COSEWIC
Assessment and Status Report

on the

Pink-footed Shearwater
Ardenna creatopus

in Canada

ENDANGERED
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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COSEWIC
Assessment Summary

Assessment Summary – November 2016

Common name
Pink-footed Shearwater

Scientific name
Ardenna creatopus

Status
Endangered

Reason for designation
This long-lived seabird nests on only three islands off the coast of Chile, where it has suffered significant declines due to nest predation by introduced predators, exploitation by humans and habitat degradation. It also experiences mortality due to incidental take by fisheries across its range, including important foraging areas off the coast of British Columbia. Bycatch risk from fisheries has increased over the last three generations. This species is also sensitive to offshore oil spills.

Occurrence
British Columbia, Pacific Ocean

Status history
Designated Threatened in May 2004. Status re-examined and designated Endangered in November 2016.

COSEWIC
Executive Summary

Pink-footed Shearwater
Ardenna creatopus

Wildlife Species Description and Significance

The Pink-footed Shearwater is a stocky seabird about the size of a medium gull. In flight individuals appear heavy, with laboured wingbeats alternating with glides. It is distinguished from other North Pacific shearwaters by a combination of greyish-brown plumage above, variably mottled pale grey underparts with white wing linings, and a dusky head. The plumage of adult and juvenile birds is alike and there are no seasonal differences, although males are larger than females on average. Its pinkish-yellow, dusky-tipped bill and pink legs and feet are distinctive. The Pink-footed Shearwater is a globally threatened species that is known to breed at only three sites worldwide.

Distribution

The Pink-footed Shearwater is known to breed on three islands off the coast of Chile: Mocha, Robinson Crusoe, and Santa Clara islands. At sea, the Pink-footed Shearwater primarily occupies waters of the continental slope, shelf-break, and shelf of the eastern Pacific. Its range extends from its breeding islands north along the coast of South and North America to the Gulf of Alaska and the southern Bering Sea, but only a few individuals occur north of Haida Gwaii. In Canada, the Pink-footed Shearwater occurs exclusively off the coast of British Columbia, with observations concentrated off the west coast of Vancouver Island, the entrance of the Strait of Juan de Fuca, and in Queen Charlotte Sound. Numbers in Canada peak from June to October.

Habitat

Pink-footed Shearwaters nest in burrows that they excavate in the soil of their breeding colonies. On Mocha Island, burrows are located in dense native forest along the seaward sides of upper slopes and ridgetops, while on Robinson Crusoe and Santa Clara islands, nests are located in remnant native forests or open terrain with grassy vegetation or bare soils. In the marine environment, Pink-footed Shearwaters display a preference for biologically productive waters associated with the continental slope, shelf and shelf-break.

Biology

Pink-footed Shearwaters breed during the austral spring and summer, with birds returning to their colonies from early to mid-October. They lay a single egg per year, with egg-laying occurring from late November to mid-December. Eggs hatch from late January to mid-February after a prolonged incubation period, and fledging primarily occurs in May. Both parents share in incubation. After chicks fledge, post-breeders migrate north to their wintering grounds off Peru and the Pacific coast of the US and Canada.

Population Sizes and Trends

The global population size of the Pink-footed Shearwater is estimated at 28,000 breeding pairs. At Mocha Island, the population is believed to have declined considerably over the 20th century due to illegal chick harvesting and introduced predators. A study at Mocha Island in the late 1990s estimated a substantial decline in the number of breeding pairs (~40%) from an estimate in the late 1980s, although methods differed between surveys. There is plausible evidence of decline on Robinson Crusoe Island within the past 55 years (3 generations) due to predation of adults and chicks by Coatimundis and feral cats. However, the Robinson Crusoe population is thought to have been stable over the past 15 years, and monitoring at Mocha Island since 2010 suggests a stable population over that time. Trends within the Canadian range of the species are unknown.

Threats and Limiting Factors

Threats facing this species at its colonies include human exploitation and disturbance, predation, disturbance and competition from introduced mammals; and habitat loss and destruction, particularly via erosion compounded by vegetation loss. At sea, the species is threatened by interactions with fisheries, oil and other pollution, plastic ingestion, and likely by competition with humans for prey fish.

Protection, Status and Ranks

The Pink-footed Shearwater is listed as Threatened in Canada, as Endangered in Chile, and as Vulnerable by the IUCN. The British Columbia Conservation Data Centre ranks it as Vulnerable. In 2015, it was added to Annex 1 of the Agreement on the Conservation of Albatrosses and Petrels, an agreement under the Convention on the Conservation of Migratory Species (Bonn Convention), under which it is also listed. The Juan Fernández Archipelago is a Chilean national park, and a national reserve protects the portion of Mocha Island occupied by nesting Pink-footed Shearwaters. In Canada, the species occurs within the Gwaii Haanas National Marine Conservation Area.

TECHNICAL SUMMARY

Ardenna creatopus

Pink-footed Shearwater

Puffin à pieds roses

Range of occurrence in Canada: British Columbia, Pacific Ocean

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	18.3 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred and projected (see **Population Sizes and Trends** and **Threats and Limiting Factors** sections).
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	A past reduction is inferred, but percent is unknown. One study at Mocha Island in the late 1990s estimated a substantial decline there (~40%) since a survey in the late 1980s (see Population Sizes and Trends).
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No. b. Yes. c. No. Chick harvesting ban has been enforced since 2010 on Mocha Island, but a few hundred chicks are still taken each year and there are suggestions that harvest may be increasing again. On Robinson Crusoe, predation and competition from introduced mammals remains as a threat. Mortality from fisheries bycatch is ongoing, as is chronic and acute oil spill risk.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (Canadian waters)	285,500 km²

Index of area of occupancy (IAO) (Based on 2x2 km grid value; area occupied at breeding colonies)	72–88 km²
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of "locations" (use plausible range to reflect uncertainty if appropriate)	3 (islands)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown. Over the time span for which data exist (early 2000s to present), there is no evidence of a decline in index of area of occupancy. A decline in historical extent is suspected but direct evidence is lacking.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	No, for marine habitat in Canada. Unknown for marine habitat outside Canada. Yes, there is an inferred and observed decline in terrestrial habitat quality over past 55 years due to winter erosion and resultant damage or destruction of nest burrows, facilitated by overgrazing by introduced mammals. Erosion is the most serious threat on Santa Clara Island, affecting at least 50% of nesting habitat, and is ongoing. Habitat degradation via impacts of invasive plants is ongoing.
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations	17,202 mature individuals (8601 pairs) on Santa Clara and Robinson Crusoe islands, plus 38,880 mature individuals (19,440 pairs) on Mocha Island
Total	~56,000 mature individuals (28,000 breeding pairs). This is a global population estimate; not all mature birds occur in Canadian waters every year.

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	NA - not done

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes

i. Fishing and harvesting aquatic resources (fisheries bycatch); hunting and collecting terrestrial animals (chick harvesting);

ii. Invasive non-native/alien species (various direct and indirect impacts to the species and its breeding habitat, including ecosystem level modifications);

iii. Pollution (chronic and acute oil spills, plastic debris, light pollution, air-borne pollutants); and

iv. Climate change and severe weather (severe weather leading to burrow erosion).

What additional limiting factors are relevant?

Life history of the species: single egg per year; long-lived, slow to mature species so particularly vulnerable to adult mortality.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	NA - entire Canadian population immigrates from its breeding grounds in Chile
Is immigration known or possible?	NA
Would immigrants be adapted to survive in Canada?	NA
Is there sufficient habitat for immigrants in Canada?	NA
Are conditions deteriorating in Canada?	NA
Are conditions for the source population deteriorating?	NA
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	NA (species does not breed in Canada)

Data Sensitive Species

Is this a data sensitive species? No

Status History

Designated Threatened in May 2004. Status re-examined and designated Endangered in November 2016.

Status and Reasons for Designation:

Status:	**Alpha-numeric codes:**
Endangered	B2ab(iii,v)
Reasons for designation: This long-lived seabird nests on only three islands off the coast of Chile, where it has suffered significant declines due to nest predation by introduced predators, exploitation by humans and habitat degradation. It also experiences mortality due to incidental take by fisheries across its range, including important foraging areas off the coast of British Columbia. Bycatch risk from fisheries has increased over the last three generations. This species is also sensitive to offshore oil spills.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No quantitative information is available on rates of population decline.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered (B2ab iii,v) because IAO is under the threshold of 500 km^2, there are fewer than 5 locations, habitat quality is continuing to decline on the breeding grounds, and there is an inferred and projected continuing decline in number of mature individuals.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable; exceeds thresholds for population size.
Criterion D (Very Small or Restricted Population): Does not meet criteria for Endangered, but meets Threatened (D2) because there are only 3 locations, which could be negatively affected within a short time period.
Criterion E (Quantitative Analysis): Not conducted.

PREFACE

In the previous 2004 status report, it was noted that little information exists on the biology of the Pink-footed Shearwater. Until the late 1990s, colony-based studies were sporadic and had been carried out by only a few researchers. Although there are still a number of gaps in our understanding of the biology of this species, ongoing work is slowly increasing the amount of information available. Advances in our understanding of the species include the following:

- A revised estimate of global population numbers based on nest surveys or censuses at all known colonies.
- There is new information confirming fisheries bycatch off the coast of South and Central America.
- More information exists on the relative impacts of non-native mammals, with feral cats now known to be the greatest mammalian threat to the species in their colonies. There is also more detailed information on the impacts of introduced herbivores, namely European Rabbits and cattle.
- European Rabbits were eradicated from Santa Clara Island in October 2003. Since their elimination, there has been significant revegetation. This will presumably reduce future erosion (though it continues to be the greatest threat here) and related habitat loss or degradation at this location, although rabbits remain on Robinson Crusoe.
- A chick harvesting ban has been enforced on Mocha Island since 2010, though some chicks are still illegally taken and the rate may be increasing. Five years of data from Mocha Island suggest that the population there is currently stable; it was previously thought to be declining, largely as a result of chick harvesting.
- Recent studies have provided new data on reproductive parameters and corrected earlier information on dates of return to the colonies.
- Preliminary genetic work supports the hypothesis of no genetic structuring among island colonies.
- An additional decade of at-sea observations over the Canadian range of the species has confirmed the regular occurrence of the Pink-footed Shearwater off Haida Gwaii, and shown that the species occurs in Canadian waters during both the breeding and non-breeding seasons.

There are several more years of satellite-tracking studies of Pink-footed Shearwaters during the breeding season, and new studies tracking birds over their post-breeding dispersal and winter migration. Previously, it was thought that most Pink-footed Shearwaters underwent a post-breeding migration up into the California Current off the US and Canada, but it was not known whether the entire population migrated or whether some adults overwintered in the vicinity of the colonies. It can now be said that effectively the entire population migrates, although based on at-sea surveys and the (limited) tracking data collected to date, it is possible that at least 50% of the population migrates no farther north than the shelf and shelf-break waters of Peru.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2016)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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2016

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

*Ardenna creatopus (*Coues, 1864) is commonly known as the Pink-footed Shearwater. In French the species is called “Puffin à pieds roses”. In Chile, where the species breeds, it is known as “Fardela Blanca*”* or “Fardela de Vientre Blanco". Taxonomy is as follows:

Class: Aves

Order: Procellariiformes

Family: Procellariidae

Genus: *Ardenna*

Species: *creatopus*

Synonyms: *Puffinus creatopus*; *Ardenna creatopus creatopus* (Christidis and Boles 2008).

This species was previously placed in the genus *Puffinus,* but is now classified as *Ardenna* (del Hoyo *et al*. 2014). Based on genetic data, Penhallurick and Wink (2004) proposed splitting *Puffinus* into two genera, *Puffinus* and *Ardenna.* Although Penhallurick and Wink (2004) considered *A. creatopus* and the Flesh-footed Shearwater *(A. carneipes*) to be conspecific, more recent examinations support the traditional treatment of these as sister taxa (Austin *et al*. 2004; Christidis and Boles 2008; del Hoyo *et al*. 2014; Remsen *et al*. 2015).

Morphological Description

The Pink-footed Shearwater (Figures 1a, 1b) is a seabird the length of a medium-sized gull but with a stockier form. In flight, individuals appear heavy, with laboured wingbeats alternating with stiff-winged glides (Martin and Myres 1969; Sibley 2003). It is generally distinguished from other North Pacific shearwaters by a combination of greyish-brown plumage above, variably mottled pale grey underparts with white wing linings, and a dusky head (Harrison 1983; Sibley 2003). The plumage of both sexes and adult and juvenile birds is alike (Harrison 1983), although males are larger than females (Guicking *et al.* 2004). Its pinkish-yellow, dusky-tipped bill and pink legs and feet (Harrison 1983), visible at close range, are distinctive.

The closely related Flesh-footed Shearwater also has a light bill and pale pinkish feet, but has entirely dark plumage apart from its pale flight feathers. Sooty (*A. grisea*) and Short-tailed (*A. tenuirostris*) shearwaters, which often occur in the same habitat as Pink-footed Shearwaters off the coast of British Columbia (BC), have an overall dark plumage with white underwing coverts, and a dark bill.

Figure 1a. Pink-footed Shearwater *Ardenna creatopus*, at Mocha Island colony (photo by Peter Hodum).

Figure1b. Pink-footed Shearwater at sea off British Columbia, ventral view (photo by Ben Lascelles, with permission).

Population Spatial Structure and Variability

Because the Pink-footed Shearwater occurs in Canada only as a non-breeder, the concept of demographic isolation does not apply in Canada. On its breeding grounds in Chile, Guicking *et al*. (2004) found that birds from the Juan Fernández Archipelago tended to be larger than those from Mocha Island, but explained this as being due to physiological adaptations to local foraging conditions (see Physiology and Adaptability, below). Preliminary studies showed no evidence of island-specific genetic divergence for the Pink-footed Shearwater (Guicking *et al.* 2004). Nonetheless, given what is known about the low rate of gene flow in other procellariiformes with high dispersal abilities (Rabouam *et al.* 2000; Welch *et al*. 2012), it is plausible that the Mocha and Juan Fernández populations are isolated reproductively, and may constitute distinct subpopulations.

Designatable Units

This report deals with a single designatable unit. No subspecies have been recognized for the Pink-footed Shearwater (BirdLife International 2012; Remsen *et al*. 2015). Nor do individuals at Mocha Island or Juan Fernández show attributes that suggest birds breeding at these sites come from discrete or evolutionarily significant units. For example, breeding birds from all islands sometimes forage in the same marine region (see Habitat Requirements, below). As noted above, preliminary results suggest no evidence of genetic distinctiveness among island colonies (Guicking *et al*. 2004).

Special Significance

The Pink-footed Shearwater is a globally threatened bird that is known to breed on only three islands. Chicks are considered a local delicacy and are illegally harvested for food on Mocha Island by island residents (Guicking *et al*. 1999), although a harvest ban has largely been enforced since 2010 (Azocar *et al.* 2013; CONAF 2013). The species now forms a central element of local conservation initiatives on Mocha, with events such as a ‘Shearwater Cup’ soccer tournament contributing to strengthened environmental awareness and cultural identity for island residents (WWF Chile 2011; CONAF 2013; Municipalidad de Lebu 2015).

There is no Aboriginal Traditional Knowledge available at this time that is pertinent to the status assessment of the Pink-footed Shearwater. Although other seabird species occur commonly in coastal middens in BC (Crockford 2003), only three specimens of this species have been identified at archaeological sites in the province, from Benson Island in the Broken Group Islands (Frederick and Crockford 2005; I. McKechnie, pers. comm.).

DISTRIBUTION

Global Range

The Pink-footed Shearwater is a bird of the continental shelf (defined as waters out to the 200 m isobath), shelf-break, and continental slope (the zone between the 200 m and 500 m isobaths) of the eastern Pacific (Guicking *et al*. 2001; Kenyon *et al*. 2009; Mangel *et al*. 2012; Figure 2). It is known to breed on only three islands off the coast of Chile: Mocha Island in south-central Chile, 35 km offshore (50 km^2 in area); and 600 km to the northwest in the oceanic Juan Fernández Archipelago, on Robinson Crusoe (Isla Másatierra; 48 km^2) and Santa Clara (2.2 km^2) islands (Ojeda *et al*. 2003; BirdLife International 2012; Azocar *et al*. 2013; Figure 2). Although it has been suggested that birds may also breed on Chile's Guafo Island (CEC 2005; Hinojosa and Hodum 2007), a recent survey of the avifauna there considers the Pink-footed Shearwater to be a non-resident visitor (Reyes-Arriagada *et al.* 2009).

The marine range of the Pink-footed Shearwater extends north from its breeding grounds along the coast of South and North America to the Gulf of Alaska and the southern Bering Sea (Wahl *et al*. 1989; Figure 2). Although relatively few individuals occur north of Haida Gwaii, BC, the species has been sighted as far north as 58.34° N (Gould *et al*. 1982; Morgan *et al*. 1991; Kenyon *et al*. 2009). Pink-footed Shearwaters are known to occur in all seasons off Peru and Chile. In the North American part of its marine range, the species primarily occurs during the boreal spring, summer and autumn, though it sometimes also occurs in winter as far north as Washington and Canada (Wahl *et al.* 2005; Kenyon *et al*. 2009; K. Morgan, unpubl. data). Birds seen in New Zealand were formerly considered vagrants but now are reported there regularly. A handful of vagrants have been recorded from the Central Pacific (Hawaii and the Line Islands) and Australia, and a specimen has been collected from the Atlantic coast of Argentina (Harrison 1983; Onley and Scofield 2007; Force and Ballance 2009; BirdLife International 2012). The recent range expansion to New Zealand may indicate that the at-sea range of Pink-footed Shearwaters is not completely described (i.e., they may regularly occur in regions where they are currently considered accidental).

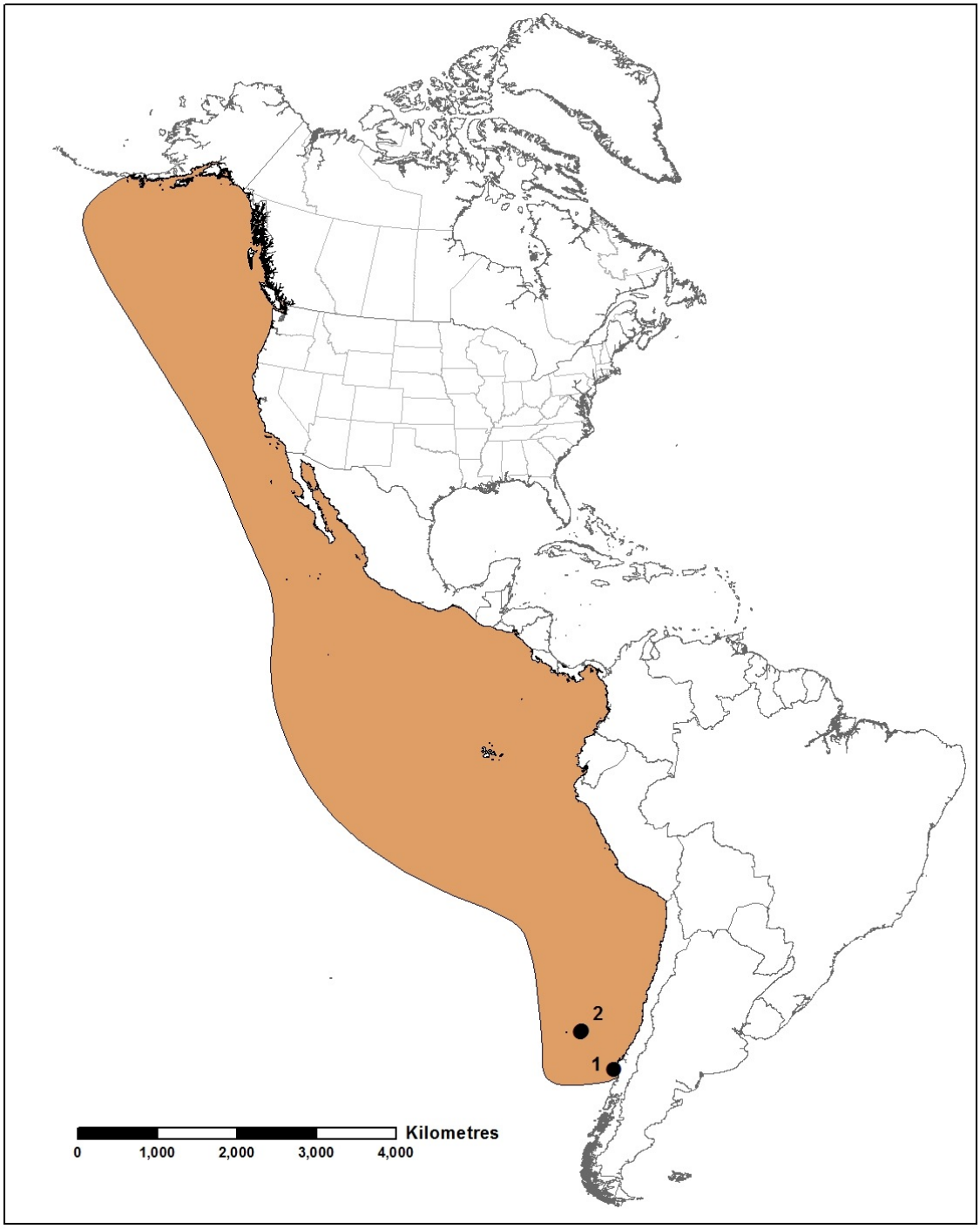

Figure 2. Global distribution of the Pink-footed Shearwater *Ardenna creatopus* (to the east of line), based on maps from BirdLife International (2003). 1 – Mocha Island colony, 2 – Juan Fernández Archipelago colonies (Robinson Crusoe and Santa Clara islands). This species is also regularly reported from New Zealand (not shown; intervening range not known). Data source: BirdLife International and NatureServe (2015). Map prepared by Alain Filion, COSEWIC.

Canadian Range

In Canada, the Pink-footed Shearwater occurs exclusively off the coast of BC, with Hecate Strait and the west coast of Haida Gwaii (Figure 3) representing the northern limits of where it regularly occurs (Morgan 1997; Harfenist *et al*. 2002; Kenyon *et al*. 2009; K. Morgan, pers. comm.; Figure 3). Its distribution tends to be closely associated with the continental shelf, shelf-break, and continental slope off the west coast of Vancouver Island, the entrance of the Strait of Juan de Fuca, and during fall, off the coast of Haida Gwaii (Morgan *et al*. 1991; Kenyon *et al*. 2009). The affinity of Pink-footed Shearwaters for these waters seems to be confirmed by data from recent satellite-tag studies (Mangel *et al*. 2012; Azocar *et al*. 2013; seaturtle.org 2015). Two observations suggest that Pink-footed Shearwaters may occasionally use waters over offshore seamounts in Canada's Pacific (Figure 3). There is a seasonal pattern of occurrence in Canada (Morgan *et al*. 1991; Kenyon *et al*. 2009). Numbers of Pink-footed Shearwaters increase off Vancouver Island during spring (March-May), and peak in the summer (June-July) through fall (August-October).

There is limited information on the historical distribution of this species in Canada prior to the 1980s, but existing observations do not suggest that its range has changed over the last 3 generations (55 years) or more. Martin (1942) stated that the species "appear[ed] to be rare" off the coast of Vancouver Island in the 1930s and 1940s, but this was conceivably due to erratic sampling effort and limited observations offshore. Brooks and Swarth (1925) noted that Pink-footed Shearwaters occurred "regularly" to the north of BC waters, but "more commonly" to the south. During the 1940s, the species was recorded off the west coast of Vancouver Island from late April through May, with numbers increasing and peaking from July and into August. Flocks of up to 20 individuals were frequently encountered during August around La Perouse and Swiftsure Banks (Martin and Myres 1969). Guzman and Myres (1983) reported concentrations of Pink-footed Shearwaters off central Vancouver Island in the spring of 1977-78, and high numbers off Vancouver Island and the Olympic Peninsula, Washington in fall 1977. Recent observations have documented the presence of large flocks of Pink-footed Shearwaters in the last half of May and in mid-July, including an estimated 1400 and 2500 birds, respectively, off the entrance to the Strait of Juan de Fuca. Up to 650 birds have been seen west of Nootka Sound in late May (P. Lehman, pers. obs.).

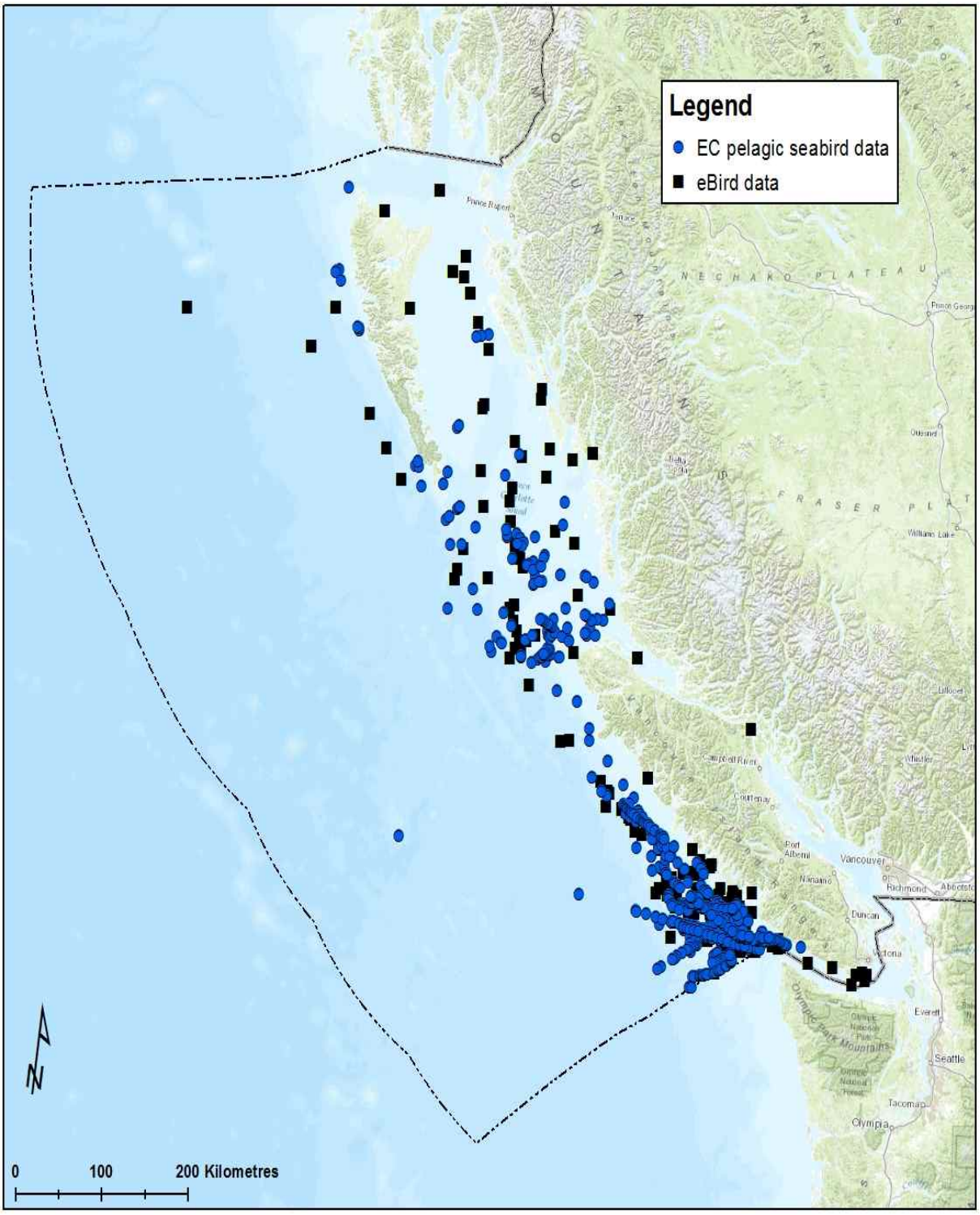

Figure 3. Canadian range of the Pink-footed Shearwater off British Columbia, based on sightings from the Environment and Climate Change Canada seabird at-sea surveys, 1981–2015 and observations provided to eBird from 1968–2015. Dotted line denotes limits of Canada's jurisdictional waters. Map prepared by Alain Filion, COSEWIC.

Extent of Occurrence and Area of Occupancy

The Canadian extent of occurrence (EO) for the Pink-footed Shearwater is about 285,500 km^2. In marine areas where the species has not been recorded, as well as for areas that have not been surveyed, it is not possible to say definitively that the areas are not used by Pink-footed Shearwaters. For the nesting colonies in Chile (the smallest area essential to the survival of existing populations), the index of area of occupancy (IAO) is estimated at 72–88 km^2, based on the spatial extent of all colonies within 2 x 2 km grid squares.

Search Effort

Distributional data for the Pink-footed Shearwater in Canada have primarily come from marine seabird surveys begun in 1981 by the Canadian Wildlife Service (CWS; Morgan *et al*. 1991; Kenyon *et al*. 2009). In Canada's Pacific, CWS conducts at-sea surveys for marine birds from vessels of opportunity (e.g., Canadian Coast Guard patrols or Department of Fisheries and Oceans research cruises). Thus, effort has been spatially and temporally inconsistent from year to year. Surveys occur year-round, although effort is somewhat reduced in fall and winter (Kenyon *et al.* 2009; K. Morgan, pers. comm. 2015). All surveys are conducted by trained and experienced observers, with one observer on board per trip. The majority of vessel trips have taken place over the continental shelf and slope, but cruises west of the 500 m isobath have also occurred semi-regularly, providing additional coverage in the offshore zone. To check for sightings in inside waters with minimal CWS survey coverage, records submitted to eBird in Canada were also consulted (eBird 2015); eBird sightings are recorded opportunistically by volunteer birders with a range of experience. Although regular eBird records are not checked for accuracy, 'unusual' (e.g., extralimital) records require extra documentation be provided with the record.

Canadian at-sea observations have recently been complemented by satellite-tracking data. In 2006, 2009, 2011, 2013, and 2015, researchers working in the Juan Fernández Islands and at Mocha Island attached satellite transmitters to breeding Pink-footed Shearwaters, enabling tracking of 5–10 adult birds per year in the months after they left their nesting colonies and migrated northwards to their wintering grounds (Oikonos 2015; seaturtle.org 2015; K. Morgan, pers. comm.).

HABITAT

Habitat Requirements

Breeding

Pink-footed Shearwaters nest in burrows in forested and non-forested slopes at their island colonies. At Mocha Island, a coastal plain surrounds the ridged interior highlands occupied by Pink-footed Shearwaters. Birds are restricted to the seaward-facing slopes and ridge crests of these highlands, where a series of subcolonies are situated in dense native

forest from about 150 m above sea level to the ridgetops (Guicking *et al.* 1999; Guicking *et al*. 2001; P. Hodum, unpubl. data). On their approach, birds crash through the forest canopy to the ground outside their burrows; to depart, they climb tree trunks to departure points near the forest canopy (Hodum 2014).

On Robinson Crusoe Island, the largest subcolony is located primarily in remnant native forest along a ridgeline. All other subcolonies on this island are on open slopes that are dominated by non-native herbaceous vegetation and, in places, completely exposed soils (Hodum 2014; P. Hodum, unpubl. data). At this location, Pink-footed Shearwaters are not found at low elevations; the lowest colony occurs at about 100 m elevation. Neither do birds nest in the invasives-dominated scrub/matorral (dry shrubland) slopes, or in the higher elevation forest remnants in the island's interior. On Santa Clara, small subcolonies of 10-300 burrows are scattered over the island's open slopes, which are sparsely vegetated with grasses and herbs (Guicking and Fiedler 2000; Azocar *et al*. 2013; Hodum 2014).

Home range

During the chick-rearing phase, Pink-footed Shearwaters nesting on Santa Clara Island extensively use shelf and shelf-break waters (Hodum *et al.* 2004; Azocar *et al.* 2013). Satellite-tracking studies have shown that during the breeding season, Pink-Footed Shearwaters from all three island colonies aggregate at a foraging hotspot in Chile's nearshore Talcahuano region near Mocha Island – an area of high abundance of small forage fishes such as sardines (Clupeidae) and anchovies (Engraulidae; Guicking *et al*. 2001; Azocar *et al*. 2013; Hodum 2014). Associated oceanographic conditions include highly saline waters, and stable sea-surface temperatures of 14–18°C (Brown *et al*. 1975; Guicking *et al*. 2001). In addition to the primary use of continental shelf and shelf-break waters in the Talcahuano region, a few tracked birds also travelled to pelagic waters within a few hundred km of their breeding colonies (Azocar *et al*. 2013).

Wintering

While few in number, austral winter sightings of the Pink-footed Shearwater off the coast of Chile are associated with sea-surface temperatures of 14–18°C (Jehl 1973), as they are off the coast of California (Ainley 1976; Briggs *et al*. 1987). Offshore of North America, Pink-footed Shearwaters appear to be positively associated with the continental shelf (Wahl 1975; Guzman and Myres 1983; Briggs *et al*. 1987; Vermeer *et al*. 1989; Morgan *et al*. 1991) and with aspects of the California Current system (Ainley 1976; Briggs *et al*. 1987), which extends as far north as Triangle Island off the coast of BC. In general, these areas are characterized by seasonal periods of upwelling and high biological productivity (Hay 1992).

In Canadian waters, the Pink-footed Shearwater is most commonly encountered over the continental shelf and shelf-break off Vancouver Island, inshore (at least) to the 90 m depth contour (Guzman and Myres 1983; Vermeer *et al*. 1989; Kenyon *et al*. 2009). The west coast of Vancouver Island has been described as a "wintering hotspot" for this species (Azocar *et al*. 2013).

Habitat Trends

On both Robinson Crusoe and Santa Clara islands in Chile, Pink-footed Shearwater burrows are located in open terrain with grassy vegetation. Historical accounts, however, indicate that much of this habitat was once heavily forested, but was intensively logged during the 18th and 19th centuries (Stuessy *et al*. 1998). This deforestation was compounded by the introduction of domestic herbivores (including sheep, cattle, horses, donkeys, pigs, and goats) prior to and during the 20th century, so that forested areas have been greatly reduced through logging, grazing, and resulting erosion, all of which continue to the present day (albeit with the current rate of habitat loss unknown; Bourne *et al*. 1992; Stuessy *et al.* 1998; Hahn and Römer 2002; CEC 2005). Extensive winter (i.e., wet season) soil erosion on Robinson Crusoe and Santa Clara islands annually destroys or alters a substantial number of shearwater burrows, with recent research on Santa Clara documenting the inter-seasonal disappearance and destruction of burrows in several subcolonies. There are no quantitative estimates of burrow loss, although the rate is known to be higher on Santa Clara than on Robinson Crusoe, where most of the colonies have relatively stable soils because of herbaceous ground cover (CEC 2005; Azocar *et al*. 2013; P. Hodum, unpubl. data). Nonetheless, since the eradication of European Rabbits (*Oryctolagus cuniculus*) on Santa Clara Island in 2003, there has been significant revegetation, including some native plant species, and rates of erosion and burrow loss appear to have slowed at monitored sites (P. Hodum, unpubl. data). Destruction of nest burrows due to trampling by cattle on Robinson Crusoe Island has decreased as a result of exclusion fencing, and burrow destruction during illegal chick harvests on Mocha Island, previously thought to be widespread, is now thought to be only occasional following enforcement of a harvesting ban (see Habitat Protection and Ownership, and Threats and Limiting Factors; Guicking *et al.* 1999; Gladics *et al.,* submitted MS; P. Hodum, unpubl. data).

There is evidence that inter-seasonal biophysical variability in the marine habitat used by Pink-footed Shearwaters is changing within and outside Canadian waters, but these changes and their impacts are not well understood and there is currently no consensus as to whether the system is becoming more or less variable (e.g., Sydeman *et al.* 2013; Boulton and Lenton 2015).

BIOLOGY

Pink-footed Shearwaters are philopatric breeders that nest in burrows they excavate in native forest and open slopes at their island colonies. During the breeding season, adults undertake extended foraging trips of 2-18 days (Hodum and Wainstein 2003), with fish dominating chick diet during this period (Hodum *et al*. 2004; P. Hodum, unpubl. data). Birds capture their prey through surface feeding and surface and plunge diving, with some dives exceeding 35 m (P. Hodum and S. Shaffer, unpubl. data). At the end of the breeding season, a large proportion of the population undertakes a lengthy trans-equatorial migration, spending the northern summer and fall on the continental shelf off the coasts of

the United States and Canada, where birds feed on fish, squid and, to a lesser degree, crustaceans (Baltz and Morejohn 1977; Ainley and Sanger 1979; Prince and Morgan 1987). A more detailed account of the biology of this species can be found in Hinojosa and Hodum (2007), Environment Canada (2008), and Azocar *et al.* (2013).

Life Cycle and Reproduction

Pink-footed Shearwaters breed over the southern spring and summer, with birds returning to their colonies from early to mid-October. They lay a single egg per year, with egg-laying occurring from late November to mid-December (P. Hodum, unpubl. data; Azocar *et al.* 2013). Eggs hatch from late January to mid-February after a prolonged incubation period (Hodum and Wainstein 2002, 2003; Hinojosa and Hodum 2007), and fledging occurs from late April to the first week of June (Guicking *et al*. 2001; P. Hodum, unpubl. data). Both parents share in incubation. After being brooded for the first 1–3 days after hatching, chicks are left unattended. Adults are almost never found in the burrows during the day after this initial, brief brooding period, returning only at night to feed their young (Guicking *et al.* 1999; Hodum and Wainstein 2002). During the early part of the breeding period, the colony is also attended by pre-reproductive young birds and failed breeders all looking for a burrow and a mate for future years. This colony attendance behaviour means that the non-breeding population is also at risk from introduced predators (see Threats and Limiting Factors), particularly as non-breeding birds primarily occupy territory above ground (Guicking *et al.* 2001; Dunham *et al.* 2007; Hinojosa and Hodum 2007).

For the Juan Fernández islands, burrow occupancy (i.e., proportion of burrows occupied) was estimated to be from 64%–73%, while at Mocha Island it was 81% (CONAF 2013). Hatching success (eggs hatched per eggs laid) for nests monitored on Santa Clara during the 2002–2005 and 2011 breeding seasons was estimated at 68–93% (Hodum and Wainstein 2002, 2003, 2004; Azocar *et al.* 2013). On Mocha Island, hatching success has been estimated at 79% (CONAF 2013). For successfully hatched chicks on Santa Clara Island, 88% to 94% survived through the mid-chick period (late March; >40 days of age; Hodum and Wainstein 2002, 2003, 2004). Exact fledging dates and survival until fledging have not been investigated, but Hodum and Wainstein (2003, 2004) reported an overall breeding success rate (chicks fledged per eggs laid) of 69% and 73% for their two study years. Breeding biology is similar between Mocha Island and the two islands in the Juan Fernández group (Guicking and Fiedler 2000; P. Hodum, unpubl. data). The rate of migration among the colonies is unknown.

There is no information on Pink-footed Shearwater sex ratio, age at first breeding, proportion of breeders in the population, or individual frequency of breeding. Generation time is estimated at 18.3 years (BirdLife International 2012). There is no information available on adult or sub-adult survival rates, and the causes of natural mortality are unknown.

Physiology and Adaptability

Pink-footed Shearwaters breeding at Juan Fernández are generally larger than those from Mocha Island (Guicking *et al.* 2004). It has been suggested that these size differences could indicate differing growth responses to local environmental conditions, such as potential differences in diet and prey availability or distances to foraging grounds (with longer distances to foraging grounds meaning longer intervals between chick feeding; Guicking *et al.* 2004; P. Hodum, unpubl. data).

Dispersal and Migration

After chicks fledge in May, post-breeders from Mocha and the Juan Fernández islands migrate north to their wintering grounds off Peru and the Pacific coast of Canada and the US, returning to their breeding colonies again in October (Azocar *et al*. 2013; Hodum 2014). This migratory route primarily follows Pacific shelf and shelf-break waters off the Pacific coast of the Americas, with birds wintering in Canadian and US waters traversing thousands of kilometres through the territorial waters of up to 12 countries (Harrison 1983; Guicking *et al*. 2001; Mangel *et al.* 2012; Azocar *et al*. 2013; seaturtle.org 2015). It was previously believed that during the post-breeding period, most Pink-footed Shearwaters migrated to the California Current, but recent satellite-tracking studies, combined with at-sea surveys showing high winter densities of Pink-footed Shearwaters in Peruvian waters, now suggest that Peru is an important wintering region for the species. Based on the (limited) tracking data collected to date, it is possible that at least 50% of the population migrates no farther than the shelf and shelf-break waters of that country (Jahncke *et al.* 1998a,b; Azocar *et al*. 2013; P. Hodum, unpubl. data). Satellite-tracking data suggest that birds move rapidly through the sub-tropics and tropics once leaving coastal upwelling systems of the Humboldt Current and the southern California Current (P. Hodum, unpubl. data). Ainley (1976) speculated that yearly differences in abundance of Pink-footed Shearwaters off California may be connected to (austral) winter ocean conditions off Peru and Chile, so that during periods of low Peruvian Anchoveta (*Engraulis ringens*) production off the South American coast, Pink-footed Shearwaters may move in greater numbers to the California Current region.

Post-fledging juveniles presumably disperse along routes similar to those used by adults, remaining at sea for an unknown period of months or years before returning to breed or to begin pre-breeding prospecting and courtship activities. The degree to which birds disperse from their natal site to other colonies is not known.

Interspecific Interactions

The Pink-footed Shearwater associates with other shearwaters throughout its marine range, including Sooty and Buller's (*A. bulleri*) shearwaters (Yocom 1947; Wahl 1975; Briggs *et al*. 1987; Guicking *et al.* 2001), and likely competes with them for prey (with Sooty Shearwaters being more aggressive at mixed-shearwater feeding flocks; K. Morgan pers. comm.). Small forage fishes such as Araucanian Herring (*Clupea bentincki*) and Peruvian Anchoveta are believed to be the main prey of breeding birds in Chile (Guicking *et al*. 2001;

P. Hodum, unpubl. data), and are also important to birds over-wintering off the coast of Chile and Peru (Ainley 1976). Interactions with introduced mammals are described in Threats and Limiting Factors, below. There are no native predators at the colonies. Birds may be depredated at sea, but this has not been documented.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Current Pink-footed Shearwater population estimates are based on censuses or surveys of burrows at colonies. Depending on the site and its size, direct counts of all observed burrows were used to calculate the total number of burrows. This technique was used on Santa Clara and Robinson Crusoe islands. The scale and dispersion of the colonies on Mocha precluded the use of comprehensive direct counts. On Mocha Island, a series of transects were used to estimate burrow densities in different colonies, with the overall burrow count extrapolated from the transect data. During surveys, occupancy was determined principally by infra-red burrow camera assessment of a subset of burrows in survey plots, and by extrapolation of empirically-derived occupancy rates to surrounding areas. In addition, some earlier surveys used the presence of fresh feces at the burrow entrance and/or the characteristic smell of procellarids coming from the burrow. Surveys were carried out at Mocha Island from 2008–2012, and at Robinson Crusoe and Santa Clara islands between 2002 and 2011 (Azocar *et al*. 2013; P. Hodum, unpubl. data).

The sampling effort for Canadian waters is described above in Search Effort. The estimate of at-sea abundance in Canada, below, is based strictly on extrapolation of average at-sea densities and does not take into account spatial or temporal variability in survey effort (Environment Canada 2008).

Abundance

The estimated population size of the Pink-footed Shearwater is as follows: Mocha Island, 19,440 breeding pairs; Robinson Crusoe Island, 5075 breeding pairs; and Santa Clara Island, 3526 breeding pairs, for a total of 28,041 pairs. The total global population is thus estimated at approximately 28,000 breeding pairs (Azocar *et al*. 2013). There are no quantitative estimates of the numbers of non-breeders in the population, although BirdLife International (2012) suggests a maximum population size of 100,000 individuals worldwide including non-breeders.

The species has been described as BC's second most numerous shearwater (Guzman and Myres 1983). Based on the known geographic extent of the species' occurrence, and on densities recorded in at-sea surveys, it has been estimated that between 10,000 and 20,000 Pink-footed Shearwaters occur in Canadian waters from June to October each year (Environment Canada 2008). The estimate for Canada likely represents a significant proportion of the global population, and highlights the importance of the waters off BC for Pink-footed Shearwaters during this time of year. Three of 10 breeding

adults tagged with satellite transmitters in 2015 at Mocha Island travelled as far north as Canadian waters (seaturtle.org 2015).

Fluctuations and Trends

Population trends of the Pink-footed Shearwater are poorly understood. Historically, diaries and vessel logs noted the presence of the species in the Juan Fernández islands as early as the 17th century (when mariners collected birds from their burrows for food). Pink-footed Shearwaters were again 'discovered' on Robinson Crusoe Island in 1874, while accounts from the early 1900s described their burrows as being plentiful there (CEC 2005). Murphy (1936) also noted that Pink-footed Shearwaters were abundant on Mocha Island, and described hillsides that were honeycombed with burrows, indicating high densities of the species at that time. Despite the existence of a number of historical accounts, no early population estimates were made and so there are no historical trends for this species. Nonetheless, the Pink-footed Shearwater population was most likely much larger prior to the introduction of mammalian predators and the advent of chick harvesting (see Threats and Limiting Factors).

There are also few data with which to calculate more recent population trends (i.e., over the last 3 generations, or 55 years). For Robinson Crusoe Island, the most recent account states that "according to all documents and reports released since 1999, the Robinson Crusoe population has been more or less stable over the past 15 years" (Azocar *et al*. 2013), with support for this apparent stability provided by recent burrow occupancy and reproductive success monitoring (2002-2014; P. Hodum, unpubl. data). It is important to note that inferences about population trends based on burrow occupancy and reproductive success parameters, while providing a helpful perspective on possible population stability, are limited, given that they are insensitive over the short term to demographic lags due to changes in survival of different age classes. Over the longer term, however, populations are thought to have undergone severe and ongoing declines following the introduction of Coatimundis (or Coatis; *Nasua nasua*) in the 1930s (Bourne *et al*. 1992; Guicking and Fiedler 2000). The current global population estimate of 28,000 pairs is lower than the low end of the range given in the previous Canadian status report for this species (COSEWIC 2004), which estimated a total breeding population of 57,738–60,340 individuals (28,869–30,170 pairs). It is not known whether this represents a more accurate estimate, or whether it represents an actual decline.

On Santa Clara Island, the breeding population increased by an estimated 40% in the three years following the eradication of rabbits in 2003, with an increase in breeding pairs from 2544 in 2003 to 3470 by 2006 (Hinojosa and Hodum 2007; Azocar *et al*. 2013; based on rates of burrow occupancy). However, it should be noted that this does not reflect a true population increase of that magnitude, but rather signals that previously unsuccessful adult birds were able to enter the breeding population following the removal of rabbits, with which they appear to compete for burrows early in the breeding season (see Threats and Limiting Factors).

For Mocha Island, data are similarly inadequate to calculate historical population trends, but the population is believed to have declined considerably in the 20th century due to illegal chick harvesting and introduced predators (Guicking *et al.* 1999; Hinojosa and Hodum 2007). Ibarra-Vidal and Klesse (1994) estimated a Mocha Island population of 84,190 individuals in 1988, while Guicking *et al.* (1999) reported a population of 25,000 pairs (50,000 individuals) based on work conducted in 1997 and 1998. It is worth noting that these latter authors saw their estimate as reflective of a decline, rather than being at odds with the estimate of Ibarra-Vidal and Klesse (1994) for a decade earlier. Schlatter (1984) similarly indicated that the Mocha Island population of Pink-footed Shearwaters was declining drastically. A ban on chick harvesting (see Threats and Limiting Factors) has been enforced since 2010; and 5 years of breeding season monitoring data now suggest a stable population during that time window (P. Hodum, unpubl. data).

The opportunistic nature of at-sea surveys in Canada mean that data should not be used to determine trends in species distribution or abundance in Canadian waters (K. Morgan, pers. comm.).

Rescue Effect

The concept of rescue effect does not apply to this species in Canadian waters.

THREATS AND LIMITING FACTORS

The threats facing the Pink-footed Shearwater at its breeding colonies include human exploitation and disturbance, introduced species, and habitat loss and degradation (Schlatter 1984; Hinojosa and Hodum 2007). As described below, the importance of each of these differs among breeding localities. At sea, the species is threatened by interactions with commercial and subsistence fisheries, oil and other pollution, plastic ingestion, and likely by competition with humans for prey (CEC 2005; Hinojosa and Hodum 2007; Environment Canada 2008; Azocar *et al*. 2013; CONAF 2013). The overall impact of all threats was calculated to be in the High range (see Appendix 1 for threat calculations).

Threats

Biological Resource Use

Overall, these threats were calculated as having a Medium impact.

A) Fisheries Bycatch: (IUCN Threat #5.4)

This was calculated as a Medium threat. Although the magnitude of the threat has yet to be fully determined, recent assessments (at-sea observer monitoring, fisher surveys) have confirmed fisheries bycatch as a threat to Pink-footed Shearwaters in waters off South and Central America (Dávila Pérez *et al*. 2009; Cabezas and Suazo 2011; Mangel *et al*. 2012; Suazo *et al*. 2014). These assessments caution that results are still preliminary and

that exact bycatch rates and population impacts have yet to be determined. However, the number of adult and immature Pink-footed Shearwaters killed in fisheries interactions may be considerable; semi-formal ("rapid response") surveys of fishing captains at 13 ports in Chile resulted in an estimate of ~1000 birds killed per year in that region's net fisheries alone (based on reported bycatch rates and estimates of fleet sizes per port; Mangel *et al.* 2012). Bycatch rates were highest and bycatch was most commonly reported for vessels operating in the vicinity of Mocha Island. Mocha is to the south of the Talcahuano region, a foraging hotspot where Pink-footed Shearwaters from all three island colonies aggregate, and an area with some of the highest levels of industrial and artisanal fisheries activity in the country (Mangel *et al*. 2012; Azocar *et al*. 2013). As the estimated bycatch rate above is for one region of Chile alone and does not include information from all types of fisheries, it is obviously a conservative estimate. Mangel *et al*. (2011, 2012) also reported Pink-footed Shearwater bycatch in Ecuadorian and Peruvian gillnet and longline fisheries, with an initial estimate solely of the Peruvian gillnet fishery of an additional 500–1000 Pink-footed Shearwaters killed per year.

Apart from the above estimates, Pink-footed Shearwater bycatch is known to occur in multiple fisheries in Chile, Peru and Ecuador, with purse-seining, long-lining, and industrial gillnet fisheries all identified as catching this species (Cabezas and Suazo 2011; Mangel *et al*. 2012; Suazo *et al*. 2014). Bycatch mortality is also suspected in other South American fisheries. Satellite tracking of Pink-footed Shearwaters has revealed spatial overlap with numerous gillnet, purse seine and longline fleets (Mangel *et al*. 2012; Suazo *et al*. 2014). It is also thought that bycatch risk has increased over the last 55 years due to increases in both fishing effort and the number of potentially injurious techniques used (P. Hodum, pers. obs.). For Central America, preliminary surveys in Guatemala recently recorded Pink-footed Shearwater bycatch in a longline fishery for sharks and Dolphinfish (*Coryphaena hippurus*; Dávila Pérez *et al*. 2009).

In Canadian waters, the commercial longline fishing effort (for Pacific Halibut *Hippoglossus stenolepis* and rockfish *Sebastes* spp.) is concentrated along the continental shelf, with additional fishing effort along the coast of northern Vancouver Island and Queen Charlotte Sound (Smith and Morgan 2005). Although there are no estimates of the direct spatial overlap between longline fisheries and Pink-footed Shearwaters in Canada, the species is associated with the shelf and shelf-break in Canadian waters and there is a risk of interaction with the fishing fleet. A program is in place to monitor and mitigate bycatch in Canada's west coast longline fishery; however, the effectiveness of recommended mitigation measures has not been assessed, and compliance monitoring appears to be quite limited (K. Morgan, pers. comm.). There are presently no records of Pink-footed Shearwater bycatch from the offshore longline fleet, but a lack of records does not mean a species is not caught in a fishery as species identification is an issue. For example, a Short-tailed Shearwater was salvaged from the halibut longline fishery via a 2000–2005 seabird bycatch program and that bird was originally misidentified as a Pigeon Guillemot (*Cepphus columba;* K. Morgan, pers. comm.). There are no bycatch records for Pink-footed Shearwater from the British Columbia gillnet fleet, likely because this fishery operates in BC inshore waters – though there is also very little bycatch monitoring in the BC gillnet fleet (L. Wilson pers. comm.; K. Morgan pers. comm.). Nonetheless, bycatch of this species in the

North Pacific is known to have occurred in at least two fisheries as it was documented in the high seas gillnet squid fisheries in the 1990s (Johnson *et al*. 1993; Ogi *et al*. 1993), and more recently in a longline fishery off the coast of California (A. Gladics, pers. comm. 2016).

B) Harvesting of Chicks (IUCN Threat #5.1)

This threat was judged to have a Medium to Low impact. In Chile, although the practice of harvesting chicks for food is illegal on Mocha Island, they are considered a local delicacy and high numbers have historically been taken each year by the island's residents (with reports of some commercial exchange with the mainland noted by Guicking *et al*. 1999, and confirmed as still occurring as recently as 2014; V. López and P. Hodum, unpubl. data). The scale of that harvest, as described, was conceivably large enough to have caused population level impacts. Chick harvesting by locals was first reported in the early 20th century, with early exploitation levels unknown. More recently, Guicking *et al.* (1999) estimated a harvest of 3000-5000 chicks per year, or 20% of annual chick production. CONAF (2013) reported a loss of 8000 chicks per year (~40% of the production of the current population estimate of 19,400 nests). Since 2010, the Chilean government has enforced the chick-harvesting ban and the take of chicks has dropped dramatically, so that only about 200 (CONAF 2013) or "several hundred" (Azocar *et al*. 2013) chicks are estimated to be taken per season.

It is important to note that obtaining meaningful estimates of take rates from an illegal harvest is extremely difficult and estimates of recent harvest levels are uncertain. However, there are suggestions that chick harvesting might be increasing slightly again, despite enforcement efforts and community-awareness programs (P. Hodum, pers. obs.). Trade in chick meat also continues to occur with communities on the mainland, and is not regulated except at the colonies. Chilean government agencies are aware of this local export market and have indicated a commitment to enforce the ban at local ports opposite Isla Mocha. Impacts extend beyond harvesting as the disturbance and burrow destruction involved in extracting chicks can affect the pair bond of the adults nesting there, effectively removing burrows and adults from chick production for one or more subsequent years (Hinojosa and Hodum 2007; Azocar *et al*. 2013). On Mocha Island, chick harvesters historically used tools such as hooks and mattocks to access chicks in longer burrows, destroying nests in the process. Guicking *et al.* (1999) noted that such burrow destruction occurred "in many cases" of harvesting; at present, nest destruction continues to occur, albeit with unknown frequency (P. Hodum pers. obs.).

C) Logging and wood harvesting (IUCN Threat 5.3)

Although its impact is probably negligible, firewood harvesting of dead and downed wood on Mocha Island can damage nesting burrows and destroy the trees that shelter them. CONAF attempts to control this activity.

Invasive Species (IUCN Threat # 8.1)

This threat was calculated to have a Medium impact. Each island has its own invasives issues. There is some evidence that invasive species may have led to a decline in habitat quality, number of adults, and perhaps area of occupancy over the past 55 years, although there is imprecise information prior to the last decade. Predation, disturbance, and competition at their nesting colonies by non-native mammals (both predators and herbivores) are presently the greatest known set of threats to nesting Pink-footed Shearwaters. Of the introduced mammals, feral cats currently pose the greatest threat on Robinson Crusoe and Mocha islands, via predation on both chicks and adults (Hinojosa and Hodum 2007). In addition, aggressively invasive plant species like Maqui (*Aristotelia chilensis*), Elm-leaf Blackberry (*Rubus ulmifolia*) and Chilean Guava (*Ugni molinae*) dramatically alter plant community composition and structure, creating dense stands of vegetation inconsistent with use by shearwaters (Stuessy *et al.* 1998; P. Hodum, pers. obs.).

At Robinson Crusoe Island, cats and Coatimundis are believed to have contributed to severe population declines of Pink-footed Shearwaters in the past (Bourne *et al*. 1992; Guicking and Fiedler 2000; Hodum and Wainstein 2002). Coatis were introduced to the island in the 1930s to control rat populations, and were abundant until the 1980s. They may also have been particularly efficient bird predators, as Bourne *et al*. (1992) reported a Coati killing up to 30 Pink-footed Shearwaters in one night. A targeted control program from the late 1990s to the early 2000s meant that there have been relatively few Coatis present in recent years; however, they have continued to prey upon Pink-footed Shearwaters, and as of 2016 the Coati population appears to have begun to increase with the relaxation of hunting pressure. At present, Coati control is an opportunistic endeavour (Hahn and Römer 2002; Azocar *et al*. 2013; P. Hodum pers. obs.). Cats have likely been present on this island for at least 300 years (Azocar *et al*. 2013). Feral cats now pose the greatest mammalian threat on Robinson Crusoe: a preliminary assessment of mammalian predation by Hodum and Wainstein (2003) estimated that, on average, 2–4% of Pink-footed Shearwater nests in three study plots failed as a result of predation of chicks or adults, with most mortality attributed to cats. Annual predation-related mortality at monitored burrows ranged from 0–3% for adults and 0–20% for chicks, with mortality rates varying among colonies and among years (Hinojosa and Hodum 2007).

Camera traps installed in multiple colonies on Robinson Crusoe Island have documented the presence of feral cats, supporting the results of predation surveys in breeding colonies (E. Hagen and P. Hodum, unpubl. data). In addition, stable isotope analysis of feral cat feces indicated the presence of Pink-footed Shearwaters in their diet (V. Colodro and P. Hodum, unpubl. data). Cat predation does not appear to have declined from levels measured in the early 2000s (P. Hodum, unpubl. data).

Rats (*Rattus rattus* and *R. norvegicus*) are also present on Robinson Crusoe Island. Given the impact of rats on ground-nesting seabirds elsewhere in the world, it is probable that they depredate Pink-footed Shearwaters, although stable isotope analysis of tissues from trapped rats suggests that such predation is likely infrequent, with the results indicating a primarily terrestrial isotopic signature and a dietary trophic level below that of shearwaters (Hinojosa and Hodum 2007; Azocar *et al*. 2013; P. Hodum, unpubl. data).

Grazing mammals threaten Pink-footed Shearwaters on Robinson Crusoe Island, both via direct impacts and habitat alteration (see Habitat Loss and Destruction, below). Trampling by domestic cattle has killed adults and chicks, with 48% of burrows at one locality previously showing some level of structural damage (Hinojosa and Hodum 2007; Gladics *et al.,* submitted MS). However, a cattle-exclusion fence installed at this site in 2012 protects about half of the subcolony and cattle no longer have access to other colonies on Robinson Crusoe (Hodum 2014; Azocar *et al*. 2013; Gladics *et al.,* submitted MS).

Introduced European Rabbits occur in high numbers on Robinson Crusoe Island (e.g., ~ 52,000 individuals in 1982; Hahn and Römer 2002) and have been present there since the 1940s (Ojeda *et al.* 2003). There is evidence that rabbits affect Pink-footed Shearwater reproductive success, with birds particularly sensitive to rabbit disturbance or burrow competition during the courtship period (Hodum and Wainstein 2002, 2003; Hodum 2007; Azocar *et al*. 2013).

Santa Clara Island has been free of introduced mammals since rabbits were eradicated in 2003 (Ojeda *et al*. 2003; Azocar *et al*. 2013). The response of nesting Pink-footed Shearwaters to rabbit removal was instructive; within 3 years, breeding pairs increased by nearly 40% (Hodum 2007; also see Population Trends, above). Prior to the eradication, burrow occupancy averaged 43%, but since 2004 has pretty consistently averaged between 60-70% (Hinojosa and Hodum 2007; P. Hodum, unpubl. data). This suggests that the high numbers of rabbits present on Robinson Crusoe may still be significantly affecting Pink-footed Shearwater breeding success there.

On Mocha Island, camera traps have documented feral cats in the colonies, as well as low levels of cat predation of adults. There is also camera trap evidence of occasional take of Pink-footed Shearwaters by domestic dogs (P. Hodum, unpubl. data). Dogs often accompany chick harvesters (see Harvesting of Chicks, below) into the forest and likely take chicks just inside or sitting outside their burrows (Guicking *et al.* 1999). Rats are known to occur on Mocha Island, where they have been observed entering shearwater burrows, and evidence of predation has been observed (Guicking *et al*. 1999).

Although there is currently no evidence to support the suggestion that Pink-footed Shearwaters may breed at Isla Guafo (a small island south of Mocha; CEC 2005; Reyes-Arriagada *et al.* 2009), it is worth mentioning that this site may also be significantly threatened by non-native predators. There is evidence that the introduced rats occurring there depredate Guafo's nesting Sooty Shearwaters, while feral cats are also found on this island (Moreno-Gómez *et al*. 2010).

Habitat Loss and Degradation through Natural System Modifications (IUCN Threat 7.3)

This threat was calculated to have a Medium to Low impact. Grazing by cattle and introduced rabbits causes ongoing habitat damage on Robinson Crusoe Island (see Invasive Species, above), while trampling by cattle outside exclusion fences likely continues to directly impact a low number of burrows (Hinojosa and Hodum 2007; Gladics and Hodum 2010; Gladics *et al.,* submitted MS; Hodum 2014). Habitat conversion by non-native plants is also a threat to Pink-footed Shearwaters on Robinson Crusoe Island (Stuessy *et al.* 1998; Hinojosa and Hodum 2007).

The effects of historical deforestation and of past and ongoing grazing by introduced herbivores are compounded by storms and periods of heavy rain, with Pink-footed Shearwater burrows affected to a greater extent in de-vegetated areas than at vegetated sites (Hodum and Wainstein 2002). Erosion affects breeding populations indirectly through destroying or altering burrows (CEC 2005; Azocar *et al*. 2013). On Santa Clara Island, the primary threat to Pink-footed Shearwaters is the high rate of erosion due to loss of native vegetation cover, even though non-native herbivores are now eradicated there; at least 50% of breeding habitat on Santa Clara is vulnerable to erosion impacts (Hodum 2014; P. Hodum, unpubl. data).

Other ecosystem modifications include changes to prey availability. During the breeding season, Pink-Footed Shearwaters concentrate at a foraging hotspot where there are large commercial and artisanal catches of small forage fishes (primarily sardines and anchoveta; Azocar *et al*. 2013). As there is direct overlap between fisheries and at least part of the diet of Pink-footed Shearwaters, human competition for these high-quality food sources may limit shearwater populations.

Fire should also be considered a potential threat to nesting Pink-footed Shearwaters and their habitat, particularly in terms of potential mortality during the chick-rearing stage, and as an agent for increasing erosion via vegetation loss. Accidental fires have been documented in the Juan Fernández Islands, including a 70 ha fire on Selkirk Island as recently as 1996 (Stuessy *et al*. 1998). The period of peak fire risk coincides with the incubation and chick-rearing phase.

Pollution (IUCN Threat #9)

This threat was judged to have an impact of Medium to Low. Schlatter (1984) listed pesticides, discharge of industrial wastes, and oil spills as potential threats to Pink-footed Shearwaters foraging near their colonies off the Chilean coast. However, impacts of these threats on population size or trends have not been measured. Becker (2000) documented elevated levels of methyl mercury (MeHg) in the feathers of breeding adults and young chicks from Mocha Island. Levels in the body feathers of older chicks were much reduced, suggesting adult exposure during migration or wintering, with MeHg in the down of young chicks being derived from affected eggs. Polychlorinated biphenyl (PCB) residues have also been found in Pink-footed Shearwater eggs in Chile (Cifuentes *et al*. 2003).

Foraging seabirds are known to ingest floating pieces of plastic they mistake for food or ingest them incidentally when consuming other foods (e.g., Blight and Burger 1997). Ingestion can lead to injury or death via physical damage or a reduction in ingested volume of prey (Sievert and Sileo 1993). Preliminary investigation of Pink-footed Shearwater diet of a small sample of birds at the Santa Clara colony during 2003-2004 indicated that this species also ingests plastic (P. Hodum, unpubl. data; CONAF 2013), and a recently established program of monitoring plastic ingestion by Pink-footed Shearwaters, using birds that die due to light impacts, has documented ingestion rates of 95% in the 20 individuals necropsied (P. Hodum unpubl. data).

Oil discharges and plastic ingestion likely pose a threat to Pink-footed Shearwaters in their Canadian range. Pink-footed Shearwaters are attracted to ships on their wintering range (K. Morgan, pers. comm.; Kenyon *et al*. 2010). Ship attraction behaviours increase the risk of mass mortality from either chronic or catastrophic oiling events, if aggregations of birds encounter contaminants. The marine shipment of petroleum products and other bulk goods is likely to increase in Canadian Pacific waters as several marine terminal projects are currently being proposed for the BC coast, with a concomitant increase predicted in shipping traffic (EnviroEmerg Consulting 2008). The vessels travelling to and from these terminals will transit the Canadian waters occupied by Pink-footed Shearwaters (Stantec 2013; Oaten *et al.* 2014), and increased shipping traffic increases the risk that Pink-footed Shearwaters and their prey will be exposed to oil spills and other contaminants (e.g., via illegal bilge cleaning) in Canadian waters.

To address ship-source oil pollution, since the early 1990s Transport Canada has carried out surveillance for oily discharges in Canadian Pacific waters. Surveillance is conducted under the Canadian National Aerial Surveillance Program (NASP) and is concentrated along shipping routes and around port areas, using conspicuous red aircraft, with the objective of providing a deterrent against illegal discharge. Serra-Sogas *et al.* (2008) reported a general pattern of decreasing to stable discharge detection rates with increasing surveillance over the period from 1993–2006. O'Hara *et al.* (2009) found reductions in the proportion of oiled bird carcasses and beaches since the onset of NASP surveillance, suggesting a deterrence effect west of Vancouver Island around Barkley Sound — one of several locations where there have been numerous sightings of Pink-footed Shearwater. O'Hara *et al.* (2013) examined the relationship between discharge detection rates and surveillance effort in three marine regions of BC from 1997–2006. For areas occupied by Pink-footed Shearwaters, there was limited evidence for a deterrence effect in the region west of Vancouver Island, and no evidence for the region north of Vancouver Island. Beginning in 2007, surveillance in all regions intensified with the introduction of more sophisticated equipment and longer-range aircraft; deterrence over this more recent period has not been assessed.

Elsewhere, there is growing evidence that surveillance for illegal oil discharges may simply displace them in time (e.g., a limited increase in nighttime discharges in areas under Dutch Aerial Surveillance; Vollaard 2015) and space (Gullo 2011). This suggests that illegal discharges may be increasing in areas with less or no surveillance.

Light pollution is judged to have a negligible impact. On Robinson Crusoe Island, adults and fledglings are attracted to artificial lights on streets and sports fields in the single town on the island. Light attraction causes both direct mortality, whereby birds are killed through collisions with buildings, and indirect mortality, whereby light-disoriented birds land in an urban area and are subsequently killed by cats or dogs. A minimum of 70 Pink-footed Shearwaters are downed by light attraction each year, with 35–50 of these killed (P. Hodum unpubl. data). Mortality presumably also results from light attraction to oil platforms and ships; although there is no information on this threat, it is assumed to cause negligible mortality.

Limiting Factors

Natural limiting factors for the Pink-footed Shearwater include the amount of suitable habitat at their nesting colonies, and natural fluctuations in prey availability at sea (e.g., as mediated by El Niño events), particularly during the breeding season. Schlatter (1984) also suggested the species is affected by harmful algal bloom events, but did not provide further detail. While these are naturally-occurring events, they are thought to be increasing in frequency as a result of eutrophication and perhaps climate change (Van Dolah 2000; Sellner *et al*. 2003).

Population growth in the Pink-footed Shearwater is limited by life-history characteristics apparent in all Procellariiformes: low fecundity (only one egg produced per year); high mate fidelity (mate loss results in delayed return to the breeding population); and likely delayed sexual maturity. These life-history traits make the species particularly vulnerable to any adult mortality caused by threats such as fisheries bycatch or introduced predators.

Number of Locations

The Pink-footed Shearwater is known to breed at only three islands worldwide. As invasive predators represent an island-wide threat for this species (see Threats and Limiting Factors), each island should be considered as a location. Thus, for the purposes of applying assessment criteria, the Pink-footed Shearwater occurs at three locations. Fire should also be seen as a potential island-wide threat for the very small Santa Clara Island. The information on patterns of bycatch mortality is currently insufficient to determine whether Pink-footed Shearwaters should be considered as occurring at only one locality as a result of a shared population-wide threat.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

In Canada, the Pink-footed Shearwater was assessed as Threatened by COSEWIC in 2004, and is listed in Schedule 1 of the *Species at Risk Act*, meaning that it is protected under that act. Pink-footed Shearwaters are also protected under the *Migratory Birds*

Convention Act in Canada. The species was also approved for listing as Endangered in Chile in 2007 due to reduction in its breeding area, population declines, and declining quality of habitat (Hinojosa and Hodum 2007); it was listed in 2008 (Ministerio del Medio Ambiente undated).

Non-Legal Status and Ranks

The Pink-footed Shearwater is listed as Vulnerable (BirdLife International 2012) by the IUCN and as a Species of Common Conservation Concern by the Commission for Environmental Cooperation (CEC) of Canada, Mexico and the USA. The species is also included in Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, or the Bonn Convention), and in May 2015, Pink-footed Shearwater was included in Annex 1 of the Agreement on the Conservation of Albatrosses and Petrels (ACAP), an agreement under the CMS. The BC Conservation Data Centre ranks the Pink-footed Shearwater as Vulnerable.

The Pink-footed Shearwater is ranked by NatureServe for other jurisdictions as follows:

> Global Status: G3 (31 October 2008)
> Rounded Global Heritage Status Rank: G3 — Vulnerable
>
> National Status Rank – United States: NNA (5 Jan 1997)
> National Status Rank – Canada: N3N (15 November 2011)
>
> Subnational Heritage Status Rank – United States: Alaska (S1S2N), Oregon (SNA), Washington (S1S2N)
> Subnational Heritage Status Rank – Canada: British Columbia (S3N)

Canada's Waterbird Conservation Plan ranked Pink-footed Shearwater as High Conservation Concern due to its threats and the number of birds using Canadian waters (Milko *et al.* 2003). In 2016, the Pink-footed Shearwater was placed on the North American Bird Conservation Initiative's Watch List (of "the species most at risk of extinction without significant conservation actions to reverse declines and reduce threats"; NABCI 2016).

Habitat Protection and Ownership

The Juan Fernández Archipelago was declared a Chilean National Park in 1935 and a UNESCO Biosphere Reserve in 1977, so human activities such as timber harvesting are prohibited in areas occupied by nesting shearwaters (CONAF 2013; Azocar *et al*. 2013). About 45% of Mocha Island was declared a national reserve (Reserva Nacional Isla Mocha) in 1988, with the reserve protecting the forested highlands occupied by nesting Pink-footed Shearwaters (Hinojosa and Hodum 2007). Both localities are managed by Chile's Corporación Nacional Forestal (CONAF). At one of the Robinson Crusoe Island colonies, Tierras Blancas, researchers have recently constructed a 1700 m long predator-

and rabbit-proof fence. A cattle-exclusion fence built around Robinson Crusoe's second-largest subcolony in 2012 fully protects about 50% of that breeding population. These fences protect most of the only two Robinson Crusoe subcolonies still vulnerable to cattle impacts (Hodum 2014; Gladics *et al.,* submitted MS; P. Hodum, unpubl. data). There is interest on the part of the Municipality of Juan Fernández and many residents of San Juan Bautista (the town on Robinson Crusoe) in installing 'seabird-friendly' street lighting throughout town, but this project is still in an early planning phase. At present, there are two areas within the municipality's boundaries that have had green lights installed to minimize nocturnal seabird attraction.

The marine range of the Pink-footed Shearwater falls within the jurisdictions of 12 countries (Mangel *et al*. 2012). Within their Canadian range, Pink-footed Shearwaters occur within the Gwaii Haanas National Marine Conservation Area Reserve (NMCAR) off Haida Gwaii, where conservation-zone planning is active but not in place. The NMCAR is developing a draft Site-based Action Plan for species at risk that includes planning for oil spill preparedness and potential impacts to the Pink-footed Shearwater (P. Shepherd, pers. comm.; Parks Canada 2016). Environment and Climate Change Canada is also developing a Management Plan for the proposed marine Scott Islands National Wildlife Area.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Louise Blight is a marine conservation biologist who has been working on seabirds, marine systems, and species at risk for over 20 years. Her work has included primary research on gulls and alcids in BC, at-sea surveys in the Pacific Ocean, and censuses and field studies of penguins, larids, and procellariiformes in the Antarctic and Southern Ocean. Her travels have also led to extended forays into coastal and marine habitats in Latin America and Australia. She is a long-standing member of Canada's Pacific Albatross and Petrel Recovery Team, and a current member of COSEWIC Birds SSC.

Peter Hodum is a conservation biologist who has 30 years of experience studying the ecology and conservation of seabirds and island systems. He has worked in Chile for 15 years, leading conservation and restoration programs in the Juan Fernández Islands and Mocha Island. He has been the lead scientist on a long-term conservation research program focused on the Pink-footed Shearwater, as well as on the other globally threatened procellarid seabirds breeding on the Juan Fernández Islands. He has served on the Canadian Pacific Albatross and Petrel Recovery Team since its inception.

Matt Fairbarns is a conservation biologist with over 35 years experience working with rare species and ecosystems in western Canada. He has authored over 20 COSEWIC status reports and numerous recovery strategies, and reviewed numerous status reports as a member of a COSEWIC SSC. He has over 40 years' experience as a keen birdwatcher.

Appendix 1. THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	Pink-footed Shearwater
Date (Ctrl + ";" for today's date):	11/05/2016
Assessor(s):	Louise Blight, Jon McCracken, Marcel Gahbauer, Dwayne Lepitzki, Peter Hodum, Dave Fraser, Ruben Boles, Iain Stenhouse, Peter Arcese, Joe Carney, Karen Timm, Joanna James
References:	draft COSEWIC report (Jan 2016) and draft threats calculator prepared by L. Blight (31 Dec 2015); telecon 11 May 2016

Overall Threat Impact Calculation Help:		Level 1 Threat Impact Counts	
Threat Impact		high range	low range
A	Very High	0	0
B	High	0	1
C	Medium	4	1
D	Low	2	4
Calculated Overall Threat Impact:		High	High

Assigned Overall Threat Impact:	AB = High
Impact Adjustment Reasons:	
Overall Threat Comments	Breeds only on 3 islands off Chile (69% of mature individuals on Mocha; 18.1% and 12.6% on Robinson Crusoe and Santa Clara); estimated ~56,000 matures; there is evidence that individuals from all 3 islands are also present in BC during winter.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development						
1.1	Housing & urban areas						No housing developments in colony areas. Colonies are all in protected areas.
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.3	Livestock farming & ranching	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Exclusion fencing on Robinson Crusoe Is. protects many of the birds historically threatened by cattle on this island (not all subcolonies threatened by cattle). Fencing protects most of 1 subcolony previously threatened by cattle, and about 50% of the Piedra Agujereada subcolony of >1100 pairs.
2.4	Marine & freshwater aquaculture						Not associated with aquaculture in Chile. Not considered a threat in Canada either, because facilities are located close to shore and this species occurs in pelagic waters (offshore)
3	Energy production & mining						
3.1	Oil & gas drilling						There is an oil & gas moratorium in waters off BC. There are no plans for offshore oil/gas exploration in Chile.
3.2	Mining & quarrying						
3.3	Renewable energy						There could be development on Robinson Crusoe Is, but no plans for at least 10 years. Uncertain what impacts might be for wind turbines in offshore waters on the wintering grounds.
4	Transportation & service corridors						
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use	B	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	Harvest of chicks is increasing again by some unknown amount (probably modest) despite enforcement of ban and outreach efforts. Harvest probably lower than it was historically. Harvesting apparently occurs only on Mocha Is. (several hundred per year =~1% of annual production of Mocha Island population). Commercial trade in chicks with mainland Chile used to exist, and is occurring again. Effect of hunting extends beyond chick mortality as hunters sometimes destroy burrows to reach chicks, resulting in loss of nest and pair bond of adults (i.e., loss of at least 1-2 y breeding effort for the pair).
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Collection of firewood at Mocha Island; but presumed minimal impact other than occasional burrow damage and loss of trees that protect burrows from erosion. Monitored by government, with variable effort.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Entire population (including breeders and non-breeders) is exposed to fisheries bycatch. Mortality seems high, and mitigation currently not in place. ~1000 birds per year off Chile, 500-1000 off Peru yields 2000/56,000 = 3.6% of population, but this presumably includes immatures. On the other hand, we only have data from some fisheries in two countries, so bycatch rates are underestimated. Note that bycatch for Chile in report is only for a subset of fisheries, for one region. Bycatch is also known from Ecuador and Guatemala, though there are no good figures on numbers.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						Underdeveloped but no impacts if it were to happen
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	No adverse effects have been seen stemming from research (tagging, nest monitoring).
7	Natural system modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression		Not Calculated (outside assessment timeframe)	Pervasive (71-100%)	Serious - Slight (1-70%)	Low (Possibly in the long term, >10 yrs)	Risk of fire is an ongoing threat of unpredictable magnitude at all 3 colonies. Accidental fires have been documented in the Juan Fernández Islands. There have been no fire incidents at colonies in about 40 years, though one occurred on the archipelago's Isla Selkirk, which affected other species of seabirds about 20 y ago. Peak fire risk coincides with chick-rearing period, though main colonies are largely denuded, so this is mainly a risk of low-intensity grass fires.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Ecosystem-level effects of invasives and cattle on habitat are covered here (rabbits, plants, cows). Non-native plants can dramatically alter plant community composition and structure, creating dense stands of vegetation inconsistent with use by shearwaters. On Santa Clara Island, the primary threat is the high rate of erosion due to loss of native vegetation cover. Rabbits compete in terms of plant resources and burrow sites. Fishing is also a potential ecosystem threat as it can result in decreased abundance, quality and availability of prey as well as ecosystem-wide changes.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	
8.1	Invasive non-native/alien species	C	Medium	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Scope of threats by non-native species is broad. Each island has its own invasive issues. Santa Clara does not have any non-native mammals any longer - just legacy of rabbits (removed 2004). Mocha Island has cats, rats and dogs. Robinson Crusoe Is has dogs, cats, rats and Coatimundis. Rabbits continue to compete for burrows and affect reproductive success on Robinson Crusoe; cats depredate adults and chicks on Mocha and Robinson Crusoe; rats have unknown effects on these same two islands; Coatis depredate adults and chicks on Robinson Crusoe, albeit at reduced numbers over historical ones; dogs take adults and chicks on Mocha Island. Overall impacts of mammalian predation on shearwater population size are largely unknown. Annual predation-related mortality at monitored burrows ranged from 0–3% for adults and 0–20% for chicks, with mortality rates varying among colonies. Coatimundis were controlled in the 90s, but anecdotal evidence suggests they are rebounding on Robinson Crusoe (where about 20% of population nests). Dogs and cats also exacerbate light attraction mortality (see 9.6 below).
8.2	Problematic native species		Unknown	Unknown	Unknown	High (Continuing)	Species could be affected by harmful algal bloom events. These are naturally-occurring events, but thought to be increasing in frequency as a result of eutrophication and perhaps climate change. However, mostly near-shore so may not directly affect shearwaters, but could affect their food supplies near nesting colonies. Mocha Is. is not far offshore, and is in the same area as Chiloe Is., which has been in the news lately because of HABs http://www.theguardian.com/world/2016/may/17/chile-red-tide-salmon-farming-neurotoxin
8.3	Introduced genetic material						
9	Pollution	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Household sewage & urban waste water						Species doesn't forage in nearshore wastewater output areas
9.2	Industrial & military effluents	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Threat of oil spills (both chronic discharges and severe spills) is ongoing and increasing, especially in non-breeding areas. Species occurs in flocks on water so could be hit hard by a catastrophic spill. No shoreline monitoring for oiled birds in Chile.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Impacts of plastic ingestion are unknown but ongoing. Extensive presence of microplastic particles in seawater in Strait of Georgia and Queen Charlotte Strait {see Harbour Porpoise report). No evidence that plastic kills individuals directly, but probably a contributing factor. Microplastics could be endocrine disruptors and vectors for contaminants (e.g., PCBs). Plastics could also be transferred to chicks. 19/20 birds killed via light attraction on Robinson Crusoe Island contained plastic.
9.5	Air-borne pollutants		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Mercury found in shearwater tissues presumably from an international airborne source, as are PCBs. Not known whether there are population-level impacts
9.6	Excess energy		Negligible	Pervasive (71-100%)	Negligible (<1%)	High (Continuing)	A couple of hundred birds per year are affected in town on Robinson Crusoe Is with 35-50 dead birds/y (adults and fledglings) from direct collision, or non-fatal collision followed by cat/dog predation. Not a problem on Santa Clara or Mocha islands. Primarily street lights, sports fields. Offshore oil/gas platforms and ships throughout whole range of the species could be a threat for collision mortality, but magnitude unknown.
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						A tsunami caused human fatalities on Robinson Crusoe Is in 2010. However, probably not a threat, because colonies are high up from coast, and out of reach of tsunamis.
10.3	Avalanches/landslides						
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Could be higher in the future.
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Shifts in marine habitat will doubtless affect such a wide-ranging species, but effects are unknown. Species has likely evolved to adjust foraging efforts to take such variability into account.
11.2	Droughts						Could affect forest composition in long term, but beyond scope of 10-yr window.
11.3	Temperature extremes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Storms are an issue on Santa Clara, threatening erosion and resulting burrow loss for at least 50% of breeding population there. Other sites are affected, but to a much lesser degree.