Appendix I

to

Working Paper "Current Status of the Ross Seal (*Ommatophoca rossii*): A Specially Protected Species under Annex II"

A summary of status of knowledge of the biology, distribution, and abundance of the Ross Seal, *Ommatophoca rossii*

compiled by

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Background

The Conference on the Conservation of Antarctic Seals[1] proposed a prohibition of commercial exploitation of pinnipeds[2] in the Antarctic which was later codified in the Convention for the Conservation of Antarctic Seals (CCAS)[3]. Article 4 of CCAS allows for special permits to be issued particularly for scientific research to take small numbers of all seals to collect sufficient information on life history and ecology of the species as a basis for conservation and management within the framework of the Antarctic Treaty. Annex I of CCAS provides for commercial harvests of limited numbers of all species except Ross seals (*Ommatophoca rossii*) and southern fur seals (*Arctocephalus sp.*) for which commercial catch or killing are prohibited by designating them as *Protected Species*[4]. When environmental protection in the Antarctic was expanded in 1991 as the Protocol on Environmental Protection to the Antarctic Treaty, the Ross seal was listed as a *Specially Protected Species* in Annex II of the Protocol, That designation was evidently as a simple automatic clerical inclusion without substantive consideration because the species had been informally listed in Annex A of Agreed Measures for the Conservation of Antarctic Flora and Fauna at the IIIrd Antarctic Treaty Consultative Parties meeting in 1964. The Ross seal classified by the IUCN in 1996 as a species of *'Least Concern*[5]*.*

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[1] London, 3-10 February 1972

[2] The term pinniped is a non-taxonomic term that has been applied to a group of three families of marine carnivores; the Phocidae (true or earless seals), the Otariidae (the eared seals = fur seals and sea lions), and the Odobenidae (walrus). It is derived from *pinnipes*, the Latin for fin- or wing-footed, a composite of the Latin *pinna*, meaning wing or feather, and *pes* meaning foot. These closely related families are all derived from terrestrial carnivore ancestors. There is as yet no consensus on whether different groups of terrestrial carnivores are independent ancestors to the three groups or which group they might be descended from if they all have a common ancestor. The CCAS applies to Southern elephant seals (*Mirounga leonina*), leopard seals (*Hydrurga leptonyx*), Weddell seals (*Leptonychotes weddellii*), crabeater seals (*Lobodon carcinophaga*), Ross seals (*Ommatophoca rossii*), and all Southern Hemisphere fur seals (*Arctocephalus* sp.).

[3] Agreed on at the VIIth Antarctic Consultative Meeting, Wellington, New Zealand. Entered into force 11 March 1978.

[4] CCAS Annex 1 §2(a)

[5] This designation recognizes that there is adequate data to assess that the species is widespread and abundant, and neither threatened nor near threatened (IUCN 2006).

Status of knowledge of the Ross seal

The Ross seal (*Ommatophoca rossii*) is one of four phocid pinnipeds that lives exclusively in the Southern Hemisphere with breeding populations confined to the circumpolar pack ice of Antarctica. The species was named after Sir James Clark Ross who collected two of these seals in 1840 at 68ºS and 176ºE during his voyage into the Ross Sea on the HMS *Erebus* and HMS *Terror.* Gray (1844, 1875) used those two seals as the type specimens to describe the species. The genus name is from the Greek *omma* meaning eye, highlighting its large size. Ross seals grow to about 2 to 2.5 m long and up to 200 kg. Recent measurements of 41 post-breeding and newly molted adult seals in the Ross Sea in 1999/2000 were, on average, about 2.04 m long, 1.33 m in girth, and weighed about 158 kg with no significant differences between males and females (B.S. Stewart unpubl. data). Other reports of body size have been variable and unequivocal (King 1964, Bonner and Laws 1964). Oritsland (1970) estimated longevity at 12 years and age of sexual maturity at 3-4 years for males and 2-7 years for females based on a sample of seven females and eight males collected in 1964.

Ross seals have relatively small but robust bodies with short, broad heads. The eyes are noticeably large and forward pointing reflecting adaptations to their deep diving and foraging habits. The teeth are all small and the post-canines are simple without shearing or grinding structure. The canine teeth are very sharply conical, evidently adaptations for catching squid which seems to be the primary prey (Hamilton, 1901, Wilson, 1907, Brown 1915, Solyanik 1965, King 1969 Skinner and Klages 1994, Bengtson and Stewart 1997). The short pelage is dark brown dorsally and cream or tan ventrally, with several dark stripes radiating down the throat from the mouth and some spotting along the boundary between the counter-shaded dorsal-ventral pattern. Seals molt from late December through January and perhaps mid-February (Skinner and Westlin-van Aarde 1989, Southwell 2003, Ackley et al. 2003, B.S. Stewart, unpubl.). Ross seals forage at depths of around 100 to 200 m and occasionally as deep as almost 400 m (Bengtson and Stewart 1997, Southwell 2005).

Breeding

The few observations and data on the reproductive biology of Ross seals suggest that pups are born from mid-October through November (Solyanik 1964, Tikhomirov 1975, Thomas et al. 1980, Southwell et al. 2003). Mating may occur just after that in December and early January. 0ritsland (1970) reported a 101 cm foetus collected on 23 September, 1964 and estimated length at birth to be 105 cm or longer whereas King (1969) suggested a length of 120 cm. and weight of 27 kg at birth. Erickson et al. (1972) reported recent corpora lutea and implanted blastocysts in two Ross seals collected in the Amundsen Sea on January 29, 1972.

Distribution

Ross seals have not often been encountered in the Antarctic. They have been long thought to live in heavy pack ice around the continents, where few ships or expeditions have travelled. Consequently, little is known of the species' distribution, abundance, life history, and basic natural history. They may range all around the Antarctic continent though areas of higher density appear to be in the Ross Sea, the

King Haakon VII Sea and perhaps parts of the western Weddell Sea. Though Ross seals may indeed give birth and mate in remote and inaccessible areas of pack ice, recent studies have begun to discover that they may live and forage in open water far from seasonal pack ice from late summer (January-February) through early to mid-spring (October-November).

Vagrants have been observed at several sub-Antarctic islands, New Zealand, and Australia (Erickson and Hofman 1974, Reeves et al. 1992, Reeves et al. 2002). Most sightings of Ross seals have been of solitary seals through but small groups and aggregations have been seen a few times (Mawson 1915, Bonner and Laws 1964, Ray 1970, Erickson et al. 1971, Splettstoesser et al 2000). Some of these aggregations and groups were recorded in areas of sparse ice and evidently reflected the absence of suitable haulout habitat,

Haulout patterns

Bengtson et al. (2007) monitored three Ross seals in the Ross sea from late December through October and found that peak haulout occurred at mid-day with seals spending most of the night in the water foraging (Fig 1), similar to the pattern reported earlier for one seal in the Weddell Sea (Bengtson and Stewart 1997).

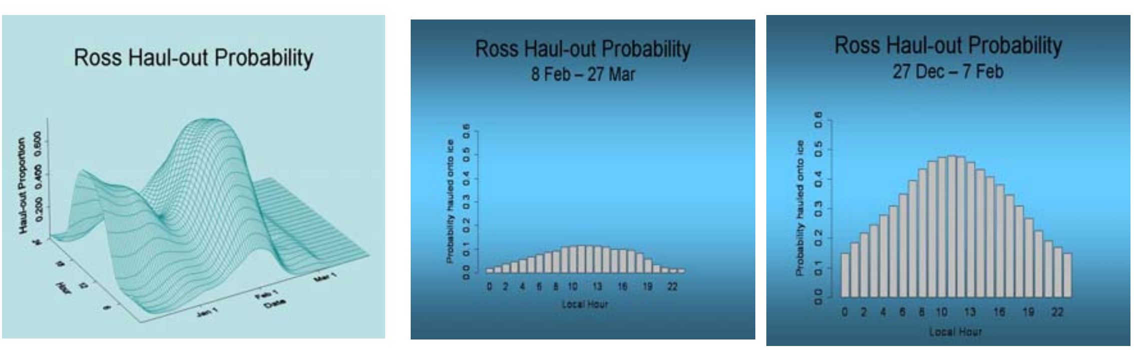

Figure 1. Haul out characteristics of Ross seals in the Amundsen and Ross seas in 1999/2000 (Bengtson et al. 2007).

Southwell et al. (2007) combined haulout pattern data obtained from satellite-linked data recorders from studies conducted in East Antarctica (Southwell et al. 2003), the King Haakon VII Sea (Nordøy and Blix 2005), and the Amundsen and Ross seas (Ackley et al. 2003, Bengtson et al. 2007) and found a unimodal pattern of haulout of Ross seals that peaked at mid-day in mid to late summer (Fig. 2) though there was considerable variability among seals.

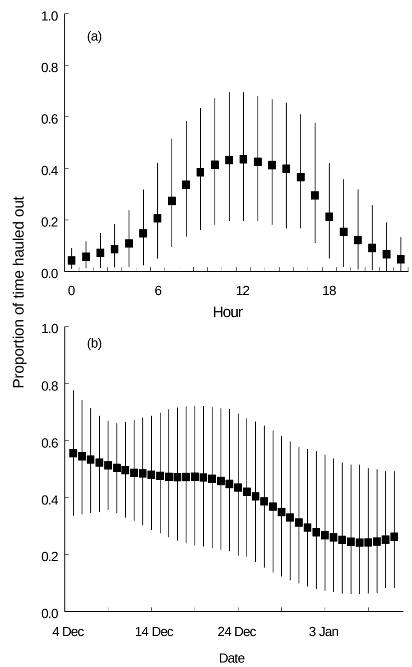

Figure 2. Modelled haul-out profile of Ross seals in East Antarctica (a) by hour within a day, for the mid-point of the survey period (23 December), and (b) across days within the survey period, for solar midday. Vertical lines are 95 percentile ranges, and closed squares are medians, of the 1000 bootstrap replicates (Southwell et al. 2007).

Movements

Recent data from Ross seals tracked from late austral summer through spring have demonstrated that these seals spend much of each year at sea north of seasonal pack ice (Blix et al. 1998, Nordoy and Blix 2002, Bengtson et al. 2007b).

Habitat

Ross seal distribution in austral spring and summer, at least, appears to be directly related to the distribution and density of pack ice. Seals evidently breed in heavy, interior region pack ice and then haulout nearer the edge of the pack ice but on large stable ice floes in late summer to molt. Accumulating evidence indicates that seals spend most of their time foraging in pelagic areas north of pack ice after they finish the molt in late summer and through early autumn. Immature and non-breeding seals may spend an entire year or more in pelagic habitats.

Population size

Population count data are meager and densities calculated from them have been variable and low. Laws (1953) estimated 10,000 Ross seals in the Falkland Island Dependencies and Scheffer (1958) estimated the total Antarctic population between 20,000-50,000. Four of 4,742 seals counted in 552.47 nm^2 surveyed in the Weddell sea in the late 1960s were Ross seals and their density in that area was estimated as 0.007 seals/nm^2 (Erickson et al., 1970). Eklund and Atwood (1962) estimated Ross seal density in in East Antarctica (105°-112°E longitude) at 0.301/nm^2. In the western Ross Sea, Ray (1970) estimated densities at 0.04 to 0.4/nm^2. Eklund and Atwood (1962) estimated the circumpolar population at 51,400 from estimated density in a small survey area and then projected the estimate to 2,200,000 nm^2 of pack ice with surface cover between 0.3 and 1.0%. Gilbert and Erickson (1977) estimated Ross seal density in the Bellingshausen and Amundsen seas (85°W-135° $nm^2$30'W) at 0.108 nm^2 then calculated a minimal estimate of 28,968 Ross seals in 215,771 nm^2 of pack ice. Based on regional systematic surveys, the species was then later estimated at 220,000 in 1977 (Gilbert and Erickson 1977) and 131,000 in 1990 (Erickson and Hanson 1990). The comprehensive censuses of pack ice seals in 1983 found substantially lower densities of Ross seals than had been reported earlier (cf. Siniff *et al.* 1970; Gilbert and

Erickson 1977; Erickson et al. 1983; Erickson and Hanson 1990) though it is not clear whether these difference represent real declines rather than differences in densities associated with differences in pack ice habitat or perhaps hauling patterns. Splettstoesser et al. (2000) made regional and circumpolar surveys in the austral summers of 1992/93, 1996/1997, and 1997/98 aboard a Russian icebreaker tourist cruise. Most seals were found in light to heavy pack ice and they found relatively large concentrations in the Riiser-Larsen Sea (14ºE to 35ºE longitude) where they estimated denities at 0.02 seals/nm^2 in 1996/97 and hauled out on fast ice near Gaussberg (66º13' S, 89º35'E) in 1997/98 when there was mostly open water nearby and in the broader region (57º'E to 100ºE) in 1992/93 when there was heavy pack ice through late summer.

More recently, a circumpolar international program[6] to derive estimates of population abundance of crabeater, leopard, Weddell, and Ross seals was conducted from the early 1990s through 2000 (Fig 3; cf Ackley et al. 2003, Bester and Stewart 2006, Southwell et al. 2007).

[6] The International Antarctic Pack Ice Seal (APIS) program.

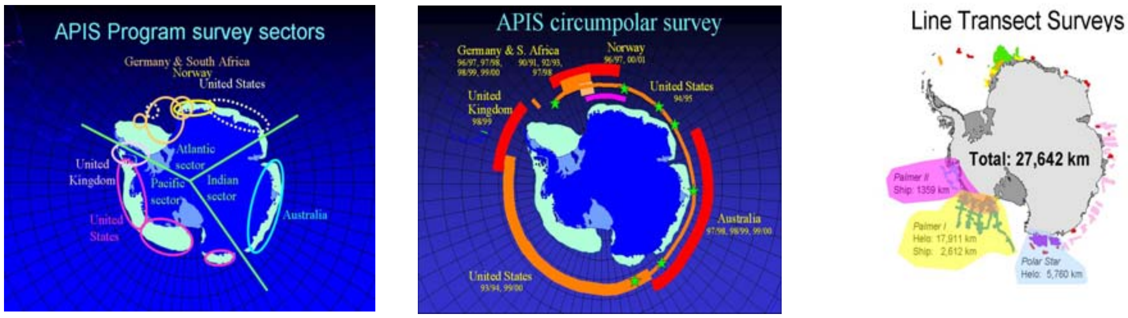

Figure 3. APIS International survey allocation, timing and results of line transects accomplished

Line transect surveys of pack ice (25,561 km) and fast ice (2,080 km) conducted by helicopter and ship in the Amundsen and Ross seas (between 150° E and 100° W) from late December 1999 through early March, 2000 resulted in an estimate of 22,600 seals (11,700 to 43,700) between 180° - 130° W with the highest density in the interior pack ce (0.04 seals/km^2) (Figs 4, 5; Bengtson et al. 2007).

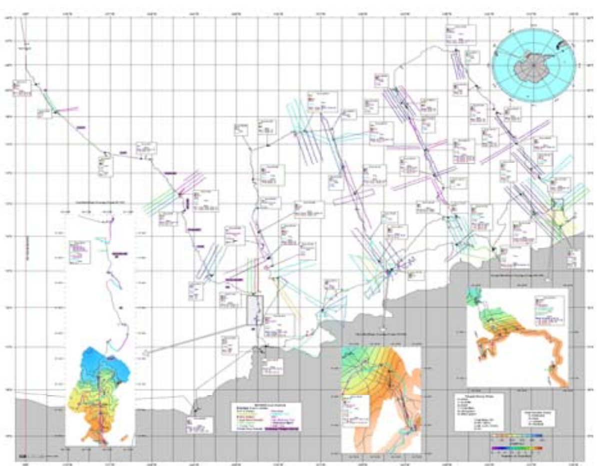

Figure 4. Line transects from ship and helicopter conducted in the Ross and Amundsen Seas in 1999/00 (Bengtson et al. 2007).

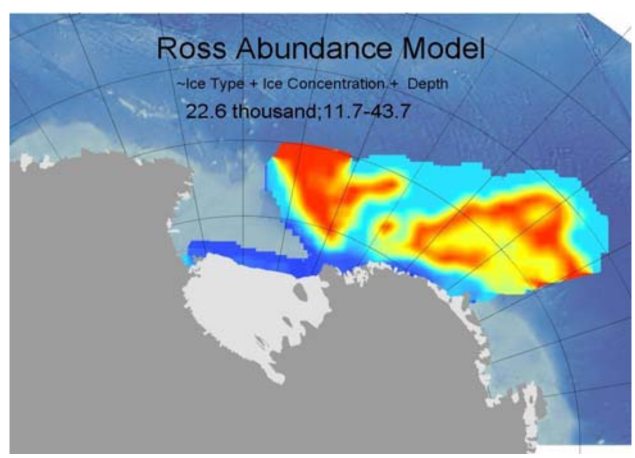

Figure 5. Estimated density and abundance of Ross seals in the Ross and Amundsen seas in 1999/00 relative to pack ice coverage (Bengtson et al. 2007).

Southwell et al (2007) made line transect surveys from helicopter of the pack-ice zone between longitudes 64^{o}E and 150^{o}E, where about 1 500 000 km^2 had >1/10 ice-cover and likely suitable habitat for Ross seals, from helicopter (Figs 6, 7). The computed estimates of abundance ranged from 20,500 (lower 2.5 percentile) to 226,600 (upper 97.5 percentile with best estimates of 41,300 to 55,990 (Southwell et al. 2007) similar to that reported earlier by Erickson and Hanson (1990).

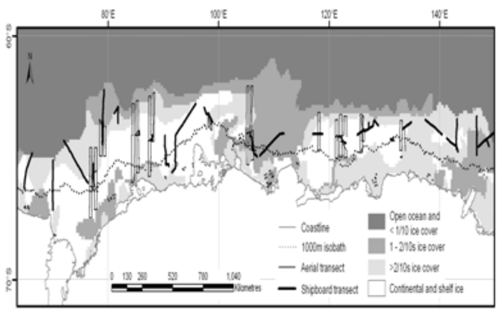

Figure 6. Aerial and shipboard survey transects and distribution of ice at the time of the survey in East Antarctica in 1999/2000 (Southwell et al. 2007).

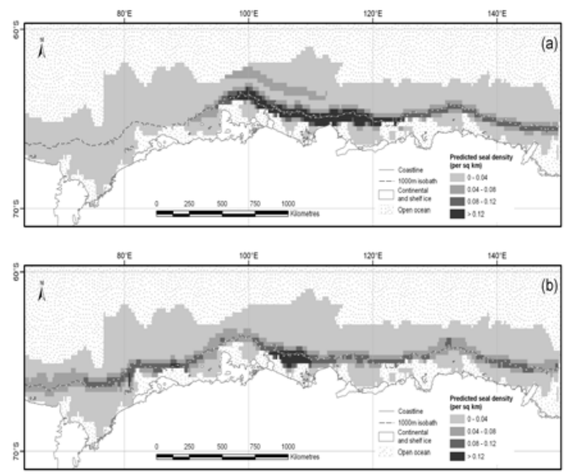

Figure 7. Predicted Ross seal distribution in East Antarctica, based on the predictive model for (a) definite sightings only, and (b) definite plus probable sightings (Southwell et al. 2007).

Bester et al. (2002) made an aerial survey off the Princess Martha Coast of Queen Maud Land in the King Haakon VII Sea in 1992/1993 (Fig. 8) and found the density of Ross seals to be 0.57 seals/nm^2.in December and B0.122 seals/nm^2 in January when pack ice was melting and haulout space became more concentrated. This compares with densities of 0.45-2.91 seals nm^{-2} in the same area determined by shipboard surveys made in the 1970s (Bester et al. 1995, Bester et al. 2002).

Norwegian scientists made aerial surveys in the pack ice of the Weddell Sea in January and February 1997. The results of those surveys have not yet been reported (Fig. 8; Blix unpublished data).

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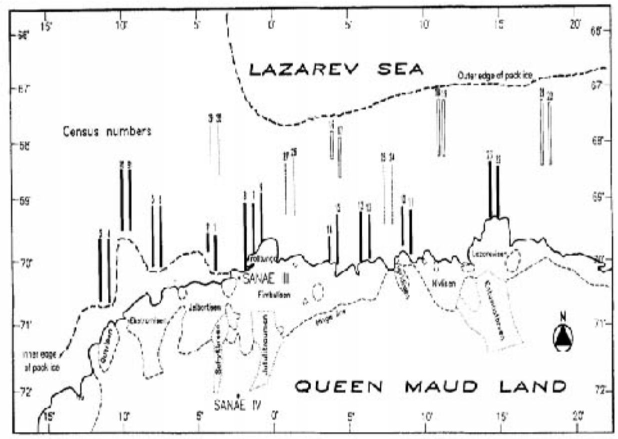

Figure 8. Aerial surveys made off Queen Maud Land in 1992/1993 (Bester et al. 2002). Increasing numbers indicate the transect sequence. Classification of transects are indicated by line types: thick solid line = inner zone; thick boxed line = outer zone; broken line = middle zone.

Aerial surveys were made in the eastern Weddlell Sea (22°W to 8° E and 66° to 73° S) in each austral summer from 1996/97 through 2000/01 (Figs 10, 11; Plotz unpublished data; Bester et al. 2002).

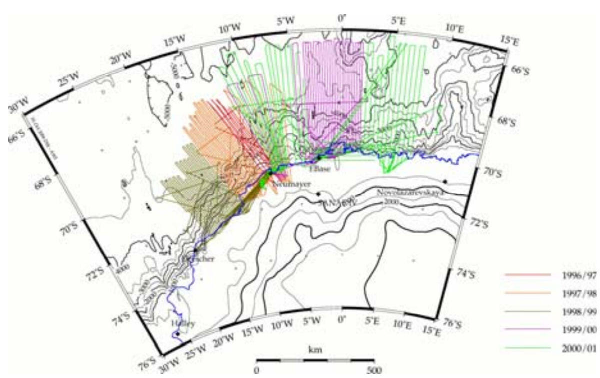

Figure 10: Aerial surveys in the eastern Weddell Sea from 1996/1997 through 2000/2001 (Ploetz, unpublished data).

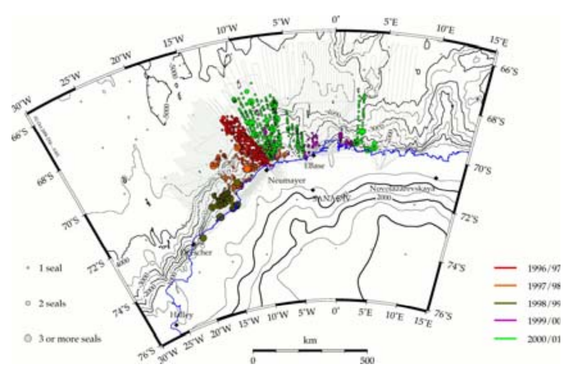

Figure 11:.Distribution and abundance of seals counted during the 5 EMAGE-APIS flight campaigns. The northernmost seal counts (coloured circles) of the 5 annual surveys roughly correspond to the location of the northern sea ice margin during the each survey (Plotz unpublished data)..

A preliminary analysis of the data from aerial and shipboard surveys in 1997/98 for the area bounded by $07^{0}08'$ and $45^{0}33'$

West longitude[7] found 45 Ross seals for a density of 0.08 seals/nm^2 (Bester and Odendaal 1999, 2000). The data for surveys during the other years have not yet been reported.

Habitat trends

Seasonal and yearly variation in the size and nature of the pack ice zone clearly has an influence on the distribution and density of breeding and molting Ross seals (cf. Splettstoesser et al. 2000, Gilbert and Erickson 1977). Consequently, its breeding season range will likely contract if the Southern Ocean climate continues to warm and seasonal pack ice coverage contracts. The non-breeding season foraging habitats of Ross seals are still poorly known, but recent data suggest that they are mesopelagic areas north of pack ice zones and may overlap with southern elephant seals and other migratory subarctic marine vertebrates.

Threats

There has been essentially no commercial harvest of the species and none are planned or likely to be seriously considered. The non-aggregating nature and remote breeding habitat of Ross seals shelter them from virtually all potential direct interactions with human activities. The apparent solitary behavior and broad distribution on non-breeding seals may also reduce direct interactions with commercial fishing activities. Perhaps the most important threat is loss of breeding habitat accompanying ocean climate warming and constriction of seasonal pack ice, as it is with all seals that breed in pack ice and fast ice habitats.

[7] During the survey the eastern Weddell Sea was ice free whereas a substantial pack ice field remained in the western Weddell sea.

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