shetland. Penguins are top predators of the Antarctic ecosystem food chain and as such they have been considered good indicators of the conservation status of the environment. Then, penguin monitoring programs and reproductive ecology studies become of great relevance. This is reinforced because the reproductive colonies are found in areas of increasing human activities including krill fishing and sea borne tourism, like the case of Ardley Island. We deliver our results of annual censuses of adults and chicks and reproductive success of the Ardley island nesting populations of the three *Pygoscelis* species during the period of the last ten years. The annual census statistics reveal yearly fluctuations of reproductive populations, reproductive success is shown as number of chicks per nesting couple. The most abundant population is *Pygoscelis*

papua (around 4.000 nests), followed by *P. adeliae* (around 1.000) y *P. antarctica* (less than 40). The reproductive success of the three species has the same sequence of magnitude. During the period of study, the population of *P. papua* and *P. antarctica* showed a tendency to stability. Meanwhile *P. adeliae* during the last few years has showed a tendency to decrease its nesting population size. This is probably associated to fluctuations of sea ice yearly cycles as it has been found in other areas of the range of this species.

IFAW PENGUIN REHABILITATION AND RESEARCH NETWORKValeria Ruoppolo^{1,2,3}, Barbara Callahan^{1,4}, Rodolfo P. da Silva Filho^{1,3}, Sergio Rodriguez Heredia⁵ and Jay Holcomb^{1,4}¹ International Fund for Animal Welfare (IFAW) Emergency Relief Team - Oiled Wildlife Division² Projeto BioPesca.³ Centro de Recuperação de Animais Marinhos - Museu Oceanográfico, Fundação Universidade Federal do Rio Grande (CRAM – MO, FURG).⁴ International Bird Rescue and Research Center (IBRRC).⁵ Fundación Mundo Marino (FMM).

South America has seven species of penguins distributed along the Atlantic and Pacific coasts. The Magellanic penguins (*Spheniscus magellanicus*) breed in large colonies in Argentina and Chile and migrate north as far as Southwest Brazil between March and September. Gandini et al. (1994) estimate that 42,000 Magellanic penguins die each year due to chronic oil pollution along the coast of Chubut Province, in Argentina. Every year, different species of oiled and/or debilitated penguins show up on beaches along their migration range and between 350 to 500 animals are rescued by different rehabilitation organizations in Argentina, Uruguay and Brazil. Due to limiting factors such as funding for gasoline, fish for larger numbers of birds and other expenses related to the rehabilitation process, the search for beached penguins is still insufficient, leaving many animals in remote areas to die, therefore the IFAW Penguin Network was developed. Its main purpose is to bring together rehabilitation organizations working with penguins in South America and help them to increase the number of rescued animals, standardize rehabilitation protocols and data collection. The goal is to understand the effects of oiling on penguins and to mitigate these effects through rehabilitation, research and prevention. The IFAW Emergency Relief Team – Oiled Wildlife Division, co-managed by the International Bird Rescue and Research Center (IBRRC), is a world-class team of experts in rehabilitating animals injured in oil spills, best known for the rescue and rehabilitation of more than 21,000 oiled African penguins in South Africa in 2000. Between 2001 and 2004 the IFAW ER Team was directly involved in emergency responses for the recovery of penguins in Argentina, Uruguay, Brazil and Chile where 1,090 oiled birds were rescued, with 85.1% (928/1,090) been successfully rehabilitated by five different institutions. The need for this Network, its expansion and increased capabilities are evident, as past rehabilitation efforts managed by SANCCOB, IBRRC and IFAW have been extremely successful to the point that Cape Nature Conservation, in South Africa, considers rehabilitation of oiled penguins to be a valuable, cost effective and essential species conservation and management tool.

DIVING PHYSIOLOGY OF THE KING PENGUIN (*APTENODYTES PATAGONICUS*): TEMPERATURE ADJUSTMENTS, ENERGY SAVINGS AND SWIMMING EFFORT

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Recent studies showed reductions of different body temperatures while foraging at sea in several species of diving birds. In diving endotherms, a reflex peripheral vasoconstriction is the mechanism involved to limit heat exchange and preserve a high and stable core temperature.

However, in king penguins even deep organs and tissues have been found to undergo temperature drops during prolonged diving activity. These latest results pointed up the potential role of temperature reduction in diving energetic and could partly explain the large discrepancy between theoretical and observed aerobic dive autonomy. To determine how temperature variations are interrelated to diving behaviour and/or environmental characteristics, we measured both the temperature of the ambient and of the main propulsive muscle, the pectoral, together with the associated movements, revealed by the down stroke of the flippers. In this study, we examined the possible interrelations between changes in pectoralis temperature, frequency and amplitude of the flippers strokes as an index of locomotor work, and environmental parameters. Our results showed temperature drops of several degrees of the pectoral muscle during prolonged diving bouts. Nevertheless, at the scale of one unique deep dive, the pectoral temperature increased when progressing to depth (+0.3°C), while water temperature decreased and stroke frequency was averaging 1.6 Hz. This high level of activities continued during the bottom part of the dive, with very complex and irregular patterns, in frequency and amplitude, of the flipper strokes. However, during this period the pectoral temperature stayed constant. Finally, during the ascending part of the dive, the pectoral temperature decreased (-0.3°C), while flippers stopped stroking at a mean depth of 60m. In this presentation, thermoregulation of the pectoral muscle in the king penguin is discussed in terms of production and dissipation of heat and its implication in diving physiology and energetic. Our results suggest that even during hard muscular work, penguins rely on physiological and behavioural adjustments to minimize the energetic cost of diving.

HUMBOLDT PENGUINS AFTER THE "GUANO RUSH": ARE THEY STILL NESTING ACCORDING TO "MURPHY'S LAW"?

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In his "Oceanic Birds of South America" (1936), R. C. Murphy stated that the removal of guano in the second half of the nineteenth century, to be sold as fertilizer mainly in North America and Europe, greatly reduced the number of Humboldt penguins (*Spheniscus humboldti*) and other seabirds along the coasts of Peru and northern Chile. The ancient guano layers were the main substrate in which the penguins dug their burrows, which led Murphy to suggest that without this guano layer the birds were forced to breed in sub-optimal habitats. At present, deep guano layers are still absent from most seabird islands which raises the question of how Humboldt penguins cope with this nest-substrate scarcity. In an attempt to answer this, we surveyed eleven islands where Humboldt penguins nest along the Chilean coast, ranging from Pan de Azúcar (26°09'S) to Puñihuil (41°55'S). Nests were categorized by nest-type according to concealment and substrate. We identified nine different nest-types, with the most abundant being rock-covered (e.g. Pan de Azúcar, Choros, Concón, Pájaro Niño) and vegetation-covered nests (e.g. Chañaral, Tilgo), followed by dirt burrows (e.g. Cachagua) and rock crevices (e.g. Pupuya). Only at two colonies we found nesting in guano (Pájaros and Concón). Each colony presented a dominant type of nest (50-90% at each colony), which indicates that penguins use the sites available at each island and thus are flexible in their behavior of habitat selection. Data from the literature indicate that burrow-like nests are more successful than other nest-types, which suggests that despite this behavioral flexibility, Humboldt penguins may be still using precarious nesting sites, and thus still breeding according to "Murphy's law". A travel grant from Penguin Conference Japan made possible this presentation at the V International Penguin Conference.

PROTECTING PENGUINS WITH CREATIVE OCEAN ZONING IN THE SW ATLANTIC

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Marine protected areas number over 4000 worldwide and cover over 1.6 million square km. Less than 0.5% of the oceans are protected (compared to 11.5% of the Earth's land surface), and the status of many marine species continues to deteriorate. Strong political and economic forces oppose the creation of protected areas that would restrict exploitation of marine resources. In the SW Atlantic, human activities such as fishing, shipping, oil exploration and transport, and pollution are putting increasing pressure on marine ecosystems. The Magellanic penguin, a top predator, has the charisma to galvanize political support. When thousands of penguins were killed each year in the 1980's along the Chubut coast, the government and oil companies changed oil discharge practices and moved tanker lanes farther offshore. These penguins are a useful focal species for marine conservation. Most Magellanic penguins migrate north from their colonies along the Atlantic coast during the austral winter, following a "highway" along the coast from May to July. Most appear to remain in Argentinean waters, but some move as far north as the Brazilian coast before returning to their breeding colonies in August and September. We document that few marine areas around Magellanic penguin breeding colonies are currently protected, and that the penguin migration route has no protection. Because the birds remain for the most part inside the exclusive economic zone (EEZ) of coastal nations, penguin protection can be implemented at a national level. We show that a core area and moving corridor could be designated a national park or marine sanctuary within Argentina where activities that specifically threaten penguins (e.g., fishing and oil transport) would be restricted during the months penguins use the area. Argentina could protect much of the population on the wintering grounds, but a corridor in the winter months (July to early September) extended into the EEZ of Uruguay and Brazil would further benefit the species. This novel approach of having a spatial and temporal protected area for a few months of the year could minimize conflicts between people and penguins, with little impact on human economic activities.

ECTO- AND ENDOPARASITES OF AFRICAN PENGUIN *SPHENISCUS DEMERSUS*

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This study of penguin-parasites showed two species of ecto- and four different endoparasites. The number of setae at the segment V of mid- and hindtarsae of the males were the most important detail to identify the flea *Parapsyllus longicornis humboldti* JORDAN, 1942. The tick *Ornithodoros capensis* NEUMANN showed a capitulum, which cannot be seen in a dorsal view and a dorsal plate length: breadth ratio of 1:0.7. Intestinal cestodes *Tetrabothrius lutzi* PARONA, 1901 and *Tetrabothrius eudyptidis* LOENN-BERG, 1896 could be identified by their scolices and the different ways of male atrial canal and vaginal canal into the atrium genitale. A nematode called *Contraecaecum variegatum* RUDOLPHI, 1809 was identified through a bifurcated interlabium. Samples of liver and lung were searched for *Plasmodium* sp. All studies were made with a scanning electronic microscope (SEM) and details of interior tissues were proved with histological methods. Samples were collected alongside the South African Coast from different Penguin colonies.

LONG-TERM TRENDS IN DIET OF ROCKHOPPER PENGUINS, AND IN MARINE PRODUCTIVITY, AS REVEALED THROUGH STABLE ISOTOPE ANALYSES

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Rockhopper penguins *Eudyptes chrysocome* have undergone marked population declines at some of their main breeding sites. For example, at Campbell Island in New Zealand, the number of rockhopper penguins decreased by approximately 94% between the 1940s and 1980s. It is generally thought that this particular population decrease was due to changes in sea temperature, which brought about either a shift in penguin diet or a decrease in food availability. Exploring these possibilities through conventional dietary approaches is severely limited by a lack of dietary data from the period when the population was large. Stable isotope analyses of a time series of feather samples taken from contemporary birds and from birds held in museum collections dating back to the nineteenth century can overcome the limitations of conventional approaches, not only providing data on penguins' diet but also on the relative level of productivity of the marine ecosystem in which birds foraged. We present isotopic data for rockhopper penguins from throughout their breeding range (New Zealand sub-Antarctic islands, South Indian Ocean and South Atlantic Ocean) covering 150 years. We use these data to determine long-term trends in rockhopper penguin diet and to explore spatial patterns of marine productivity over similarly long time scales.

GENTOO PENGUINS: INDICATORS OF PHYSICAL FORCING IN THE SOUTHWEST ATLANTIC

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In the southwest Atlantic sector of the Southern Ocean, temporal variability in the physical environment has been recorded since the early part of the last century. For example, ocean temperatures are known to vary both between seasons and between years. Time series analyses of sea surface temperatures at South Georgia show the presence of high levels of autocorrelation, with periodicity evident in temperature anomalies at lag periods of approximately 3 to 4 years. Crosscorrelation analyses with temperature anomaly data for the El Niño 4 region in the Pacific show that variability at South Georgia also reflects temperature fluctuations in the Pacific, with the Pacific leading South Georgia by approximately 3 years. Biological variability is also apparent at South Georgia, being evident in data from a suite of top predators as well as in data from fish and Antarctic krill. Increased krill biomass appears to coincide with cold anomaly periods. In contrast, periods of reduced predator breeding performance are strongly correlated with warm anomaly periods, but lagged by a number of months. For some predators the most critical periods appear to be prior to the breeding season during the summer and early autumn of the preceding year. Thus, gentoo penguins (*Pygoscelis papua*) show a strong negative relationship between the number of chicks fledged and sea surface temperatures in the preceding February some 12 months earlier. Other top predators also show similar negative relationships between the reproductive success and temperature in the preceding season. Such relationships most likely reflect prey (krill) availability. The explanation of the observed relationships not only requires a detailed understanding of environmental variability, but also predator demography and foraging dynamics, and prey biomass and recruitment.

TRACKING ROCKHOPPER PENGUINS AT NEW ISLAND SOUTH, FALKLAND ISLANDS: RESULTS FROM THE 2000-01, 2001-02, AND 2003-04 SEASONS

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We present satellite-tracking data for Rockhopper Penguins at New Island South, Falkland Islands, and compare these data to previous satellite tracking results and to an index of ocean productivity. In 2000-01, we tracked four breeding males and three breeding females during the late chick-rearing period. Males traveled greater total (1421 ± 86 km) and maximum distances (279 ± 144 km), and had trips of longer duration (longest trip: 11.8 ± 7.8 days) than females (total: 978 ± 228 km; maximum: 111 ± 85 km; longest trip: 6.3 ± 2.9 days). In 2001-02, we tracked four breeding males during the late chick-rearing period. The males traveled a total distance of 1143 ± 608 km, a maximum distance of 288 ± 224 km, and were away on their longest trip for 17.5 ± 13.5 days. In February-March 2002, we tracked two recently molted juveniles. This is the first study to track immature penguins, giving us important insight into where this critical age class goes at sea. Both birds remained within 100 km of New Island. In 2003-04, we tracked three breeding males during the late chick-rearing period. On average, these males traveled greater total (2143 ± 55 km) and maximum distances (388 ± 151 km), and had trips of longer duration (longest trip: 26.3 ± 10.5 days) than in any previous year, 1997-2002. As in 1997-98 and 1998-99, males made long foraging trips hundreds of km W or WSW toward the coast of Tierra del Fuego during the late chick-rearing period. Some individuals foraged within 100 km of New Island in all years. Unlike in 1997-98 and 1998-99, none foraged due south of New Island. When we compared satellite locations to chlorophyll a estimates, tracks of males on long foraging trips corresponded well to areas or edges with higher chlorophyll a values than the surrounding water. In all years, 1997-2004, penguins used an area designated for oil and gas development. Detailed knowledge of when and how penguins use the ocean is essential if tools like ocean zoning are to be effective in reducing conflicts between penguins and humans.

PENGUINS AND PEOPLE IN PATAGONIA: HOW TOURIST VISITATION AFFECTS BEHAVIOR AND PHYSIOLOGY IN MAGELLANIC PENGUIN (*SPHENISCUS MAGELLANICUS*) ADULTS AND CHICKS

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Human population growth and consumption is radically modifying the environment. Even practices with a conservational mandate such as ecotourism have the potential to negatively affect animals. It is therefore increasing important to know what impact humans have on the behavior and physiology of wildlife. This is particularly relevant for penguins, as these charismatic birds are very popular foci for tourist visitation worldwide. We measured behavioral (head turns or approach distance) and physiological (stress hormone corticosterone) responses to human visitation in Magellanic penguin (*Spheniscus magellanicus*) adults and chicks at Punta Tombo, Argentina. Adult penguins rapidly habituate to human presence in the breeding colony (within 5 days of repeated contact), and tourist visitation is perceived as less stressful than capture and restraint. These data, coupled with yearly reproductive success information, suggest that Magellanic penguins have little negative consequences due to tourist visitation. However, we also show that adult penguins in tourist areas have a decrease in the physiological capability to express the stress hormone corticosterone. It is unknown whether this physiological change in tourist penguins could have longer term negative impact on breeding adult penguins. We further found that Magellanic penguin chicks raised in tourist areas show a rapid expression of the corticosterone stress response, much earlier than chicks in areas not visited by humans.

While this rapid expression of a stress response may not be detrimental to Magellanic penguin chicks, such patterns of early exposure to high corticosterone have been known to have negative consequences much later in life in other species. Finally, near fledging, chicks in the tourist area already show a behavioral habituation to human disturbance (small approach distance) but do not yet show the decreased physiological stress response as in adults. This suggests that the pattern of behavioral and physiological habituation in Magellanic penguins is uncoupled, occurring at different rates as penguins adapt to human visitation.

IS HAND RAISING ORPHANED AFRICAN PENGUIN CHICKS WORTH THE EFFORT? AN ASSESSMENT FROM THE APOLLO SEA OIL SPILL

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The African Penguin *Spheniscus demersus* is endemic to southern Africa, breeding at 29 colonies in South Africa and Namibia. The population declined by 90% during the 20th century and the species is listed as "vulnerable" under the red data criteria of the IUCN. Increased competition for a reduced food supply and marine pollution, particularly from oil spills, currently threaten the population. Poor annual survival of young birds and the resulting low recruitment to the breeding population is thought to be responsible for the continued decline of this species. Few attempts have been made to hand rear penguin chicks and release them back into the wild. Available evidence suggests that what attempts have been made met with little success. In South Africa, oil spills occurring during the breeding season of African Penguins have twice resulted in large numbers of chicks being orphaned. On 20 June 1994, the bulk ore carrier Apollo Sea sank near Dassen Island, causing 10 000 African penguins to be oiled. Large numbers of nests at Dassen and Robben islands were effectively abandoned because the parents had either died or were in the rehabilitation centres, and as a result there were many orphaned chicks. At Dassen Island, 437 of these orphans were hand reared, flipper-banded and subsequently released. Staff of Marine and Coastal Management banded 399 chicks at nests on Dassen Island during the course of that year. These birds were unaffected by the oil spill and thus formed a control population against which the performance of the hand reared birds could be measured. By October 1999, 11% of the orphaned chicks and 9% of the naturally reared chicks had returned to breeding colonies, mostly to Dassen Island, and there was no evidence of a higher mortality rate for hand-reared birds. The proportions of birds found dead and of those that attempted to breed were similar for both orphaned and naturally reared chicks and patterns of post-fledging dispersal were also identical. Survival rates of naturally reared chicks from Dassen Island banded between 1990 and 1994 indicated that 1994 was a poor year. Hand rearing of orphaned African Penguin chicks appeared to be successful and could be an important conservation initiative following major oil spills.

FORAGING AREAS OF KING PENGUINS AND PHYSICAL FEATURES: IS THERE A LINK?

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In 1999 and 2004, we tracked King penguins during incubation at Macquarie Island and Heard Island, respectively. Total foraging distances, maximal distances from the colony and foraging trip durations were compared for both locations and related to oceanographic features, such as currents and bathymetry. At Macquarie Island, the behaviours among individual penguins were more similar to those tracked at Heard Island. Also, foraging distances were greater at

Macquarie than at Heard Island. Frontal structures appeared more important at Macquarie than at Heard Island.

HOW DOES THE TIMING OF MOLT AFFECT THE ONSET OF BREEDING AND REPRODUCTIVE PERFORMANCE OF HUMBOLDT PENGUINS AT PUNTA SAN JUAN, PERU

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The timing and duration of molt of banded Humboldt Penguins was determined during three years (1994-96) at Punta San Juan, Peru in order to examine possible relations with the timing of breeding and the annual breeding success. Unlike the extended breeding season (from April to December), the molting period of adult Humboldt Penguins was highly seasonal and synchronous. Molting took place from the beginning of January to the end of March, but 90% of the population molted within a period of 3 weeks, with a peak between the second and third week of January. The molt was not skipped or repeated in a year. The molt of juveniles was more asynchronous than adults, extending from January to June. Before coming ashore, penguins continuously foraged for a mean period of two weeks, when they gained between 32% and 37% of the pre-molting body mass. Penguins fasted for 15 to 32 days, losing between 8% and 9% of the pre-molting body mass. After replacing their old feathers, they remained at sea for a mean period of two weeks to replenish their fat reserves. The timing and duration was similar between sexes, but changed year to year perhaps as a result of food conditions. There was a positive correlation between the timing of molt and the onset of the first breeding season and breeding frequency. Adults that molted earlier started breeding earlier and showed a higher breeding success than those individuals that molted later. Molt rather than breeding, occurred when food availability was the highest: anchovies are closer to the coast and in shallower waters during the austral summer than in other seasons. A seasonal and synchronized molt during the period of high food supply is adaptive by increasing not only adult survival but also to maximize the annual reproductive success. The onset and pattern of breeding Humboldt Penguins at Punta San Juan does not necessarily match the periods of high food supply, but it is the result of a synchronized molting period.

POSTER PRESENTATIONS

FOSSIL PENGUINS FROM SOUTH AMERICA

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Penguins have an exclusive austral history that extends back 55 My (Late Paleocene, Antarctica) and constitute the most frequently birds in marine Cenozoic assemblages. Fossil penguin collections consist mainly on isolated non-homologous bones from several localities in Antarctica, Africa, Australia, New Zealand, and South America. Focused in the latest area, the fossil record comes from both Atlantic and Pacific coasts. Like the recent species, all the remains belong to the Spheniscidae (except one exhumed in the Upper Eocene of Tierra del Fuego considered as a Pansphenisciformes). From the Upper Eocene- Lower Oligocene of Patagonia are recorded *Arthrodytes andrewsi* and *Paraptenodytes robustus* (San Julian Formation) plus a Peruvian penguin (Otuma Formation). A gap exists between these Paleogene faunas and the better known Neogene assemblages. In the lower Miocene of Patagonia have been found *Eretiscus tonni*, *Palaeospheniscus bergi*, *P. patagonicus*, and *P. biloculata* (Gaiman Formation) and *Paraptenodytes antarctica* (Monte León Formation). In the Middle Miocene - Lower Pliocene of Chile (Bahía Inglesa Formation), were recognized a Spheniscidae cf. *Spheniscus* sp., *Pygoscelis* sp., *Palaeospheniscus* sp., *Paraptenodytes robustus* y *P. antarctica*. From the Middle Miocene of Peru (Pisco Formation) come *Spheniscus megaramphus* and *S. urbinai*, and *Palaeospheniscus patagonicus* (Chilcatay Formation). Finally, in the lower Upper Miocene of Patagonia appear *Paraptenodytes antarctica* and a new taxa currently under study. Through the study of these fossils, it can be pointed out: (1) All these taxa are exclusive of South America; (2) both Atlantic and Pacific assemblages share several taxa of generic and specific level (*Paraptenodytes antarcticus*, *P. robustus* and *Palaeospheniscus patagonicus*); (3) sympatric diversity does not seem to be overestimated; (4) The Miocene penguins display close osteological similarities with the recent taxa; (5) longevity showed by fossil penguin is considerably bigger than any other South American continental avian species known (i.e. *Paraptenodytes antarcticus*, at least 11 My). There are no records of giant forms in the South American Cenozoic sediments and during the Miocene and the beginning of the Pliocene, the penguin fauna becomes thrive and diverse. By this time, living genus like *Pygoscelis*, currently known in Antarctica and subantarctic islands, have been recognized in Chile.

WITHIN-SEASON MASS CHANGE OF ADÉLIE PENGUINS RELATED TO ADULT CONDITION AND CHICK PROVISIONING RATES

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Using an automated weighbridge, we measured individual mass change and food load delivered to chicks in ~100 pairs of Adélie Penguins (*Pygoscelis adeliae*) at Cape Crozier, Ross Island, over the course of six breeding seasons, 1997-2002 (average of ~30 pairs per season). The weighbridge logged the individual identity, direction and time of travel, and mass of individuals from a subcolony of approximately 200 pairs; from this information we calculated trip duration and food load per trip. Most individuals lost mass during the guard and crèche stages

of chick rearing in most seasons. However, in a difficult breeding season (1997), adult mass was low to begin with (below 3.2 kg) and increased during the chick period. The amount of mass change in females was positively related to foraging trip duration in all seasons, with trip duration decreasing the more mass a female had lost. This relationship was not evident in males. As we've reported previously, males made consistently shorter-duration foraging trips than females. However, once the effect of individual mass change was factored in, there was no difference in trip duration between males and females. Food load per trip was related to mass change in both sexes, with significantly more food per trip delivered by individuals that had lost more mass. These results suggest that Adélie Penguins regulate their condition depending on environmental parameters, with impacts to the amount of food delivered to chicks. Mass change in adults may serve as a suitable proxy for environmental conditions: "good" years are ones in which adults can afford to lose mass, and "bad" years are ones in which adults need to gain mass while attempting to provision chicks. Further, differences in foraging trip duration may be more closely related to relative condition of adults than to sex.

GEOGRAPHIC VARIATION IN SEXUAL DIMORPHISM IN LITTLE PENGUINS (*EUDYPTULA MINOR*)

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We examined the geographic variation in mean bill depth and bill depth sexual dimorphism between 8 colonies of Little penguins (*Eudyptula minor*) in south-eastern Australia. There was a positive correlation between mean male and mean female bill depths ($r^2 = 0.78$, $P < 0.01$). Adult bill depth was also positively correlated to chick fledging mass ($r^2 = 0.93$, $P < 0.05$) and negatively related to number of birds ($r^2 = 0.96$, $P < 0.02$) at some colonies suggesting bill depth is influenced by local food availability during the breeding period. The degree of sexual dimorphism (Mean Difference index, MD%), however, was not correlated to colony size. In contrast, there was a strong positive correlation ($r^2 = 0.83$, $P < 0.01$) between MD% and the overall density of birds at the colonies. These findings suggest sexual dimorphism in bill depth in Little penguins is primarily influenced by sexual selection (either through intra-sexual competition or mate choice) rather than niche-separation to avoid inter-sexual competition for food.

ENERGY COSTS OF STEEL FLIPPER BANDS CAUSED BY FEATHER WEAR

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It has been widely reported that Antarctic penguin species are greatly affected by the use of steel flipper bands. The reason is usually argued to be that the bands cause significant hydrodynamic drag, forcing the penguins to expend significantly more energy while swimming and catching prey. It appears that penguins from warmer climes wearing similar flipper bands experience significantly fewer problems. There are reports of some problems with Little penguins (*Eudyptula minor*) with birds carrying bands having reduced breeding success. However, it is hard to find any evidence of widespread detrimental effects of bands on African penguins (*Spheniscus demersus*), although we recognise that there have not yet been completed studies investigating the effects of bands on these penguins and that poorly-fitted or manufactured bands have on occasion caused mortality, e.g. through restricting swelling of flippers during moult or causing penguins to become snared in fishing line or bushes. We have

however, noted that nearly all African penguins wearing steel flipper bands suffer from wear of the feathers on their bodies under the flippers. In many cases this can result in a large area (ca. 1 cm²) of bare skin. We argue that in the temperate climate around the coasts of southern Africa, the loss of insulation caused by such feather wear is not significant. However, if similar feather wear occurs on Antarctic species then simple heat transfer calculations show that the heat loss will be significant. For example, we calculate that an Adelie penguin (*Pygoscelis adeliae*) with a bare patch of skin of area 1 cm² would need an additional energy input of between 5 and 15% simply to maintain its body temperature while swimming.

RESIGHTING RATES OF AFRICAN PENGUINS RELOCATED OR OILED FOLLOWING THE TREASURE OIL SPILL IN 2000

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Following the "Treasure" oil spill in 2000, oil surrounded Dassen and Robben Islands and washed ashore at several landing beaches, so that all African Penguins (*Spheniscus demersus*) at Robben Island and many from Dassen Island venturing into the sea were almost certain to be oiled. As the number of oiled penguins was expected to rise into the thousands (and eventually amounted to about 19,000, including 14,800 from Robben Island), a decision was taken to remove clean birds from these two islands. Around 19,500 African penguins (mostly birds in adult plumage and including 7,200 from Robben Island) that were not oiled, were caught, transported some 700 km to Port Elizabeth and released to swim back to the Western Cape area. About 3,000 of the trans-located penguins were banded. We have since then been carrying out intensive monitoring, especially on Robben Island. The proportion of the trans-located "swimmers" subsequently seen is lower than the proportion of oiled and rehabilitated birds that we have resighted (26% against 43%). Of the swimmers, about 37% were taken from Robben Island, whereas about 75% of the oiled birds were taken off Robben Island. The majority of resightings have been from the intensive work of Earthwatch volunteers on Robben Island (about 70% of all the resightings). If we assume that all the oiled birds from Robben Island came from that island, and if both groups have similar survival rates, we are seeing about the right proportion of the swimmers and the survival rates of the swimmers are similar to those of the oiled birds. The estimate of the number of penguins in adult plumage at Robben Island at the time of the spill was 18,000. Eventually, some 22,000 penguins were removed from this locality, including those in immature plumage. This suggests that most oiled birds collected from Robben Island were from that locality and that most of the "swimmers" returned to the Western Cape. The three "swimmers" that were tracked each returned rapidly to the islands from which they were taken.

A REVIEW OF KING, ROCKHOPPER AND MACARONI PENGUINS IN BRAZIL

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The King Penguin (*Aptenodytes patagonicus*), Rockhopper Penguin (*Eudyptes chrysocome*) and Macaroni Penguin (*Eudyptes chrysolophus*) are rare visitors in the Brazilian coast. In this study we review their records and present three additional sightings. Two King Penguins were found 40 km north of the Uruguayan border in January 2003, one alive and the other in an advanced stage of decomposition. The live King Penguin weighed 15.6 kg, with 73.0 cm of total length. This bird was found on 03 January 2003 and died 24 days after. Previous records were one live bird in Rio de Janeiro in January 1995, and another alive in Arroio do Sal, Rio Grande do Sul coast, in March 1995. This species has a Sub-Antarctic circumpolar distribution, breeding in South Georgia, Prince Edward, Falkland, Crozet, Kerguelen, Heard, and Macquarie Islands. One Rockhopper Penguin was recorded on 29 January 2003 in the southern Brazilian coast. The specimen was found 150 km from Uruguay, alive, weighting 1.76 kg and molting. It was released at sea in June 2004, with 2.2 kg. All previous records are from Rio Grande do Sul state. The first record was a live bird on an unknown date in Cassino Beach, which died in 1956 and was exposed at the Universidade Federal de Pelotas Museum. Two dead Rockhoppers were subsequently found, one between Mostardas and Quintão beaches, in August 1980, and the other one in Cassino beach, in June 1981. Additionally, two skins are deposited at the Fundação Universidade Federal do Rio Grande Bird Collection. Another stranded Rockhopper was found oiled in Cassino Beach in winter 1995. This species has a circumpolar distribution and breed on the Falkland Islands, islands off Tierra del Fuego, Tristan da Cunha, Gough, St Paul and Amsterdam Islands, Southern Indian and Southern Pacific Oceans, and Islands of New Zealand. Macaroni Penguins have a circumpolar distribution, breeding in Falklands, Gough, South Georgia and other places. The only record for this species in Brazil is a flock of 11 birds near the Uruguayan border in July 1964. A specimen was collected and the skin is at the Universidade de São Paulo Zoology Museum.

PYGOSCELIS PAPUA OF PETERMANN ISLAND: SPATIAL STRUCTURE OF POPULATION AND MORPHOLOGICAL VARIATION

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The Petermann Island (65°10' S, 64°08' W) is the place of localization of the most southern large population of *Pygoscelis papua* and the edge of gentoo population area. The 2210 nests of gentoo were registered during summer of 2002-2003. In total the 132 nesting groups were identified. Along the island they were distributed non-uniformly. Some of them were situated close to others and some were settled very aside of other nests. Nestings differed also with the altitude and with the place where penguins used to go to the water for feeding ("beach"). The nestings (and nests) were classified as "anchorite-social", high-low situated and according to their usual beach. The following three groups of adult birds were investigated for morphological variability. First group - EP ($n = 124$) - from the rookery at the low place of eastern part of Petermann Island, near the refuge. Second group - WP ($n = 113$) - from the rookery situated high on the hill at the small peninsula of western part of the island. The third group - BP ($n = 73$) - adults of different rookeries that had the common beach near the refuge. Analysis of variability of 16 morphological traits revealed statistically significant differences among groups for some of the traits. Relations between groups were different, for instance: Body mass, kg: BP > EP > WP

($M \pm SE$, respectively $5,29 \pm 0,05$; $5,41 \pm 0,05$ and $5,73 \pm 0,07$); Length wing - coccyx, cm: $BP > WP > EP$ ($36,4 \pm 0,2$; $35,5 \pm 0,1$ and $35,2 \pm 0,2$); Length of the tail from coccyx, cm: $EP > WP > BP$ ($14,2 \pm 0,1$; $14,0 \pm 0,1$ and $13,6 \pm 0,1$). Some differences (body mass) may be explained by different time of birds' examination. First were inspected birds of EP group, then - WP and last - BP. As a result the observed differences may reflect physiological and morphological changes during the breeding period. At the same time other traits (body length) don't change significantly during the season and differences between groups may suggest the certain level of genetic differences.

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DYNAMICS OF NESTING AND REPRODUCTIVE SUCCESS OF GENTOO ON PETERMANN ISLAND IN 2002-2003

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The colony of gentoo at the Petermann Island ($65^{\circ}10' S$, $64^{\circ}08' W$) is one of the most south populations of *Pygoscelis papua*. The colony was left by most of birds in the middle of the May 2002. Overwhelming majority of birds returned to the Petermann Island at the end of September. First eggs were registered in the period of 23rd - 28th of November. The egg-lying bulk was in the first half of December, when the eminences showed up from under snow. 87% of gentoo couples laid two eggs and the rest - one or none. Incubation period was continued near 23 - 27 day. First chicks hatched at the end of December, the most intensive hatching was observed during the first decade of January. New nests were appeared and eggs were laid while new territories released out of the snow. The reproductive period of 2002-2003 summer continued till the first week of February inclusive (end of observations of the season). At the beginning of February chicks (about 16 %) left nests for the kindergarten. In December we carried out the total registration of gentoo nests at the Petermann Island. Total number of the nests was 2210. Thus, the number of adults was about 4500 birds. For monitoring of dynamics of reproductive success we selected 20 nesting groups (more than 500 nests). These groups were checked for nests, eggs and chicks every ten days. The reproductive success (number of progeny per nest) for those nests was as follow: 1,58 (03.12.02); 1,68 (20.12.02); 1,62 (30.12.02); 1,46 (10.01.03); 1,24 (20.01.03) and 1,15 (30.01.03). Petermann Island is one of the most tourist-visited places in Antarctica. To evaluate the level of tourism impact on gentoo reproductive success we checked also the dynamics of reproductive success of another small gentoo colony (28 nests) at the Nameless Island situated near the Petermann Island but never visiting by tourists ($65^{\circ} 12' S$, $64^{\circ} 05' W$). On the 30.12.02 the number of progeny per nest was 1,68, and 31.01.03 it decreased to 1,25.

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CYTOGENETIC PARAMETERS OF GENOME INSTABILITY OF *PYGOSCELIS SP.*

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The comparative analysis of cytogenetic parameters of genome instability of *Pygoscelis sp.* and other birds of Antarctic ecosystem was carried out. The rates of micronuclei (MN) and other nuclear anomalies (NA) in mature erythrocytes of peripheral blood were selected as main indicators of genome instability. The blood samples of three species of *Pygoscelis* genus (*P. adeliae*, *P. antarctica*, *P. papua*) and *Phalacrocorax atriceps* were collected in austral summer

of 2002-2003 (Petermann Isl). The samples of blood of *Catharacta maccormicki* were collected in austral summer 2001-2002 (Galindez Isl). Blood smears were fixed in 96% methanol and stained with 2% Giemsa stain. The mature erythrocytes (10.000 cells minimum for each bird) were scored under light microscope for micronuclei and nuclear anomalies. To characterize genome instability of birds we have studied level of MN and more frequent NA. More frequently registered NA were classified as "budding nucleus" (*bn*), "two-lobe nucleus" (*tln*), "tailed nucleus" (*tn*) and "nucleus with cavity" (*nc*). The average rate of micronuclei of *P. antarctica* was $0,02 \pm 0,02\%$, *bn* - $0,17 \pm 0,04\%$, *tln* - $0,18 \pm 0,06\%$, *nc* - $0,38 \pm 0,08\%$. The middle value of micronucleus frequency of *P. adeliae* was $0,17 \pm 0,02\%$, *bn* - $0,13 \pm 0,05\%$, *tln* - $0,13 \pm 0,05\%$, *nc* - $0,28 \pm 0,07\%$, *tn* - $0,08 \pm 0,04\%$. The average rate of micronuclei of *P. papua* was $0,05 \pm 0,02\%$, *bn* - $0,10 \pm 0,03\%$, *tln* - $0,09 \pm 0,05\%$, *nc* - $0,12 \pm 0,05\%$, *tn* - $0,03 \pm 0,02\%$. The average rate of micronuclei of *C. maccormicki* was $0,04 \pm 0,02\%$, *bn* - $0,02 \pm 0,02\%$, *tln* - $0,09 \pm 0,03\%$, *nc* - $0,12 \pm 0,04\%$, *tn* - $0,01 \pm 0,01\%$. The average rate of MN of *Ph. atriceps* was $0,20 \pm 0,14\%$, *bn* - $0,10 \pm 0,10\%$ and *tln* - $0,10 \pm 0,10\%$. The application of studied parameters to characterize the species' and populations' features of genome instability of Antarctic birds will be discussed. This work was supported in part by grant INTAS-2001-0517.

INTER-ANNUAL CHANGE IN THE FORAGING SUCCESS OF KING PENGUINS IN RELATION TO OCEANOGRAPHIC CONDITIONS AT KERGUÉLEN ISLANDS, SOUTH INDIAN OCEAN

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Detecting and understanding the consequences of long-term changes in southern marine ecosystems is of prime importance. Top predators such as penguins are the only components of these ecosystems that can be easily monitored. They are directly influenced by the availability of their prey which are themselves influenced by abiotic components.

King Penguin *Aptenodytes patagonicus* is one of the largest consumers of myctophids fish, a key resource and temperature-sensitive, of the southern ocean. As part of a long-term study on the foraging ecology of King penguin, we investigated variations in foraging success at Kerguelen (South Indian ocean) in relation to climatic variability. Data were available for 8 years (1995, 1998-2004). The foraging movements (determined by satellite tracking) and the diving behaviour of penguins breeding at the Ratmanoff colony (>60.000 pairs) were recorded together with the sea water temperature on the same individuals each austral summer from 1998 to 2004 ($n = 41$ birds). Temperature and pressure were sampled with resolutions of $0,18^{\circ}C$ and 2 m respectively. Data about myctophid availability was available from pelagic trawls conducted over 3 summers (1998-2000).

Results indicated that many parameters related to foraging behaviour such as dive distribution, dive rate, dive depth and bottom time show high flexibility both within the population and from year to year. The foraging parameters varied concurrently with changing oceanographic conditions (temperature of the upper water column) and food availability. In all years the birds foraged eastward along a transect following the Kerguelen shelf break south of the Polar Front. The penguins foraged between 110 and 640 km from the colony and dived mostly between 120 and 250 m. During a year of abnormal warm water and low myctophid availability such as 1998, they dived deeper and increased their dive rate and bottom time by contrast to normal years (50 %, 57 % and 7 % differences, respectively). Also the relative proportion of non-myctophid fish species was higher in the diet. On the other hand, the maximal foraging range, chick provisioning rate and breeding success at the guard stage did not differ significantly. Adjustment of diving parameters by King Penguins probably optimises their foraging success so as to maximize feeding for themselves and provisioning their chick in response to environmental variability.

BREEDING SUCCESS AND POPULATION TRENDS IN ADELIE PENGUINS IN AREAS WITH LOW AND HIGH LEVELS OF HUMAN DISTURBANCE

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The breeding performance of Adelie penguins (*Pygoscelis adeliae*) was studied at Hope Bay (Esperanza Bay), Antarctic Peninsula, by comparing an area with low levels of human disturbance (LLD) and an area with high levels of human disturbance (HLD), close to an Argentine research station.

From 1995 to 2002 (except for 1999) the following population parameters were measured in both areas (1) the number of breeding pairs, (2) the number of chicks at fledging and (3) the number of chicks produced by breeding pairs. Counts were made for 35 breeding groups situated in the HLD area and 24 breeding groups located in the LLD area. The number of chicks per breeding pair was obtained by following 100 marked nests in each area. All parameters were measured as described in the CCAMLR Monitoring Program protocols.

The magnitude and direction (increasing or decreasing) of breeding population sizes and the number of chicks creched were similar in both areas. Overall, the number of breeding pairs decreased from 4,744 to 4,144 (12%) in the LLD area, and from 8,744 to 7,510 (14%) in the HLD area. The number of chicks fledged increased from 3,808 to 4,890 (28%) in the LLD area, and from 6,997 to 8,165 (17%) in the HLD area. Breeding success (chick fledged per marked nest) did not differ significantly between areas in any of the seasons compared. There was no evidence of adverse effects caused by the proximity of the Esperanza Station on the breeding performance of Adelie penguins at Hope Bay.

BREEDING SUCCESS AND POPULATION SIZE OF ADELIE PENGUINS IN MIXED BREEDING SITES. CAN THE PRESSURE OF CHINSTRAPS HAVE A LONG TERM EFFECT?

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At Laurie Island (South Orkney Islands), there are some breeding areas where two *Pygoscelis* species (*Pygoscelis adeliae* and *P. antarctica*) breed at the same sites (mixed sites), competing for the available space, and there are other areas where only the Adelie penguin breeds (single sites). To study the effects of this competition on the breeding performance of the Adelie penguin, breeding pairs and chicks fledged were counted on five mixed sites and two single sites from 1995 to 2002 (except for 2000), as described in the CCAMLR Monitoring Program protocols. Additionally, between 70 and 120 nests of Adelie penguins were marked and followed daily to quantify the losses due to usurpation by arriving *P. antarctica*.

The numbers of Adelie breeding pairs increased by 20% in single groups while they dropped by 36% in mixed groups. As a consequence, while breeding pairs in mixed groups represented 73% of the total breeding pairs counted during 1995, they only represented 50% by 2002. The number of chicks fledged followed a similar overall trend in mixed and single groups throughout the study period. However, while the fledged chicks counted in mixed groups represented 64% of the total number in 1995, they only amounted to 47% in the 2002 season. The number of chicks fledged per breeding pair (taken as the ratio of the number of chicks fledged to the number of breeding pairs for a given breeding group) followed an identical trend between years in mixed and single sites. However, this ratio was 10 to 35 % lower in mixed sites than in single sites. On average, 28.5% (range 16.6- 49.3) of the marked nests were usurped by *P. antarctica*. The peak of Adelie nest losses to Chinstraps occurred between 6-20 November in all seasons, except for 1997 and 1999, when due to the later arrival date of Chinstraps, the peak of nest site takeovers took place between 20 November and 6 December.

We suggest that the presence of Chinstraps had not only direct adverse effects on the breeding success of Adelie penguins in mixed sites, but also a possible long term effect by negatively impacting on the recruitment of pre-breeding birds.

LITTLE PENGUINS AS INDICATORS OF CLIMATE CHANGE

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Recently there has been renewed interest in the use of natural systems in detecting climate change. Continuous biological datasets, covering a number of decades, are rare in Australia, however, data do exist on the timing of commencement of breeding of Little Penguins on Phillip Island in south-eastern Australia over 30 years. The mean laying date of the penguins on Phillip Island, has become progressively later over time and the question is raised as to whether this can be interpreted as a climate change signal.

ARE KIWIS BETTER DIVERS THAN AUSSIES: AN INTRASPECIFIC COMPARISON OF FORAGING EFFORT IN LITTLE BLUE PENGUINS EUDYPTULA MINOR

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Little blue penguins, the world's smallest penguin, breed in several small colonies in New Zealand and Australia where environmental conditions and breeding success varies dramatically amongst colonies. However, they feed on similar types of prey (Clupeids) and face similar limitations on their foraging range. In this study, we compare the diving performance of little blue penguins at two colonies in New Zealand (Motuara Island and Oamaru) and two colonies at eastern (Phillip Island) and Western Australia (Penguin Island) using miniaturised time-depth recorders of similar size. Sampling was focused on the guard stage when parents mostly make one-day trips. In New Zealand, diving little blue penguins showed higher vertical velocities than in Australia, with males gaining depth two times faster and females between 60% and 80% faster than Australian penguins. The pause between dives was longer for penguins in Australia. Penguins dived up to four times deeper in colonies with lower breeding success (Motuara Island and Phillip Island) which resulted in dives up to three times longer for those two locations. As little blue penguins have one of the shortest foraging ranges among seabirds, their diving performance at different locations can help to reveal the constraining conditions under which they evolved their foraging behaviour.

STRUCTURE OF THE HELMINTH COMMUNITY OF THE MAGELLANIC PENGUIN: FIRST RESULTS FROM NORTHERN ARGENTINEAN COAST

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In this work we present the first results about the parasites helminth community of *Spheniscus magellanicus* on the Argentinean coast. From 1996 to 2001, 30 Magellanic Penguins, which were found dead, were collected (20 from Chubut province, 6 from the same area but coming from a massive mortality occurred in 2000, and 4 from Buenos Aires province). The birds were dissected and the helminthes recovered studied using conventional techniques. The prevalences (P), mean intensities (MI) and mean abundances (MA) were calculated for each parasitic species. The 100% of the hosts were parasitized. The 20 specimens from Chubut were parasitized for some of the following helminthes: *Tetrabothrius lutzi* (Cestoda: Tetrabothriidae) (intestine, P = 80%, MI = 42, MA = 34); *Cardiocephalooides* sp. (Digenea: Strigeidae) (intestine, P = 55%, MI = 128, MA = 70); *Cosmocephalus obvelatus* (Nematoda: Acuariidae) (esophagus, P = 25%, MI = 5, MA = 1.4), *Contraecaecum* sp. (Nematoda: Anisakidae) (adults: esophagus and stomach, P = 40%, MI = 149, MA = 60; larvae: intestine, P = 100%, MI = 283, MA = 283) and *Corynosoma* sp. (Acanthocephala: Polymorphidae) (intestine, P = 55%, MI = 55, MA = 30). The relations variance-mean and Morisita Index, the distribution of the parasite species in the host population fits to the Binomial Negative model. The parasitic interactions in the intestine, which were analyzed by the Fager Index, showed only a positive association between *T. lutzi* and *Cardiocephalooides* sp. ($t = 2.76; p < 0.05$), although the others association values were closely to the level of significance. The Index of diversity of Shannon-Weaver was relatively low ($I_{Sh} = 0.9$) and the equitability was of an intermediate value ($E = 0.56$). The specimens examined from de massive mortality were parasitized for the same helminthes parasites, excepting *C. obvelatus* which was absent; the prevalences and intensities were much higher, indicating a bad condition of the birds. In the penguins from Buenos Aires, *C. obvelatus*, *T. lutzi* and *Corynosoma* sp. were not present; however, an undescribed *Tetrabothrius* species was found instead. According with the analysis performed, we can conclude that the helminth community in *S. magellanicus* is very predictable. The low value of parasitic diversity observed is corroborating the hypothesis that a narrow trophic spectrum corresponds with few ways of incorporation of parasites, because most helminthes are transmitted by food.

PENGUIN POPULATION MONITORING - HOW MANY PENGUINS SHOULD WE COUNT?

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The use of population size of penguins as a monitoring tool to detect the effects of fisheries is well established. The size of a population is a product of the effects of demographic processes (survival and recruitment) as well as movement processes (immigration and emigration). Using colony census data from penguins as a tool to monitor the effects of fisheries generally depends on detecting demographic changes rather than movement induced changes. However, in very few cases is it possible to count all of the individuals in a population and generally a convenient sub-unit(s) is chosen with the assumption that any changes recorded will be representative of the population as a whole. However, at small scales, relative to the total population, the effects of movement induced changes may often be sufficient to obscure demographic changes and therefore limit the ability to determine the causes of any observed changes. Data on the population size and breeding success of Adélie and chinstrap penguin, collected as part of the long-term monitoring of a number of colonies on Signy Island, South Orkney, are used to

identify a range of different scenarios where demographic and movement processes might be implicated in changes in population size. The results of these analyses are discussed in the context of a general approach to determining the appropriate scale at which monitoring of penguin population size should be conducted.

TO FLEE OR NOT TO FLEE: AFRICAN PENGUINS AND PEOPLE

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Ecotourism in the Western Cape Province, South Africa, is a huge and growing industry. African Penguins *Spheniscus demersus* (Vulnerable) are a drawcard in the industry, and the species has a reputation for tolerance of humans at its most visited mainland breeding site (Boulders Penguin Colony). One-third of the global population of the species occurs on Dassen Island, a site that will soon be accessible to tourists. The aim of this study was to describe the behavioural responses of breeding penguins on Dassen Island to approaches by a small group of people, and to investigate the effects of nest type and breeding stage on these responses. Three people, always wearing the same clothes, approached breeding birds on foot at a slow, constant pace. Key responses (vigilance, agonism, shifting position on the nest and nest abandonment) of penguins were recorded prior to the approach and at 5 m from the nest. Three nest types were defined: exposed, semi-exposed and rock shelters. Nest contents were recorded as eggs, small chicks or large chicks. Most birds became vigilant prior to the onset of the approach and demonstrated agonistic behaviour when approached to 5 m. Pre-approach behaviour was generally resumed as soon as the approachers retreated to their start position. An agonistic response to a 5 m approach was more common for birds with chicks than for those with eggs. About one-quarter of birds with exposed nests abandoned during approaches. All except one of these birds were incubators. African Penguins breeding on Dassen Island appear sensitive to disturbance by small groups of humans on foot. Tourism on the island will have to be carefully regulated to avoid negatively impacting the breeding success of this important population.

VARIABILITY IN NEST TEMPERATURE BETWEEN DIFFERENT NEST TYPES AND ITS IMPLICATION ON DESERTION FOR THE AFRICAN PENGUIN (*SPHENISCUS DEMERSUS*)

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African penguins *Spheniscus demersus* come ashore to breed from mid-January/February where they lay a clutch of 1-2 eggs. This is frequently followed by mass abandonment of eggs during periods of extreme heat experienced in February/March. On Robben Island a variety of nest types and habitats are used as nest sites, including scrapes, burrows, and artificial nest boxes in open grassland, rooikrans thickets and woody forested areas. Mini-biologgers recording temperature at 15 minute intervals were placed in a sample of active nests of various nest and habitat types. The nests were monitored weekly, where nest contents and presence of an adult bird were recorded until nest failure occurred, when the logger was removed and the data downloaded to a PC. Only nests that were clearly abandoned (i.e. unattended, but still had egg(s) present) were used in the analysis. The aim of this study is to ascertain to what extent temperature extremes vary between different nest and habitat types, and whether all nest desertions are a direct result of heat stress experienced by the incubating bird, or whether perhaps some are an indirect result, as the birds may not be suffering from heat stress themselves, but merely 'following the crowd' due to their colonial nesting instincts. Some trends in nest temperature per habitat and nest type will be presented as well as insights into what actually triggers mass abandonment of clutches during extreme temperatures.

BREEDING SUCCESS OF KING PENGUINS (*APTENODYTES PATAGONICUS*) UNDER CONTROLLED CONDITIONS

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Since the year 2000 a reproductive program for King penguins (*Aptenodytes patagonicus*) has been developed at the Mar del Plata Aquarium's penguins habitat. The program started with an initial group of 9 individuals, mainly adults, housed at the aquarium from 7 years ago. The reproductive season of these species in nature is from October to February, and the same conditions exist under controlled environment. This species lay one egg every three years which is incubated by both parents. In the present work we evaluate the success of the developed program. Postures were registered from the first year of application of the program. No success was achieved in the first reproductive season either because the egg was lost during the transfer between parents in the incubation period or due to development failure. In 2003 seven king penguins of different ages and sexes were incorporated to the habitat. This allowed the arrangement of new couples. During the 2003 reproductive season two of the arranged couples had successfully bred. Two chicks were born in December, after 54 days of incubation with one week of difference. The animals remained with their parents and were always fed by them. Parents were fed ad libitum twice a day with different fish species such as anchovy (*Engraulis anchoita*), horse mackerel (*Trachurus lathami*), striped weakfish (*Cynoscion guatucupa*), silver side (*Odontheistes argentinensis*) and blue fish (*Pomatomus saltatrix*), according to the seasonal availability. The penguins were weighed weekly with a mechanical scale. The daily weight increment was in average 98.5 g for chick #1 and 81.4 g for chick #2 showing a similar growth rate. The chicks differed in relation to the age in which they abandoned their parents protection (62 days for chick #1, and of 53 days for chick #2). The first dawn appeared approximately 32 days after they were born and the first feathers started appearing at the age of 160 days. The obtained results should be compared with those in nature so as to evaluate differences between environments, and the incidence of controlled conditions in the development of the reproductive behaviour of the species.

DO NUMBERS COUNT? GENTOO PENGUIN BEHAVIOUR IN RESPONSE TO SINGLE AND GROUP PEDESTRIAN APPROACHES ON SUBANTARCTIC MACQUARIE ISLAND

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Predator group size is known to be a significant factor influencing anti-predator behaviour in wildlife. Similarly, group sizes of anthropogenic stimuli, eg. numbers of wildlife tourists, are suggested to play an important role in how wildlife will respond to human activities (Frid & Dill 2002). Developing an understanding of these responses can assist wildlife managers in producing more appropriate minimal impact guidelines for human activity near wildlife. During the 2002 – 2003 austral summer on subantarctic Macquarie Island (54°30'S 158°57'E), we undertook a study to determine if there was a difference in the behavioural responses of guarding Gentoo penguins *Pygoscelis papua* when exposed to single persons or groups of people visiting the nest. This was achieved using an experimental design, whereby the behavioural responses of guarding Gentoo penguins were collected before, during and after exposure to a standardised pedestrian approach of either a single person or a group of five people. For both pedestrian approach treatments, behaviour in the presence of pedestrians was significantly different to that recorded prior to the pedestrian stimuli, primarily characterised by heightened vigilance activity. However, the frequency and duration of vigilant activity was significantly greater in the presence of groups of people than single persons, suggesting that Gentoo penguins associated a higher level of perceived risk with increased numbers of people during pedestrian visitation. Further, for both pedestrian approach treatments, there was

evidence that vigilance levels continued to remain elevated after the pedestrians departed. The relevance of findings for the management of human-Gentoo penguin interactions on Macquarie Island are discussed.

Frid, A. & Dill, L. (2002). Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology*, 6: 11 [online] <http://www.ecologyandsociety.org/vol6/iss1/art11>.

SHAPE CAN INFLUENCE THE RATE OF COLONY FRAGMENTATION IN ROCKHOPPER PENGUINS

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There have been considerable population declines at a number of Rockhopper Penguin *Eudyptes chrysocome* rookeries over the past 50 years or so. At Campbell Island, New Zealand large contiguous rookeries have fragmented into several smaller sub-colonies and although the underlying cause of the major part decline was possibly diet related, it seems likely that predation may be having an increasingly important impact. Borrowing from island and habitat fragmentation theory, we hypothesised that since predation and colony contraction are edge related, the initial shape of the colony may play an important role in how quickly it might fragment and in turn how long it might persist. We investigate the conditions under which colonies of different shape would fragment using a series of model simulations, and investigate how this might relate to the decline in numbers.

POPULATION SIZE, RECENT TRENDS AND CONSERVATION STATUS OF THE AFRICAN PENGUIN (*SPHENISCUS DEMERSUS*) IN NAMIBIA

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Since the 1990s all African penguin (*Spheniscus demersus*) breeding localities in Namibia were visited and the breeding population estimated. Four localities, Possession, Halifax, Ichaboe and Mercury islands account for 97% of the total Namibian breeding population. Regular counts of moulting adult birds and active nests at these localities are used to estimate recent population trends. Since the 1950s, the Namibian adult penguin population has decreased by 2.5% per year, from roughly 100000 adult individuals to 27000, while the number of nests at breeding peak has decreased by 3.7% per year. This decline has slowed during the last decade, with the adult penguin population declining by 1.5% per year and the number of active nests at breeding peak by 2.0% per year. Numbers of adults have decreased most rapidly on Possession Island, from an estimated 46000 adults in 1956 to only 1600 individuals in 2002. Numbers on Ichaboe Island decreased sharply after 1995. Mercury and Halifax islands are the only Namibian breeding localities with more than 1000 individuals, where numbers have either stabilised or have increased during recent years. The species is currently listed as globally "vulnerable". The Namibian population has recently been re-evaluated using the latest IUCN criteria and has been classified as "endangered" owing to its rapid continuing decline. Threats include lack of food, low quality breeding habitat, disturbance, oiling, predation and competition with Kelp gulls (*Larus dominicanus vetula*) and Cape fur seals (*Arctocephalus pusillus pusillus*). Conservation actions need to include better legislation as well as the investigation of suitable practical measures such as the use of artificial shelters to improve breeding success.

AN ESTIMATE OF POPULATION SIZES OF ROCKHOPPER AND MACARONI PENGUINS AT ISLAS SAN ILDEFONSO AND DIEGO RAMIREZ, CHILE

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During the incubation period of 2002, we estimated numbers of breeding pairs of rockhopper and macaroni penguins at Islas Ildefonso and Diego Ramirez, in Southern Chile. Both locations comprise island groups and we conducted ground censuses at the largest island within each group. Firstly, we searched the islands to locate breeding areas and used a hand-held GPS to survey the boundaries of these (latitude, longitude and elevation). Surface areas of the colonies, taking slope into account, were determined through plotting the GPS points into a spatial analysis program (ArcInfo). Then we calculated the densities of the penguins in the areas with two area-sampling techniques, quadrat sampling and distance sampling. To extend the survey over the entire archipelagos, we conducted aerial photography of all the islands and within the resultant photographs we distinguished the locations of penguin colonies. Based on estimated areas of occupation and the densities derived at the ground-surveyed islands, we derived archipelago estimates. Our population estimates are compared with data from the early 1980s to record the current status of these penguins in southern Chile.

IS CAROTENOID-BASED PLUMAGE INVOLVED IN MATE CHOICE BY SNARES CRESTED PENGUINS?

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Carotenoid-based colours such as red, orange, yellow can potentially serve as important sexual signals that function as indicators of the health and quality of prospective mates. Carotenoids are relatively scarce and are known to have health benefits. It is hypothesized that high-quality individuals will be able to acquire and deposit more carotenoids in the structures used for their sexual displays. Snares Crested Penguins are one of the penguins that have elongated yellow crests however, whether this is used for their sexual display is largely unknown. This study will examine mate choice of Snares Crested Penguins by studying the relationship between the male body characteristics with their plumage colours.

AVIAN PREDATION AT A SOUTHERN ROCKHOPPER PENGUIN COLONY ON STATEN ISLAND, ARGENTINA

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The association between avian predation on Southern Rockhopper Penguins (*Eudyptes chrysocome chrysocome*) and subcolony size was examined during the chick-rearing period. In addition, activities of various predator and scavenger species at these subcolonies was documented and quantified for the first time. Eight subcolonies ranging from 69 to 1520 nests were observed for 461 h from 6-31 December 2003. Striated Caracaras (*Phalacrocorax*

australis), were the most common predator/scavenger species in all subcolonies except for two in which Kelp Gulls (*Larus dominicanus*) and Dolphin Gulls (*Larus scoresbii*) were dominant. Total activity rates by both gull species were significantly higher during the last week of our study, once crèches had formed. Searches, predation and attempted predation rates for all species together were higher in larger subcolonies and relative rates were collectively negatively associated with subcolony size, but this was not significant. For Striated Caracaras, over 50% of the predation and attempted predation events were from central tussocks and on nests that were next to these tussocks. Striated Caracaras probably spend more time in larger subcolonies which offer a greater area with central tussocks compared to smaller subcolonies where central tussocks are generally absent. Predation and attempted predation by gulls were only on central nests and from the air. Neither chick mortality nor probability of predation showed a significant correlation with subcolony size. The largest as well as the smallest subcolonies had the lowest chick mortality and probability of predation compared to the rest of the subcolonies.

THERMOREGULATION IN MAGELLANIC AND HUMBOLDT PENGUINS

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The Humboldt penguin is endemic to the Humboldt Current with colonies extending from Isla Foca, Perú (5°S), to Puñihuil, southern Chile (42°S), while the Magellanic penguin breeds from Cape Horn up to 42°S on the Atlantic coast, and up to 29°S on the Pacific coast. Although, these species overlap in their distribution by ca. 900 km, it is expected, that species-specific adaptations may have moulded different physiological responses in these two species, letting each be optimally adapted to the environmental conditions in its breeding distributional range. It is expected that seabirds in colder climates have higher metabolic rates, lower thermal conductance and a lower limit of the thermoneutral zone than seabirds in warmer climate. To test these predictions, we conducted flow respirometry experiments in the congeners Magellanic and Humboldt penguins: we measured oxygen consumption and body temperature in air at ambient temperature ranging from -2 to 40 °C. We found that the thermoneutral zone extends from 2 to 16 °C for the Magellanic and from 4 to 30 °C for the Humboldt penguins. Resting metabolic rate differed significantly between Magellanic (3.2 Wkg⁻¹) and Humboldt (3.7 Wkg⁻¹) penguins. Minimal thermal conductance was also significantly lower in the Magellanic (0.09 W[Kg °C]⁻¹) than in Humboldt (0.15 W[Kg °C]⁻¹) penguins. Our results show that in the Humboldt penguins higher metabolic rates are not accompanied by an increase in insulation and reduction in the lower limit of the thermoneutral zone. The lower thermal conductance of the Magellanic compared to the Humboldt penguin reflects an adaptation to colder climates. It appears that the observed physiological responses of the Magellanic and Humboldt penguins reflect the conditions they faces in their colonies during the breeding period. Funding through FONDECYT 1010250 and Volkswagen Foundation.

REHABILITATION OF MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*) IN THE ATLANTIC RAINFOREST COAST FROM 1999 THROUGH 2003

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The populations of Magellanic penguins, as well as other species of South American *Spheniscus* (*S. humboldti* and *S. mendiculus*), have declined due mainly to oil pollution, interaction with fishing activities and weather changes caused by global warming. The report by

penguin fishers in Southeast Brazil has been taking place through decades, because penguins are migratory birds that cross international borders as part of their life cycle. The ones found alive in the Atlantic Rainforest Coast are taken to the Aquário de Santos for recovery and rehabilitation. The birds are stabilized and get specific treatment, being released or redirected to other institutions that have appropriate facilities according to the law on the maintenance of captive species. The Aquário de Santos has reported successful reproduction of penguins since 2001. Although the Magellanic penguin is not considered a threatened species by IUCN, population monitoring and research may help explain the reason of the observed strandings and help establish actions for reducing human related effects. The most common effects observed in stranded birds were debilitation in juvenile individuals (55,90%), clinical infection by aspergilosis (8,7%), bacterial infections (14,47%), oiling (6,76%) and traumas due to interactions with fisheries and predators (6,9%). The weight of juveniles individuals that arrived at the Institution in the last 5 years appears to reflect the higher or lower food availability, that probably varies due to climatic factors. Wider studies in Brazilian Coasts are necessary to improve Magellanic penguin conservation strategies.

HUMBOLDT PENGUIN CENSUS ON ISLA CHAÑARAL, CHILE: RECENT INCREASE OR PAST UNDERESTIMATES OF PENGUIN NUMBERS?

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While Isla Chañaral (29°02'S) in Chile has long been recognized as one of the most important breeding islands for the Humboldt Penguin, reported numbers of birds there never exceeded 3,500 breeding individuals in the last two decades. However, in 2002, a one-day survey found considerably more penguins present on Isla Chañaral such as to exceed the world population estimate for the species (3,300 - 12,000 birds). Between 9 and 14 February 2003 we conducted a Humboldt Penguin census on Isla Chañaral. Two different survey methods were combined to assess the number of penguins. Terrestrial or surface counts were used to survey penguins on open plains or beaches. Small area surveys of randomly established counting quadrats were conducted to assess the number of penguins in nests as well as total number of nest sites. Results from small area surveys were extrapolated using surface size ratios of counting quadrats vs. entire nesting sectors. We determined that approximately 22,000 adult Humboldt Penguins, 3,600 chicks and 117 juveniles were present on the island during the survey. The results were much higher than any previously published estimate. Natural processes alone cannot account for a population increase, and penguin numbers on Isla Chañaral previously have been underestimated. The results correspond well with recent publications that suggest that Humboldt Penguin numbers in Chile have been underestimated in the past due to inconsistent census methods. There are concerns about the current protection status of the island in light of its fragility and importance as the premier breeding location of the Humboldt Penguin along its entire distributional range.

FOSSIL PENGUIN REMAINS AT THE SOUTH SHETLAND ISLAND: TAPHONOMICAL INFERENCES

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A vertebrate fossil assemblage was exhumed from the Holocene raised beach deposits on the coast of Potter Peninsula, King George Island (South Shetland Islands, Antarctica), where the geological composition is dominated by Lower Tertiary volcanic sequences and Quaternary deposits. The vertebrates remains found at Pingfo locality (62°15'26"S, 58°37'08"W), were identified to species where possible, and radiocarbon dates on penguin bones as well as new taphonomical data were obtained as a contribution to reconstruct the Holocene environmental history of this area. The subfossil assemblage includes remains assigned to *Pygoscelis adeliae*, *P. papua*, *Catharacta antarctica* and unidentified marine mammals. Radiocarbon dating on the penguin bones yielded near 5800 yr BP, corresponding to mid-Holocene epoch. We found nearly 450 penguin bones, which correspond to: 8 skulls, 224 appendicular elements, 12 sternum, 131 parts of girdle, 13 synsacrum and 50 vertebrae, among others. Similar proportion of bone types was observed in the modern tanatocoenoses in the study area, where remains of penguins -some of them preyed on by skuas and marine mammals- constitute large accumulations. The studied fossil-bearing raised beach deposits reflect the glacio-isostatic emergence of the coastal area, where important uplifts have been identified. Additionally, the avian assemblage is composed of flying-bird remains assigned to Brown skua *Catharacta antarctica*, including three bones of the wing, two of the leg, a synsacrum with the pelvic girdle, and a jaw. The bird bones and a fragmentary appendicular bone of sea elephant *Mirounga leonina* suggest that the complete fossil assemblage represents biocoenoses, representing organisms inhabiting the coastal area of King George Island. The presence of non-reworked bones accompanied by a partially articulated penguin skeleton indicates that the remains underwent minimum transport, being accumulated near the site of death. This idea is confirmed by the discovery of several nearly complete skulls and sternums as well as the presence of penguin's tail feathers, which abound within the studied sandy beds. Besides, this proposal is congruent with the rapid sedimentation produced by the beach dynamics associated to the mid-Holocene episodes of marine transgression reported from this coast.

COLOUR VISION CAPABILITIES OF LITTLE PENGUINS, *EUDYPTULA MINOR*

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Many penguin species have coloured markings ranging from yellow to red on their head and necks which may be used in specific displays between individuals. To recognize these markings on other individuals, penguins should have good perception of light at longer wavelengths. However, a study showed that penguins have poor perception at this end of the light spectrum. Although Little Penguins have no coloured markings, they may be useful to determine the perception of colours at long wavelengths due to the similar anatomy of the penguin eye. I examined three anatomical characteristics of the retinas of Little Penguins; (i) the ratio of rods to cones; (ii) the density of visual receptors in different regions of the retina; and (iii) the type/colour of oil droplets present in the retina. This study found the retina of the Little Penguin to be cone dominated and the majority of the oil droplets in the cones to be pale/green, with much smaller proportions of yellow, clear/colourless and red oil droplets. The low proportion of red oil droplets indicates reduced sensitivity at longer wavelengths (yellow-red). Little Penguins have a higher concentration of receptors in the posterior-temporal region of the retina, which means that their vision is better when looking up and forward. The poor perception of long wavelength light suggests that perception of colour for Little Penguins is not a primary function

of the eye. This poor perception may be enough for other penguin species to recognise the coloured markings. The results indicate that the retina is primarily designed for seeing under water where the wavelength of light is reduced. In addition, the higher visual acuity in the posterior-temporal region of the retina supports the theory that penguins come from below to catch their prey.

CONSERVATION OF HUMBOLDT PENGUINS IN PERU: EXPERIMENTAL APPROACH USING ARTIFICIAL COLONIES, DECOYS AND SOUND RECORDINGS

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This study was a follow up of tests using artificial nest burrows for increasing breeding success of the endangered Humboldt Penguin at Punta San Juan, the largest breeding colony in Peru. In 1996, penguins using artificial nests placed on an open colony were more successful than surface nesters because they were less affected by heat stress, gull predation, likelihood of fights with con-specifics, and aggressions from Peruvian pelicans. During El Niño 1997-98 penguins using artificial nests were less affected by rainfall and fox disturbance than surface nesters. In 2000, we tested use of penguin decoys and sound recordings to attract Humboldt penguins to artificial colonies with covered nests in order to expand suitable breeding areas targeting mainly guano-bird reserves, which altogether hold 50% of the population in Peru. Four colonies each with 20 artificial nests and different groups of adults and chick decoys were used to test size of decoy-group (21 versus 30 individuals) and the presence/absence of conspecific sound (adult and chick vocalizations) as possible attracting factors. The rates of visits, time spent at the colony and frequencies of nest checking were not affected by the size decoy-group but were affected by the presence of conspecific sounds. Penguins showed higher response for the colony without the sounds, possibly due to its closer location to the transit routes. Penguins performed more displays towards single adult decoys, and combinations of adult and chick decoys. Likewise penguins had more interactions with the "standing" and chick decoy positions than the "ecstatic" and "lying" positions. Although penguins visited all colonies and showed interest in the artificial nests, the nests were not occupied for breeding. The increase of available nesting habitat after El Niño 1997-98 may have slowed the occupancy of artificial nests. Overall our results showed that Humboldt penguins can respond to artificial manipulations, which can potentially be used for their conservation. The combined use of artificial nests, decoys and sound may serve to help design similar enhancements to higher quality nest sites in other locations for Humboldt penguins.

IMPACT OF AVIAN MALARIA IN CAPTIVE PENGUINS AT EDINBURGH ZOO, AND RELEVANCE TO WILD PENGUINS

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Exposure to *Plasmodium* spp. has been recorded in wild penguin populations, but has only been implicated in avian malaria deaths of captive *Spheniscus* spp. penguins, housed outdoors in zoos. Ante-mortem detection of intra-erythrocytic stages in bloodsmears is unreliable and molecular and serological tests only demonstrate exposure, not clinical disease. Post-mortem diagnosis of significant infection may be missed if *Plasmodium* schizonts are not demonstrated in tissue sections. A cause of death could not be found in 39% (n = 1271, 95%CI 36-42%) of penguins examined post-mortem at Edinburgh zoo from 1914-2004. It was postulated that malaria may have contributed to these deaths. Hepatic histology samples were evaluated for

non-specific pathology that could be caused by infection with *Plasmodium*. Pathology included peri-vascular mononuclear cell infiltration, erythrophagocytosis, and hemosiderin deposition. No significant association (Fisher's exact test, $p > 0.5$, $n = 92$) between season (March-September) and proportion of all penguins showing pathological changes was found (-0.14-0.27 95% CI), as would be expected by an arthropod-borne agent causing clinical disease. Similarly no significant association was found for deaths only due to undiagnosed causes ($p > 0.5$, $n = 48$), and undiagnosed causes in a single species, Gentoo penguins (*Pygoscelis papua*) ($p > 0.2$, $n = 34$). Only a single 10 month old gentoo penguin was confirmed with *Plasmodium* infection on demonstration of schizonts on post-mortem hepatic histology. No significant difference in pathology was found before and after prophylactic treatment of Gentoo penguin chicks with antimalarials and treatment of *Culex* spp. mosquito breeding sites with *Bacillus thuringiensis israeliensis* were instituted in 1999 ($p > 0.98$, $n = 92$). Avian malaria is thus unlikely to be a significant cause of undiagnosed deaths in penguins at Edinburgh zoo. As suitable arthropod vectors and *Plasmodium* in the local wild bird population are both present, the possibility exists that, in contrast to *Spheniscus* spp., the species held by Edinburgh zoo (King penguins *Aptenodytes patagonicus*, Gentoo penguins *Pygoscelis papua*, Macaroni penguins *Eudyptes chrysolophus*, Rockhopper penguins *Eudyptes chrysomus*) are not particularly susceptible to clinical disease caused by *Plasmodium*. Work is needed to elucidate if this is the case in wild populations exposed to *Plasmodium*. Further factors, and implications for studies of *Plasmodium* in wild penguin populations will be discussed.

STATISTICAL CLASSIFICATION OF DIVING BEHAVIOUR IN FEMALE ROCKHOPPER PENGUINS FROM STATEN ISLAND, ARGENTINA

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Time and depth recorders are capable of storing information over several weeks, yielding thousands of dives. Dives are usually characterized by variables strongly related. Multivariate methods provide both a useful tool to analyse huge amounts of data (dives), and to reduce the number of variables and human subjective bias in interpreting diving behaviour. 11819 dives of eight adult females of southern rockhopper penguins (*Eudyptes chrysocome chrysocome*) recorded during the chick rearing period in Tierra del Fuego were classified manually and statistically (principal component analysis, discriminant function analysis and cluster analysis). Using a combination of these methods all dives were classified into nine dive types. Each of them was characterized by a combination of the variables used to feed the multivariate analysis (like duration, bottom time, maximum depth, etc.). Visual inspection of the distribution of the dive types over the foraging trip context and time of the day, allowed to assign functionality to each dive type. The nine types were then reclassified into three hypothesized function groups: travelling, searching and foraging. The first one was characterized by shallow depths and short duration dives restricted at the beginning and end of a foraging trip. The exploration group was composed by dives of middle to intermediate depths, longer duration than the previous but with similar descent and ascent rates. The foraging group was similar to the second one but characterized by lower ascent rate. This characteristic was reported in other crustaceans' eaters pursuing mobile patches of preys. Most of the dives belong to the foraging group and occurred often immediately after some searching dives type. The classification of dives could be used to estimate foraging effort and efficiency, by allowing calculation of the proportion of time spent performing dives associated with foraging and the relative number of feeding events recorded. Although such an index remain a coarse estimate of foraging effort and efficiency, it would provide further insight into key aspects of the foraging ecology of these animals.

SEX AND BREEDING STAGE DIFFERENCES IN THE DIET OF SOUTHERN ROCKHOPPER PENGUINS (*EUDYPTES CHRYSOCOME CHRYSOCOME*) IN STATEN ISLAND, ARGENTINA

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Southern rockhopper penguins as all the crested species are sexually dimorphic and each sex has specific breeding duties. During the brooding period only females feed their chicks while both parents did it during the crèche stage. The stomach contents of 20 females during brooding and 10 from each sex during the crèche stage in 2002/2003 breeding season were analysed and the diet and stages and sex differences studied. Moreover, the foraging trips duration in both periods was assessed by an automated reading system that detected breeding birds, which were injected with transponders in previous seasons. In both stages a mixture of crustaceans, cephalopods and fish larvae and juveniles were found. Nevertheless, not all the prey species remained the same in both stages and also the frequency of occurrence and composition by number varied. We found also differences in prey species and composition by number between sexes during the crèche period. Given the duration of the foraging trips, the foraging areas were almost the same in both stages. However, almost twice the number of penguins were foraging during the crèche compared with the brooding stage. The diet and differences found between stages and sexes and its relation with the habitat, sexual dimorphism and competition are discussed.

UNCOUPLING PROTEIN AND ATP/ADP CARRIER INCREASE MITOCHONDRIAL PROTON CONDUCTANCE AFTER COLD ADAPTATION OF KING PENGUINS

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Juvenile king penguins develop adaptive thermogenesis after repeated immersion in cold water. However, the mechanisms of such metabolic adaptation in birds are unknown, as they lack brown adipose tissue and uncoupling protein-1 (UCP1), which mediate adaptive nonshivering thermogenesis in mammals. We used three different groups of juvenile king penguins to investigate the mitochondrial basis of avian adaptive thermogenesis in vitro. Skeletal muscle mitochondria isolated from penguins that had never been immersed in cold water showed no superoxide-stimulated proton conductance, indicating no functional avian UCP. Skeletal muscle mitochondria from penguins that had been either experimentally immersed or naturally adapted to cold water did possess functional avian UCP, demonstrated by a superoxide-stimulated, GDP-inhibitable proton conductance across their inner membrane. This was associated with a markedly greater abundance of avian UCP mRNA. In the presence (but not the absence) of fatty acids, these mitochondria also showed a greater adenine nucleotide translocase-catalysed proton conductance than those from never-immersed penguins. This was due to an increase in the amount of adenine nucleotide translocase. Therefore, adaptive thermogenesis in juvenile king penguins is linked to two separate mechanisms of uncoupling of oxidative phosphorylation in skeletal muscle mitochondria: increased proton transport activity of avian UCP (dependent on superoxide and inhibited by GDP) and increased proton transport activity of the adenine nucleotide translocase (dependent on fatty acids and inhibited by carboxyatractylate).

MONITORING HEMATOCRIT VALUES AND WEIGHT OF MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*) DURING THE REHABILITATION PROCESS

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The objective of this work was to verify hematocrit and weight variation in Magellanic penguins (*Spheniscus magellanicus*) during the rehabilitation process. In 2002 and 2003, upon arrival at the Centro de Recuperação de Animais Marinhos (CRAM), a marine animal rehabilitation center located in Southern Brazil, penguins were weighed and blood samples collected for hematocrit determination. Additional sample collection and penguin weighing were weekly performed until the rehabilitated penguins were released. The penguins (n=90) showed mean values (\pm SE) of hematocrit of $46.81 \pm 0.58\%$; $41.92 \pm 0.56\%$; $41.58 \pm 0.60\%$; $42.34 \pm 0.48\%$; $44.62 \pm 0.31\%$ upon arrival at CRAM, after the second, third and fourth week of recovery and before release, respectively. Hematocrit was significantly higher upon arrival at CRAM ($p < 0.05$). It also was significantly higher at the second, third and fourth weeks of recovery and before release ($p < 0.05$). Hematocrit after the second, third and fourth weeks showed similar values ($p > 0.05$). Mean weight of the penguins (n=75) was 2.725 ± 0.055 kg; 2.985 ± 0.0466 kg; 3.005 ± 0.0475 kg; 3.127 ± 0.0521 kg; 3.692 ± 0.0729 upon arrival, after the second, third and fourth week of recovery and before release, respectively. Weight was significantly lower upon arrival ($p < 0.05$) and significantly higher before release ($p < 0.05$). Weight after the second, third and fourth weeks of recovery showed similar values ($p > 0.05$). Low weight upon arrival suggests the penguins were fasting or starving. Water ingestion occurs through feeding, consequently dehydration occurred as a result of starvation. Dehydration was verified through high hematocrit values upon arrival, which decreased after hydration therapy.

THE PRESENCE OF THE MAGELLANIC PENGUIN (*SPHENISCUS MAGELLANICUS*) ON THE NORTHEASTERN COAST OF THE PROVINCE OF BUENOS AIRES, ARGENTINA, AND ITS RELATIONSHIP WITH PETROLEUM CONTAMINATION

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The population of Magellanic penguins of the Southeast Atlantic migrates towards the north arriving approximately at 23° south latitude (Brazil), during the non-breeding season. During this pelagic movement, parts are affected by petroleum spills or by derivative products. Numerous spills have occurred along the Argentine Coast which according to the reports of the Argentine Naval Prefecture, happened from 1998 to 2003, principally in ports, the same being controlled by trained personnel. Not having declared the possibility of eventual accidents or illegal discharge maneuvers on the high seas. However the constant appearance of affected penguins evidence the chronic presence of petroleum in our waters. La Fundación Mundo Marino (FMM), San Clemente del Tuyú, Buenos Aires, Argentina, receives oiled birds that are rescued in an area of approximately 160 kilometers from the north Buenos Aires coast (from 36°22' S/56°44' W to 37°15' S/56°58' W). From 1987 until 2003, 1,616 Magellanic penguins have been received. Of those, 79,64% were oiled, 69,2% adults and 30,7% juveniles. The mayor appearance of oiled penguins (75,06%) occurs between the months of may and august, a period that coincides with the pelagic phase of the biological cycle. On the arrival of each penguin its general condition is evaluated, morphometric measurements are taken, and they are identified with metal rings. The rehabilitation consists of: stabilization, feeding, removal of the contaminant, and re-conditioning of the plumage. Once they are discharged from veterinary medical care, and coinciding with the appropriated migration period, the birds are restored to the wild. These techniques have been

perfected through out these 17 years, allowing the percentage of rehabilitated birds to reach 94% in the last three years. This treatment of 1,616 birds for oil spills is insignificant in relation to the conservation of the penguin species. It has however, given us proof of constant petroleum spills for over 17 years, using the penguin as a biological indicator of the contamination that exists, and proves the necessity of efficient political control of the contaminant. In this way, it makes proven techniques possible and trained personnel available for eventual oil spills that can affect the stability of the penguin colonies.

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ANALYSIS OF THE SOURCES OF INTERANNUAL VARIABILITY ON THE REPRODUCTIVE PARAMETERS AND DIET OF CHINSTRAP PENGUIN ON LAURIE ISLAND, SOUTH ORKNEY ISLANDS, ANTARCTICA

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The CCAMLR Ecosystem Monitoring Program (CEMP) included krill predator parameters to detect changes in krill availability that can be attributed to the harvesting of krill. To this end it is necessary to establish baselines of interannual variability and to discriminate between changes due to natural factors other than variability in krill abundance. The results of the analysis of the diet and reproductive success CEMP parameters at Mossman Peninsula, Laurie Island in five breeding seasons (1998-2002) are presented here. Stomach contents weights, general diet components and krill length distribution were obtained using the standard CEMP methodology in Chinstrap penguin (*Pygoscelis antarctica*). Similar data from Adélie penguins (*P. adeliae*) were used for comparison purposes. Standard meteorological parameters were available, together with glaciological information. Krill was present in all the samples, while the frequency of occurrence of fish and amphipods was variable within and between years; always below 65%. The nested ANOVA of krill lengths in stomach contents indicates that Chinstrap penguins do not feed on the same aggregations and that a set of penguins is required to obtain a sample representative of the length distribution. Significant differences in lengths of krill available to penguins were found between days and years. Graphic analysis of Kolmogorov distances between penguins confirms these results. The weight of the stomach contents along the five years studied presented interannual variability that could not be explained by any particular cause, except in 1998 when the influence of the late breaking of the pack ice was highly significant in the stomach contents weights before and after the breaking of the pack ice. The late breaking of pack ice was identified as the cause of the significantly low reproductive success observed in 1998 (0.67 chicks/nest in 1998 against relative stable values around 1.2 in the other years of early breaking of the pack ice). It should be noted that the causal relationship between the late breaking of the pack ice and the marked descent in reproductive success was established on the basis of the comparison of Chinstrap with Adélie penguin data.

ARE NEST-BOXES TOO HOT FOR LITTLE PENGUINS?

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In order to assess on the potential impact that artificial nest-boxes may have on the occupation rate or physical condition of adults and chicks of Little Penguins *Eudyptula minor*, temperature was recorded continuously for 37 days simultaneously inside 7 nest-boxes, and in the

surrounding bush. The temperature inside the boxes was always higher than that in the bush, the difference being greater around noon. Solar radiation was suspected to be the main cause of the high temperatures recorded inside of the boxes. Temperature differences between outside and inside the boxes were smaller on windy and dry days. Our results indicate that the maximum temperatures experienced by Little Penguins in the nest-box may likely reflect the most unfavorable conditions for the birds. In order to avoid hyperthermic conditions, an improvement in the ventilation of nest-box is suggested here.

OCCURRENCE OF MALARIA IN MAGELLANIC PENGUINS (*SPHENISCUS MAGELLANICUS*) IN A REHABILITATION CENTER IN SOUTHERN BRAZIL

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Avian malaria is caused by *Plasmodium* sp. parasites and is a recognized disease problem of penguins during captive circumstances, causing significant mortality. Parasites are transmitted between vertebrate hosts mostly through *Culex* spp. and *Anopheles* spp. mosquitoes, which inject sporozoite forms of the parasite. On a simplistic approach, these invade liver cells and multiply into a different tissue-stage, the merozoites, later invading red blood cells (Gardiner et al., 1998; Grim et al., 2003). According to Grim et al. (2003) malaria is identifiable as the cause of death in the presence of clinical signs such as anorexia, depression, vomiting, dyspnea, parasitemia and postmortem findings. Gross lesions may include pallor caused by anemia, pulmonary edema, hydropericardium and splenomegaly (Gardiner et al., 1998; Grim et al., 2003). Sudden death is common. In 2001, Centro de Recuperação de Animais Marinhos (CRAM), a marine animal rehabilitation center located in Brazil, had two Magellanic penguins (*Spheniscus magellanicus*) dieing unexpectedly. Necropsy was performed and findings included hemorrhagic and edematous lungs, hydropericardium, splenomegaly, hepatomegaly with friable consistency. Microscopically, the main lesions were related to the liver and included moderate periportal granulocytic and mononuclear infiltrates; discrete to moderate multifocal necrotic areas; multifocal areas of extramedullary erythropoiesis; moderate congestion; and the presence of malaric pigment within macrophages and endothelial cells. The goal of this abstract is not only to document the record of malaria affecting penguins in Brazil, but also to alert other institutions rehabilitating seabirds in the region to consider preventative measures against the vector, to identify and monitor the presence of hemoparasites when considering reintroduction. *Acknowledgements:* We thank Dr. C.H. Gardiner (Registry of Veterinary Pathology - Armed Forces Institute of Pathology, Washington D.C., USA) for his assistance.

THE INTRODUCTION OF THE PENGUIN CONFERENCE JAPAN

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PCJ, that is NGO which consists of a lot of members who belong to zoos and aquariums and people who are interested in penguins, has been being active for all species of penguins since established in 1990. Since that, PCJ is being active to support and cooperate for penguin conservation of the world. For example, we keep to cooperate conservation of Humboldt

penguin in wild and support to SANCCOB, South Africa. In this conference, we introduce about our activity on poster.

DECREASE IN A POPULATION OF ADELIE PENGUINS AT KING GEORGE ISLAND, ANTARCTICA

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As part of a monitoring study of an Adelie penguin colony, birds occupying nests with eggs and chicks at fledging were counted annually from 1995 to 2002, at Stranger Point, King George Island, Antarctica. During the study period the breeding population showed a decrease between 1995 and 1996, increasing during 1997 and 1998, when the breeding population reached the 1995 level. There was a continuous decrease from 1998 to 2002, when the number of breeding pairs represented only 49.9% of those counted during 1995. The number of chicks at fledging followed a similar trend to that of the breeding population, the smallest number occurring in 2002, when it was 63.4% lower than in 1995. The decrease in both population parameters of Adelie Penguins is discussed in relation to the reduced population sizes of krill observed in the Antarctic Peninsula region and to the reduction of critical wintering habitats

PRELIMINARY RESULTS ON THE POST-BREEDING DISPERSAL OF MAGELLANIC PENGUINS FROM ISLA MARTILLO, TIERRA DEL FUEGO

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The winter dispersal of Magellanic penguins (*Spheniscus magellanicus*) breeding on Isla Martillo (54°54'S, 67°23'W, Beagle Channel, Tierra del Fuego) has been monitored for the first time. Eight birds (4 females and 4 males) were successfully equipped with satellite transmitters between 22 and 24 March 2004. The devices lasted for a mean period of 38±20 days (min=8, max=63), with 4 devices lasting >50 days. The last device stopped transmitting on 26 May 2004.

All birds left Isla Martillo within days after being equipped and travelled eastwards through the Beagle Channel until they reached the open sea. Then, they moved northwards along the coasts of Tierra del Fuego and southern Patagonia. During the initial tracking period birds travelled in coastal waters not further than 30 miles away from the coast. However, the two birds with longest attachment times (53 and 63, respectively) left coastal waters briefly to cross San Jorge Gulf, only to return to coastal waters in southern Chubut where devices finally ceased transmission. Two birds remained in coastal waters of Tierra del Fuego for >50 days, suggesting that some animals may remain in the area for at least the initial winter period. Presumably, during their dispersal penguins made extensive use of tidal fronts common in coastal waters of Patagonia and Tierra del Fuego. Our findings have major implications for the conservation of Magellanic penguins breeding in Tierra del Fuego. Five birds travelled through an oil exploitation area in northern Tierra del Fuego, and the two birds with longest attachment times also travelled through an area licensed for shrimp fisheries in central Patagonia, which is known to catch penguins incidentally. However, birds also travelled through proposed maritime protected areas: six birds travelled

through a Provincial Park planned for Tierra del Fuego (Península Mitre), and two of them later traveled by a maritime area proposed for the recent National Park Monte León, underlining their biological importance.

THE RETURN OF THE KING AND THE GROWTH OF THE GENTOO. NEW DATA ON PENGUINS NESTING IN TIERRA DEL FUEGO.

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King penguins were known to nest at Staten Island (Tierra del Fuego). One of the known breeding localities was Puerto Roca, where hunters reported about 20,000 pairs in 1869. By the early XX century the colony disappeared due to hunting. We recorded birds in the coasts of Staten Island in five occasions from 1992 to 2003. Birds are also known to visit Isla Martillo (Beagle Channel) to moult in numbers from one to three on every summer. On 9th January 2004 we recorded three animals on Puerto Roca. One of them was incubating an egg, in the same exact location reported for the colony during the XIX century. We did not verify the viability of this egg later in the season. If a chick was raised it would have represented the return of king penguins to Staten Island after 94 years. Reports of gentoo penguins from the Tierra del Fuego archipelago are scarce. Despite of some sightings in the Cape Horn area, no breeding record existed for the area. Gentoo penguins were reported to visit and nest on Isla Martillo since the 1980's. The colony is located within a Magellanic penguin colony, and showed an increase in numbers of active nests, from one (December 1992 and December 1993), to five (November 2000), eight (November 2002) and nine (November 2003). Isla Martillo represents the only known breeding ground for gentoo penguins in South America. We found no evidence of gentoo penguins nesting or visiting Staten Island despite intensive surveys. The growth of the gentoo penguin colony from Isla Martillo may be the result of the recruitment of birds descendent of the first settlers or to movements of animals from the Falkland (Malvinas) Islands (or both factors acting together). Also, we propose that the vast fuegian archipelago may hide unknown breeding locations for gentoo penguins, to be revealed in the future.

VARIATIONS IN ADELIE PENGUIN HEART RATE AND BEHAVIOUR

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The study investigates impacts of stressors on physiological and behavioural reactions in incubating penguins. This contribution describes equipment and methods, provides data on heartbeat in relation to behaviour during incubation, and compares these parameters in Adelie penguins with Nimon's data on Gentoo penguins *P. papua*. In a field study based in SSSI no. 13, Potter Peninsula, King George Island (South Shetland Islands), simultaneous records were obtained of variations of heartbeat and behaviour in incubating Adelie penguins *Pygoscelis adeliae*. Heartbeat was measured using artificial eggs fitted with infra-red sensors, following the method initiated by Nimon et al. (1994: Journal of Physiology 481, pp. 57-58), but employing a TtiVips data-logger and software programme that made the equipment more portable and facilitated advanced analyses of results. Elements of behaviour were recorded for identification

and categorisation, using a standard Sony video camera (Hi8; CCD-TR200E) installed in a tent. Recordings were made in November 22 – December 02, 2001, during the second half of the incubation period. The data present correlating variations in heart rate and behavioural sequences as reactions to external stressors (conspecifics and/or tourists) in comparison to those obtained from undisturbed birds. This research, based in the Department of Zoology, University of Marburg, Germany, forms part of a long-term programme of studies into impacts of tourism initiated by the Scott Polar Research Institute, Cambridge, in co-operation with the Department of Antarctic Biology, Polish Academy of Sciences. The current project is a co-operation between Pilipps-Universitaet Marburg and Imperial College, London.

EFFECT OF COLONY SIZE AND ENVIRONMENTAL VARIABILITY ON PREDATION ACTIVITY AT PENGUIN COLONIES IN ANTARCTICA

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The activity of predators and prey dynamic may change with colony size and environmental variability such as weather, phenology, time of day, or availability of alternative food resources. Larger colonies may receive greater attention by predators because of larger prey availability and greater edge areas. However, data in the literature is inconsistent, with studies showing negative relationships between colony size and predation risk, and others addressing no relationship or even positive trends. How predators respond to changing foraging constraints, and how these dynamics may influence prey populations are questions not clearly answered. The purpose of this study was to evaluate the influence of colony size and environmental variability on predation rates at penguin colonies in Antarctica. Predation activity at Adelie, Gentoo and Chinstrap penguin colonies was monitored at Harmony Point (Nelson Island) and Stranger Point (King George Island), South Shetland Islands. Samples were taken from late October 1997 to late March 1998. Activity rates by Southern Giant petrels, Skuas, Kelp Gulls and Sheathbills were assessed through the analysis of 132 h of observation. Multiple regressions, partial correlation and principal component analyses were carried out to evaluate the effect of environmental variables upon the activity of predators. Activity rates of predators and scavengers were significantly influenced by colony size at Chinstrap and Adelie colonies, with higher search rates observed at larger colonies. No colony size effect was observed in Gentoo colonies. Attempted predation and predation rates do not significantly changed with colony size. Activity rates changed with time of day in Giant Petrels and Skuas. Predation rates were significantly influenced by penguin's phenology in Adelie and Gentoo colonies; no effect was observed in Chinstrap colonies. Environmental variability also affected predation activity, being wind intensity the stronger variable. Foraging activity of Giant Petrels and Skuas was positively correlated with wind intensity; however, predation attempts and predation rates in these species were higher with weak or moderate wind intensities. No clear effect of reduced predation with colony size was observed in this study. Results were also contrasting at different colonies, both considering colony size, colony composition and other sources of environmental variability.

IMPACT OF CRUDE OIL ON FEATHERS OF AFRICAN PENGUIN *SPHENISCUS DEMERSUS*

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Feather samples were taken from an oiled African Penguin *Spheniscus demersus* on admission, after washing, rinsing and day 1 after cleaning. These were prepared to be studied with a scanning electronic microscope (SEM) and showed evidence of the effects of cleaning feathers of oiled birds at the SANCCOB (Southern African National Foundation for the Conservation of Coastal Birds) Facilities in Capetown, R.S.A. These pictures are accompanied by washing guidelines how to handle a bird during a complete cleaning procedure.

DIVE BEHAVIOUR OF ROCKHOPPER PENGUINS IN NEW ZEALAND

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Rockhopper penguins *Eudyptes chrysocome* have undergone a marked population decline over the last 70 years at their main breeding sites in New Zealand. At Campbell Island, the number of rockhopper penguins decreased by approximately 94% between the 1940s and 1980s. Stable isotope analyses have revealed that diet has not changed over this period, but the possibility remains that penguins experience relatively low food availability during the breeding season and that they have to devote increased time and effort to acquiring food. We investigate this idea by investigating foraging ecology of rockhopper penguins breeding at Campbell Island. We quantify dive effort, in terms of number and depth of dives, proportion of time spent diving and dive duration, in rockhopper penguins using time-depth recorders. These are the first such data for rockhopper penguins from New Zealand. We discuss the results in relation to findings from similar work on rockhopper penguins carried out elsewhere in this species breeding range.

PENGUINS IN PERIL? ISOTOPIC INSIGHTS INTO DIET, MARINE PRODUCTIVITY AND SEA TEMPERATURE CHANGES

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Breeding populations of rockhopper penguins *Eudyptes chrysocome* in New Zealand's sub-Antarctic have declined dramatically over the past 60 years. For example, at Campbell Island, between the period 1940s-1980s, rockhopper penguins suffered a 94% reduction in numbers. The reasons for this marked population crash were not clear but changes in penguin diet, either a switch in prey species taken or a reduction in prey availability, perhaps the result of changes in sea surface temperatures, were a likely explanation. However, hypotheses involving changes in penguin diet have not been tested, and sea temperature data were limited. We present isotopic data to address the following specific questions: 1. Have New Zealand rockhopper penguins switched diet over the period when populations crashed? 2. Is there any evidence to indicate that there has been a shift in the level of productivity within New Zealand's sub-Antarctic marine ecosystem upon which rockhopper penguins depend? Additionally, the issue of sea temperature change is considered by presenting a time series of $\delta^{18}\text{O}$ signatures from shell carbonate of the brachiopod *Neothyris lenticularis*, and relating these data to corresponding trends in the strength of prevailing westerly winds over the sub-Antarctic region. Finally, we

comment on the current state of rockhopper penguin populations at Campbell Island with respect to their interactions with avian and mammalian predators.

A NEW SEABIRD REHABILITATION CENTRE FOR THE EASTERN CAPE OF SOUTH AFRICA

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The Eastern Cape of South Africa is richly endowed with breath-taking scenery, beautiful beaches and is also important for its breeding seabirds. Algoa Bay supports up to 18 000 pairs of African Penguins, which is approximately a third of the total population. Bird Island houses one of the largest gannetries in the world, numbering some 160 000 Cape Gannets and virtually the entire southern African population of Roseate Terns breeds on the islands of Algoa Bay. Oil pollution is a major threat to seabirds. Up to now, most major pollution incidents in southern Africa have affected the coastline of the southwestern Cape. However, low level oiling is a daily occurrence in Algoa Bay and affects a number of seabirds, particularly African Penguins. The facilities presently available for treating oiled birds were not specifically designed for this purpose and are inadequate to deal with a large number of oiled birds. No regular monitoring of the islands in Algoa Bay is carried out to identify and rescue oiled birds. With the additional shipping expected as a result of the building of a new deep-water port at the mouth of the Coega River, the risk of pollution and major disasters will inevitably increase. There is a need therefore for a rehabilitation centre and an active monitoring policy. The South African Marine Rehabilitation and Education Centre Trust (SAMREC) intends to build such a centre on the western shores of Algoa Bay, near to the city of Port Elizabeth. The centre will combine the care of oiled, sick and injured seabirds with an education centre, outlining the problems faced by seabird populations and the urgent need for their conservation. Funds for the building of the centre have been secured courtesy of the National Lotteries Board and the National Ports Authority. However, additional funds need to be found to equip the building and to cover the costs of day to day running and staffing.

BREEDING PRODUCTIVITY AND ANNUAL CYCLE OF REHABILITATED AFRICAN PENGUINS FOLLOWING OILING

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The success of rehabilitation efforts is often measured by the number of individuals that survive to return to their breeding colony. However, little is known about the effect of the oiling and the subsequent rehabilitation on the breeding productivity and annual cycle of rehabilitated birds that return to their breeding colony. At Dassen Island in the south-western Cape, a monitoring study was initiated soon after the first rehabilitated African Penguins were released following the Apollo Sea oil spill in June 1994. Eight years after the Apollo Sea spill at least 75% of the rehabilitated penguins had been recorded breeding. The breeding productivity of the rehabilitated birds was, on average, no different to that of other penguins that were not affected by the oil spill. However, in a couple of the nest cohort comparisons, when both the Apollo Sea rehabilitated birds and birds unaffected by the oil spill fared poorly owing to adverse feeding conditions, the rehabilitated birds did notably worse than the unaffected birds. These differences were restricted to only a couple of comparisons within the first two years of the study, highlighting the short-term nature of this impact. Other subtle and short-term impacts of oiling

and rehabilitation on African Penguins following the Apollo Sea oil spill included the disruption of annual moult and breeding cycles, and breaking of pair bonds owing to the death or prolonged absence of a partner. In the recent Treasure oil spill about 19,500 penguins were taken off Dassen and Robben islands to prevent them from becoming oiled. They were released 800 kilometres away at Cape Recife in the Eastern Cape province. Interim results indicate that the relocation of these birds was a remarkable success and that relocated birds recover more rapidly than rehabilitated birds. Relocation and rehabilitation are not mutually exclusive processes. Relocation of birds should be seen as an additional management tool, which can be utilised when large numbers of birds are known to be threatened by oil pollution.

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