

THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

The Minister approved this conservation advice and transferred this species from the Vulnerable to the Endangered category, effective from 07/12/2016

Conservation Advice

Arctocephalus tropicalis

subantarctic fur-seal

Taxonomy

Currently accepted as *Arctocephalus tropicalis* (Gray 1872). No subspecies are recognised.

A review of pinniped taxonomy (Berta & Churchill 2012) recommended that the genus *Arctocephalus* only apply to *A. pusillus* (Australian fur-seal), with all other species/subspecies using the genus *Arctophoca*. However, the Marine Mammal Society's Committee on Taxonomy returned to using *Arctocephalus* for all southern fur seals until remaining uncertainty about phylogenetic relationships within the Order Carnivora were resolved. This was done by Nyakatura & Bininda-Emonds (2012) in their revision of the mammalian Order Carnivora. The Society's Committee on Taxonomy (2014) as well as the International Union for the Conservation of Nature (IUCN) Pinniped Specialist Group (Hofmeyr 2015) have confirmed their continued use of *Arctocephalus*. As such, this document (and the Department of the Environment and Energy) will continue to use *Arctocephalus tropicalis* as the species name.

Summary of assessment

Conservation status

Endangered: Criterion 4

The highest category for which *Arctocephalus tropicalis* is eligible to be listed is Endangered.

Arctocephalus tropicalis has been found to be eligible for listing under the following categories: Criterion 4: Endangered.

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

Reason for conservation assessment by the Threatened Species Scientific Committee

Arctocephalus tropicalis was listed as Vulnerable under the predecessor to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) the *Endangered Species Protection Act 1992* and transferred to the EPBC Act in July 2000.

This advice follows assessment of new information in *The Action Plan for Australian Mammals 2012* (MAP) (Woinarski et al., 2014) provided to the Committee to change the listing status of *Arctocephalus tropicalis*. The MAP considered that the species' status was Endangered and that the list referred to in section 178 of the EPBC Act should be amended to reflect this.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 32 business days between 4 May 2016 and 17 June 2016. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process.

Species information

Description

The subantarctic fur-seal has distinctive coloration that distinguishes it from congeneric species, the Antarctic fur-seal (*A. gazella*) and the long-nosed fur-seal (*A. forsteri*). Adult males have chocolate brown to black fur on their upperparts with a contrasting yellow chest and face, and a well-developed mane, chest and shoulders. They have a crest of black fur on the top of the head which becomes erect when excited. Adult females are lighter in colour, being dark grey or dark chocolate brown on their upperparts, and pale yellow on their chest and face. Pups are glossy-black with a dark chocolate brown belly. The species has long white sensory whiskers and external ears (Goldsworthy 2008; DEH 2004a).

The species is sexually dimorphic with adult males measuring 150–190 cm in length and weighing 90–160 kg; while adult females are 100–140 cm with a weight of 30–50 kg. Newborns are 60–70 cm and weigh 4–6 kg (Goldsworthy 2008).

Distribution

Globally, the subantarctic fur-seal has a wide southern hemisphere distribution, and a dispersed breeding distribution on isolated subantarctic and subtemperate islands north of the Antarctic polar front in the southern Indian, Pacific and Atlantic Oceans (Arnould 2009; Hofmeyr 2015). The International Union for the Conservation of Nature (IUCN) notes that the global estimate for the species in the early 2000s was over 400 000 and currently classifies the species as Least Concern (Hofmeyr 2015).

In the Australian region, the only established breeding colony occurs on Macquarie Island, 1500 km south-southeast of Australia (Goldsworthy 2008). Some individuals occur at Heard Island, 4000 km southwest of Australia; and some wide-ranging (mostly juvenile) vagrants occasionally reach beaches on Tasmania, the Australian mainland and offshore islands with more than 50 individuals having been recorded from New South Wales to Western Australia since the 1970s (Gales et al., 1992; Shaughnessy 1999; Mawson & Coughran 1999). Jefferson et al. (2008) noted that subantarctic fur-seals have also occasionally been recorded at the Davis and Mawson Australian Antarctic research stations on the Antarctic continent.

Fur-seals were previously abundant at Macquarie Island, but were extirpated by intense sealing within a decade of discovery in 1810 (Ling 1999). Although sealing records do not differentiate what species of fur-seals comprised the over 200 000 skins taken, it has been argued that the timings of hunts demonstrate that the majority were likely to have been subantarctic fur-seals (Shaughnessy & Fletcher 1987). In the aftermath of the sealing years, fur-seals were not known to breed on Macquarie Island for over 130 years until 1954 (Kirkwood & Goldsworthy 2013).

Relevant Biology/Ecology

Most subantarctic fur-seals, except for females with pups, spend much of their time at sea during winter and spring, but very little is known about their movements and behaviour at sea (Jefferson et al., 2008). These fur-seals are opportunistic pelagic foragers that generally feed in areas of high productivity, including oceanographic fronts; their diet consists of various fish, cephalopods, crustaceans, and (at Amsterdam Island) penguins (Hofmeyr 2015; Jefferson et al., 2008). At Macquarie Island, they forage at night in mostly shallow 10–20 m depths, and feed mainly on *myctophid* (lantern) fish species, squid, and small numbers of crustaceans (Shaughnessy & Fletcher 1987; Robinson et al., 2002; Goldsworthy 2008). Foraging trips at Heard Island are longer than at Macquarie Island, where lactating females tend to feed at two locations about 30 km and 100 km north of the island (Shaughnessy & Goldsworthy 1993; Robinson et al., 2002).

Large males hold and defend beach territories for exclusive mating rights with small numbers of breeding females (Lancaster et al., 2006, 2007a). On Macquarie Island, the species prefers to breed in cobblestone boulder coves at Goat Bay and the southern regions of Secluded Bay,

while non-breeding seals also use tussock slope habitats above the colonies (Shaughnessy 1999; Goldsworthy et al., 2009; Lancaster et al., 2010). The preferred breeding sites on Macquarie Island are estimated to be less than 1 km² in area (Lancaster et al., 2010; Goldsworthy pers. comm., cited in Woinarski et al., 2014). Males establish territories in late October, and pups are born from mid-November to early January with births peaking in December. Females nurse pups on shore between foraging trips until weaning them about 300 days later in September (Shaughnessy et al., 1988; Goldsworthy 2008). There is sporadic pupping at Heard Island, where three subantarctic fur-seal pups were recorded between 1987 and 2004, though there is little information on timing, breeding sites or weaning (Goldsworthy & Shaughnessy 1989; Page et al., 2003).

Females are sexually mature at approximately 3–6 years and have a mean birth interval of 1 year; males reach puberty at approximately 4 years or older but do not become sexually mature and hold territories until approximately 8–9 years of age or older (Bester 1990, 1995; Georges & Guinet 2001; Dabin et al., 2004). Longevity in the wild is 20–23 years for females (Arnould 2009), with some evidence of reproductive senescence in females older than 16 years from Amsterdam Island, possibly related to low food availability (Dabin et al., 2004). Generation length for the species is unknown, but generation length for the related long-nosed fur-seal is estimated to be 9.9 years (Chilvers & Goldsworthy 2015). The overall rate of increase in the population is approximately 6.8 percent per year (Goldsworthy et al., 2008).

The percentage of female fur-seals that produce pups at Macquarie Island and the rate of pup growth both show a very strong negative relationship with sea surface temperatures in the preceding autumn (Goldsworthy et al., 2008). Cool SSTs north of Macquarie Island are correlated with increased myctophid fish in the diet of Antarctic and other fur-seals and increased female fecundity (Goldsworthy et al., 2008). Climate and oceanographic variability and change consequently appear to have important influences on breeding success through foraging success and subsequent fecundity and quality of offspring (Goldsworthy et al., 2008).

Subantarctic fur-seals are not considered to be migratory although some individuals can travel widely across large ocean distances. A low level of continued immigration into the Macquarie Island population is indicated by sightings of animals originally tagged as pups at Marion and Amsterdam Islands (approximately 6000 km away), and by individuals occurring on the Australian mainland and on the Antarctic continent (Shaughnessy & Fletcher 1987; Shaughnessy et al., 1988; Mawson & Coughran 1999; Wynen et al., 2000; Goldsworthy et al., 2009). Two pups tagged at Marion Island were subsequently sighted at Heard Island, about 3000 km to the east (Goldsworthy 2008). However, it is not known if these immigrants remain in, or contribute significantly to, breeding in Australian colonies, or whether or not immigration is likely to decrease in the future.

The fur-seal community at Macquarie Island is the only subantarctic island where all three sympatric (*Arctocephalus tropicalis*, subantarctic; *A. Gazelle*, Antarctic; and *A. forsteri*, long-nosed) fur-seal species are known to hybridise (Goldsworthy et al., 1999, 2008; Lancaster et al., 2006, 2007a, 2007b). Hybridisation rates among the fur-seals at Macquarie Island have decreased from around 30 percent in 1994 to 16 percent in 2003 (Lancaster et al., 2006). At present there is little concern that continued hybridisation at Macquarie Island will threaten the genetic integrity of the species (Goldsworthy et al., 2009; Lancaster et al., 2010).

Hybridisation is also likely to be occurring at Heard Island. The few male subantarctic fur-seals recorded have been juvenile or sub-adult males and there is no record of a male holding a breeding territory on the island (Page et al., 2003). Subantarctic fur-seal females are expected to be mating Antarctic fur-seal males as that population is increasing at 12–20 percent per year (Page et al., 2003).

Threats

Threats to the subantarctic fur-seal are outlined in the table below (modified from Woinarski et al., 2014 and DotE 2016).

Threat factor	Consequence rating	Distributional extent over which threat may operate	Evidence base
Climate and oceanographic variability and change	Moderate – Large	Broad	Increased sea surface temperatures in the foraging grounds north of Macquarie Island during autumn has a strong negative relationship with fecundity rates in fur-seals, leading to lower pupping rates and pup growth rates during the following breeding season (Goldsworthy et al., 2008).
Predation of pup cohort at Macquarie Island	Moderate – Large	Entire	In the 1996/97 breeding season the level of predation from one male Hooker sea lion was 43% of the total fur-seal pup cohort (Robinson et al., 1999). The population of Hooker's sea lions is increasing at the nearest colony, Campbell Island, New Zealand.
Fisheries entanglement and bycatch	Minor	Broad	Seals entangled in fishing gear have been reported at Macquarie and Heard Islands (Shaughnessy 1999; Mawson & Coughran 1999; Shaughnessy et al., 2003). Four subantarctic fur-seal entanglements were reported in 2011/12 (Alderman, pers comm., 2016)
Pollution	Minor	Localised – Minor	Fur-seals are vulnerable to chemical pollution and ingested plastic fragments, or micro-plastics, that can cause stress, impair health and potentially increase disease (Shaughnessy 1999; Kirkwood et al., 2003; Evans 2003).

How judged by the Committee in relation to the EPBC Act criteria and regulations

Criterion 1. Population size reduction (reduction in total numbers)			
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased. A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible. A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3] A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible. based on any of the following (a) direct observation [except A3] (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat (d) actual or potential levels of exploitation (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites			

Assessment: Not eligible under Criterion 1

Evidence:

There are long-term monitoring data on pup abundance and population trends of subantarctic fur-seals for the established breeding colony at Macquarie Island. Initial colonisation and population growth have been studied since 1948, with detailed monitoring occurring in many years since 1954; however, annual monitoring ceased in the 2011-2012 season (Shaughnessy and Fletcher 1987; Shaughnessy et al., 1988; Shaughnessy 1999; Goldsworthy et al., 1999, 2008, 2009; S. Goldsworthy pers. comm., cited in Woinarski et al., 2014). Data show that the colony size has been increasing steadily at approximately 6.8 percent per year and has not declined over the last three-generation (30 year) period (Goldsworthy et al., 2008, 2009).

The small colony at Heard Island was monitored in 1987 and in 2000–2001 (Goldsworthy & Shaughnessy 1989; Page et al., 2003). There has been sporadic pupping, with no more than a single pup birth being recorded in the breeding seasons of 1987, 2000–2001 (Goldsworthy & Shaughnessy 1989; Page et al., 2003; S. Goldsworthy pers. comm., cited in Woinarski et al., 2014).

Following assessment of the data the Committee has determined that the species is not eligible for listing in any category under this criterion as the past, current or future population declines are thought unlikely to exceed 30 percent in any 3-generation period.

Criterion 2. Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
AND at least 2 of the following 3 conditions indicating distribution is precarious for survival:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Assessment: Not eligible under Criterion 2

Evidence:

The extent of occurrence is estimated to be greater than 20 000 km² and the area of occupancy less than 10 km², in the Australian component of the subantarctic fur-seal's range (Woinarski et al., 2014). There is a single established breeding location, excluding the occasional records of breeding at Heard Island where the population is not sufficiently well-established to be considered self-sustaining. Though the species is very restricted in number of locations, the population is not declining and no extreme fluctuations have been recorded.

Following assessment of the data the Committee has determined that the area of occupancy is very restricted but the extent of occurrence is not limited. The number of locations is limited but the species is not declining or experiencing extreme fluctuations, therefore, the species has not been demonstrated to have met this required element of this criterion.

Criterion 3. Population size and decline			
	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1 An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2 An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Assessment: Not eligible under Criterion 3

Evidence:

The breeding colony on Macquarie Island is small, with fewer than 50 breeding females recorded in 2007, and a very small number of breeding males holding territories (Goldsworthy et al., 2009). The most recent census (2011/12 season) estimated pup production to be 45 (Goldsworthy et al., 2009, Goldsworthy pers. comm., 2016). As noted under Criterion 1, the species is not declining.

In contrast to Macquarie Island, the very small number of subantarctic fur-seals at Heard Island (the 2000–2001 survey recorded at least eight individuals) does not appear to be increasing though sporadic pupping has been recorded (Page et al., 2003).

The total number of mature individuals is very low, however the population is not declining. Therefore, the species does not meet the required elements of this criterion.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
Number of mature individuals	< 50	< 250	< 1,000

Assessment: Eligible under Criterion 4 for listing as Endangered

Evidence:

The total abundance of subantarctic fur-seals in Australian waters is difficult to estimate precisely due to their distribution on remote Macquarie and Heard subantarctic islands, with occasional records of individuals from southern Australia and Antarctica. In addition, hybridization and introgression with other species at Macquarie Island (Goldsworthy et al., 1999, 2009; Lancaster et al., 2006, 2007a) complicates assessment of the abundance of this breeding population. However, based on the 2011/12 season, the total subantarctic fur-seal population at Macquarie Island is estimated to be about 200 (Goldsworthy pers. comm., 2016). The number of mature individuals is lower than this; estimated to be 50–100 (Goldsworthy et al., 2009; Woinarski et al., 2014). (See also Criterion 3). The small number of mature individuals on Heard Island (see Criterion 2) is unlikely to be enough to increase the total population numbers to above 250.

The Committee considers that the total number of mature individuals is fewer than 200 which is very low and therefore, the species has been demonstrated to have met the relevant elements of Criterion 4 to make it eligible for listing as **Endangered**.

Criterion 5. Quantitative Analysis			
	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Assessment: Insufficient data to determine eligibility

Evidence:

A population viability analysis has not been undertaken at either Macquarie or Heard Island.

Conservation Actions

Recovery Plan

The combined *Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan* (DEH 2004b) has two main objectives: to maintain current levels of protection for these two species to enable population growth so that these species can be removed from the threatened species list under the EPBC Act; and to ensure that any future anthropogenic impacts are not limiting their recovery. The Recovery Plan noted that in the absence of significant current anthropogenic threats, the only identified action was to monitor populations of these species in the Australian region.

The *Review of the Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan* (DotE 2016) was conducted in 2015 and found that regular population monitoring activities did occur at Macquarie Island, but not Heard Island. The annual survey for subantarctic fur-seals on Macquarie Island (a 26 year dataset) ceased after the 2011/12 season as a result of reduced resources.

The review recommended that a recovery plan was not needed for the two species as significant anthropogenic threats were not demonstrated and a revised Conservation Advice would update relevant information and conservation/research priorities.

A recovery plan is therefore not recommended for this species. The subantarctic fur-seal is still recovering from extirpation in the early 19th century and though numbers are low, the species is increasing at a steady rate at Macquarie Island. There is no current significant anthropogenic threat affecting the species and there are existing management arrangements outlined below that are location-specific and threat-specific.

Primary Conservation Action

As the numbers of subantarctic fur-seal continue to be low, it is important to understand any anthropogenic impacts that may affect the recovery of the species in the future and address these as soon as possible. Receiving accurate and timely reports of fisheries interactions with the species, whether the interaction is lethal or not, as well as opportune information on impact of marine debris or pollution events, may prompt responsive mitigation measures or initiate management responses even at the remote sites where the species is found.

Conservation and Management Priorities

Both Macquarie and Heard Islands are managed under protection regimes associated with their status as World Heritage sites, as well as nature and wilderness reserves respectively. The waters around the islands are protected under Tasmanian legislation (Macquarie Island) as well as under Commonwealth legislation (Macquarie Island Marine Park and Heard and McDonald Islands Marine Reserve). In these reserve areas, fishing is restricted and the Heard Island/McDonald Island fishery must report on any interactions with seal species. Waters around Macquarie Island are protected 0–3 nm from the coast under Tasmanian legislation, and protected 3–200 nm from the coast in the Commonwealth Macquarie Island Marine Park. Waters down to 1000 m depth around Heard Island are similarly protected in the Commonwealth Heard Island and McDonald Islands Marine Reserve.

The *Threat Abatement Plan for the impacts of marine debris on vertebrate marine life 2009-2014* (DEWHA 2009) is currently being reviewed and a new plan is expected in 2017. The issue of impacts of marine debris in the Southern Ocean and subantarctic islands will be addressed in the revised plan.

Recommended management actions and research priorities are outlined in the tables below (modified from Woinarski et al., 2014 and DotE 2016).

Theme	Specific actions	Priority
Active mitigation of threats	Continue high levels of protection for subantarctic fur-seals in important breeding, foraging and haul-out sites. Ensure Macquarie Island/Heard Island management and fisheries management plans include reference to seal monitoring and protection.	High
	Continue, and where necessary adapt, management actions to reduce disturbance and pollution/marine debris impacts on subantarctic fur-seals and their important breeding, resting and foraging habitats.	Medium-high
	Improve data collection and reporting of fisheries interactions throughout the seals' foraging ranges. Including improving species identification; expanding data collected by observers (photos/samples from mortalities); utilising deep sea observation systems (e.g. cameras) to observe underwater interactions.	Medium-high

Survey and Monitoring priorities

Theme	Specific actions	Priority
Resume ongoing monitoring program and ensure any program is based on Tasmanian DPIE (2005) survey methodology guidelines and the recommendations in the Goldsworthy et al. (2008) report.	Resume long-term annual monitoring at Macquarie Island, and prioritise surveys of the population at Heard Island, to better quantify abundance, pup production and population trends, movements, hybridisation rates and population structure.	Very high
Survey to better define distribution (with reference to guidance documents noted above)	Expand surveys to better define the fine-scale distribution and breeding interactions among species, population and annual pup abundance, and movements of individuals.	Medium
Investigate alternative survey techniques to maximise opportunity of obtaining population data	Investigate new survey technologies (e.g. use of drones) that may provide an opportunity to increase knowledge of population data on remote islands (taking into account local weather conditions).	Low-medium

Information and Research priorities

Theme	Specific actions	Priority
Assess impacts of threats on species	Improve understanding of the potential for climate and oceanographic change, and associated seawater temperature rises, to affect fur-seal food resources and reproductive success	High
	Improve understanding of the potential risks of fisheries interactions, and potential prey depletion to affect the recovery and growth rates of populations. This should include analysis of logbook data and any reported interactions between Macquarie Island/Heard Island fisheries and seals.	Medium-low
	Assess the impacts of disturbance, pollution and associated risks of disease on the health status of subantarctic fur-seals.	Low-medium
	Analyse the occurrence and characteristics of marine debris (including micro-plastics) on remote sub-Antarctic islands and associated impacts on seal species.	Low-medium
Assess relative effectiveness of threat mitigation options	Assess the effectiveness of fisheries closures near colonies and other management actions in reducing potential impacts of fisheries on these fur-seals.	Medium
Undertake research to develop new or enhance existing management mechanisms	Expand genetic research to monitor changes in hybridisation rates and gene flow through immigration, in order to identify the extent to which populations might be partially maintained by extra-limital populations.	Medium
Assess diet, life history	Improve understanding of diet, foraging ecology, and life history parameters (including predation on pup cohort) controlling population growth, and determine the generation length for Australian populations.	Medium
Assess habitat requirements	Expand research to better understand key foraging habitats for subantarctic fur-seals and potential changes resulting from increased sea surface temperatures.	Medium
Undertake research to develop new or enhance existing management mechanisms	Investigate the efficacy of using remote survey techniques such as satellite imagery for census counts on remote islands	Low-medium

Recommendations

- (i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **transferring** from the Vulnerable category to the Endangered category:
Arctocephalus tropicalis
- (ii) The Committee recommends that there not be a recovery plan for this species.

Threatened Species Scientific Committee

6 September 2016

References cited in the advice

- Arnould, J. P. Y. (2009). Southern Fur Seals *Arctocephalus* spp. In *Encyclopedia of Marine Mammals* (eds W. F. Perrin, B. Würsig & J. G. M. Thewissen), pp. 1079-1084. Academic Press, Amsterdam.
- Berta, A., & Churchill, M. (2012). Pinniped taxonomy: review of currently recognized species and subspecies, and evidence used for their description. *Mammal Review* 42, 207-234.
- Bester, M. N. (1990). Reproduction in the male sub-Antarctic fur seal *Arctocephalus tropicalis*. *Journal of Zoology* 222, 177-185.
- Bester, M. N. (1995). Reproduction in the female sub-Antarctic fur seal *Arctocephalus tropicalis*. *Marine Mammal Science* 11, 362-375.
- Chilvers, B. L. & Goldsworthy, S. D. (2015). *Arctocephalus forsteri*. The IUCN Red List of Threatened Species.
Available on the internet at: <http://www.iucnredlist.org>.
- Dabin, W., Beauplet, G., Crespo, E. A. & Guinet, C. (2004). Age structure, growth, and demographic parameters in breeding-age female subantarctic fur seals, *Arctocephalus tropicalis*. *Canadian Journal of Zoology* 82, 1043-1050.
- Department of the Environment (DotE) (2016). *Review of 2004-2009 Recovery Plan for Subantarctic Fur Seal (Arctocephalus tropicalis) and Southern Elephant Seal (Mirounga leonina)*. Unpublished report.
- Department of the Environment and Heritage (DEH) (2004a). *Biology, threats and conservation status of the sub-Antarctic fur seal and southern elephant seal in Australian waters*. Available on the internet at: www.environment.gov.au/resource/sub-antarctic-fur-seal-and-southern-elephant-seal-recovery-plan
- Department of the Environment and Heritage (DEH) (2004b). *Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan 2004-2009*. Available on the internet at: www.environment.gov.au/resource/sub-antarctic-fur-seal-and-southern-elephant-seal-recovery-plan
- Department of the Environment, Water Heritage and the Arts (DEWHA) (2009). *The Threat Abatement Plan for the impacts of marine debris on vertebrate marine life 2009-2014*. Available on the internet at: <http://www.environment.gov.au/marine/publications/threat-abatement-plan-impacts-marine-debris-vertebrate-marine-life>

- Evans, K. (2003). Pollution and marine mammals in the Southern Hemisphere: potential or present threat? In *Marine mammals: fisheries, tourism and management issues* (eds N. J. Gales, M. Hindell & R. Kirkwood), pp. 400–441. CSIRO Publishing, Melbourne.
- Gales, N. J., Coughran, D. K. & Queale, L. F. (1992). Records of sub-Antarctic fur seals *Arctocephalus tropicalis* in Australia. *Australian Mammalogy* 15, 135-138.
- Georges, J. Y. & Guinet, C. (2001). Prenatal investment in the subantarctic fur seal, *Arctocephalus tropicalis*. *Canadian Journal of Zoology* 79, 601-609.
- Goldsworthy, S. D. (2008). Subantarctic fur seal *Arctocephalus tropicalis*. In *The Mammals of Australia*. Third edition. (Eds S. Van Dyck & R. Strahan), pp. 726–727. Reed New Holland, Sydney.
- Goldsworthy, S. D. & Shaughnessy, P. D. (1989). Sub-Antarctic Fur seals *Arctocephalus tropicalis* at Heard Island. *Polar Biology* 9, 337-339.
- Goldsworthy, S. D., Boness, D. & Fleischer, R. (1999). Mate choice among sympatric fur seals: female preference for conspecific males. *Behavioural Ecology and Sociobiology* 45, 253-267.
- Goldsworthy, S. D., He, X., Lewis, M., Williams, R. & Tuck, G. (2001). Trophic interactions between Patagonian toothfish, its fishery and seals and seabirds around Macquarie Island. *Marine Ecology Progress Series* 218, 283-302.
- Goldsworthy, S. D., McKenzie, J., Page, B., Lancaster, M. & Bool, N. (2008). *Population status and trends in the abundance of the fur seals at Macquarie Island*. Report to the Department of the Environment, Water, Heritage and the Arts. SARDI Research Report Series No. 308, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.
- Goldsworthy, S. D., McKenzie, J., Page, B., Lancaster, M. L., Shaughnessy, P. D., Wynen, L. P., Robinson, S. A., Peters, K. J., Baylis, A. M. M. & McIntosh, R. R. (2009). Fur seals at Macquarie Island: post-sealing colonisation, trends in abundance and hybridisation of three species. *Polar Biology* 32, 1473-1486.
- Hofmeyr, G. J. G. (IUCN Pinniped Specialist Group) (2015). *Arctocephalus tropicalis*. In *The IUCN Red List of Threatened Species*. Available on the internet at: <http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T2062A45224547.en>
- Jefferson, T. A., Webber, M. A. & Pitman, R. L. (2008). *Marine mammals of the world*. Elsevier, Amsterdam.
- Kirkwood, R. & Goldsworthy, S.D. (2013). *Fur Seals and Sea Lions*. CSIRO Publishing, Collingwood, Australia.
- Kirkwood, R., Boren, L., Shaughnessy, P. D., Szteren, D. M., Mawson, P., Huckstadt, L., Hofmeyr, G., Oossthuizen, H., Schiavani, A., Campagna, C. & Berris, M. (2003). Pinniped-focused tourism in the Southern Hemisphere: A review of the industry. In *Marine mammals: fisheries, tourism and management issues* (eds N. J. Gales, M. Hindell & R. Kirkwood), pp. 257-276. CSIRO Publishing, Melbourne.
- Lancaster, M. L., Gemmell, N. J., Negro, S., Goldsworthy, S. D. & Sunnucks, P. (2006). Ménage à trois on Macquarie Island: hybridization among three species of fur seal (*Arctocephalus spp.*) following historical population extinction. *Molecular Ecology* 15, 3681-3692.

- Lancaster, M. L., Goldsworthy, S. D. & Sunnucks, P. (2007a). Multiple mating strategies explain unexpected genetic mixing of New Zealand fur seals with two congeners in a recently recolonized population. *Molecular Ecology* 16, 5267-5276.
- Lancaster, M. L., Bradshaw, C. J. A., Goldsworthy, S. D. & Sunnucks, P. (2007b). Lower reproductive success in hybrid fur seal males indicates fitness costs to hybridization. *Molecular Ecology* 16, 3187-3197.
- Lancaster, M. L., Goldsworthy, S. D. & Sunnucks, P. (2010). Two behavioural traits promote fine-scale species segregation and moderate hybridisation in a recovering sympatric fur seal population. *BMC Evolutionary Biology* 10, 143.
- Ling, J. K. (1999). Exploitation of fur seals and sea lions from Australian, New Zealand and adjacent subantarctic islands during the eighteenth, nineteenth and twentieth centuries. *Australian Zoologist* 31, 323–350.
- Mawson, P. R. & Coughran, D. K. (1999). Records of sick, injured and dead pinnipeds in Western Australia 1980-1996. *Journal of the Royal Society of Western Australia* 82, 121-128.
- Nyakatura, K. & Bininda-Emonds, O. R. P. (2013). Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. *BMC Biology* 10, 1-31.
- Page, B., Welling, A., Chambellant, M., Goldsworthy, S. D., Dorr, T. & van Veen, R. (2003). Population status and breeding season chronology of Heard Island fur seals. *Polar Biology* 26, 219-224.
- Robinson, S. A., Goldsworthy, S. D., van den Hoff, J. & Hindell, M. A. (2002). The foraging ecology of two sympatric fur seal species at Macquarie Island, *Arctocephalus gazella* and *A. tropicalis*, during the austral summer. *Marine and Freshwater Research* 53, 1071-1082.
- Robinson, S., Wynen, L. & Goldsworthy, S. D. (1999). Predation by a Hooker's sea lion (*Phocarcos hookeri*) on a small population of fur seals (*Arctocephalus* spp.) at Macquarie Island. *Marine Mammal Science* 15(3), 888-893.
- Shaughnessy, P. D. (1999). *The Action Plan for Australian seals*. Environment Australia, Canberra.
- Shaughnessy, P. D. & Fletcher, L. (1987). Fur seals *Arctocephalus* spp. at Macquarie Island. *NOAA Technical Report, NMFS* 51, 177-188.
- Shaughnessy, P. D. & Goldsworthy, S. D. (1993). Feeding ecology of fur seals and their management at Heard and Macquarie Islands. *Proceedings of the NIPR Symposium Polar Biology* 6, 173-175.
- Shaughnessy, P. D., Shaughnessy, G. L. & Fletcher L (1988). Recovery of the fur seal population at Macquarie Island. *Papers and Proceedings of the Royal Society of Tasmania* 122, 177-187.
- Shaughnessy, P. D., Kirkwood, R., Cawthorn, M., Kemper, C. & Pemberton, D. (2003). Pinnipeds, cetaceans, and fisheries in Australia: A review of operational interactions. In *Marine mammals: fisheries, tourism and management issues* (eds N. J. Gales, M. Hindell & R. Kirkwood) pp. 136–152. CSIRO Publishing, Melbourne.

Tasmanian Department of Primary Industries and Environment (Tas DPIE) (2005). *Part B – A survey methodology to monitor population change in Sub-antarctic fur seals and Southern elephant seals*. Second part of a report on *Population monitoring for Sub-antarctic fur seals (Arctocephalus tropicalis) and Southern elephant seals (Mirounga leonina)* for the Department of the Environment & Heritage. Unpublished report by the Nature Conservation Branch of the Tasmanian Department of Primary Industries and Environment.

Woinarski, J. C. Z., Burbidge, A. A. & Harrison, P. L. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Collingwood.

Wynen, L. P., Goldsworthy, S. D., Guinet, C., Bester, M. N., Boyd, I. L., Gjertz, I., Hofmeyr, G. J. G., White, R. W. G. & Slade, R. (2000). Postsealing genetic variation and population structure of two species of fur seal (*Arctocephalus gazella* and *A. tropicalis*). *Molecular Ecology* 9, 299–314.

Other sources cited in the advice

Alderman, R. (2016). Personal communication by email, January 2016. Department of Primary Industries, Parks, Water and Environment, Tasmanian government.

Committee on Taxonomy (2015). List of marine mammal species and subspecies. Society for Marine Mammalogy.

Available on the internet at:

<https://www.marinemammalscience.org/species-information/list-of-marine-mammal-species-subspecies/>.

Goldsworthy, S. D. (2016). Personal communication by email, January 2016. South Australia Research & Development Institute.