

Hearing Abilities in Antarctic Penguins

by Eric J. Woehler¹

SPECIES' POPULATIONS, BREEDING SEASONS AND FORAGING STRATEGIES

Six species of penguins breed on the Antarctic continent, the Antarctic Peninsula, the South Shetland and South Orkney Islands. Their breeding populations within the Antarctic Peninsula, and the South Orkney and South Shetland Is., and estimates of global populations are given below (Tab. 1). Typical breeding seasons are also presented, but it must be noted that these will vary inter-annually and intra-annually under the influence of factors such as sea-ice extent and ENSO (inter-annual) and the location of each breeding colony (southerly localities will be later than northerly localities, as their breeding season is "compressed" within the shorter summer). Their foraging strategies (categorized as near-shore or off-shore) and typical durations of foraging trips are also tabulated. As with breeding season events, foraging behaviour will vary intra-seasonally and inter-seasonally (in terms of dive duration, dive depth, foraging location, etc). The distribution of known penguin breeding colonies is circum-continental, with Emperor and Adélie penguins predominant on approximately 75 % of the coast, with two major concentrations in the Ross Sea and in Prydz Bay (Fig. 1). The third concentration is in the Antarctic Peninsula region, where some of the largest penguin colonies are present. All six species breed within the area (predominantly Chinstrap Penguins), and the Peninsula region

has a greater diversity than the remainder of the Antarctic with respect to penguins (Fig. 2). The distribution at sea of non-breeding penguins is less clear. Non-breeding individuals of all six species move throughout the Southern Ocean, and in many cases, to areas well north of the winter pack-ice zone. However, it is not possible to estimate densities of penguins at sea as there are no estimates of non-breeding penguin populations or the extent of their travels.

VOCALISATIONS AND HEARING ABILITIES OF PENGUINS

Vocalisations associated with agonistic, contact and breeding behaviours of penguins in colonies were documented by JOUVENTIN (1982). His results are summarized in Table 2. There are no empirical data of at-sea vocalizations by penguins, but there is no reason to believe that they would be different. Penguins are known to call at sea; these calls have been characterized as "contact" calls in that individual penguins maintain contact with other birds while at sea.

Research conducted by MARKOV (1977) suggested that Macaroni Penguins were able to vocalize under water. Immediately after introducing a single bird into an 8 x 2.2 x 1 m tank at Moscow Zoo, recordings of sound and ultrasound indicated

species	Antarctic Peninsula including S Orkney and S Shetland Is. (pairs)	global species population (pairs)	arrive at colony	eggs hatch	chicks fledge	depart from colony	foraging strategy and duration	dive depths (m)
Emperor	1,200	220,000	March	April	June	late Nov+	offshore extended	>400
Adélie	630,000	2.5 million	Oct.	Nov	Dec	March	offshore, short-extended	200
Chinstrap	2.5 million	7.5 million	Nov	Dec	Jan	March	inshore, same day to short trips	<100
Gentoo	75,000	300,000	Oct	Dec	Jan	March	inshore, same day to short trips	<80
Macaroni	13,000	11 million	Oct	Nov	Dec	March	inshore, same day to short trips	<100
Rockhopper	1	2-3 million	Oct	Nov	Dec	March	inshore, same day to short trips	<80

Tab. 1: Tabulation of population data within the Antarctic Peninsula region, global species' populations, breeding season events and generalized foraging strategies for the six species of penguins that breed in the Antarctic and on the Antarctic Peninsula.

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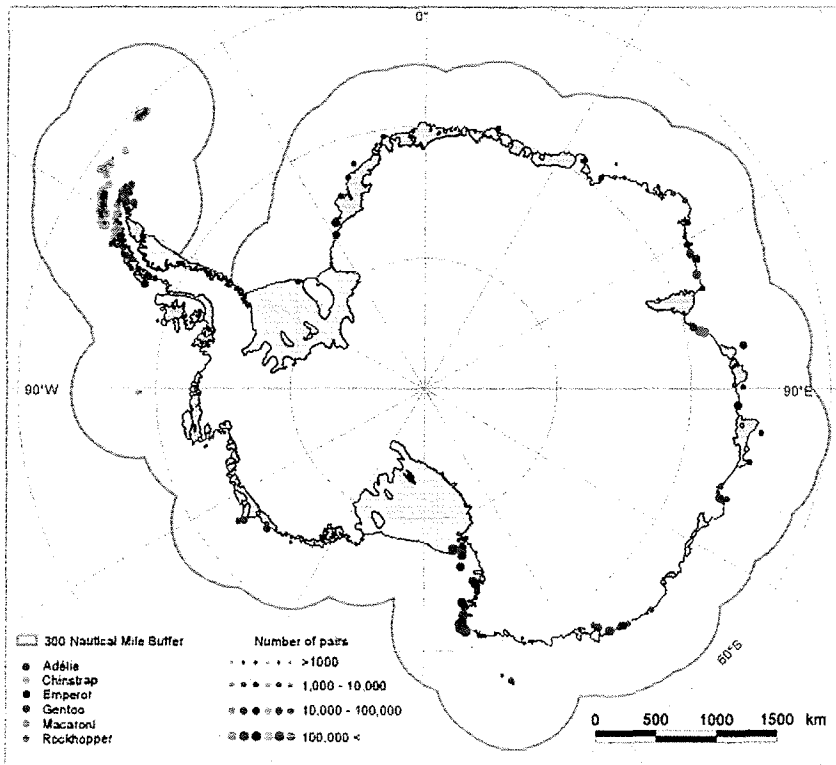


Fig. 1: Map showing the distribution and abundance of six species of penguins around the Antarctic continent. A 300 nautical mile buffer has been drawn around each penguin colony to indicate potential foraging ranges. Data from WOehler (1993) and WOehler & CROXALL (1997).

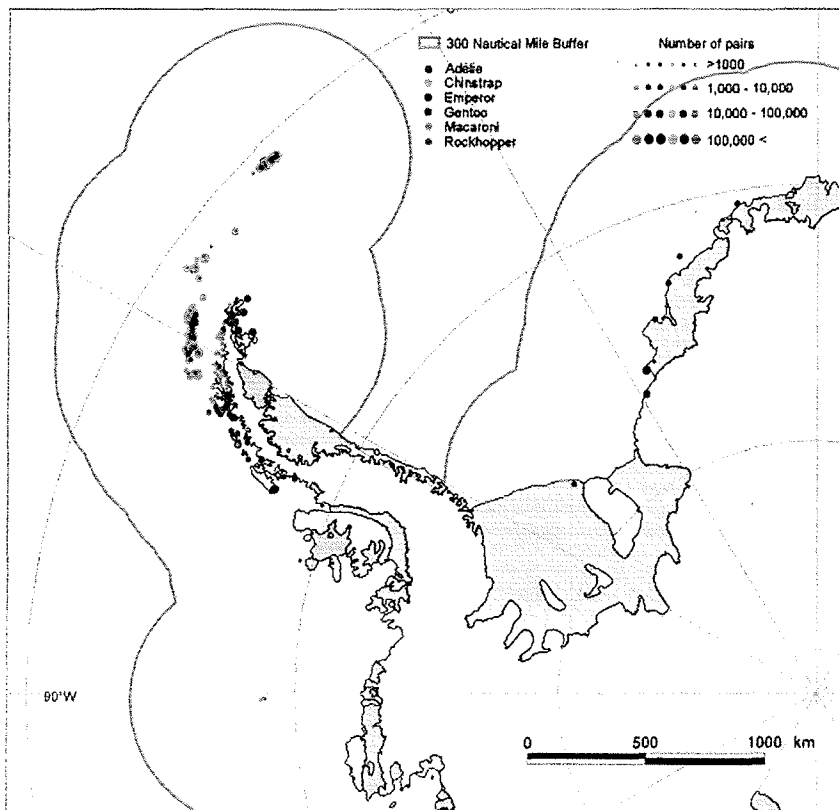


Fig. 2: Map showing the distribution and abundance of six species of penguins in the Antarctic Peninsula region. A 300 nautical mile buffer zone has been drawn around each penguin colony to indicate potential foraging ranges. Data from WOehler (1993) and WOehler & Croxall (1997).

species	frequency range (Hz)	max intensity freq (Hz)	auditory range (Hz)
Emperor	500 - 6000	2000	30 - 12,500
Adélie	800 - 5000	200 - 5200	no data
Chinstrap	500 - 4000	2000	no data
Gentoo	400 - 4000	2000 - 3000	no data
Macaroni	1000 - 8000	1000 - 3800	no data
Rockhopper	1000 - 8000	800 - 3000	no data

Tab. 2: Summary of results obtained by JOUVENTIN (1982) of the frequency ranges, maximum intensities and auditory ranges of six species of penguins.

that the bird was vocalizing, mainly in the 2.5 - 7 kHz, with the range extending between 0.5 and 20 kHz. Further, the ultrasound recordings suggested vocalizations by the penguins to 120 kHz (Fig. 3). Unfortunately, these results were based on a single bird, the experiment has never been repeated, and there has been no subsequent research into these preliminary results. It should be noted that the results reported in the text do not match the results presented graphically in the paper. Until further research is conducted, the ability and extent of vocalisations by penguins whilst underwater must remain indeterminate.

There has been only a single study investigating the underwater hearing abilities of penguins (COOPER 1982). African penguins *Spheniscus demersus* were subjected to a series of noises in an attempt to reduce mortalities associated with underwater blasting. Three approaches were used: firing of

guns over water, playback of underwater noises and vocalisations of Orca (*Orcinus orca*) were trialled to scare penguins out of areas in which blasting was to take place. The gunfire and underwater noises reduced mortality, but the playbacks of Orca calls did not.

CONCLUSIONS

There are good data on the distribution, abundance, foraging ecologies and onshore vocalisations of the six species of penguins that breed on the Antarctic continent, including the Peninsula. It is clear that penguins are present around the entire Antarctic coast and that breeding individuals are present within colonies throughout the year (Tab. 1). In contrast, the hearing abilities and underwater vocalisations are poorly documented, and require further research (Tab. 2). Finally, it should be noted that there are approximately 14,000 breeding pairs of Blue-Eyed Cormorants (*Phalacrocorax atriceps*) on the Antarctic Peninsula; these birds can dive to 90 m and must be included in all considerations regarding the operation and potential impact of acoustic technologies in the Southern Ocean.

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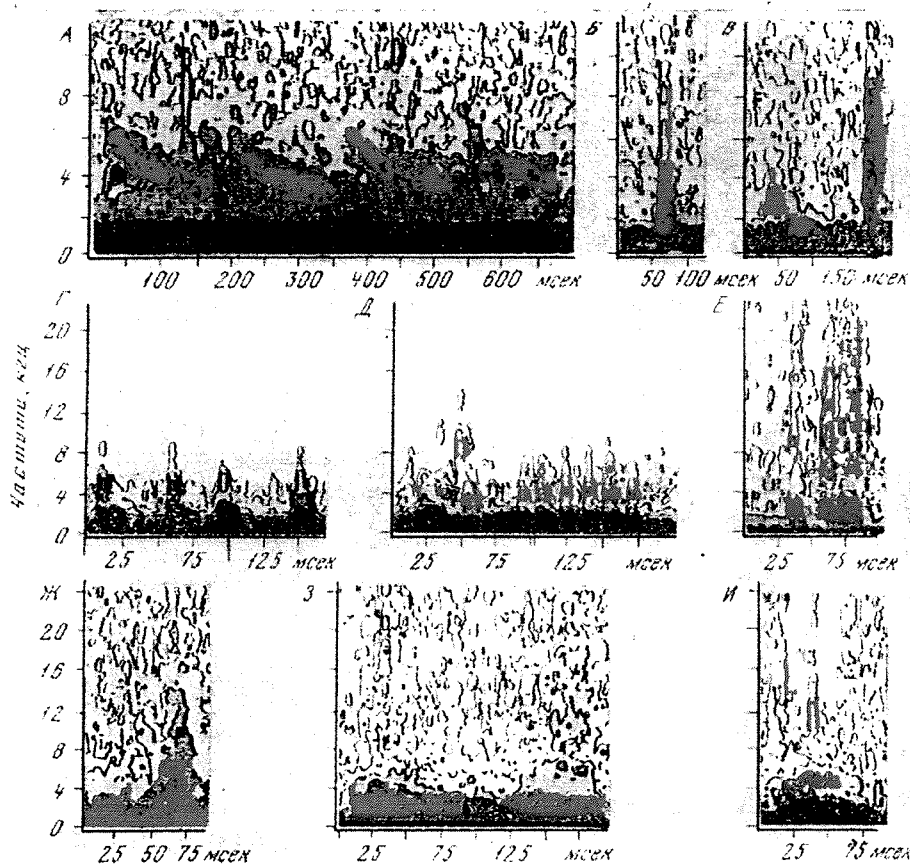


Fig. 3: Sonograms of sound and ultrasound recordings of a Macaroni Penguin in a tank from MARKOV (1977). Time scales on abscissa are in msec, with frequency (kHz) on the ordinate; red colour indicates most intense vocalisation.

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