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Developing long term monitoring programme for birds and mammals in the Indian ocean and Antarctica

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Abstract

Protocol on Environmental Protection of the Antarctica Treaty made it mandatory for all countries maintaining a permanent research station at Antarctica to monitor key environmental indicators, for assessing and verifying the impact of any activity in and around the area of their operations. The wildlife Institute of India was given the responsibility of developing a long term monitoring protocol for major wildlife found around the Indian research stations at Dakhshin Gangotri, Maitri and Princess Astrid coast.

Under this programme during January and February 1997, wildlife census along the shelf between 10° E to 13° E longitude was carried out using AS 350 BA Squirrel helicopter flying at 112 km/hour (60 knots) at an altitude of 61 m (200 ft) above sea level. The width of the transacts was 300m from the ice shelf towards sea. All sorties were made between 1100 and 1600 hours coinciding with peak hauling out time for seals. During the census whenever animals were seen, their location was recorded on a Magellan Trial Blazer XL hand held GPS receiver unit. Simultaneously, number of animals seen, ice types, floe size and environment conditions were recorded on a note sheet that was later transferred to computerized date sheets, A total of 12 hours of flying time was used and 5 sorties were made for the census. Additional two sorties of two and four hours respectively were used as trial to get familiar with the area and the species, and to develop a map of the coast line along the shelf.

During the census two species of seals viz Weddell and Crabeater, and five species of birds viz Emperor and Adelie penguins, Antarctic and Snow petrels, and South polar skuas were seen. The overall density of Weddell and Crabeater seals was 6.57, ± 1.27 and 0.48 ± 0.1, whereas for Emperor and Adelie penguins it was 29.5, ± 7.30 and 12.28, ± 4.97 respectively.

In the case of Weddell seal and Emperor penguin the abundance was significantly higher during the sorties carried out in January, where as in the case of Crabeater seal and Adelie penguin it was higher in February. The wildlife sightings to the west of the Indian discharge point were significantly higher than the eastern side. Three zones with large congregation of seals and penguins have been identified, viz. Zone I 1 10.25-10.65°E, Zone II - 10.90-11.5° and Zone III 11.25-12°E.

Of the total sightings, 77% of Weddell seal, 36% Crabeater seal, 74% of Em-

peror penguin and 17% of Adelie penguins were observed on fast ice. The abundance of Weddell seals was positively associated with the extent of fast ice but was negative in the case of Crabeater seals, which showed positive associations with pack ice. Similar pattern was observed for Emperor and Adelie penguins, respectively. Our estimates of mean encounter rate derived during this study is comparatively higher for all species except that of Crabeater seals. Comparative data for 1995, 1996 and 1997 shows a consistently increasing trend for all species, except Crabeater seals. In case of crabcater seal, which is essentially a pack ice seal, the reason of sighting of lesser number of these seals is justified. The Other reasons could be observer bias in identifying seals and lesser logistic support during earlier studies.

During the voyage period 64 species of birds were recorded of which 62 species were pelagic sea birds. Of the 62 pelagic species, identity of 53 species was confirmed. Petrels and shearwaters were the most dominant taxa (19) followed by terns and noddies (9), albatrosses (6), and strom-petrels (5). Fourteen species of marine mammals were recorded, of which eleven species were cetaceans and three pinniped. Of the 11 identified species of cetaceans, 5 were dolphins, 1 porpoise and 5 whales. Three pinniped were, Crabeater seals, Weddell and Ross seals.

Introduction

The advent of people in the Antarctic realm has initiated a process of human-induced environmental change (BATTAGLIAet al., 1997). Even the heroic age of the pioneering explorers has left its mark on the Antraclic landscape, in the from of abandoned huts and supplies, though many of these are now justifiably preserved as relics of considerable historic merit. Such early traces of human presence in Antarctica were but a forerunner of much greater impacts accompanying the onset of later scientific expeditions, involving the construction of stations, importation of large quantities of materials, equipment and supplies - and the consequent production of waste (SAGE, 1985; IUCN, 1990). The impacts, while localized, have been considerable, and they result from a wide variety of sources including in addition to sewage, kitchen, laundry and laboratory effluent; fuels and lubricants; old machinery; discarded storage and packing containers and materials; and abandoned buildings, vehicles, and associated equipment (IUCN, 1990), Additionally, and largely unobserved, are the waste materials previously dumped offshore and littering the shallow sea floor in the environs of some stations. Such contamination of soil and waters has been accompanied, and accentuated, by pollution of surrounding air with particulate matter produced in burning combustible wastes and fuels, and through vehicle exhaust emissions. In some regrettable cases wildlife has been displaced and protected areas have been damaged by the dumping of wastes.

Many forms of human activities accompanied by the production of noise, fying aircrafts, over or close to breeding colonies of penguins or other sea- birds

can cause severe disturbance (IUCN, 1990). Explosive charges used in geophysical seismic investigations can produce very high transitory peaks of sound pressure. On land these are likely to be of little consequence (except near bird and seal colonies) but at sea, when exploded at depth there is the potential for serious damage to birds, seals and whales. The use of low frequency sound generators to study temperature gradients in the seas is a worrying development, since these sounds are transmitted over hundreds of kilometers and may interfere with the communications of Baleen whales (1UCN 1990).

The legal framework within which the problems of conservation in the Antarctica have to be considered, consists primarily of the Antarctic Treaty, and various other subsequent pieces of legislation (SAGE, 1985). Article II of the Antarctic Treaty (recommendations Vl-4, VIII-13, IX-5 and XII-3) has made it mandatory for all countries to lake up "Initial Environmental Evaluation" prior to taking up any project in Antarctica. This has to be done in order to determine whether the activity might reasonably be expected to have a significant impact on wildlife and environment. If the proposed activity is likely to have no more than a minor or transitory effect on the environment, the activity may proceed with the proviso that appropriate monitoring of the actual impact should take place, otherwise a "Comprehensive Environmental Evaluation " should be prepared.

The rapid progress towards the implementation of the Protocol for the Prolection of the Antarctic Enviornment has had a number of important effects on Antarctic science (BATTAGLIA et al., 1997) It has changed the organisation of research and logistics by requiring Environmental Impact Assessments (EIA) of all activities, by increasing the requirements for environmental monitoring and by highlighting the lack of knowledge in some key areas for implementation (BATTAGILIA et al., 1997). The establishment of research stations on the limited areas of snow free ground has always been a matter of concern. While competing for this scarce resource with the native flora and fauna, it is essential that the activities of these research stations cause minimum impact on the surrounding environment. Besides, the recent development of tourism has raised other issues about potential damage to the Antarctica environment, flora and fauna (BATTAGILIA et al., 1997). The biological significance of the impact of such human interference on native environment including flora and fauna has yet to be resolved. One approach is to identify key species and, by monitoring some aspects of their biology to determine the potential impact at the species and community level.

Since 1982, the Government of India is taking active part in Antarctic research by establishing its first permanent research station Dakhshin Gangotri at the Princess Astrid Coast, and subsequently in 1987 by establishing its second research station Maitri at the Schirmacher oasis (70° 46'S &. 11° 45'E). In 1995, the Government of India initiated its own long term monitoring programme for assessing impacts of its research stations on flora of the Princess Astrid Coast

and the Schirmacher oasis and in areas of its operation. Between 1995 and 1997, the Wildlife Institute of India took part in the Indian Scientific Expeditions to Antarctica with the aim to develop a long term monitoring protocal for seals and penguins along the Princess Astrid Coast (SATHYAKUMAR, 1996).

Objectives

The major objectives of this study were to;

1. standardise the techniques for monitoring seals and penguins along the Princess Astrid Coast, East Antarctica;
2. derive estimates of seals and penguins along the Princess Astrid Coast between 10-13° E latitude;
3. relate their abundance with changing sea ice conditions during expedition summer period (January -February),
4. examine the distribution pattern of pelagic birds and sea mammals in the Indian ocean along the ship's course while travelling to Antarctica.

In 1996 the XVI Indian scientific Expedition to Antarctica started from Marmagoa port at Goa on December 12 and returned on April 7, 1997. During the expedition the pelagic bird community and sea mammal distribution were also monitored, en route. This report has two components 1) census of wildlife along the Princess Astrid Coast, 2) Wildlife monitoring en route to Antarctica and back to India.

Status of seals and penguins along the Princess Astrid coast

The Antarctic regions are especially the abode of sea birds and seals. Seven species of penguins (STONEHOUSE,1985), thirty species of petrels of which six are albatross, two cormorants, five gulls and terns, breed within the Antarctic circle (SIEGFRIED, 1985; SAGE, 19851 IUCN, 1990). The Antarctic seals though limited only to six species are extremely abundant in number (BONNER, 1985). Besides, seven species of filter feeding Baleen whale and eight species of Toothed whale occur to the south of the Antarctic convergence (GEMBELL, 1985; IUCN, 1990). It is crucial to assess the biodiversity of Antarctica, viewed now days as an immense natural reserve to be protected from human impacts. Antarctic biodiversity, both at the species and community levels, varies form place to place and from group to group and is unique (BATTAGLIA et al,, 1997). Whilst in some cases we now have a positive indication of the factors causing this, in most cases a convincing picture is still lacking. This is largely due to lack of information on the distribution pattern, community structure and population status of flora and fauna from many parts of the Antarctic region. Within the mandate of the current project sponsored by the Wildlife Institute of India, we investigated the relative abundance of Antarctic seals and penguins along the Princess Astrid Coast so as to relate it with changing sea ice conditions during the expedition summer period (January-February).

Study Area

The Princess Astrid Coast is situated between meridians 5°E and 20°E. the sampling stretch lies with in 10ºE to 13ºE longitude and is part of the Fimbul ice shelf to the east of the Weddell sea. The Princess Astrid Coast was discovered by captain Halvorsen while sailing in Sevilla during March, 1931.

1 he climate here is typical to Droning Maud Land. Extreme maximum temperature is +3°C and extreme minimum is of -48°C.The sea remains frozen between April to December. On the approach of summer along the coast, the fast ice becomes fragmented into pack ice by early January, and the area remains snow free between February to March the sea starts freezing again. A special hydrograpic feature of the sea in front (Lazarev Sea/Prince Haakon VII Sea) of the Astrid Coast is a pronounced on-shelf advection of relatively warm water orginating at the Antarctic divergence by the Weddell Gyre reflow (ZIMMERMANN, 1997). The water temperature at the bottom varies between -1.8 and 2°C.

The ice shelf in the coast is known as Fimbul ice shelf. It is highly indented towards its sea face margin which develops many cracks at every few hundred meter intervals. Ice shelf is often 15-25 meter high with occasional ramps in many places. During this expedition approximately 120 km (65 nautica miles)of the coast line along the Princess Astrid coast was monitored to determine the abundance of major wildlife along the coast. The transacts were from the berthing point of ship (69° 52'S&12°08'E) to 40 nautical miles west (74 km) and 23 nautical miles east (46 km) (Table 1)

When the expedition team reached Antarctica on January 4, 1997 by M.V, Polar Bird, approximately 20 nautical miles of fast ice from the coast towards sea was still intact. At places along the fringe there was some pack ice. By January 28 the fast ice along the shelf started breaking, allowing the ship to berth along the coast. Aerial census was carried out between January 12 and February 20, 1997 by helicopters, using the ship as base.

The data collection method follows ERICKSON et al. (1993) for seals from an aircraft. For the census a AS 350 BA Squirrel helicopter was used. On January 12, 1997 two sorties of one hour each were made to get familiar with the area and the species, and for comparing differences in sighting frequency of different seal species at different flying altitudes and cruising speed. Wildlife census along the shelf between 10ºE to 13ºE longitude was earned out by flying at 112 km/hour (60 knots) at an altitude of 61m (200 feet) above sea level. The width of the transacts was 300m from the shelf towards sea. All sorties were made betweem 1100 and 1600 hours coinciding with peak hauling out time for seals. Apart from the pilot, two observers were involved with the census. The role of the front row observer was to spot animals. Identify species and the their number and habitat condition, the role of back row observer was to record the observations, taking GPS positions, and also count animals for large groups. Basking seals were iden-

tified following LAWS (1993)

During the census, whenever animals werc seen, then location was recorded on a Magellan Trial Blaset XL hand held GPS rcceiver unit Simultaneously, number of animals seen, ice types, floe size and environment condition were recorded on a note sheet that was later transferred to computerized data sheets Wherever counting was not possible or believed to be erroneous due to large group size, especially of penguins photographic records were made that was later counted and tallied with the data collected while flying (Annexure I) For comparison oi difference in sightings while fying, ground truthing was also made at sites where large congregation of seals and penguins were found. A total of 12 hours of flying time was used and 5 sorties were made for the census Apart from these, a sortie of 4 hours was made along with the members of the Naval Hydrographic Team, Government of India for generating a map of the coast line along the shelf GPS locations ol all sightings were plotted against the map to identify areas of high wildlife concentration

Table. 1: Details of the soi ties used tor census of wildlife along the Princes Astrid Coast, Antarctica between 10-13° E meridians during January - February 1997.

Date sortie No		Direction	Start hrs	Finish hrs	Duration min.	Length km	Area Km^2
17/01/97	3	West	1225	1405	100	64 82	19 45
17/01/97	3	East	1420	1510	50	46 30	13 89
18/01/97	4	West	1300	1500	120	74 08	22 22
06/02/97	5	West	1105	1310	125	72 22	21 67
06/02/97	5	East	1615	1710	47	46 30	13 89
09/02/97	6	West	1205	1335	135	74 08	22 22
20/02/97	7	West	1205	1335	90	74 08	22 22

Results

Abundance of wildlife along the Princes Astrid Coast

During the census two species of seals viz Weddell and Crabeaters, and five species of birds viz Emperor and Adelie penguins, and Antarctic and Snow petrels, and South polar skuas were seen. Chance sightings of several other birds and cetaceans were also made (Appendix I) Though all seven species were counted, data pertaining to seals and penguins are presented in this report. The overall density of Weddell and Crabeater seals and Emperor and Adelie penguins were 6 57 ± 1 27, 0 48 ± 0 13, 29 5 ± 7 30 and 12 28 ± 4 97 respectively Transact (sortie) wise density of seals and penguins has been summarised in Table 2. The abundance of seal and penguins varied considerably among sorties along the western (ANOVA F=0 605, p=0 661) and eastern shelf (ANOVA, F=0 20, p=0 833) In the case ol Weddell seals and Emperor penguins the abun-

dance was significantly higher during the sorties carried out in January, where as in the case of Crabeater seals and Adelie penguins it was higher in February.

Distribution of wildlife along the coast

The coast line between 10-13°E as a single entity had areas with higher concentration of seals and penguins in certain sites indicating choices for these sites. Areas with higher concentration of wildlife sightings have been identified and marked on a map generated through GIS (Figure 2.1 a & b). The wildlife sightings to the west of the Indian discharge point were significantly higher than eastern side (Mann-Whifney U test, U=3529.0, W=6014.0, Z=-0.4559, 2 failed p=0.6485). Three zones with large congregation of seals and penguins have been identified, viz . Zone I - 10.25-10 65°E, Zone II - 10,90-11.5° and Zone III - 11.25-12° E (Figure 1-a & b). These zones were used more because they provide sheltered bays and low ramps on ice shelf which are used by seals and penguins for basking and during moulting respectively.

Table 2 : Density (animals/km^2) of seals and penguins along the Princess Astrid Coast, Antarctica between 10° - 13°E meridians, during January-February 1997.

Transacts		weddell		seal	Crabeater seal		UI seal*		Adelie penguin		Emperor penguins	
Date	No.	Direction	Density	No.	Density	No.	Density	No.	Density	No.	Density	No.
17/1/97	3	West	9.87	192	0.21	4	0	0	1.18	23	43.56	847
17/1/97	3	East	5.98	83	0	0	0	0	3.10	43	33.98	472
18/1/97	4	West	10.17	226	0.40	9	0.22	5	3.10	69	44.46	988
06/2/97	5	West	9.78	212	1.11	24	0.14	3	34.89	756	50.86	1102
09/2/97	6	West	4.54	101	0.36	7	0.04	1	26.64	592	25.69	571
20/2/97	7	West	3.78	84	0.54	12	0.09	2	7.96	177	7.78	173
Mean			6.57		0.48		0.49		12.28		29.5	
Standard Error			±=1.27		±=0.13	61	±=0.03		±=4.97	±=7.30	4156	

* UI - Unidentified

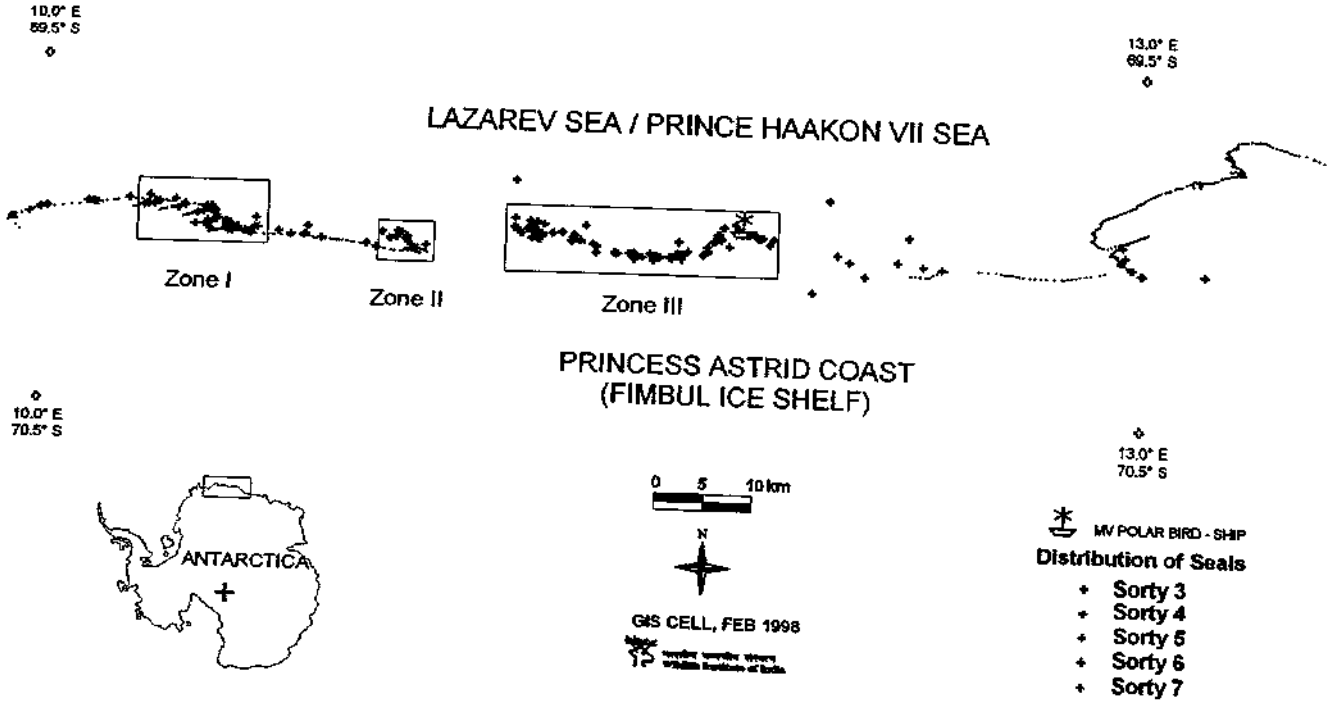

Fig. 1a : Distribution of seals along the princess Astrid Coast between 10°-13° E Antarctica during Jan-Feb, 1997

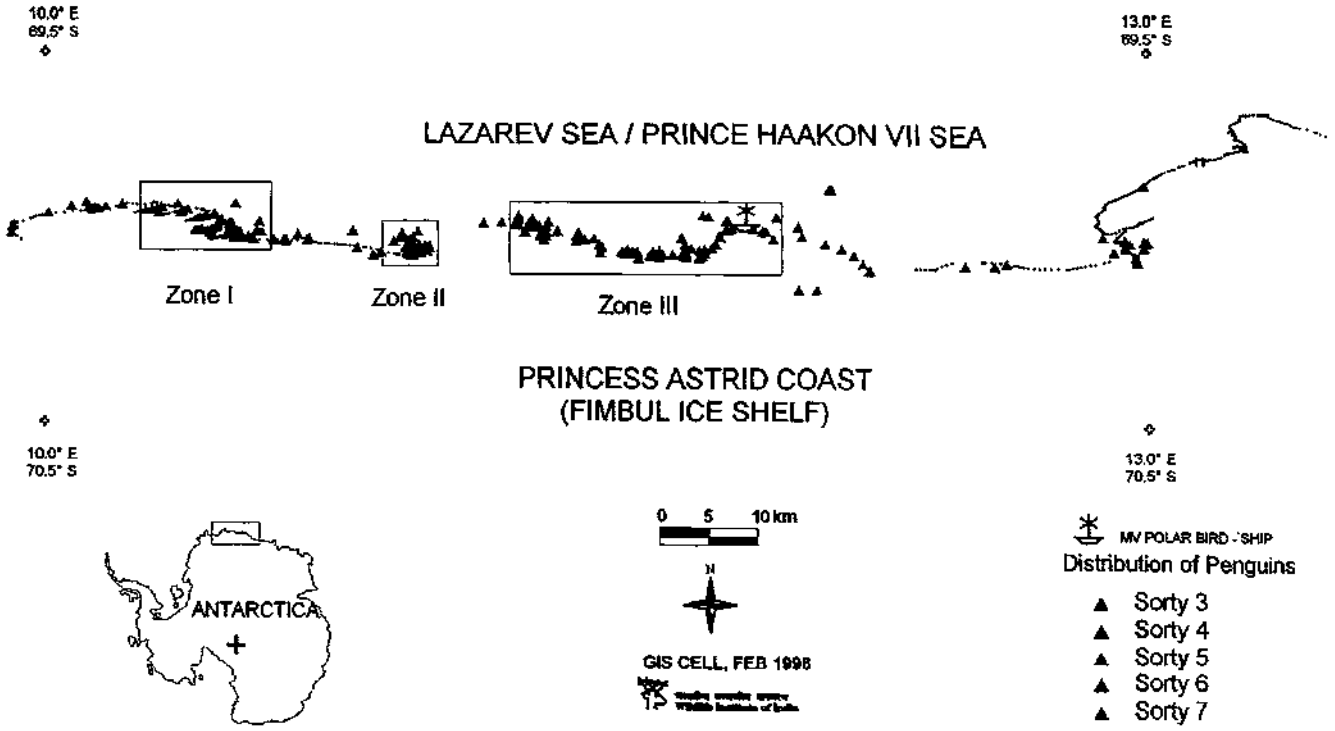

Fig. 1b : Distribution of penguins along the princess astrid coast between 10° -13° E Antarctica during Jan-Feb, 1997

Association of seals and penguins with changing sea ice conditions

Along the coast, apart form polynea, we identified five type of sea ice conditions Viz Pack ice, fast ice, ice shelf, eroded shelf 01 low-shelf and icebergs Sightings of wildlife on vai IOUS ice types/habitats along the coast have been shown in Figure 2 Of the total sightings 77% of Weddell seals and 36% of Crabeater seals, 74% of Emperor penguins and 17% of Adelie penuins were observed on the fast ice. The abundance of Weddell seals was positively associated with the extent of fast ice (Figure 3 but was negative in the case of Crabeater seals, which showed positive association with pack ice The pattern was similar with Empror and Adelie penguins also (Figuie 4 & Annexure II).

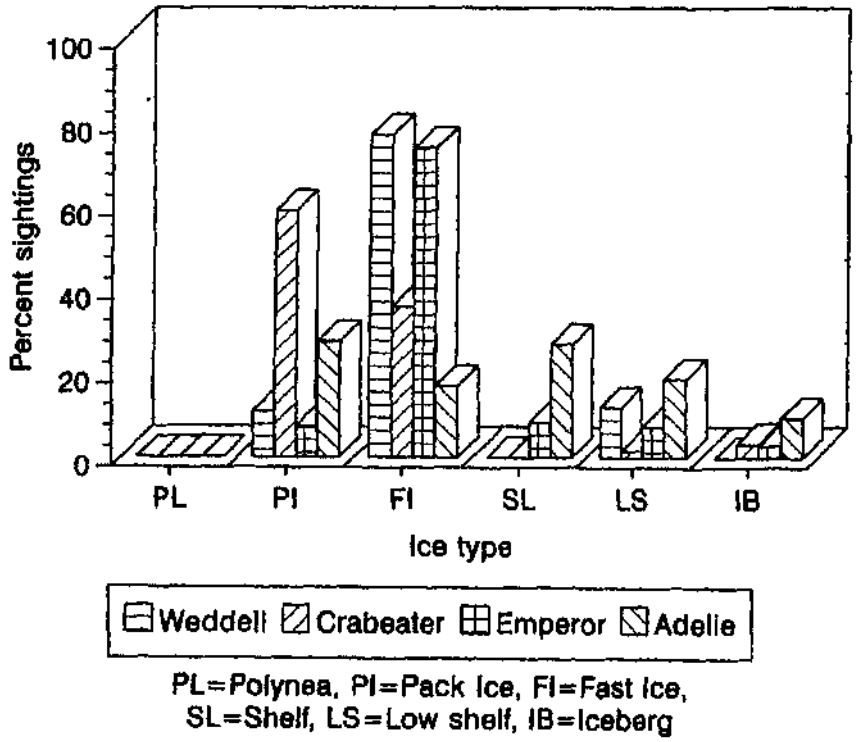

Fig : 2 Sighting of wildlife on various ice types/habitats along the princess Astrid Coast during Jan-Feb. 1997

Apart from this study, the representatives of the Wildlife Institute of India took part in the XIV and XV Indian Scientific Expeditions to Antarctica in 1994-1995

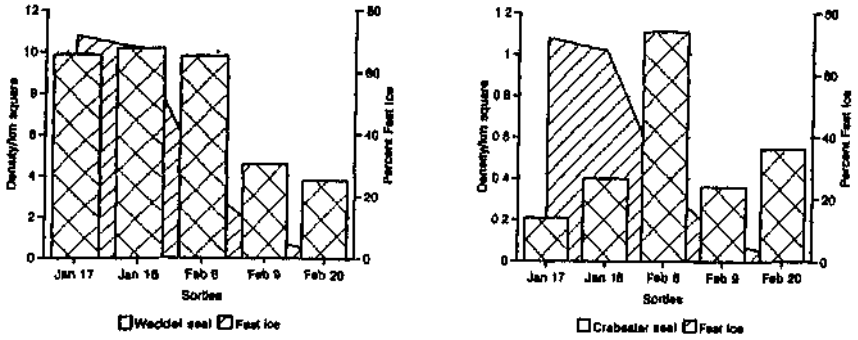

Fig. 3 : Association between fast ice and seal sightings along the Pincess Astrid Coast, East Antarctica during Jan-Feb, 1997

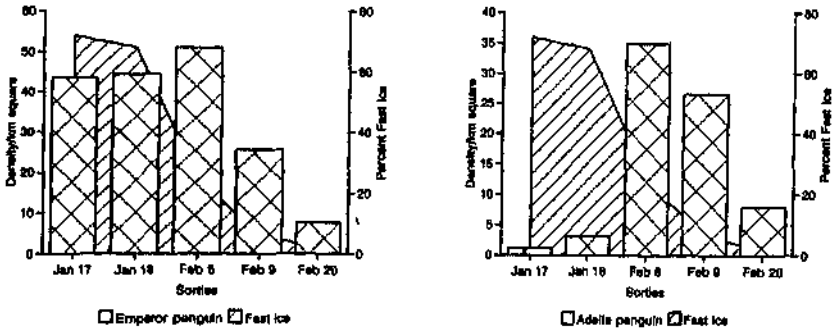

Fig. 4 : Association between fast ice and seal sightings along the Pincess Astrid Coast, East Antarctica during Jan-Feb, 1997

and 1995-1996 respectively and conducted similar kinds of census along the coast and provided encounter rates for seals and penguins (SATHYAKUMAR, 1996;BHATNAGAR &SATHYAKUMAR, 1997).For comparison we converted our data into encounter rate too. The results for three consecutive census have been summarised in Table 3. Our estimates of mean encounter rate derived during this study is comparatively higher for all species except that of Crabeater seals. The increasing trend could be explained due to better logistic support such as two trained observers instead of one as in previous two expeditions, helicopter pilots experience in wildlife surveys, and due to flying at lower elevation on the seaward side of the shelf.

Table 3 : Mean encounter rate of seals and penguins recorded during 1995-1997 along the princess Astrid Coast, Antarctica.

Species	1995	1996	1997
Weddell seal	0	1.1	1.97
Crabeater seal	1.15	1.1	0.12
Emperor penguin	1.42	3.5	8.85
Adelie penguin	0.62	1.9	3.68

Discussion

Human diturbance due to tourism or research has been implicated in the decline of many Antarctic wildlife population (e.g. THOMPSON, 1977; WILSON et al.,1990; YOUNG ,1990; WoEHLER et a., 1994). Princess Astrid Coast is extensively being used as discharge point for many research stations situated in Dronning Moud Land, specifically for Norwegian station Trawl, Russian Novolasarevskaya, Indian Dakhsin Gangalri and Maitri, Japanese, Asuka and, abandoned GDR station George Foster (ANON, 1990). We believe that this area is more disturbed in comparison to areas where not many stations or discharge points are located. In spite of several stations being operational in the Princess Astrid Coast, base line information on the population status of seals and penguins from this region is not available. Thus it was imperative to assess the status of seals and penguins populations along this coast as future changes in the distributions and abundance can not be ascertained due to lack of baseline information. Given an increased probability of adverse effects on wildlife populations in many places in Antarctica in the event of any catastrophic event, or habitat degradation and modification, the information generated through this study may help in conserving seal and penguin populations, how ever small they may be in the region.

For conducting census of seals and penguins it was recommended that the transact should be placed at right angles to known gradient in abundance i.e. from the ice edge towards the consolidated pack (ERICKSON et al., 1993). Dur-

ing the previous two expeditions the participants from the Wildlife Institute of India have carried out the census at an altitude of 100 m and at 70 knots/hour (e.g. BHATNAGAR & SATHYAKUMAR, 1997). We found difficulties in identifying seals at this level as well as in counting large penguin groups. Subsequently, we reduced the altitude to 61m (200 ft) and cruising speed of 112 km/hr (60 knots) for a clear view. Because of safety reasons we were not allowed to fly perpendicular to shelf , upto 300m width towards sea front. This might have resulted in higher Weddell seal density because of clumped distribution of seals along the tidal cracks close to shelf, and lower Crabeater seal density as very few pack ice zones were covered during the census.

Significantly more wildlife (abundance/groups) sightings in the western part of the shelf is linked to the presence of more sheltered bay and creeks in the western shelf than the eastern shelf. At the Russian discharge point (11° 37'E 70° 02'S) we observed largest congregation of Emperor penguins and Weddcll seals. Because of sheltered bay at the Russian discharge point the sea ice remained frozen till February 20, and it started re-freezing by March 1, 1997. Availability of more fast ice prolonged the stay of Weddell seals and provided better moulting habitat for Emperor penguins. The average height of the eastern shelf is more than the western shelf and also there are fewer ramps or low shelf in eastern side, These provide lesser basking sites for seals and less shelter for moulting penguins. Consequently the abundance of wildlife is much higher at the western shelf.

The Weddell seals are the animals of fast ice near-shore region and are quite sedentary in nature (BONNER, 1985). During the early sorties in January, the extent of fast ice was significantly more than in February. Hence there were more Weddell seal sightings in the early sorties. The Crabeater seals are the animals of the drifting pack ice, and rarely seen ashore and are great wanderes (BONNER, 1985). Their sightings along the coast is of chance occurrence. Though it was not evident it is likely that sightings of Crabeater seals is influenced by pack ice.

In the early sorties in January we observed Emperor penguins in large moulting groups on fast ice, and by early February their moulting was over and they dispersed due to absence of fast ice. This justifies higher abundance of Emperor penguins during earlier sorties. Where as the Adelie penguins were in dispersed groups during early January, by early February they congregated mostly on shelf and on stranded icebergs for moulting. Hence we saw more Adelie penguins during February. The other reasons for segregation of the two penguin species could be due to their different breeding cycles. Emperor penguins lay eggs in May/June and have matured chicks by the middle of next summer and their dispersal takes place around February. While Adelie penguins lay eggs only in October and have growing chicks to look after during summer.

Conservation Significance

Prior to the study undertaken by the Wildlife Institute of India information on the populations status of seals and penguins along the Princess Astrid Coast, east Antarctica was not available. Since 1994, the Wildlife Institute is providing information on the distribution pattern of seals and penguins from this part of the Antarctica. During this study we have identified three high concentration zones of seals and penguins. During January and February, 1997, approximately 1100 Emperor and 750 Adelie penguins, and 220 Weddell and 24 Crabeater seals were using these areas. Presence of humans, large ships, discharge operations and aircraft movement convoys is in some or other way may disturb these animals. It is suggested that the high animal concentration zones be avoided as far as possible.

On the basis of this study, we recommend following measures for conducting census of seals and penguins along the Princess Astrid Coast.

Recommendations for monitoring of sea] land penguin populations along the Princess Astrid Coast

1. As evident from this study, census using helicopter at an altitude of 61 m (200 ft) above sea level, along the shelf on the sea ward side and flying at 112 km/hr (60 knots) without disturbing the animals, will yield better results.
2. Census should be carried out in sunny days between 1100 and 1600 hours.
3. Three sorties in the first half of January and three sorties in the second half of February each with 2 to 3 hours duration are sufficient to estimate the seals and penguins.
4. The sorties should not be clumped (daily) or too widely spaced (8-10 days interval). Clumped sorties may not be able to detect significant variations in the samples and sorties carried out in long intervals will show skewed population because of changing ice conditions.
5. The width of the transacts can be decided at the time of census depending on available a fast ice, nevertheless it should not be more than 300 mat any time.
6. It is suggested that the transacts to assess seal abundance should be perpendicular to shelf, placed randomly at 10 km (5 nautical miles) interval.
7. For estimating Crabeater seal abundance it is important to monitor pack ice zone separately, when the ship is relatively free after off-loading
8. Diurnal fluctuations in numbers of seals occur in some seal species (e.g.) Crabeater seals). In order to correct for this variation with time of the day, it is desirable to carry out activity studies periodically throughout the survey.
9. To avoid large variations in the estimation of abundance of seals and

penguins, it is suggested to initiate capture recapture techniques particularly Jolly-Seber technique or Petersen estimator, for estimating abundance (SEBER, 1996).

10. It is recommended that two persons should be involved in census and this team should preferabley continue for 2-3 years to remove observer bias and for consistency in results.
11. However, for continuous monitoring of seal and penguin populations, it is suggested that every 2-3 years reconnaissance of the coast along the shelf be carried out by volunteers from the expedition team, who have been given prior training in carrying out areal surveys and identification of species.
12. To facilitate the animal and bird count, it is suggested that areal photographs of the congregation of seal and penguins in zone I, II, and III be taken from helicopter flying at 91m (300 ft.) elevation.

Recommendations for conservation in the region

1. As per the provision for designation of specially protected areas under the Antarctic Treaty System (ATS), one of the criteria is to identify areas which have significant breeding colonies of birds and mammals. During this study at least two major breeding colonies of the emperor penguins have been located in zone II and III. Accordingly, protection to these areas and regulating human activities in the area as per the agreed measures for the conservation of Antarctic flora and fauna needs to be taken up at appropriate level.

2. Appropriate guidelines are to be framed and precautionary steps are required to be taken while carrying out research activities, so as to minimise the disturbance to the native flora and fauna. Some of these could be of not landing within 200m of a breeding colony, avoiding any contact, feeding or capturing of any wild animal and strict compliance of the waste disposal measures.

Status of birds and marine mammals of Indian ocean

Ecological zoogeography is concerned with environmental parameters and distributions. Both of individual species and assemblages of species (COHEN, 1973). Although reasons for studying plant and animal distribution are diverse, the approaches have common ground in the data necessary to adequately answer questions related to comprehensive theory of biogeography (MACARTHUR & WILSON, 1967). The Indian ocean and its biodiversity is the least known of all oceans (DITRICH, 1973). The pelagic bird community structure of Indian ocean, their abundance and pattern of distribution form Indian coast to Antarctica is poorly investigated, and so are the marine mammals. The Indian Scientific Expedition to Antarctica passes through Ca 11,000 km stretch of Indian ocean, form the tropics to the south polar zone. It provides on excellent opportunity for

observing the pelagic bird community and sea mammal population of the Indian ocean. Nevertheless, in the last 15 years of expedition these aspects of the biology of Indian ocean were least investigated. Since 1994, the wildlife institute of India is documenting distribution of birds and mammals of the Indian Ocean en route to Antarctica. In the XV Indian Scientific Expedition to Antarctica distribution pattern of birds and mammals was examined (BHATNAGAR & SATHYAKUMAR, 1997). During this expedition the major objectives were to;

1. Validate the monitoring technique developed by the members of the Wildlife Institute of India during earlier expedition for long term application, and
2. Prepare a check list of birds and marine mammals of the Indian ocean.

Methods

Observation on the birds and mammals were carried out mostly from the bridge of MV Polar Bird a 100m long ice class frigate traveling approximately 9-12 nautical miles/hour during December 12, 1996 to January 4 1997, onward journey and during March 7-April 5, 1997 during return journey. The journey started form Goa, west India on December 12 1996 and reached Antarctica (69°5 l'S&l l°55'E)via Mauritius on January 3, 1997. For the return journey the ship started sailing on March 9, 1997 and reached Goa on April 5, 1997 via Durban, South Africa and Mauritius. The route map of the ships course have been shown in Figure 3.1. During the voyage everyday monitoring was carried out between 0600 to 0900 and between 1500 to 1800 hours. Identification of birds was carried cut by using HARRISON (1983), and sea mammals by using CARWARDINE (1995).

During the monitoring period whenever sighting of birds or sea mammals were mode, following informations were recorded

-date,
-time of sighting (local and universal)
-location on a Magellon GPS receiver
-Weather condition
-perpendicular distance from the ship
-angle relatively to the ship's course
-species
-their number, and
-activity

The expedition passed through Tropical Arabian sea and oceanic islands of Lakshadweep, West of Maldives. After crossing the equator it passed through Seychelles and Chagos Archipelago, close to Cargadon Carajon islands and then to Mauritius. After two days of halt at Mauritius the ship took south westerly route, passing close to Reunion islands, West to Amsterdam and St paul, and then 5 nautical miles off to the Sub-Antarctic Marion and Prince Edward islands. It crossed Antarctic circle of 66°30S on January 2, 1997 and reached 20 nautical

of the Princess Astrid Coast on January 4, 1997. Thus the whole voyage provided a transact of Ca 10,000 km passing through Indian ocean and Southern sea through some of the worlds main upwelling areas, first off the indian coast in Arabian Sea, then around equator and finally close to the Antarctic circle. During the return voyage the ship's course was diverted prior to Marion island (49°13'S&26°34'02E)for Durban, South Africa and then to Mauritius. After Mauritius the ship took the normal course and reached west coast of india on April 5, 1997.

During the voyage period 64 species of birds were recorded of which 62 species were pelagic sea birds. Of the 62 pelagic species, identity of 53 species was confirmed (Appendix II). Of the two non-pelagic birds curlew is considered as wader, and the second one could be Mauritian kestrel as it was seen off the coast of Port Louis. The summarised results for different bird groups have been give in Table 4. Petrels and shearwaters were the most dominant taxa (19) followed by terns and noodies (9), albatrosses (6), and storm-petrels.

Table 4 Composition of major avian taxa recorded along the ship's course during the XVI Indian Scientific Expedition to Antarctica 1996-97. Total species as per Harrison (1983)

5 Composition of major mammal taxa along the ship's course and number of taxa recorded during the XVI Indian Scientific Expedition to Antarctica 1996-97, Total species as per Martin (1990)

Avian group	Total	No.of spp.recorded
Penguins	7	4
Albatrosses	7	6
Petrels & Shearwaters	20	19
Prions	3	3
Storm-petrels	7	5
Tropicbirds	2	2
Gannets & Boobies	3	2
Frigatebirds	2	1
Skuas	4	2
Gulls	6	3
Terns & Noodies	15	9
Cormorants	2	-

Marine Mammals

Fourteen species of marine mammals were recorded, of which eleven species were cetaceans, 5 were dolphins, 1 porpoise and 5 whales (Appedix II). The three pinnipeds were, Crabeater, Weddell and Ross seals. Group wise mammals siglings en route to Antarctica have been shown in Table 5

Marine mammal group	Tolal species	No. of spp. Recorded
Rorqual Whales	5	5
Beaked whales	2	1
Oceanic dolphins	9	5
Porpoises	1	1
Pinnepedia	4	3

Sea birds are defined as those species whose normal habitat and food sources is the sea, whether they be coastal, offshore or pelagic (HARRISON, 1983). The travel route passed through the distribution range of 86 species and 2 vagrants reported so far (HARRISON, 1983; BHATNAGAR & SATHYAKUMAR, 1997). Of the 86 species 64 (74%) were recorded during the voyage. Of the 73 currently recognized marine cetaceans (MARTIN, 1990), 21 species occur within the travel route, of which 15 species (71 %) were recorded during the voyage. Of the seven species of Antarctic seals four species were recorded during the voyage, and identity of one is doubtful (Leopard seal). This justifies the suitability of the monitoring methods used. Though we recorded the number of birds seen during the voyage, we have not estimated their abundance. This is because we did not have control on factors such as ship's speed, time of departure and monitoring route. We feel that the monitoring is adequate only for examining presence and absence of a species from a given stretch. As evident from the study the bird diversity and abundance was higher in both tropic, and temperate regions. This could be related to upwelling (WATSON, 1975; SIEGFRIED, 1985), but we believe that the presence of oceanic islands strongly influence bird distribution and abundance. The data generated during this study is under further investigation to relate bird divers and abundance with the presence of islands.

From times immemoriaity sea vesses arc being used to record distribution and abundance of pelagic birds and marine mammals. We tested different part of the ship for the suitability of sites as observation points. We are convinced that the bridge is the safest place as observation point, as it gives shelter from inclement weather for long hours of monitoring. It is believed that there will always be sighting bias due to different light conditions. Sightings greater than 500 m away from the ship will have more bias.

From the study and on the basis of our experience we have come out with few recommendations that we believe will be helpful in strengthening the monitoring protocol for generating better results.

1. The departure time of the ship from Goa and from Antarctica be kept fixed preferably in the morning hours. Simultaneously the cruising speed of the ship shouid be kept uniform (12-13 nautical miles/hour). This will help in generating consistent and comparable data.

2. The transact width should not exceed more than 500 m from the ship's course.
3. Prior knowledge on estimation of bird abundance from a moving vessel, and experience of identification of sea birds is a preprequisite. Monitoring by two trained independent observers will generate better data on abundance or birds.
4. To avoid risk to the observer it is recommended that in ice class ship, the bridge could be used as vantage point for observations.

Acknowledgments

Extending research activities to the Antarctic realm by the Wildlife Instiute of India is significant in the sense that the institute has not only broadened its horizon beyond Indian wildlife, but is also keen to shoulder the responsibility for developing a monitoring protocol to assess the impact of Indian research stations on native flora and fauna at Antarctica. This is one of the prerequisite of the Article II of the Antarctic Treaty to which India is a signatory. Acknowledging the initiatives taken in this regard by Shri S.K. Mukherjee, Director, Wildlife Institute of India, we take this opportunity to express our sincere thanks and gratitude to him for extending moral, intellectual and technical support for enabling us to take part in this important event.

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References

ANON (1974). The Antarctic pilot. Hydrographic Department, Ministry of Defense, Taunton.

ANON (1990). Antarctica, the extraordinary history of man's conquest of the frozen continent. The Reader's Digest Association Inc, New York.

BATTAGL1A, B, VALENICA, J. & WALTON D.W.H. (1997). Antarctic communities : species, structure and survival. Cambridge University Press. U.K.

BHATNAGAR, YV & SATHYAKUMAR, S. (1997). Developing a long term monitoring programme for birds and mammals in the Indian ocean and Antarctica (XV Expedition). Wildlife Institute of India. Unpublished report, pp. 40

BONNER, W.N. (1985). Birds and mammals - Antarctic seals. In Key environments Antarctica. Eds. W.N.Bonner & D.W.H, Walton, Pergamon Press. Oxford, U.K.

CANADIAN HYDROGRAPHIC SERVICE (1 981). General bathymetric chart of the ocean (GEBCO). 5th edition. Sheet 5.16. Ottawa: Canadian Hydrographic Service.

CARWARDINE, M. (1995). Whales, dolphins and porpoises: The visual guide to all the worlds cetaceans. Eyewitness Handbook, london.

COHEN, D.M. (1973). Zoogeography of the fishes of the Indian ocean. In The biology of the Indian Ocean. Eds. Bernt Zeitzschel & Sebastian A Gerlach. Springer-Verlag, Berlin, pp. 451-464.

DITRICH, G (1973). The unique situation of the Indian ocean. In The biology of the Indian Ocean. Eds. Bernt Zeitzschel & Sebastian A Gerlach. Springer Verlag, Berlin, pp. 1-6

DREYER, J., HINZE, H. & MUNSCH, I.(1992). Bathymetry and seafloor mapping by hydrosweep. Berichte zur Polarforschung. 121 , 92-98

ERICKSON, A.W., SINIFF, D.B. & HARDWOOD, J. (1993). Estimation of population size. In Antarctic seals: research mehods and techniques Ed. R.M. Laws. Cambridge University Press, Cambridge, U.K. pp. 390

GAMBELL, R. (1985). Birds and mammals - Antarctic whales. In Key environments Antarctica. Eds. W.N.Bonner & D.W.H. Waffon, Pergamon Press. Oxford. U.K.

HARRISON, P (1983). Seabirds an identification guide. Croom Helm. London

IUCN, (1990). A strategy for Antarctic conservotion. World Conservation Union, Gland Switzerland.

Laws, R.M. (1993). Antarctic seals: research methods and techniques. Cambridge University Press, Cambridge, U.K. pp. 390

MACARTHUR, R. & WILSON, E. (1967). The theory of island biogeography. 203 pp. Princeton University Press.

MARTIN, R.M. (1990). The Illustrated encyclopedia of whales and dolphins. Portland House. New York.

SATHYAKUMAR, S. (1995). Developing a long term monitoring programme for birds and mammals in the Indian ocean and Antarctica. Unpublished Report. Widlife Institute of India, pp 1 3.

SEBER, G.A.F. (1986). A review of estimating animal abunadance. Biometrics. 42, 276-292

SIEGFRIED, W.R. (1985). Birds and mammals - Ocean birds of theAntarctic. In Key environments Antarctica, Eds. W.N.Bonner & D.W.H. Walton, Pergamon Press. Oxford, U.K.

STONEHOUSE, B. (1985). Birds and mammals - Penguins. In Key environments Antarctica. Eds. W.N.Bonner & D.W.H. Walton, Pergamon Press. Oxford, U.K.

THOMPSON, R.B. (1977). Effects of human disturbance on the Adelie penguin population rookery and measures of control. In Lalno, G.A., Eds Adaptation within Antarctic Ecosystems. Washington DC. Smithsonian Institution, 1177-1180.

WATSON, G.E., (1975). Birds of the Antiarctic and SubAntarctic. American Geophysical Union, Washington. 350 pp

WILSON, E.O. (1988). Biodiversity. Washington DC. National Academy Press.

WILSON, K.J., TAYLOR, R.H. & BARTON K.J. (1990). The impact of man on Adelie penguins at Cape Hallet, Antarctica. In Kerry, K.R. & Hampel, G. Eds. Antarctic ecosystems: ecological changes and conservation. Berlin & Heidelberg: SpringerVerlag, 183-190

WILSON, R.P, CULIK, B.R.. DANFELD, R. & ADELUNG, D. (1991). People in Antarctica: how much do penguins care ? Polar Biology, 11, 363-3 70.

WOEHLER, E.J., PENNEY R.L., CREET, S.M. & BURTON, R.H (1994). Impacts of human visitors on breeding success and longterm population trends in Adelie penguins at Casey, Antarctica, Polar Biology, 14, 269-274

YOUNG, E.C. (1990). Long-term stability and human impact in Antarctic Skuas and Adelie penguins. In Kerry, K.R. & Hampel, G. Eds. Antarctic ecosystems: ecological changes and conservation. Berlin & Heidelberg: Springer-Verlag, 183-190

ZIMMERMANN, C. (1997). On the Demersal fish fauna of the Lazarev Sea (Antarctica): Composition and community structure. In Antarctic communitites. Species, structure and survival. Eds Battaglia., Valenica, J. & Walton D.W.H. Cambridge University Press. U.K.

APPENDICES

BIRDS

1	Penguin, Adelie	*Pygoscelis adeliae*
2	Penguin, Emperor	*Aptenodytes forsteri*
3	Petrel, Antarctic	*Thalassoica antarctica*
4	Petrel, Snow	*Pagodroma nivea*
5	Fulmar, Antarctic	*Fulmarus glaciafoides*
6	Fulmar, Southern	*Macronectus giganteus*
7	Petrel, Wilson's storm	*Oceanites oceanicus*
8	Albatross, Wandering	*Diomedia exulans*
9	Skua, South polar	*Catharacta maccomicki*

CETACEANS

1	Whale, Killer	*Orcinus orca*
2	Whale, Sai	*Balaenoptera borealis*
3	Whale, Fin	*Balaenoptera physalis*

PINNIPEDS

1	Seal, Crabeater	*Lobodon carcinophagus*
2	Seal, weddell	*Leptonychotes weddellii*

Long term catch data in the Indian Ocean, especially the WIO, are often not detailed enough for stock assessment and. Ã© 2016 United Nations. 6. species composition purposes, a situation aggravated by the lack of adequate resources to conduct scientific studies, monitoring and enforcement (McClanahan and Mangi, 2004).Â â^'Long-term research surveys in the region are rare due to lack of professional expertise, infrastructure and financial capacity. Most of the research surveys are short term and sporadic depending on availability of donor funding. The International Indian Ocean Expedition, if regularly implemented could be the best source of long-term research survey data. Birds were useful in other ways, too. Fish hooks were frequently manufactured from bones, while feathers were highly prized as decorations to be worn in the hair or clothing. The results of this, in terms of bird populations, has been calculated by the scientist Paul Martin. His research since the 1960s has assessed the impact on flora and fauna of human arrival in various parts of the world, and he has concluded that New Zealand is a unique example because bird species were wiped out so fast, relative to other countries. The Complete Guide To IELTS (ACADEMIC READING). 3 TASK TYPE 2 Note/Table Completion. European migrants started arriving in significant numbers in the early 1800s and brought with them a whole lot of new problems. The principle purpose of this report is to provide recommendations, advice and practical guidance, for the establishment of programmes to monitor and assess the distribution and abundance of plastic litter, also referred to as plastic debris, in the ocean. The intention is to promote a more harmonised approach to the design of sampling programmes, the selection of appropriate indicators (i.e. type of sample), the collection of samples or observations, the characterisation of sampled material, dealing with uncertainties, data analysis and reporting the results and also to inform the establishment of national and regional field monitoring programmes. Developing a long-term monitoring programme for birds and mammals in the Indian Ocean and Antarctica using GPS and GIS technologies. Fourteenth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication, 12, 207â€“219.Google Scholar. Schwaller, M. R., Lynch, H. J., Tarroux, A., & Prehn, B. (2018).Â Studies on phylum Tardigrada and other associated fauna, south polar skua and bird and mammal logging during 1994â€“1995 expedition. Fourteenth Indian Expedition to Antarctica, Scientific Report, Department of Ocean Development, Technical Publication, 12, 221â€“243.Google Scholar. Wang, Z. P., & Peter, H. U. (2004). Antarctic ocean life is conserved through coordinated international management by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which can make binding consensus decisions about controlling the use of marine living resources.Â Undertakes one of the longest migrations of any mammal, with one-way distances of up to 8,461km recorded.33. Return to the same breeding and feeding grounds year after year.26. 93%.Â Long-distance migrants, such as humpback whales, occur disproportionately in higher latitudes where the speed and magnitude of climate change are the greatest, and are thought to be particularly vulnerable to the detrimental impacts through changes in habitat and prey availability and mismatches in timing.25.