



# Grey Petrel

## *Procellaria cinerea*

Pétrel Gris  
Petrel Gris

CRITICALLY ENDANGERED    ENDANGERED    VULNERABLE    **NEAR THREATENED**    LEAST CONCERN    NOT LISTED

### Sometimes referred to as

Brown Petrel  
Black-tailed Shearwater  
Black-tailed Petrel  
Cape Dove  
Pediunker



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### TAXONOMY

**Order** Procellariiformes  
**Family** Procellariidae  
**Genus** *Procellaria*  
**Species** *P. cinerea*

Originally described in 1789 by Gmelin, this monotypic species has at times been placed in its own genus, *Adamastor* (e.g. Murphy 1936), in recognition of its distinctive appearance among the *Procellaria* petrels [1].

### CONSERVATION LISTINGS AND PLANS

#### International

- Agreement on the Conservation of Albatrosses and Petrels - Annex 1 [2]
- 2008 IUCN Red List of Threatened Species - Near Threatened (since 2004) [3]
- Convention on Migratory Species - Appendix II [4]

#### Australia

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC ACT)* [5]
  - Migratory Species
  - Marine Species
- Action Plan for Australian Birds 2000 [6]
- Threat Abatement Plan 2006 for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations [7]

#### Chile

- National Plan of Action for reducing by-catch of seabirds in longline fisheries (PAN-AM/CHILE) 2007 [8]

#### France

- *Ministerial Order of 14 August 1998 (Arrêté du 14 août 1998)* [9]
  - Listed Protected Species

**New Zealand**

- *New Zealand Wildlife Act 1953* <sup>[10]</sup>
- Action Plan for Seabird Conservation in New Zealand; Part A: Threatened Seabirds <sup>[11]</sup>
- New Zealand Threat Classification System List 2008 – Declining <sup>[12]</sup>

**South Africa**

- *Sea Birds and Seals Protection Act, 1973 (Act No. 46 of 1973) (SBSPA)* <sup>[13]</sup>
- *Marine Living Resources Act (Act No. 18 of 1996): Publication of Policy on the Management of Seals, Seabirds and Shorebirds: 2007* <sup>[14]</sup>
- National Plan of Action (NPOA) for Reducing the Incidental Catch of Seabirds in Longline Fisheries 2008 <sup>[15]</sup>

**Tristan de Cunha, UK Overseas Territories**

- *The Conservation of Native Organisms and Natural Habitats (Tristan da Cunha) Ordinance 2006* <sup>[16]</sup>

**BREEDING BIOLOGY**

*Procellaria cinerea* is a colonial, winter-breeding species. It is a burrow-nesting, annual breeder, with 93% of successful birds returning to breed the following season <sup>[17]</sup>. The breeding season extends from February to December <sup>[18]</sup> (Table 1). Birds arrive at their colonies from early February <sup>[19, 20, 21, 22, 23]</sup> and eggs are usually laid from late March to early April <sup>[20, 24]</sup>. Incubation lasts 55-65 days with most chicks hatching in late May to early June <sup>[24, 25, 26]</sup>. Hatching has been reported to extend into July in the Tristan da Cunha Group <sup>[23]</sup>. The fledging period is the longest known amongst the petrels and is very variable (120-160 days), with chicks typically leaving Crozet and Kerguelen in September to early December <sup>[20, 24]</sup>, but can be as early as end of August on Marion Island <sup>[25]</sup>. The asynchrony in fledging dates within sites and years is thought to reflect food scarcity and variability during the winter rather than asynchrony in laying <sup>[24]</sup>. The age of first breeding is not known.

Table 1. *Breeding cycle of P. cinerea.*

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<b>At colonies</b>	■								■				
<b>Egg laying</b>										■			
<b>Incubating</b>	■									■			
<b>Chick provisioning</b>	■												■

**BREEDING STATES**

Table 2. *Distribution of the global P. cinerea population among Parties to the Agreement. Approximate estimates based on surveyed sites only as the global population of P. cinerea is currently unknown.*

	Australia	France	New Zealand	South Africa	United Kingdom
<b>Breeding pairs</b>	<1%	c. 10%?	c. 65%?	c. 5%?	c. 20%?

## BREEDING SITES

*Procellaria cinerea* has a wide distribution and is known to breed on the South African, French, New Zealand and Australian subantarctic islands, as well as on Amsterdam Island, and in the Gough and Tristan de Cunha group (Table 2, Figure 1). Population data are scarce and accurate census data for most breeding sites are currently lacking (Table 3). The largest population is thought to occur on Antipodes Island, with a mean of 53,000 breeding pairs estimated there in 2001 [27]. Over 10,000 pairs have been estimated to breed on Gough Island in 2001 [R. Cuthbert in 1], and thousands on Iles Crozet, Kerguelen and on the Prince Edward Islands. Macquarie, Amsterdam, Campbell and Tristan Islands hold much smaller populations, with a pair also observed on Inaccessible Island in 1983 [22], but breeding has not been confirmed.

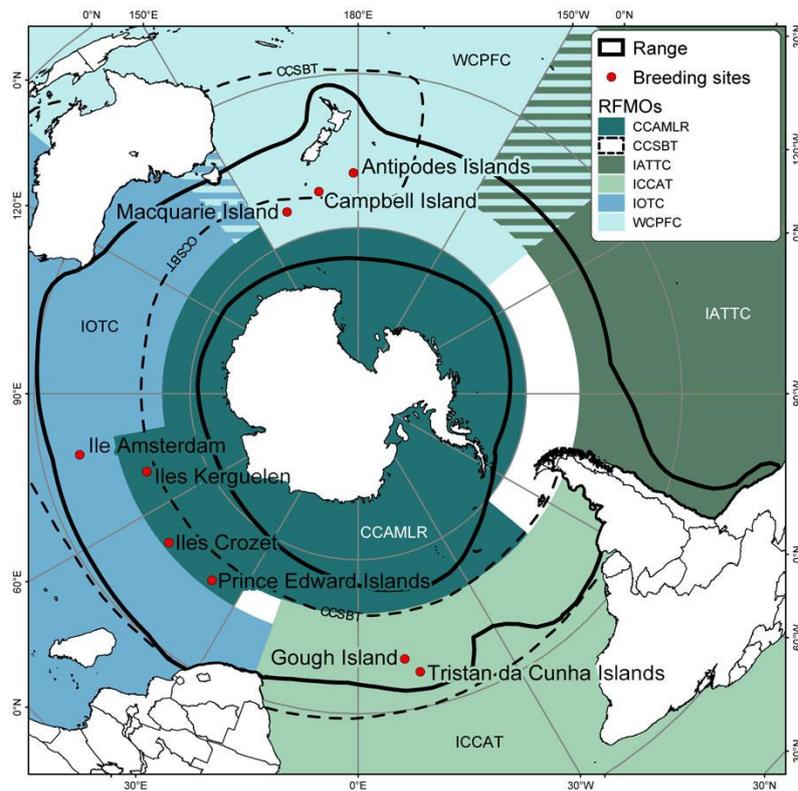


Figure 1. The location of the breeding sites and approximate range of *P. cinerea* with the boundaries of selected Regional Fisheries Management Organisations (RFMOs) also shown.

CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources  
 CCSBT - Convention for the Conservation of Southern Bluefin Tuna  
 IATTC - Inter-American Tropical Tuna Commission  
 ICCAT - International Commission for the Conservation of Atlantic Tunas  
 IOTC - Indian Ocean Tuna Commission  
 WCPFC - Western and Central Pacific Fisheries Commission

Table 3. Monitoring methods and estimates of the population size (annual breeding pairs) for each breeding site. Table based on unpublished Centre National De La Recherche Scientifique (CNRS) Chizé data (Ile de la Possession), Tasmanian Department of Primary Industries and Water, DPIW (Macquarie Island), and published references as indicated. See Glossary and Notes for explanation of monitoring method and accuracy codes.

Breeding site location	Jurisdiction	Years monitored	Monitoring method	Monitoring accuracy	Annual breeding pairs (last census)
<b>Macquarie Island</b> 54°37' S, 158°51' E	Australia	2003, 2004, 2006, 2007	A	High	74 (2007)
<b>Amsterdam Island</b> 37°51' S, 77°31' E	France	1980s	F	Medium	5-10 (1980s) [28]
<b>Iles Crozet</b> 46°26' S, 51°47' E	France	2005	F	Medium	10s (2005)
Ile de la Possession Ile de l'Est		1982	F	Low	2,000-9,000 (1984) [29]
<b>Iles Kerguelen</b> 49°09' S, 69°16' E	France	2006	C	Medium	3,400 (95% CI 1,900-5,600) (2006) [30]
Golfe du Morbihan		-	-	-	10s (2006) [30]
Jeanne d'Arc Peninsula		-	-	-	?
Ile du Port		-	-	-	?
Ile St Lanne Gramont Presqu'île Joffre		-	-	-	?

<b>Campbell Island</b> 52°32'S, 169°8'E Campbell Island Dent Island Jacquemart	New Zealand	not surveyed	-	-	100s? <sup>[11]</sup>
<b>Antipodes Islands</b> 49°42'S, 178°47'E Antipodes Island	New Zealand	2001, 2009	A	Medium	53,000 (32,000-73,000) (2001) <sup>[27]</sup>
Bollons Island		not surveyed	-	-	? <sup>[27]</sup>
<b>Prince Edward Islands</b> 46°38'S, 37°55'E Marion Island Prince Edward Island	South Africa	?	-	-	1,000s (1980s?) <sup>[31]</sup>
<b>Tristan da Cunha</b> Tristan Island 37° 7'S, 12° 17'W Inaccessible Island	UK	1974	?	?	50-100 (1974) <sup>[23]</sup>
<b>Gough Island</b> 40° 21'S, 09° 53'W	UK	2001	-	-	10,000-25,000 (2001) <sup>[R]</sup> Cuthbert in 1]
<b>Total for all surveyed sites</b>					<b>&gt;50,000?</b>

## CONSERVATION LISTINGS AND PLANS FOR THE BREEDING SITES

### International

Campbell Islands, Antipodes Islands

- UNESCO World Heritage List (inscribed 1998) <sup>[32]</sup>

Macquarie Island

- UNESCO World Heritage List (inscribed 1997) <sup>[32]</sup>
- UNESCO Biosphere Reserve - Man and the Biosphere Programme (inscribed 1977) <sup>[33]</sup>

Prince Edward Islands, Iles Crozet, Iles Kerguelen, Ile Amsterdam

- RAMSAR Convention List of Wetlands of International Importance (Prince Edward Island inscribed 2007, others in 2008) <sup>[34]</sup>

Gough Island and Inaccessible Island

- UNESCO World Heritage List (inscribed 2004) <sup>[35]</sup>
- RAMSAR Convention List of Wetlands of International Importance (inscribed 2009) <sup>[34]</sup>

### Australia

Macquarie Island

- Register of Critical Habitat - *EPBC Act 1999* (listed 2002) <sup>[5]</sup>
- Register of the National Estate (until February 2012) – *Australian Heritage Commission Act 1975* (listed 1977) <sup>[36]</sup>
- National Heritage List – *EPBC Act 1999* (listed 2007) <sup>[5]</sup>

### Tasmania

Macquarie Island

- Nature Reserve - *Nature Conservation Act 2002* (Tasmania) <sup>[37]</sup>
- Macquarie Island Nature Reserve and World Heritage Area Management Plan 2006 <sup>[38]</sup>
- Plan for the Eradication of Rabbits and Rodents on Subantarctic Macquarie Island 2007 <sup>[39]</sup>

### France

Iles Crozet, Iles Kerguelen

- National Nature Reserve (*Réserve Naturelle Nationale*) - Décret n°2006-1211 <sup>[40]</sup>. Specific areas have higher level of protection (Integral Protection Areas, *Aires de Protection Intégrale*): Iles Crozet except Ile de la Possession; some islands and coastal areas in Kerguelen.

**French Antarctic Territories (TAAF - Terres australes et antarctiques françaises)**

Iles Crozet (some coastal areas of Possession Island); Iles Kerguelen (Sourcils Noir, some islands and coastal parts of Golfe du Morbihan)

- Areas Reserved for Technical and Scientific Research (*Zones Réservées à la Recherche Scientifique et Technique*) Arrêté n°14 du 30 juillet 1985 <sup>[41]</sup>, now included in Natural Reserve Management Plan <sup>[40]</sup>.

**New Zealand**

Campbell Islands, Antipodes Islands

- National Nature Reserve - *New Zealand Reserves Act 1977* <sup>[42]</sup>
- Conservation Management Strategy. Subantarctic Islands 1998-2008 <sup>[43]</sup>

**South Africa**

Prince Edward Islands

- Special Nature Reserve (declared 1995) - *National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003)* <sup>[44]</sup>
- Prince Edward Islands Management Plan 1996 <sup>[45]</sup>

**Tristan da Cunha, UK Overseas Territories**

Gough Island and Inaccessible Island

- Nature Reserve - *The Conservation of Native Organisms and Natural Habitats (Tristan da Cunha) Ordinance 2006* <sup>[16]</sup>
- Gough Island Management Plan <sup>[46]</sup>
- Inaccessible Island Management Plan <sup>[47]</sup>

**POPULATION TRENDS**

There are no data on population trends for most of the sites (Table 4). Robertson and Bell (1984) <sup>[48]</sup> estimated 10,000-50,000 pairs at Campbell and the Antipodes Islands in the 1980s, however, more recent work, based on densities of burrows in census grids, extrapolated 32,000-73,000 pairs in 2001 on Antipodes Island alone <sup>[27]</sup>. Work to obtain another population estimate on Antipodes Island is currently underway (D. Thompson pers. comm.). In contrast, the hundreds of thousands of breeding pairs suggested for Gough Island by Richardson (1984) <sup>[23]</sup>, were revised to a more realistic figure of 10,000-25,000 pairs in 2001 [R. Cuthbert in 1]. There are no monitoring programmes for the remaining populations, with the exception of Kerguelen Islands, where an ongoing capture-mark-recapture program has yielded information on demographic parameters since the 1980s (H. Weimerskirch, unpublished data), and Macquarie Island where the species has recolonised recently after an absence of over 80 years <sup>[49]</sup>. Eight pairs were confirmed nesting on the island in 2000 <sup>[49]</sup>, increasing to 74 pairs in 2007 (DPIW, unpublished data). The smallest population on Amsterdam Island comprised only 5-10 pairs at the last estimate in the 1980s; however, the fossil record indicates that the island probably once supported one of the largest colonies in the world <sup>[50]</sup>.

Table 4. Summary of population trend data for *P. cinerea*.

Breeding site	Current Monitoring	Trend Years	% average change per year	Trend	% of population
Macquarie Island	yes	2000-2007	-	Increasing*	100%
Amsterdam Island	?	-	-	Unknown	-
Iles Crozet	?	-	-	Unknown	-
Iles Kerguelen	?	-	-	Unknown	-
Campbell Islands	no	-	-	Unknown	-
Antipodes Islands	yes	-	-	Unknown	-
Prince Edward Islands	no	-	-	Unknown	-
Tristan da Cunha	no	-	-	Unknown	-
Gough Island	no	-	-	Unknown	-

\* DPIW unpublished data

Apart from some limited breeding success data from Macquarie Island, Marion Island and Iles Kerguelen, information on demographic parameters is lacking for all sites (Table 5).

Table 5. Demographic data for the *P. cinerea* breeding sites. Table based on unpublished DPIW data (Macquarie Island) and published references as indicated.

Breeding site	Mean breeding success ±SD (study period)	Mean juvenile survival	Mean adult survival
<b>Macquarie Island</b>	45.8±24% (2002, 2003, 2006, 2007)	No data	No data
<b>Amsterdam Island</b>	No data	No data	No data
<b>Iles Crozet</b>	No data	No data	No data
<b>Iles Kerguelen</b>	mostly between 40-60% (1985-1996) <sup>[51]</sup>	No data	No data
<b>Campbell Islands</b>	No data	No data	No data
<b>Antipodes Islands</b>	No data	No data	No data
<b>Prince Edward Islands</b>			
Marion Island	13% (0-50%, 1979, 1982, 1984)* <sup>[25]</sup>	No data	No data
<b>Tristan da Cunha</b>	No data	No data	No data
<b>Gough Island</b>	No data	No data	No data

\* with cat predation

## BREEDING SITES: THREATS

Currently the most serious land based threat to *P. cinerea* is predation by introduced black rat *Rattus rattus* on many of the islands and probably by house mice *Mus musculus* on Gough Island <sup>[52]</sup> (Table 6).

Table 6. Summary of known threats causing population level changes at the breeding sites of *P. cinerea*. Table based on information submitted to the ACAP Breeding Sites Working Group in 2008.

Breeding site	Human disturbance	Human take	Natural disaster	Parasite or pathogen	Habitat loss or degradation	Predation (alien species)	Contamination
<b>Macquarie Island</b>	no	no	no	no	Medium <sup>a</sup>	Medium <sup>b</sup>	no
<b>Amsterdam Island</b>	no	no	no	Low <sup>c</sup>	no	Low <sup>d</sup>	no
<b>Iles Crozet</b>							
Ile de la Possession	no	no	no	no	no	no <sup>e</sup>	no
<b>Iles Kerguelen</b>	no	no	no	no	Low <sup>f</sup>	Low <sup>f</sup>	no
<b>Campbell Islands</b>	no	no	no	no	no	no <sup>g</sup>	no
<b>Antipodes Islands</b>	no	no	no	no	no	no <sup>h</sup>	no
<b>Prince Edward Islands</b>							
Islands	no	no	no	no	no	no <sup>i</sup>	no
<b>Tristan da Cunha</b>	no	no	no	no	no	? <sup>j</sup>	no
<b>Gough Island</b>	no	no	no	no	no	? <sup>j</sup>	no

<sup>a</sup> High rabbit *Oryctolagus cuniculus* numbers have destroyed vegetation and caused soil erosion at nesting sites. Rabbits may also disturb birds in burrows when nesting <sup>[39]</sup>.

<sup>b</sup> Cats *Felis catus* were eradicated on the island in 2000 but black rats continue to prey upon eggs and chicks. Cats and weka *Gallirallus australis* (also eradicated by 1989) were probably responsible for the extirpation of *P. cinerea* from this site. An eradication programme is scheduled to be implemented in 2010 to remove rats, house mice and rabbits <sup>[39]</sup>.

<sup>c</sup> Avian cholera *Pasteurella multocida* has been identified as the cause of a decline in the population of Indian Yellow-nosed albatross *Thalassarche carteri* on the island. The source of the pathogen may have been the poultry taken to the island to provide food for human inhabitants. The poultry was removed in 2007.

<sup>d</sup> Both black rats and cats prey on eggs and chicks.

<sup>e</sup> Black rats prey on chicks [29].

<sup>f</sup> Reindeer *Rangifer tarandus* and moufflon *Ovis ammon* trample habitat and black rats and cats prey upon eggs and chicks.

<sup>g</sup> Heavy Norway rat *R. norvegicus* predation probably constrained the population of *P. cinerea* on Campbell Island until an eradication programme in 2001 [1]. The island was declared free of rats in 2003.

<sup>h</sup> House mice are present on Antipodes Island but appear not to affect the breeding success of *P. cinerea* [11, 26].

<sup>i</sup> Cats were known to prey on chicks before their eradication on Marion Island in the early 1990s [25].

<sup>j</sup> Black rats are assumed to affect the species as at other breeding sites. House mice are assumed to impact on *P. cinerea* chicks on Gough Island as they also affect the burrow-nesting, summer-breeding petrels [52].

## FORAGING ECOLOGY AND DIET

The foraging methods of *P. cinerea* are poorly known and the diet is documented from only one study at Ile de la Possession, Iles Crozet [53]. Cephalopods were the main prey items, both by occurrence (86.7%), and mass (70.4%), followed by fish remains (46.7% occurrence, 27.8% mass) [53]. The majority of the prey occurred as unidentified fragments, nevertheless five taxa in the Teuthoidea (squid), and one species of fish, *Halargyreus johnsonii*, were identified from 30 samples [53]. The species has been typically observed foraging solitarily or in groups of three or four, but occasionally in larger flocks of up to 50 birds [54].

## MARINE DISTRIBUTION

*Procellaria cinerea* has a circumpolar distribution over subantarctic and subtropical waters, mostly between 32° and 58°S, but extending further north in the Humboldt Current and to about 18°S off the east coast of South America [55]. Data obtained from seabird bycatch suggest that during the breeding season (austral winter), females forage further north than males, in waters north of the Subtropical Convergence, up to 1,460 km from their colonies on subantarctic islands [56]. Recent studies conducted at Kerguelen Island showed that *P. cinerea* forage in eastern waters of Kerguelen, up to 2,000 km from their colonies during winter (breeding period), and that Petrels exploit the same foraging area during summer (non-breeding period; H. Weimerskirch, unpublished data).

The species is mainly pelagic [55] and overlaps with all southern Regional Fisheries Management Organisations, including SIOFA (Southern Indian Ocean Fisheries Agreement), SEAFO (South-East Atlantic Fisheries Organisation) and SWIOFC (South-West Indian Ocean Fisheries Commission), as well as the proposed South Pacific Regional Fisheries Management Organisation, SPRFMO (Figure 1; Table 7). SEAFO, SWIOFC, and SIOFA are aimed at ensuring the long-term conservation and sustainable use of fishery resources other than tuna and are principally responsible for trawl and artisanal fisheries; however SEAFO also manages pelagic species such as the Patagonian toothfish *Dissostichus eleginoides*. SPRFMO is proposed to cover both pelagic and demersal fisheries in the region (predominantly discrete high seas stocks and those stocks which straddle the high seas and the EEZs of coastal states).

Table 7. Summary of the ACAP Range States, non-ACAP Exclusive Economic Zones and Regional Fisheries Management Organisations that overlap with the marine distribution of *P. cinerea*.

	Resident/ Breeding and feeding range	Foraging range only	Few records - outside core foraging range
<b>ACAP Range States</b>	Australia France New Zealand South Africa UK	Argentina Chile Peru	Brazil Uruguay
<b>Exclusive Economic Zones of non-ACAP countries</b>	-	-	Madagascar Mozambique Namibia

<b>Regional Fisheries Management Organisations<sup>1</sup></b>	CCAMLR		
	CCSBT		
	ICCAT		
	IOTC	IATTC	
	SEAFO		-
	SIOFA		
	SWIOFC		
	SPRFMO <sup>2</sup>		
	WCPFC		

<sup>1</sup> see Figure 1 and text for list of acronyms

<sup>2</sup> not yet in force

## MARINE THREATS

At sea, the key threat to *P. cinerea* is from commercial longline fisheries. *Procellaria cinerea* was the fourth most common species observed killed in New Zealand fisheries between 1998-2004, but the second most common observed killed on bottom longline vessels (after White-chinned Petrel *P. aequinoctialis*) [57]. It comprised 13% of all observed seabird bycatch returned for autopsy from New Zealand waters between 1996 and 2005 [58]. In 2006-2007, as in earlier years, the majority of observed mortalities were adult females and occurred in winter east of the North Island of New Zealand [56, 59, 60]. Adult females also comprised most of the birds observed killed in the Japanese tuna longline fishery around Australia between 1988 and 1995 [61]. The impact of this selective mortality on the breeding population is unknown.

The species has also been recorded as bycatch in Argentine longline fisheries along the Patagonian Shelf (0-0.9% of all seabirds observed killed in 1999-2001) [62], and in the Patagonian toothfish fishery around the Prince Edward Islands (1% of all seabirds observed killed in 1996-2000), where males made up over 80% of the carcasses examined [63]. Although *P. cinerea* was recorded around artisanal Patagonian toothfish boats in southern Chile, the bycatch in this fishery was comprised entirely of *P. aequinoctialis* [64].

Substantial incidental mortality may also occur in international waters in the

southern Indian Ocean but seabird bycatch information is limited for this region [Huyser et al. 1999 in 18]. A minimum of 755 *P. cinerea* has been estimated to be killed annually in the legal and illegal Patagonian toothfish fisheries around Kerguelen since 1996 [30, 65], which is more than double the annual mortality of 300 individuals calculated to result in a decline of the Kerguelen population [30].

## KEY GAPS IN SPECIES ASSESSMENT

Population data for *P. cinerea* are largely unavailable. Accurate population numbers and trends are urgently required for most sites so that the status of this species which is known to be impacted by both fisheries and feral pests can be more confidently assessed. Apart from Kerguelen Island, and some very limited data on breeding success in other islands, information on demographic parameters, in particular juvenile and adult survival rates, is lacking for all sites. The impact of introduced predators remains undocumented on most islands. Likewise, the at-sea distribution and movements of all age groups and at all stages of the breeding cycle are poorly known. Although a two-year project assessing population size, breeding frequency, and distribution based on geolocation tracking on Antipodes Island commenced in 2009 (D. Thompson pers. comm.), there is an urgent need to collect baseline information at most breeding sites.

Further information on bycatch levels in longline fisheries which operate in international waters is also needed in order to assess the impact of potential interactions with these fleets on *P. cinerea* populations.



Photo © R. Wanless and A. Angel

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## COMPILED BY

Wiesława Misiak,  
ACAP Secretariat

## CONTRIBUTORS

David Thompson  
National Institute of Water & Atmospheric  
Research (NIWA),  
New Zealand

Mark Tasker  
Vice-Chair, ACAP Advisory Committee

ACAP Status and Trends Working Group  
Contact: Rosemary Gales  
[Rosemary.Gales@dpiw.tas.gov.au](mailto:Rosemary.Gales@dpiw.tas.gov.au)

ACAP Breeding Sites Working Group  
Contact: Richard Phillips  
[raphil@bas.ac.uk](mailto:raphil@bas.ac.uk)

ACAP Bycatch Working Group  
Contact: Barry Baker  
[barry.baker@latitude42.com.au](mailto:barry.baker@latitude42.com.au)

ACAP Taxonomy Working Group  
Contact: Michael Double  
[Mike.Double@aad.gov.au](mailto:Mike.Double@aad.gov.au)

BirdLife International,  
Global Seabird Programme  
Contact: Cleo Small  
[Cleo.Small@rspb.org.uk](mailto:Cleo.Small@rspb.org.uk)  
**Maps:** Frances Taylor

## PHOTOGRAPHS

Tui De Roy  
The Roving Tortoise Worldwide Nature  
Photography  
[photos@rovingtortoise.co.nz](mailto:photos@rovingtortoise.co.nz)

R. Wanless and A. Angel

## RECOMMENDED CITATION

Agreement on the Conservation of Albatrosses and Petrels. 2009. ACAP Species assessments: Grey Petrel *Procellaria cinerea*. Downloaded from <http://www.acap.aq> on 28 September 2010.

## GLOSSARY AND NOTES

### (i) Years.

The "split-year" system is used. Any count (whether breeding pairs or fledglings) made in the austral summer (e.g. of 1993/94) is reported as the second half of this split year (i.e. 1994).

The only species which present potential problems in this respect are *Diomedea* albatrosses, which lay in December-January, but whose fledglings do not depart until the following October-December. In order to keep records of each breeding season together, breeding counts from e.g. December 1993-January 1994 and productivity counts (of chicks/fledglings) of October-December 1994 are reported as 1994.

If a range of years is presented, it should be assumed that the monitoring was continuous during that time. If the years of monitoring are discontinuous, the actual years in which monitoring occurred are indicated.

### (ii) Methods Rating Matrix (based on NZ rating system)

#### METHOD

**A** Counts of nesting adults (Errors here are detection errors (the probability of not detecting a bird despite its being present during a survey), the "nest-failure error" (the probability of not counting a nesting bird because the nest had failed prior to the survey, or had not laid at the time of the survey) and sampling error).

**B** Counts of chicks (Errors here are detection error, sampling and nest-failure error. The latter is probably harder to estimate later in the breeding season than during the incubation period, due to the tendency for egg- and chick-failures to show high interannual variability compared with breeding frequency within a species).

**C** Counts of nest sites (Errors here are detection error, sampling error and "occupancy error" (probability of counting a site or burrow as active despite it's not being used for nesting by birds during the season).

**D** Aerial-photo (Errors here are detection errors, nest-failure error, occupancy error and sampling error (error associated with counting sites from photographs), and "visual obstruction bias" - the obstruction of nest sites from view, always underestimating numbers).

**E** Ship- or ground- based photo (Errors here are detection error, nest-failure error, occupancy error, sampling error and "visual obstruction bias" (the obstruction of nest sites from view from low-angle photos, always underestimating numbers)

**F** Unknown

**G** Count of eggs in subsample population

**H** Count of chicks in subsample population and extrapolation (chicks x breeding success - no count of eggs)

#### RELIABILITY

1 Census with errors estimated

2 Distance-sampling of representative portions of colonies/sites with errors estimated

3 Survey of quadrats or transects of representative portions of colonies/sites with errors estimated

4 Survey of quadrats or transects without representative sampling but with errors estimated

5 Survey of quadrats or transects without representative sampling nor errors estimated

6 Unknown

### (iii) Population Survey Accuracy

**High** Within 10% of stated figure;

**Medium** Within 50% of stated figure;

**Low** Within 100% of stated figure (eg coarsely assessed via area of occupancy and assumed density)

**Unknown**

### (iv) Population Trend

Trend analyses were run in TRIM software using the linear trend model with stepwise selection of change points (missing values removed) with serial correlation taken into account but not overdispersion.

### (v) Productivity (Breeding Success)

Defined as proportion of eggs that survive to chicks at/near time of fledging unless indicated otherwise

**(vi) Juvenile Survival**

defined as:

- 1 Survival to first return/resight;
- 2 Survival to x age (x specified), or
- 3 Survival to recruitment into breeding population
- 4 Other
- 5 Unknown

**(vii) Threats**

A combination of scope (proportion of population) and severity (intensity) provide a level or magnitude of threat. Both scope and severity assess not only current threat impacts but also the anticipated threat impacts over the next decade or so, assuming the continuation of current conditions and trends.

		<b>Scope</b> (% population affected)			
		Very High (71-100%)	High (31-70%)	Medium (11-30%)	Low (1-10%)
<b>Severity</b> (likely % reduction of affected population within ten years)	Very High (71-100%)	<b>Very High</b>	<b>High</b>	<b>Medium</b>	<b>Low</b>
	High (31-70%)	<b>High</b>	<b>High</b>	<b>Medium</b>	<b>Low</b>
	Medium (11-30%)	<b>Medium</b>	<b>Medium</b>	<b>Medium</b>	<b>Low</b>
	Low (1-10%)	<b>Low</b>	<b>Low</b>	<b>Low</b>	<b>Low</b>