Status and trends of the current threats to Australasian seabirds.

A review from the Australasian Seabird Group Workshop, Melbourne March 2019.

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Hosted by the Australasian Seabird Group, BirdLife Australia, and Deakin University

1. Areas of interest

The Australasian Seabird Group, a Special Interest Group of BirdLife Australia, hosted a workshop in Melbourne on 28 and 29 March 2019 to progress the development of a Marine/Seabird Program for BirdLife Australia. The purposes of the workshop were to:

- bring together key stakeholders and experts in seabird conservation and management from around Australasia,
- identify research and conservation priorities,
- collate the relevant literature on the current threats to Australasian seabirds, and to make the collection available to all participants,
- clarify the objectives, priorities and roles of BirdLife Australia and Birds New Zealand, with regards to seabirds and
- agree on a roadmap for BirdLife Australia to facilitate the development of a Seabird Conservation Program and Seabird Conservation Action Plan for Australasia.

The workshop was attended by specialist seabird experts representing most regions of Australia and from New Zealand. A list of workshop attendees is provided at Annex 1.

This brief overview of the status and trends of the current threats to Australasian seabirds is a synthesis of the workshop discussions. It is based on a collation of published and unpublished studies dealing with seabirds in Australia and New Zealand (see below), and draws on national and international reviews where appropriate; salient studies were also used. The overview excludes the Australian Antarctic Territory, the Balleny Islands and the Ross Dependency. The areas of interest comprise:

- Australia – Australia including the offshore islands of Lord Howe Island, and Macquarie Island; and the External Territories of Ashmore and Cartier Islands, the Coral Sea, Christmas Island, Cocos (Keeling) Islands, Heard Island and McDonald Islands, and Norfolk Island.
- New Zealand – New Zealand and offshore islands, Chatham Is, Snares Is, Bounty Is, Antipodes Is, Auckland Is, Campbell Is, and Kermadec Is.

2. Species of interest

Australasian seabirds were grouped into the following species groups. Pelicans and waterfowl were excluded as there are no true marine species within the areas of interest. The taxonomy for Australian birds follows BirdLife Australia's Working List of Australian Birds v3 (BirdLife Australia 2019), and for New Zealand species, the taxonomic authority was Robertson et al. (2017):

- Skuas
- Gulls, Terns and Noddies
- Tropicbirds
- Penguins
- Storm-petrels
- Albatrosses
- Petrels and Shearwaters

- Diving-petrels
- Frigatebirds
- Gannets and Boobies
- Cormorants

3. Threats

The threats to seabirds followed the IUCN Threats Classification Scheme (IUCN 2012) as used by BirdLife International (IUCN 2012), with additional (sub-)categories included to align with the Australian Federal Government's Draft *Wildlife Conservation Plan for Seabirds* (2019), prepared under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The threat categories comprised: fisheries bycatch (gillnet, longline, trawl and seine, other), competition with fisheries, marine debris (entanglement and ingestion), light pollution (terrestrial and marine), pollution (oil and metal contamination), sea-level rise and climate change, human exploitation and disturbance, habitat loss and fragmentation, invasive species (animals and plants), disease, wind farms, aquaculture and any other threat(s) to be specified.

Risk scores for Australian taxa were calculated from the product of scores for global conservation status based on the IUCN Red List Criteria, and the Australian share of the global breeding population. The IUCN Threat Category were scored as per Critically Endangered = 5, Endangered =4, Vulnerable =3, Near Threatened = 2, Least Concern = 1. The scores for the Australian share of global breeding population were scored as per 75-100 % = 5, 50-74 % = 4, 25-50 % = 3, < 25 % = 2, non breeder = 1.

For New Zealand taxa, the New Zealand Threat Classification System (Robertson et al. 2017) and the New Zealand share of the global breeding population were used: Critically Endangered = 5, Endangered =4, Vulnerable =3, At Risk Declining = 2, At Risk Recovering, Naturally uncommon, Relict or Species = 1. The scores for the New Zealand share of global breeding population were scored as per 75-100 % = 5, 50-74 % = 4, 25-50 % = 3, < 25 % = 2, non breeder = 1

Threats were coded to allow an initial quantification of threats amongst seabird groups and to identify primary threats, based on ranked scores (0-4, lowest to highest impact). The threats were coded:

- 4 Population level impacts,
- 3 Regional level impacts,
- 2 Local impacts,
- 1 Unknown, or
- 0 Nil impact(s) known.

To support the review of threats to Australasian seabirds, relevant studies and recent literature were compiled for the species and threats. Articles in peer-reviewed journals were collated and shared via a Dropbox (www.dropbox.com) link to participants. The collation of articles is available to non-attendees on request from the senior author.

4. Overview of threats

The following provides a brief description of recent studies on seabirds in the Australasian region and relevant reviews. Where possible, only studies since 2000 have been used, however older studies were cited in the absence of more recent information. A number of global reviews are relevant - notably Baker et al. 2002, Croxall et al. 2012, Phillips et al. 2016, Crawford et al. 2017, Rodriguez et al. 2019 and Ropert-Coudert et al. 2019, and all have been used. The workshop also had access to a pre-release draft of the

Australian government's Wildlife Conservation Plan for Seabirds (Commonwealth of Australia 2019a).

4.1 Fisheries bycatch

The death of seabirds caused through the interaction between birds and fisheries has been well documented and is considered one of the greatest threats faced by this group of birds (Phillips et al. 2016.). Despite extensive work in recent years within Australia and New Zealand to minimise bycatch impacts and develop effective mitigation the threat posed to seabird populations is still severe.

The New Zealand Conservation Services Program (NZ-CSP) includes interaction projects to determine the nature and extent of fisheries interactions on protected species, mitigation projects to reduce these impacts, and population projects to understand the current status and trends of bycatch species. Fisheries New Zealand also funds risk assessments and modelling projects on species impacted by bycatch. The NZ-CSP has funded annual assessments of seabirds captured as bycatch in commercial fisheries since 1996. This programme has identified species affected by different fisheries as well as collecting biological data about these birds. Annual reports are available at this website https://www.doc.govt.nz/our-work/conservation-services-programme/csp-reports/ and the Dragonfly website https://www.dragonfly.co.nz/

Analyses of seabird-fisheries interactions and assessments within the Australian Exclusive Economic Zone (EEZ) have been undertaken by Baker and Wise (2005), Baker et al. (2007), Baker and Finley (2008, 2013), Trebilco et al. (2010). Action by the Australian Government to address the key threatening process of the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations commenced in 1995 and has been pursued through successive threat abatement plans since 1998, with current action occurring under the *Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations* (Commonwealth of Australia 2018b) These plans have seen a reduction in seabird bycatch in affected fisheries by orders of magnitude.

In some oceanic longline fisheries, there is 100% observer coverage, while in others electronic monitoring applies to all full-time vessels in the respective fisheries. The actions under the plan trigger an individualised management response by the Australian Fisheries Management Authority (AFMA) where more than one seabird is observed caught on a single trip by an individual vessel, and the management response is increasingly more rigorous if seabird bycatch or the seabird bycatch rate exceeds pre-defined criteria.

AFMA provides quarterly Protected Species Interaction reports about bycatch of listed marine, migratory and threatened species under the EPBC Act (available here). The introduction of electronic monitoring across various gear types — pelagic longline, demersal longline, gillnet, and trawl — has seen improved logbook reporting of seabird interactions in affected fisheries. This includes information from gillnet fisheries about higher than anticipated seabird bycatch in these fisheries.

In 2018, the Australian Government and the States and Territories agreed to the *National Plan of Action for Minimising Incidental Catch of Seabirds in Australian Capture Fisheries* (NPOA – Seabirds, DAWR 2018). NPOA - Seabirds provides a national approach to mitigating the impact of fishing on seabirds by providing guidance on best-practice mitigation, monitoring and reporting of seabird interactions for all fishing activities. NPOA - Seabirds fulfils Australia's obligation to the UN's Food and Agriculture Organization (FAO) by aligning national efforts with those of the FAO's International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA – Seabirds) and associated best practices for reducing incidental catch of seabirds in capture fisheries.

4.2 Artisanal and recreational fisheries

Recreational fishing, including commercial game and charter fishing, can result in the injury or death of seabirds that ingest baited hooks and fishing line or get entangled in crab pots or nets. Most seabird interactions with recreational fishers are unrecorded because fishers are not required to formally report incidents in the coastal waters where most recreational fishing occurs (DAWR 2018).

Recreational fisheries are widespread in Australia and New Zealand. In New Zealand, especially in the Hauraki Gulf and Bay of Plenty, species at most risk from line fishing are Flesh-footed Shearwaters *Ardenna carneipes* and Black Petrels *Procellaria parkinsoni*. In Australia, the Australian Bird and Bat Banding Schemes used to receive reports of Flesh-footed Shearwaters caught on recreational line gear off the coast of NSW, and Shy Albatrosses *Thalassarche cauta* caught in trolling around Tasmania (B. Baker unpublished data).

A total of 14 of 18 penguin species have been recorded as fisheries bycatch globally (Ropert-Coudert et al. 2019). In New Zealand, shags, penguins and smaller shearwaters are the species most frequently reported captured in commercial set-net (gillnet) fisheries, but they are also captured by recreational fishers. New Zealand has a number of areas closed for recreational set-netting to protect inshore foraging threatened marine mammals (Hectors and Maui's Dolphins *Cephalorhynchus hectori* and *C. h. maui*, respectively). Little Penguins *Eudyptula minor* are caught in recreational gillnets around Tasmania (EJ Woehler, pers. comm.), however, there is no information to suggest that Little Penguins have been caught in recreational nets in the West Coast or South Coast Bioregions in Western Australia (B Cannell, pers. comm.).

In the Chatham Islands, Chatham Shags *Leucocarbo onslowi* and Pitt Island Shags *Stictocarbo featherstoni* are known to be caught in craypots (G Taylor unpubl. data); this gear type may impact diving seabirds in other areas but data are lacking. Small scale or artisanal fisheries in South America are a particular concern for New Zealand seabirds as a number of species migrate to the Humboldt Current and Patagonian Shelf, in particular the coastal waters of Chile, Peru, Ecuador and Argentina. Albatrosses and *Procellaria* petrels are the species most at risk.

4.3 Competition with fisheries [prey depletion]

Grémillet et al. (2018) undertook a recent global review on global competition amongst seabirds and commercial fisheries, and Ropert-Coudert et al. (2019) specifically on penguins. There are no quantitative data from Australia or New Zealand on the spatial and temporal extents, or the degree of prey competition between fisheries and seabirds. Cury et al. (2003) suggested that more than one third of the long-term biomass of forage fish should be maintained globally to ensure long term health of seabird populations and ecosystem function.

The NZ-CSP programme has recently started to investigate the indirect effects of inshore fishing (especially purse seining and trawling) on prey availability to surface feeding seabirds, and the impacts of trawling on seafloor habitats. There have been substantial decreases in Red-billed Gulls *Chroicocephalus novaehollandiae scopulinus* and White-fronted Terns *Sterna striata* that may be related to purse seining removing large shoals of fish that these species depend on to access smaller prey (G Taylor, pers. comm.). The seafloor habitat used by Yellow-eyed Penguins *Megadyptes antipodes* has also been damaged by oyster dredging and finfish trawling off the South Island. A new project is planned for 2019/20 to determine if trawling for flatfish *Rhombosolea* spp.and other benthic commercial species is limiting recovery of the Endangered New Zealand King Shag *Leucocarbo carunculatus*.

Dietary studies of Little Penguins in Western Australia undertaken between 1986 and 1997 found Garfish (*Hyporhamphus melanochir*) made up significant proportions of the diet (Klomp and Wooller 1988, Wienecke 1989, Connard 1995, Bradley et al. 1997). However, Garfish have not been found in more recent dietary studies (Murray et al. 2011, Cannell 2012, Cannell et al. 2013). Interestingly, the catch of garfish in the West Coast Bioregion has been higher from recreational than commercial fisheries (Fletcher and Santoro 2007). Currently, the stocks of Garfish are considered inadequate to support the fishery due to exploitation, and new management arrangements are under development (Gaughan and Santoro 2018).

Fisheries activity off northwest Australia is currently small to very small, and in most cases also involve activities that are likely to lead to limited interaction (ie deep water fish traps, line fishing for sailfish, line fishing targeting pelagic species (Dolphinfish *Coryphaena* spp.) at FADs (Fish Aggregating Devices). Many tropical seabird species appear to show less interest in vessels in these settings (cf with Southern Ocean species) perhaps further reducing the possibility of negative interactions.

4.4 Marine debris entanglement and ingestion

Extensive literature globally, recent reviews and syntheses from the Australasian region by Roman et al. (2016, 2019) suggested storm petrels (Hydrobatidae and Oceanitidae) may be at highest risk of ingesting marine debris whilst foraging. Studies on shearwaters have been undertaken by Hutton et al. (2008), Lavers and Bond (2013) and Lavers et al. (2014), and on burrowing petrels in New Zealand (Buxton et al. 2013). See Rodriguez et al. (2019) for extensive global review for threats to petrels and shearwaters. The King Shag in New Zealand may be threatened by the marine debris and detritus that can impact on the benthic habitats where the birds dive for prey species such as flounders and cod.

Necropsies have been performed on more than 160 Little Penguins in Western Australia since late 2003 (Cannell et al. 2016). Only one penguin was found to have ingested any plastic - a fragment of a plastic bread bag clip. The penguin had no other stomach contents and was malnourished (B Cannell pers. comm.). Some Little Penguin nest sites on Garden Island, Western Australia , have incorporated plastic rubbish such as bags, pieces of tarpaulin and plastic sheet offcuts. Chicks nesting amongst such plastic material tend to have damp down associated with the high within-nest humidity resulting from the copious faecal matter deposited on such nesting material not drying (B Cannell pers. comm.). This could result in poorer quality chicks due to excess energy used to remain warm, or other health impacts.

Injury and Fatality Caused by the Ingestion and Entanglement of Marine Life in Marine Debris has been listed a Key Threatening Process under the EPBC Act. It was considered that 20 listed threatened species are adversely affected by marine debris. A Threat Abatement Plan exists to manage this threat (Commonwealth of Australia 2018a).

Microplastics are present in many commercial products (mainly cosmetics and cleaning agents) and are used for packaging and can arise from the degradation of fibres from synthetic clothing. These products break down into smaller units over time and can be absorbed or ingested by fish, zooplankton and eventually seabirds (eg Hale et al. 2020).

While the impact of plastic ingestion and entanglement can undoubtedly lead to the death of individual seabirds, the Workshop agreed that currently available data do not support this as a population-level threatening process (Lavers et al. 2013; N Carlile unpubl. data).

4.5 Light pollution (terrestrial and marine)

Nocturnal light pollution is increasing globally (eg Davies et al. 2014, Falchi et al. 2016), and the issue is now seen as a global threat to many species of seabirds arising from collisions with vessels (eg Black 2005) and oil rigs (Wiese et al. 2001). Light pollution can result in disorientation, collision with infrastructure, death, interference in breeding cycles.

There is a substantial body of literature from around the world, recently reviewed by Rodriguez et al. (2012, 2014, 2016, 2017a, 2017b, 2017c) including local studies on Short-tailed Shearwaters *Ardenna tenuirostris* and Little Penguins at Phillip Island. Any seabirds attracted by lights to fishing vessels with observers present have this type of interaction recorded in the annual NZ-CSP reports (G Taylor, pers. comm.). New Zealand cities have started to use LED downlights for street lighting. This blueish-white light gives a darker night sky for birds overflying cities but there have been no studies as to whether the colour is more or less attractive to seabirds.

There exists a substantial knowledge gap with regards to gas flares on active oil and gas infrastructure in marine waters. In most settings, flares operate continuously for extended periods and the exposed flame height can be substantial (in some cases, the unshielded flames can exceed vertical heights of >20 m, R Clarke, pers. comm.). Despite evidence that lighting, including flares, can be a significant attractant to seabirds at night and result in mortalities, robust quantification of this impact is lacking (Weise et al. 2001), and this is especially so in Australian and New Zealand waters (R Clarke pers. comm.); see also Rodriguez et al. (2012, 2014, 2016, 2017a, 2017b, 2017c).

It is also important to note that large mortality events of seabirds (and indeed over-flying land birds) are likely associated with particular weather conditions where birds are more likely to be disorientated. These include conditions of low cloud or persistent precipitation (heavy mist, rainfall or snowfall). As these conditions may occur infrequently, attempts to assess and quantify threat must span appropriate periods of time such that a true understanding of the threat is established. Recently released *National Light Pollution Guidelines for Wildlife* (Commonwealth of Australia 2019b) have been developed for a range of taxonomic groups, including seabirds, and provide practical advice that can greatly reduce the impact of light pollution.

4.6 Oil and metals pollution, POPs, PCBs and TBT

As a group, penguins are believed to be at the greatest risk of all seabirds from marine oil spills. Two ship-based events have occurred in Australasia: MV *Iron Baron*, Tasmania in 1995 (Giese et al. 2000, Goldsworthy et al. 2000a, b), and MV *Rena* in New Zealand in 2011 (Sievwright 2014, Chilvers et al. 2015). The Montara well spill (August 2009) in the Timor Sea released crude oil and gas condensate, and surveys in the area following the spill collected 16 individual seabirds (noddies, shearwater, frigatebird and booby) were collected, (Watson et al. 2009, Gagnon and Rawson 2010).

A 5-year, biannual monitoring program for seabird populations at Ashmore Reef did not detect adverse impacts on population trends in 16 species of seabird (Clarke 2010, Clarke and Herrod 2016) following the Montara well spill in August 2009. The low level impacts detected is in stark contrast to the impacts on seabirds following other major global oil spills (eg *Exxon Valdez*, *Deep Water Horizon*). This may be because the Montara well spill involved condensate with a high percentage of volatiles in a tropical environment. Such products results in very thin oil films on the sea surface that result in lower rates of damage to seabird feather structure (Matcott et al. 2017), whilst the tropical climatic conditions are conducive to a rapid breakdown of the surface oil films.

Oil spills in Australia are managed by the Australian Maritime Safety Authority (AMSA), in conjunction with the states and the Northern Territory, through the Intergovernmental *Agreement on the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances*. The Plan sets out the role and responsibilities for government and industry in the event of marine pollution spills in Australian waters. Oil spills in New Zealand are managed through Maritime New Zealand, with Massey University contracted to manage the oiled wildlife response through its Wildbase facility http://www.massey.ac.nz/massey/learning/departments/centres-research/wildbase/wildbase-oil-response/wildbase-oil-response_home.cfm

Adult Lesser Frigatebirds *Fregata ariel* breeding off Australia's northwest coast have feather Mercury concentrations above a threshold known to be toxic to land birds (Mott et al. 2017). Mercury concentrations in their chicks and in locally-sourced prey items are low, indicating that Mercury exposure of adults largely occurs when they are on their non-breeding grounds in southeast Asia (Mott et al. 2017). Mott and Clarke (2017) showed that adult Lesser and Great *F. minor* Frigatebirds breeding at Ashmore Reef accumulated Mercury loads consistent with high exposure levels in the South China Sea. Whilst population-level impacts were not demonstrated, Endangered Christmas Island Frigatebirds *F. andrewsi* forage in similar areas during their non-breeding season, so exposure to high levels of Mercury is a plausible, but as yet unassessed threat to this species.

Lavers and Bond (2013) detailed contaminant loads in Short-tailed Shearwaters, and recent studies in Tasmania on Little Penguins (Einoder et al. 2018, Riley 2018) showed elevated high metal levels in penguin feathers related to historical industrial discharges in the Derwent Estuary, Hobart. Feather samples were collected from Little Penguins at four colonies in Western Australia to determine concentrations of Mercury and Selenium. Two of the colonies were within the coastal metropolitan region near Perth (Garden Island and Penguin Island), while the other two were in the southern coastal regions (Mistaken Island and Woody Island). Highest levels of Mercury were found in the penguins from Garden Island, with some extreme values > 4.0mg/kg body mass. The penguins from Mistaken Island had elevated Selenium concentrations (Dunlop et al. 2013).

Polychlorinated biphenyls (PCBs) are Persistent Organic Pollutants (POPs) that are harmful, toxic, and bioaccumulate through the food chain. They accumulate in fatty tissue, and have been thought to be the cause of decreases in some bird populations (http://www.npi.gov.au/resource/polychlorinated-biphenyls-pcbs). Heavy metals and POPs can adhere to plastic in the marine environment (eg Koelmans 2015, Rios Mendoza and Jones 2015, Brennecke et al. 2016). The ingestion of these plastics can be a vector for these pollutants into the tissues of marine wildlife (Brennecke et al. 2016). However, the importance of these pathways outside of laboratory conditions remains unclear (Koelmans 2015), with field-based studies in the Northern Hemisphere indicating natural food sources are a greater contributor to POP concentrations than are plastics in the diet (eg Herzke et al. 2016, Provencher et al. 2018).

Polycyclic Aromatic Hydrocarbons (PAHs) are known to be carcinogenic, mutagenic and teratogenic. Like PCBs, they are persistent and can bioaccumulate. They have been shown to have chronic toxicity to aquatic organisms. Both PCBs and PAHs are used to make plastics. There is little information available on the baseline levels of such contaminants in Little Penguins. Organ samples have been collected from necropsied Little Penguins in Western Australia to investigate levels of such pollutants, but funding is currently not available for this (B Cannell pers. comm.).

Tributyl Tin (TBT) is an endocrine disruptor and has been globally used as a marine antifoulant paint. It is now banned, but as it is very stable and resistant to degradation, it continues to be detected in sediments within harbours (eg Cockburn Sound Management Council 2013). High levels of TBT have been found in Little Penguins in Western Australia (Cannell et al. 2016). TBTs can cause abnormal neuronal function, behavioural changes, energy imbalances, morphology changes, apoptosis of cells and even the inactivation of enzymes responsible for the detoxification of environmental pollutants (Fent 1996, Meador 2011). Hepatic TBTs have also been associated with poorer body condition in sea ducks (Elliot et al. 2007).

4.7 Sea-level rise (SLR), extreme events and storm surges

Projected sea-level rises are likely to adversely affect sandy beach-nesting seabirds such as gulls, terns and noddies in the near future, then potentially other burrowing species such as penguins, shearwaters and petrels. Preliminary vulnerability assessment of Australia's coast to projected sea-level rises has been undertaken (Smartline mapping), and has subsequently been applied to natural values, including beach-nesting terns in Tasmania (see https://coastadapt.com.au/sites/default/files/case_studies/CSS4_Planning_for_conservation_in_Tas.pdf) as a case study.

The Whenua Hou Diving-petrel (*Pelecanoides whenuahouensis*, a newly described diving petrel species from New Zealand, see Fischer et al. 2018) has been affected by major storm surges destroying its sand dune nesting habitat. Up to 20m of sand dune has been lost over successive storm events, and it is believed that c.20% of the population died in a 2003 storm surge (G Taylor, unpubl. data). Rising sea levels will increase coastal erosion, which is further exacerbated during storms. In the case of Little Penguins, coastal erosion can cause the loss of nests close to beaches. Erosion can also form stepped beaches, making it difficult for penguins to access their nests (B Cannell and EJ Woehler, unpubl. obs).

Many seabird colonies are associated with low lying islands and sand cays. Whilst these low lying islands are, by their very nature, dynamic environments subject to disturbance events such as infrequent storm surge, projected rates of sea level rise in the 21st century will likely result in more rapid change or indeed total loss of some seabird breeding sites. Examples of low lying sand cays subject to potential threat include Ashmore Reef which supports in excess of 100,000 seabirds (Clarke et al. 2010), Raine Island (Queensland), which is the sole breeding site of Herald Petrel *Pterodroma heraldica* in Australia, and Mud Islands in Port Phillip Bay, Victoria, which supports a White-faced Storm Petrel *Pelagodroma marina* breeding colony.

4.8 Climate change

Recent reviews for Australian and Southern Hemisphere seabirds were prepared by Chambers et al. (2011, 2013, 2014). See Rodriguez et al. (2019) for extensive global review for petrels and shearwaters and Ropert-Coudert et al. (2019) for penguins. The predictions vary amongst species and localities, in many cases phenological changes are likely, but the extensive lack of basic ecological data on many species are hindering predictions. Current New Zealand reviews are mainly focussed on terrestrial birds. A project was started in 2019 to investigate impacts of climate change on marine species (G Taylor, pers. comm.).

Increases in sea-surface temperatures (SSTs) and frequencies of El Niño Southern Oscillation (ENSO) events, and marine heatwaves have been reported as key drivers in regional assessments (eg Oliver et al. 2017, Schaeffer and Roughan 2017), and are increasing in frequency and duration (eg Oliver et al. 2018). Mills et al. (2008) established causal links between ENSO events, prey availability and productivity in gulls in New Zealand; see also Woehler et al. (2014) for similar analyses for Tasmania.

Elevated SSTs during the pre-breeding period for Little Penguins in Western Australia have been associated with poorer breeding outcomes, a contraction of the breeding season and lower fledgling masses (Cannell et al. 2012). During a marine heatwave in Western Australia in 2011, the diet composition of Little Penguins changed, with the typical major component Whitebait (*Hyperlophus vittatus*) replaced by a tropical sardine (Scaly Mackerel *Sardinella lemuru*: Cannell 2012, Cannell et al. 2019).

Elevated ambient air temperatures have been associated with fatal hyperthermia of little penguins in Western Australian colonies (Cannell et al. 2011, Cannell et al. 2016, Marker 2016). Tropical seabirds in north-western Australian colonies are often observed gular fluttering and assuming stereotyped incubation/brooding postures (eg facing away from the sun with head lowered and mantle feathers raised to provide shading and facilitate air-flow, R Mott, pers. obs.). These behaviours minimise heat loading and heat dissipation (Bartholomew 1966; Nelson 2005).

Climate change will likely increase thermal stress of breeding adults and nestlings, with potential negative consequences for tropical seabirds that are already close to their thermal limits (Oswald and Arnold 2012). Sprinklers are now used to cool nesting Northern Royal Albatrosses *Diomedea sanfordi* at Taiaroa Head in New Zealand after heat stress resulted in the loss of breeding adults in previous years. In 2019, many Chatham Albatross *Thalassarche eremita* chicks were observed dying during hot summer conditions on the rocky north facing slopes of the Pyramid in the Chatham Islands (G Taylor unpubl. data). Chris Gaskin (in litt.) reported that many Kermadec Petrels *Pterodroma neglecta* were observed nesting in direct sunshine rather than shaded by tree cover as normal after the leaves were stripped off the plants by intense winds and salt spray from passing ex-tropical cyclones.

Ocean acidification is a threat to seabirds by potentially reducing food availability as the oceans become more acidic. When carbon dioxide (CO_2) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals. Studies have shown that lower environmental calcium carbonate saturation states can have a dramatic effect on some calcifying species, including oysters, clams, sea urchins, shallow water corals, deep sea corals, and calcareous plankton.

4.9 Geological processes [Vulcanisation, earthquakes and landslips]

Past eruptions of White Island in the Bay of Plenty (New Zealand) have deposited ash over Australasian Gannet *Morus serrator* colonies and blocked Grey-faced Petrel *Pterodroma gouldi* burrows; birds were potentially buried in the ash. Curtis Island in the Kermadec Islands is now 10m higher than it was shown in a picture taken in 1929. This uplift happened sometime before 1966. The impact on nesting birds on the island is unknown (N Carlile and G Taylor, pers. comm.).

Volcanic activity at the McDonald Islands (west of Heard Island in the Indian Ocean) is believed to have adversely affected breeding populations of seabirds sometime between 1980 and 2003. Extensive uplift and lava flows destroyed Macaroni Penguin *Eudyptes chrysolophus* colonies (Stephenson et al. 2005, Woehler 2006).

A large (7.5 magnitude level) earthquake at Kaikoura, New Zealand in November 2016 caused extensive landslips and was reported to killed 25% of the breeding population of Hutton's Shearwater *Puffinus huttoni* (NZ Department of Conservation unpubl. data). Landslips and ensuing erosion at breeding sites of Westland Petrels *Procellaria westlandica* are a frequent occurrence with major slips occurring every decade (Waugh and Wilson 2017).

4.10 Human exploitation

Human exploitation comprises legal and illegal egg, chick and adult harvesting (Rodriguez et al. 2019). There is an ongoing human take of Short-tailed Shearwater chicks in Tasmania, and of Sooty Shearwaters *Ardenna grisea* in New Zealand for their oil/feather/meat (Rodriguez et al. 2019). The Sooty Shearwater harvest is a commercial harvest but only allowed by descendants of Rakiura Maori; no annual reporting is required. About 250,000 chicks are harvested each year, and numbers at all colonies are decreasing (Anderson 1996; Kitson and Moller 2008). The Snares population of Sooty Shearwaters (no harvest on this reserve) has decreased by 50% between 1970s and early 2000s (NZ Department of Conservation unpubl. data). Little Penguins were taken by cray fishers as bait for cray pots in Tasmania until the 1980s (EJ Woehler, pers. obs).

Anderson (1996) provides an historical review of human take of Procellariids in Australasia. An assessment of the impacts of a cultural harvest of Grey-faced Petrel chicks (Anderson 1996) found that only a few hundred chicks per site are removed. Eggs of Sooty Terns *Onychoprion fuscatus* are taken annually on Phillip Island off Norfolk Island (Priddel et al. 2010), and illegal harvests also occur on Lord Howe Island and on Norfolk Island (Carlile 2019 in litt). Moller (2006) reviewed seabird harvests towards evaluating whether monitoring, research and management are adequate to assess their sustainability. He concluded that there is neither evidence for unsustainability of most current seabird harvests, nor evidence that harvesting is sustainable.

Falkland Islands squid jiggers were reported catching albatrosses as a food source. The capture was deliberate take rather than bycatch (Phillips et al. 2016) but the practice seems to have now ceased (B Baker pers. comm.). There is a small illegal take of Northern Royal Albatross and Chatham Albatross on some of the outer islands of Chatham Islands in some seasons (ACAP 2009 and 2010, respectively).

The Red-footed booby *Sula sula* has been hunted in the Cocos (Keeling) Islands, eastern Indian Ocean, since first settlement in 1827. Formerly present throughout the islands, an estimated 30,000 pairs now breed only on isolated and uninhabited North Keeling (Pulu Keeling) Island. Despite legislative protection, illegal hunting for food remains a major conservation threat. Baker et al. (2004) estimated that 2000–3000 birds were killed in most years and possibly as many as 10,000 in some years. However, population monitoring between 1985 - 2002 showed no evidence of a decrease in nesting density on North Keeling

(Pulu Keeling) Island.

Low level poaching of seabirds and marine turtles continues at Browse Island off north-western Australia, in part facilitated by international agreements that permit traditional access by Indonesian fishers to Australian waters surrounding this island. This continued pressure in conjunction with the presence of the invasive House Mouse *Mus musculus* on this island prevent seabird recolonization (R Clarke pers. obs.). Historically until at least the 1980s, there was excessive and unsustainable takes of seabirds, their young and eggs from Ashmore Reef, with records of mounds of seabird eggs in dugout canoes and piles of seabird remains (Clarke et al. 2010).

4.11 Human disturbance and recreational boat strikes

There is an extensive global literature on human disturbance to seabirds at breeding and roosting sites. Early Australian research was undertaken on Macquarie Island and elsewhere, and the effects of researchers were reviewed by Carey (2009). Guidelines for visitors to seabird colonies in the Great Barrier Reef were developed (GBRMPA 1997) and access to seabird nest sites and colonies on Subantarctic islands require permits. No recent work has been undertaken on disturbance to seabirds in Australia or New Zealand.

Human recreational activities in coastal environments pose risks to coastal-nesting species such as penguins, gulls, terns and cormorants. Recreational walkers, 4WDs, dogs and horse-riders are threats on land and increasing in frequency and intensity. Little Penguins breeding in nest boxes on Penguin Island, Western Australia, close to human presence are less likely to be occupied and have lower breeding success (Klomp et al. 1991). Frequent fatal attacks on Little Penguins by roaming dogs have killed more than 90 penguins in a night in Tasmania (EJ Woehler unpubl. data). In New Zealand predation of Yellow-eyed Penguins by uncontrolled dogs, and unregulated visitor access at some mainland sites remain issues (Mattern and Wilson 2019).

In New Zealand, King Shags are disturbed by people in boats fishing too close to breeding islands. The birds do not tolerate close encounters with people at most stages of the season. Recreational 4WDs on braided riverbeds destroy/disturb nesting Black-billed Gulls *Chroicocephalus bulleri* and Black-fronted Terns *Chlidonias albostriatus,* and disturb mainland nesting Yellow-eyed Penguins on South Island. Approximately 25% of Little Penguin mortality in Western Australia was the result of recreational boat and jet-ski strikes.

4.12 Habitat loss and fragmentation

Although habitat loss was ranked the highest threat to seabirds by Workshop Participants in the threat matrix (Annex 3), there were few published studies to support this assessment.

Craig et al. (2000) provide a review for New Zealand; no similar review has been undertaken for Australia. There is no reference to these threats in the Australian State of the Environment Report (2016). Approximately half of the aquatic habitat for Fairy Terns *Sternula nereis* in the Coorong (South Australia) has been lost (see also the *Draft National Recovery Plan for the Australian Fairy Tern*, Commonwealth of Australia 2020). The channelisation of the Prosser River on the East Coast of Tasmania has seen the IBA there listed as Threatened by BirdLife Australia and BirdLife International (Woehler 2018, http://datazone.birdlife.org/site/factsheet/orford-(tasmania)-iba-australia). There has been an extensive loss of seagrass meadows around Australia and New Zealand; these areas are critical habitats for fish nurseries.

The Flesh-footed Shearwater population on Lord Howe Island suffered 35% loss of habitat between 1978 and 2002 from urbanisation which resulted in a concomitant 19% decrease in the population (Priddel et al. 2006). A golf course development on King Island (Tasmania) destroyed nesting habitat for 15,000 Short-tailed Shearwater burrows (EJ Woehler and B Baker, unpubl. obs.). A number of options for the expansion of ports to meet the future freight needs in Perth are currently being considered. Two of these options are in Cockburn Sound and Bunbury; both of these are core foraging habitat for Little Penguins from Garden and Penguin Islands (Cannell 2019).

Braided rivers on New Zealand's South Island are breeding habitats for the threatened Black-billed Gull and Black-fronted Tern, and their substrates are being removed for gravel and shingle extraction. The rivers are also being channelised by farmers and weed encroachment is also causing loss of suitable nesting habitat for the terns and gulls (G Tayler pers. comm.).

4.13 Invasive species (animals and plants)

There is an extensive global literature on the impacts of invasive vertebrates (eg cats, rats and mice) on seabirds, and has long been recognised as the primary threat to many species on many islands (eg Baker et al. 2002, Croxall et al. 2012, Phillips et al. 2016, Veitch et al. 2019). There are extensive efforts by New Zealand to have its mainland and subantarctic islands predator free by 2050. Jones (2010) details rapid recovery on islands following eradication of rats; see also Mulder et al. (2009) and Rodriguez et al. (2019) for a global review for petrels and shearwaters.

Macquarie Island was declared predator free in 2014 and the substantial recoveries of burrowing petrels' populations were rapid and immediate. Norway Rats *Rattus norvegicus* were successfully eradicated from Campbell Island in 2001, and current efforts are underway on Antipodes Islands (New Zealand) and on Lord Howe Island (Australia). On Lord Howe Island, rodent eradication efforts in 2019 have already seen increases in breeding success of Black-winged Petrels *Pterodroma nigripennis* and a spread in the breeding locations of Masked Booby *Sula dactylatra*. Most other breeding seabirds in the Group are expected to benefit from the removal of rodents. A final check for the success of eradication will be in August 2021.

Black Rats *Rattus rattus* were introduced to Penguin Island in Western Australia in 2011, likely in the construction materials brought to the island to build boardwalks. The rats were successfully eradicated with an intensive baiting programme over a number of years (B Cannell, pers. comm.).

In the Eastern Indian Ocean and adjacent Timor Sea, seabird islands (ie islands within continental shelf waters off northwestern Australia) host populations of invasive species that pose threats to seabirds. These include Tropical Fire Ants (*Solenopsis geminate*) at Ashmore Reef (Baker et al. 2016, Hodgson et al. 2016), the Asian form of House Mouse *Mus musculus* at Browse Island and Ashmore Reef (Hodgson et al. 2016, R Clarke unpubl. data) and Polynesian Rat (*Rattus exulans*) at Adele Island. In all instances, there is evidence of direct impact on seabird reproductive outputs, and these likely lead to population-level impacts on at least some seabird species that breed at each of these sites.

Boobies, frigatebirds and tropicbirds breeding on Christmas Island are potentially threatened by the introduced Yellow Crazy Ant *Anoplolepis gracilipes*, which can alter the whole ecology of sites it occupies by killing the super-numerous Red Crab *Gecaroidea natalis*, as well as by tending scale insects that damage nesting trees (O'Dowd et al. 2003; Abbott and Green 2007).

4.14 "Problematic" native species

The small population of Shy Albatross breeding on Pedra Branca is being competitively excluded from the limited available breeding space by Australasian Gannets (Alderman et al. 2012). Increased predation of Fairy Terns by Silver Gulls *Chroicocephalus novaehollandiae* and Australian Ravens *Corvus coronoides* was exacerbated by human impacts (Greenwell et al. 2019). Little Ravens *Corvus mellori* have been reported talking eggs of Little Penguins and Silver Gulls at Phillip Island (Ekanayake et al. 2015, 2016).

4.15 Disease

Disease in wildlife is a natural component of functional ecosystems, but instances of diseases affecting populations are of concern, particularly of Threatened species. Extensive review of reported instances of avian flu, avian cholera, avian pox and others from subantarctic seabird species was undertaken by Grimaldi et al. (2011); Uhart et al. (2018) recently reviewed diseases in albatrosses and large petrels globally. Very early work on Macquarie Island (Morgan et al. 1981) examined the evidence for exposure to Newcastle Disease Virus and other diseases in resident seabird species; there has been no recent work on the Australian subantarctic islands.

Alley et al. (2004) reviewed diseases in Yellow-eyed Penguins, which are currently experiencing elevated rates of avian malaria with significant population-level impacts (Mattern and Wilson 2019). Kerry and Riddle (2009) provided extensive literature on Southern Ocean seabirds including subantarctic species. Some mortality of Little Penguins in Western Australia has been caused by two protozoan parasites, *Haemoproteus spp.* and *Toxoplasma gondii* (Cannell et al. 2013, Campbell et al. in review).

Diseases have been identified in Shy Albatrosses in Tasmania (Woods 2004, Uhart et al. 2018) and Indian Yellow-nosed Albatross *Thalassarche carteri* at Amsterdam I (Weimerskirch 2004, Rolland et al. 2009). In the case of Shy Albatrosses, a phlebovirus carried by the tick *Ixodes eudyptidis* periodically causes chick mortalities on parts of the Albatross Island colony (Wang et al. 2014) with tick control increasing survivorship of chicks by 10% (Alderman and Hobday 2017).

4.16 Wind farms and wave energy

At present (2020), there are no offshore windfarms in Australia and New Zealand, but there is a proposal for an offshore windfarm 10 - 25km off the East Gippsland coast. Terrestrial windfarms in Tasmania have been reported to kill seabirds (diving-petrels, shearwaters, prions, storm-petrels and gannets) from blade strikes (Hull et al. 2013). Species with large wingspans and relatively slow wingbeats are known to be susceptible to striking terrestrial windfarms, suggesting albatrosses, larger petrels and gannets may be at risk if offshore windfarms are constructed.

Wind farms in marine settings in the Southern Ocean are unprecedented and the threat posed to seabirds, especially those with high wing loadings that use dynamic soaring for forward motion, are unquantified and unknown. This is a significant knowledge gap that must be addressed comprehensively before any wind farms could be approved.

A trial wave energy facility was established in 2015 in Western Australia. The buoys and associated infrastructure were fully submerged and the power generated from the submersible systems was delivered to shore by subsea cables. As of 2019, the facility is no longer operational.

4.17 Aquaculture

In Australia, the largest aquaculture industries are present in Tasmania (finfish and shellfish) and South Australia (finfish). In New Zealand, there is aquaculture of shellfish and finfish (Sagar 2008). Aquaculture impacts include pollution of water with animal faeces and feed waste; decreased dissolved oxygen; changes in sediment composition and benthic communities due to deposition of waste on the seabed; increased risk, and spread of, disease (particularly with increasing density of aquaculture farms, Pomeroy and Sequeira 2019).

Extensive interactions in South Australia between Silver Gulls and aquaculture industry has been investigated (Harrison 2009), these interactions resulted in an increase in the gull population and a gull cull. Low levels of entanglement of seabirds and bird strikes (primarily gulls and cormorants) occasionally resulting in low numbers of mortalities are known from Tasmania (EJ Woehler, unpubl. data). Current and proposed moves by the finfish aquaculture industry to offshore locations off southeast Tasmania may see an increased interactions with Southern Ocean species such as albatrosses and petrels (EJ Woehler, pers. comm.).

5. Prioritisation of threats to Australasian seabird taxa

Annex 3 presents a summary of the threats identified to the broad categories of Australasian seabird taxa in the Australasian region. In many cases, it was not possible to determine whether a particular threat category was affecting one or more of the Australasian population(s) for a taxonomic group. In these instances, a low score was assigned to the threat/taxonomic group combination.

Australasian petrels and shearwaters under 600g body mass were the taxonomic group with the highest assessed threat score (31: Annex 3). Albatrosses were ranked the next highest taxonomic group (score = 25) with Australasian petrels and shearwaters over 600g body mass the third ranked group (score = 24).

The highest threat category to Australasian seabirds was habitat loss and fragmentation (scored 17), with invasive animals (score 15), with longline fisheries and disease both scoring 13 as equal third.

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Annex 2. Species prioritisation lists for Australia and New Zealand, ranked in order of priority (highest to lowest) for each country.

a. Australian taxa. Highest priority taxa ranked by risk scores, as assessed by the product of allocated scores for global conservation status using the IUCN Red List Criteria and the Australian share of the global breeding population (see Section 3. Threats, above).

Taxon	Scientific name	Population	IUCN Red List category
Christmas Island Frigatebird	*Fregata andrewsi*	Global	Critically Endangered
Abbott's Booby	*Papasula abbotti*	Global	Endangered
Providence Petrel	*Pterodroma solandri*	Global	Vulnerable
Royal Penguin	*Eudyptes schlegeli*	Global	Near Threatened
Wandering Albatross	*Diomedea exulans*	Australian	Critically Endangered
Grey-headed Albatross	*Thalassarche chrysostoma*	Global	Vulnerable
Grey-headed Albatross	*Thalassarche chrysostoma*	Australian	Critically Endangered
Shy Albatross	*Thalassarche cauta*	Global	Near Threatened
Flesh-footed Shearwater	*Ardenna carneipes*	Global	Near Threatened
Flesh-footed Shearwater	*Ardenna carneipes*	Australian	Vulnerable
Christmas Is White-tailed Tropicbird	*Phaethon lepturus fulvus*	Australian	Endangered
Indian Ocean White-tailed Tropicbird	*Phaethon lepturus lepturus*	Australian	Endangered
Southern Rockhopper Penguin	*Eudyptes chrysocome*	Global	Vulnerable
South Georgian Diving-Petrel	*Pelecanoides georgicus*	Global	Vulnerable
Herald Petrel	*Pterodroma heraldica*	Global	Vulnerable
White-necked Petrel	*Pterodroma cervicalis*	Global	Vulnerable
Gould's Petrel	*Pterodroma leucoptera*	Global	Vulnerable
New Caledonian Gould's Petrel	*Pterodroma leucoptera caledonica*	Australian	Vulnerable
Australian Gould's Petrel	*Pterodroma leucoptera leucoptera*	Australian	Vulnerable
Wandering Albatross	*Diomedea exulans*	Global	Vulnerable
White-bellied Storm-Petrel	*Fregetta grallaria*	Global	Vulnerable
Fairy Tern	*Sternula nereis*	Global	Vulnerable
New Caledonian Fairy Tern	*Sternula nereis exsul*	Australian	Endangered
Australian Fairy Tern	*Sternula nereis nereis*	Australian	Vulnerable

Annex 2. Species prioritisation lists for Australia and New Zealand, ranked in order of priority (highest to lowest) for each country (continued).

b. New Zealand taxa. Highest priority taxa ranked by risk scores, as assessed by the product of allocated scores for conservation status using the NZ Threat Classification System (Robertson et al. 2017) and the New Zealand share of the global breeding population (see Section 3. Threats, above).

Note that all New Zealand priority taxa shown here are of global populations.

Taxon	Scientific name	Population	IUCN Red List category
Black-billed Gull	*Chroicocephalus bulleri*	Global	Critically Endangered
Antipodean Albatross	*Diomedea antipodensis antipodensis*	Global	Endangered
Gibson's Albatross	*Diomedea antipodensis gibsoni*	Global	Vulnerable
Chatham Island Shag	*Leucocarbo onslowi*	Global	Near Threatened
Kermadec Storm-Petrel	*Pelagodroma albichunis*	Global	Critically Endangered
Whenua Hou Diving-Petrel	*Pelecanoides whenuahouensis*	Global	Vulnerable
Chatham Island Taiko	*Pterodroma magentae*	Global	Critically Endangered
Pitt Island Shag	*Stictocarbo featherstoni*	Global	Near Threatened
Salvin's Albatross	*Thalassarche salvini*	Global	Near Threatened
New Zealand Fairy Tern	*Sternula nereis davisae*	Global	Vulnerable
Black-fronted Tern	*Chlidonias albostriatus*	Global	Endangered
King Shag	*Leucocarbo carunculatus*	Global	Endangered
Yellow-eyed Penguin	*Megadyptes antipodes*	Global	Vulnerable
Kermadec Petrel - summer	*Pterodroma neglecta*	Global	Vulnerable
Fiordland crested Penguin	*Eudyptes pachyrhynchus*	Global	Vulnerable
Auckland Island Shag	*Leucocarbo colensoi*	Global	Vulnerable
Foveaux Shag	*Leucocarbo stewarti*	Global	Vulnerable
New Zealand Storm-Petrel	*Pealeornis maoriana*	Global	Vulnerable
Black Petrel	*Procellaria parkinsoni*	Global	Vulnerable
Chatham Petrel	*Pterodroma axillaris*	Global	Vulnerable
Hutton's Shearwater	*Puffinus huttoni*	Global	Vulnerable
Campbell Albatross	*Thalassarche impavida*	Global	Vulnerable

Annex 3. High level threat assessment of Australasian seabird taxa (see Section 3, Threats, above for details of categories).

Assemblage/Threat for Australasia seabird taxa in Australasia only	Fisheries bycatch				Marine debris		Light pollution		Pollution							Invasive species					
	Gillnet	Longline	Trawl + Seine	Competition with fisheries	Entanglement	Ingestion	Terrestrial	Marine	Oil	Metals	Sea-level rise	Climate change	Human exploitation	Human disturbance	Habitat loss + fragmentation	Animals	Plants	Disease	Wind farms	Aquaculture	Total threat score
Skuas	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	**3**
Gulls, Terns and Noddies	0	0	0	0	0	U	0	1	0	0	1	1	0	2	2	2	2	1	1	2	**16**
Tropicbirds	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	1	0	0	**7**
Penguins	2	0	U	U	0	U	1	0	3	1	1	1	0	2	2	2	1	1	0	1	**21**
Storm-Petrels	0	0	0	0	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	**11**
Albatrosses	0	4	4	1	0	0	1	1	1	1	1	1	1	0	1	3	1	2	1	1	**25**
Petrels and Shearwaters <600g	2	4	2	1	1	1	2	2	1	1	1	1	2	1	2	2	2	1	1	1	**31**
Petrels and Shearwaters >600g	1	4	3	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**24**
Diving-petrels	1	0	0	0	0	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	**12**
Frigatebirds	0	0	0	U	0	0	1	1	1	1	1	1	0	0	2	1	1	1	1	0	**13**
Gannets and Boobies	0	0	0	U	0	0	1	1	1	1	1	1	0	0	3	0	1	1	1	0	**13**
Cormorants	2	1	U	U	1	0	0	0	1	1	1	1	0	1	1	1	0	1	0	2	**16**
Total threat score	**8**	**13**	**11**	**7**	**2**	**6**	**9**	**9**	**11**	**7**	**12**	**12**	**4**	**8**	**17**	**15**	**12**	**13**	**8**	**8**	

Threats were coded to allow an initial quantification of threats amongst seabird groups and to identify primary threats, based on ranked scores. The threats were coded:

- 4 Population level impacts,
- 3 Regional level impacts,
- 2 Local impacts,
- 1 Unknown
- 0 Nil impact(s) known.