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Distribution and status of Antarctic seals and penguins along the Princess Astrid Coast, East Antarctica

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This paper presents the status of seals and penguins along the Princess Astrid coast, East Antarctica and relates it to seasonal change in sea ice conditions along the coast. The species composition of seals along the coast was 90.2% Weddell seal *Leptonychotes weddellii* and 8.3% crabeater seals *Lobodon carcinophagus*, while 1.5% of the seals could not be identified. In the case of penguins, it was 30% Adelie penguins *Pygoscelis adeliae* and 70% emperor penguins *Aptenodytes forsteri*. The overall density of Weddell and crabeater seals was 6.57 $\pm$1.27 and 0.48 $\pm$0.13 seals/km^2 respectively, and the Adelie and emperor penguins were 12.28 $\pm$4.97 and 29.5 $\pm$7.30 penguins/km^2 respectively. The abundance of Weddell seals was positively associated with the extent of fast ice while the crabeater seals showed positive associations with pack ice. Similarly, the emperor penguins showed positive association with the extent of fast ice and the Adelie penguins for the shelf as during the surveys they were moulting largely on shelf. Three zones with large congregations of seals and penguins *viz.* Zone I between 10.25-10.65ºE, Zone II 10.90-11.5^{0}E and Zone III between 11.25-12^{0}E were identified.

[**Key words:** Antarctica, Southern Ocean, Princess Astrid Coast, seals, penguins, species composition, population densities, Antarctic Treaty]

Introduction

It is crucial to assess the biodiversity of Antarctica, viewed nowadays as an immense natural reserve to be protected from human impacts. Antarctic biodiversity, both at the species and community levels, varies from place to place[1]. When considering population size of Antarctic animals it is therefore more valid to consider discrete areas rather than extrapolate to the entire Antarctic marine ecosystem, in order to determine competition or relative ecological roles among upper trophic level predators[2], or to assess the human impact on native fauna.

The Antarctic Treaty has made it mandatory for all countries to undertake environmental evaluation prior to taking up any project in Antarctica. Under this framework, the Wildlife Institute of India took up this study to develop a monitoring protocol for seals and penguins of the Princess Astrid Coast where the cargo discharge point for Indian research station is situated. The major objectives of this study were to (a) derive estimates of seal and penguin abundance between 10-13ºE meridians, and (b) to relate wildlife abundance with changing sea ice condition.

Study Area

The Princess Astrid Coast is situated between meridians 5ºE and 20ºE meridians. The sampling stretch lies within 10-13ºE longitudes. The climate here is typical to Droning Maud Land. Extreme maximum temperature is 3ºC and extreme minimum is -48ºC[3]. The sea remains frozen between April and December. On the approach of summer by early January the fast ice along the coast becomes fragmented into pack ice, and the area remains snow free between January and March. The water temperature at the bottom varies between 1.8ºC and 2ºC[3]. The ice shelf along the coast is known as Fimbul ice shelf, which is highly, indented towards sea with many cracks at every few hundred metre interval. The shelf height often varies between 15-25 m with occasional ramps in many places. During this expedition approximately 120 km (65 nautical miles) of the coastline along the Princess Astrid Coast was monitored to determine the abundance of major wildlife along the coast. Aerial survey was carried out between January 12 and February 20, 1997 by helicopters, using the ship as base.

Methods

The data collection method follows Erickson *et al.*[4] for seals from an aircraft with slight modifications because of various constraints, such as visibility and weather conditions during the flight. On January 12,

1997 two sorties of one hour each were made to familiarize with the area and the species, and for comparing differences in sighting frequency of different seal species at different flying altitudes and ground speed. Wildlife survey along the shelf between 10-13E longitudes was carried out by flying at 60 knots at an altitude of approximately 65 m from the sea surface. The width of transect was 300 m from the shelf towards sea. All sorties were made between 1100 and 1600 hours coinciding with peak diurnal hauling out time for seals. Apart from the pilot, two observers were involved with the survey. The role of the front row observer was to spot the animals, identify species and count their number. The role of back row observer was to record the observations, taking GPS positions, and also count animals for large groups. When a large group of seal or penguins was seen, the helicopter was allowed to hover for counting. Basking seals were identified following[5].

During the survey, the sea ice condition on the transect line were recorded on a visual scale of 1 to 10. This was later summed up and percentage of each type was calculated and compared with the sea ice condition for each sortie. The sample size for classification of sea ice condition is based on 467 sample points. Whenever animals were seen, their location was recorded on a Magellan Trial Blazer XL hand held GPS receiver unit. Simultaneously, the number of animals seen, ice types, floe size and environmental conditions were recorded. A total of 12 hours of flying time was used and 5 sorties were made for the survey (Table 1). The density was calculated from the transect length multiplied with width of transects and total animal/birds seen.

Results

Sea ice conditions during the survey

The extent of fast ice, pack ice and polynea during the sorties has been summarized in Table 2. Between the beginning and end of the survey the fast ice along the shelf declined by 97.5% leading to opening up of the sea (polynea). However, between first and second sorties there was very little change in the extent of fast ice. Between February 3 and 5, 1997 there was a blizzard with a maximum wind speed of 48 nm that rapidly changed the sea ice conditions. At the beginning of the survey 21.2% of the sea surface was free of ice, which increased to 67.7%, at the end of the survey. Similarly the extent of pack ice increased from 10.8% to 30.6% at the beginning and end of the survey, respectively. The extent of pack ice was highest on February 9, 1997 (Table 2).

Species composition and density of wildlife along the Princess Astrid Coast

Maximum number of seals and penguins were seen on fast ice followed by pack ice and low shelf (Fig. 1). The distribution of seals and penguins has been plotted on GIS domain. Areas with high concentration of wildlife sightings have been

Table 1–Details of the five sorties used for wildlife survey along the Princess Astrid Coast, East Antarctica between 10-13^{0}E meridians, during January-February 1997.

Date	Direction	Start	Finish	Duration (min.)	Length (km)	Area (km^2)
17/01/97	West	12 25	14 05	100	64.82	19.45
17/01/97	East	14 20	15 10	50	46.30	13.89
18/01/97	West	13 00	15 00	120	74.08	22.22
06/02/97	West	11 05	13 10	125	72.22	21.67
06/02/97	East	16 15	17 01	47	46.30	13.89
09/02/97	West	12 15	14 30	135	74.08	22.22
20/02/97	West	12 05	13 35	90	74.08	22.22

Table 2–Sea ice conditions along the Princess Astrid Coast, East Antarctica during January-February 1997

Date	Direction from ship	Start	Finish	Sea ice condition (%)		
				Fast ice	Pack ice	Polynea
17/01/97	West	12 25	14 05	68.0	10.8	21.2
18/01/97	West	13 00	15 00	66.67	12.80	20.53
06/02/97	West	11 05	13 10	24.31	33.67	41.10
09/02/97	West	12 15	14 30	6.46	46.30	47.24
20/02/97	West	12 05	13 35	1.70	30.64	67.66

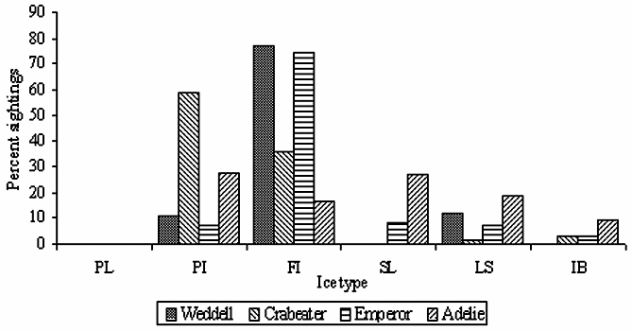

Fig. 1—Percentage of seals and penguins seen on different ice types/habitat along the Princess Astrid Coast, East Antarctica during January-February, 1997. PL = Polynea, PI = Pack ice, FI = Fast ice, SL = Shelf, LS = Low shelf, IB = Icebergs

identified and marked on the map (Fig. 2). The coastline between 10-13ºE as a single entity had areas with higher concentration of seals and penguins in certain sites indicating choice for these sites. Along the coast three zones with large congregation of seals and penguins have been identified, *viz.* Zone I between 10.25-10.65ºE, Zone II 10.90-11.5º and Zone III between 11.25-12ºE (Fig. 2).

During the survey two species of seals *viz.* Weddell *Leptonychotes weddellii* and the crabeater *Lobodon carcinophagus*, and six species of birds *viz.* Adelie penguin *Pygoscelis adeliae,* emperor penguin *Aptenodytes forsteri,* Antarctic petrel *Thalassoica Antarctica, s*now petrel *Pagodroma nivea,* Wilson's storm petrel *Oceanites oceanicus and* Antarctic skua *Catharacta antarctica* were seen. Chance sightings of a few other birds and cetaceans were also made (Appendix I). Though all seven species were counted, data pertaining only to seals and penguins are presented in this paper. In total 659 Weddell and 61 crabeater seals, and 1787 Adelie and 4156 Emperor

Appendix I: Wildlife seen along the Princess Astrid Coast between 10-13ºE meridians, during January-February, 1997

BIRDS

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

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*

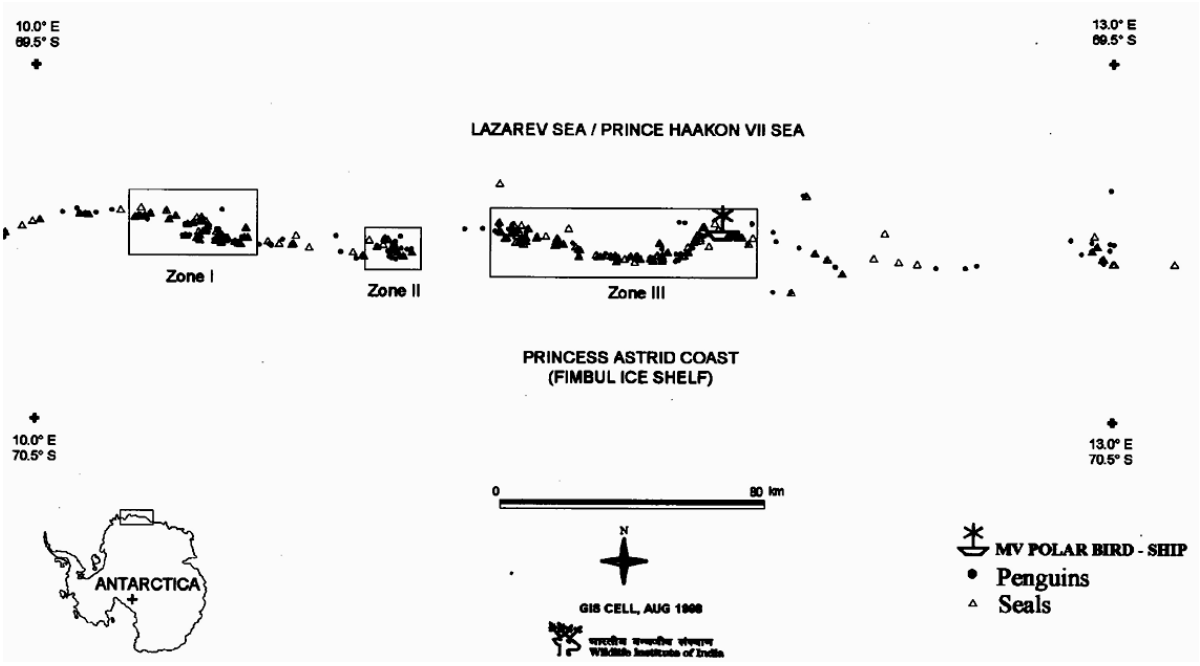

Fig. 2—Distribution of seals and penguins along the Princess Astride Coast, East Antarctica between 10-13^{0}E meridians during January-February 1997.

penguins were counted. The species composition of seals was 90.2% Weddell and 8.3% crabeater, 1.5% seals were unidentified, and whereas for penguins it was Adelie 30% and emperor 70%. The overall density of Weddell and crabeater seals and emperor and Adelie penguins was 6.57/km^2 (±1.27), 0.48/km^2 (±0.13), 29.5/km^2 (±7.30) and 12.28/km^2 (±4.97), respectively. Transect (sortie) wise density of seals and penguins have been summarized in Table 3. In the case of Weddell seals and emperor penguins the abundance was higher during the sorties carried out in January, where as in the case of crabeater seals and Adelie penguins it was higher in February (Table 3).

Group size of seals and penguins and the sea ice condition

During the survey the group size of Weddell seals varied between 8.3 ±1.4 and 3.1 ±0.6. During the first four sorties the group size decreased consistently (Fig. 3). However, during the last sortie a minor increase in the group size (5 ±1.2) was observed. This is due to the less availability of fast ice for basking at the end of the winter hence whatever ice was available the seals congregated on it. The group size of crabeater seals on the other hand was almost uniform ranging between 1 ±0 and 3 ±0.7 as they are neither animals of fast ice zone nor they formed large groups. The group size of emperor penguins varied between 66.0 ±25.1 and 9.1 ±4.5 during the sorties. The group size was higher during the earlier sorties which decreased consistently by the end of the last sortie (Fig. 4). This is linked with the availability of fast ice and moulting behaviour of the penguins. At the advent of summer the moulting of this species occurs on fast ice in large groups. The group size of Adelie penguins ranged between 2.6 ±0.9 and 16.9 ±2.4. At the onset of the survey it was 6.6 ±2.5. Subsequently, it increased during the 5th and 6th sorties as the Adelie penguins congregated for moulting on shelf. At the end of the moulting the group size became similar to as it was at the beginning of the survey. The abundance of Weddell seals was positively associated with the extent of fast ice (Fig. 5) but was negative in the case of crabeater seals. On the other hand, crabeater seals showed positive association with pack ice. The abundance of emperor penguins was also positively associated with the extent of fast ice (Fig. 5) but the Adelie penguins did not show association with fast ice as during the last three sorties they were mostly seen moulting on shelf.

Discussion

Significance of the study

Princess Astrid Coast is extensively being used as

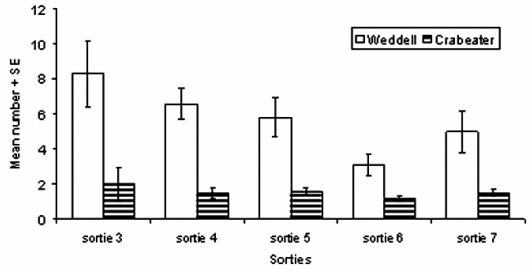

Fig. 3—Group size of Antarctic seals along the Princess Astrid Coast, East Antarctica during January-February 1997

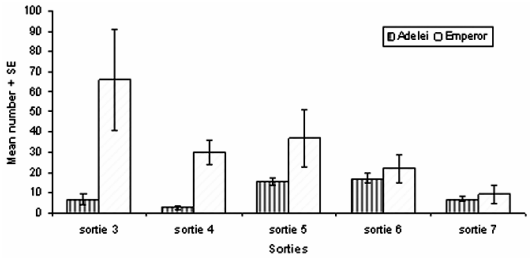

Fig. 4—Group size of Antarctic penguins along the Princess Astrid Coast, East Antarctica during January-February 1997

Table 3–Density of seals and penguins (animals/km^2) along the Princess Astrid Coast, East Antarctica between 10-13^{0}E meridians during January-February 1997

Date	Direction	Weddell seal		Crabeater seal		Adelie penguin		Emperor penguin	
		No.	Density	No.	Density	No.	Density	No.	Density
17/1/97	West	192	9.87	4	0.21	1740	1.18	4203	43.56
17/1/97	East	83	5.98	0	0	43	3.10	472	33.98
18/1/97	West	226	10.17	9	0.40	69	3.10	988	44.46
06/2/97	West	212	9.78	24	1.11	756	34.89	1102	50.86
06/2/97	East	26	1.87	5	0.31	127	9.14	3	0.22
09/2/97	West	101	4.54	7	0.36	592	26.64	571	25.69
20/2/97	West	84	3.78	12	0.54	177	7.96	173	7.78

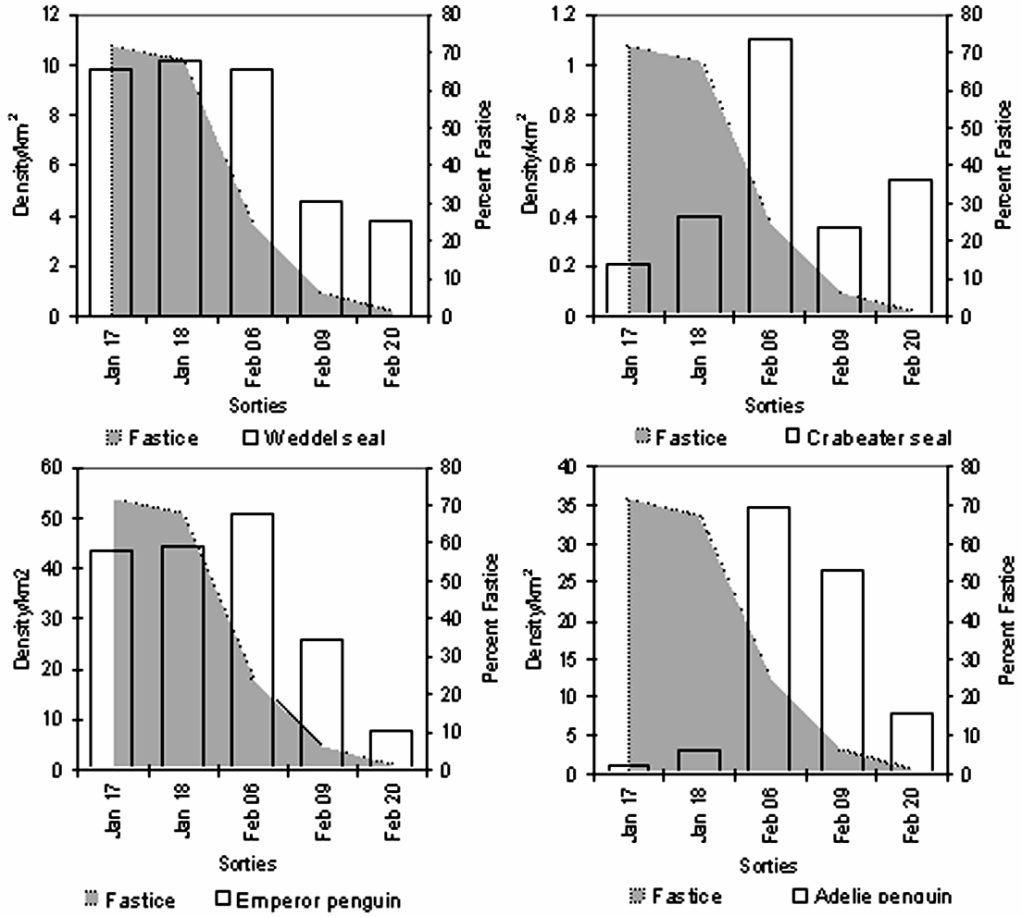

Fig. 5—Sea ice condition and wildlife sightings along the Princess Astrid Coast, East Antarctica during January-February 1997

cargo discharge point for many research stations situated in Dronning Moud Land, specifically for Norwegian station Troll, Russian Novolazarevskaya, Indian Dakhsin Gangotri and Maitri, Japanese Asuka and abandoned GDR station George Foster[6]. This area is more disturbed in comparison to areas where not many stations or cargo 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 seal and penguin populations along this coast as future changes in the distribution and abundance can not be ascertained due to lack of baseline information.

Factors influencing wildlife distribution and abundance

Significantly more wildlife (abundance/groups) sightings in the western part of the shelf are linked to the presence of more sheltered bays and creeks in the western shelf than the eastern shelf. At the Russian cargo discharge point ($11^0$37'E & $70^0$02'S) largest congregation of emperor penguins and Weddell seals was observed. Because of sheltered bay at the Russian cargo discharge point the sea ice remained frozen till February 20, it started freezing again by March 1, 1997. Availability of more fast ice prolonged the stay of 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 were 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. 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. Their sightings along the coast are of chance occurrence. Though it was not evident, it is likely that sighting 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. 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 there were more Adelie penguins during February.

Comparison with the results of other studies

The estimate of abundance in this study was higher for Weddell seal and lower for crabeater seal than the estimates by various workers during 1974 and 1995 off the Princess Martha Coast (Weddell seal: mean=0.31 seal/nm^2, SE=0.081, n=7; crabeater seal: mean=5.51 seal/nm^2, SE=1.471, n=7) [9-14]. In the case of crabeater seals, our estimate (0.48 $\pm$0.13 km$^{2)}$ was lower than those derived from ship through transect surveys in the Amundsen-Bellinghausen Seas in 1994. In our study some of the estimates have high covariance (>20%) and therefore might require more sampling (replicates) to say anything conclusively regarding the number of seals and penguins in the region. The representatives of the Wildlife Institute of India had taken part in the XIV and XV Indian Scientific Expeditions to Antarctica in 1994-1995 and 1995-1996 respectively and conducted similar surveys along the coast and provided encounter rates for seals and penguins [13-14]. For comparison, the data gathered during this study was converted into encounter rates. The results for three consecutive surveys have been summarised in Table 4. Surprisingly in 1995 no Weddell seal was seen by Sathyakumar[13]. This could be because of identification error since the entire Astrid Coast is habitat for Weddell seal[7-12, 2].

During this study three high concentration zones of seals and penguins were identified. During January and February, 1997, approximately 1100 emperor and 750 Adelie penguins, and 220 Weddell and 24 crabeater seal were using these areas. Presence of humans, large ships, cargo discharge operations and convoys are in one or other way disturbing these animals. It is suggested that the high animal concentration zones be avoided as cargo discharge points. As per the provision for designation of specially protected areas under the Antarctic Treaty System, 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 I and II. Accordingly, protection to these areas and regulating human activities as per the agreed measures for the conservation of Antarctic flora and fauna in the area need to be taken up at the appropriate level.

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