Agreement on the Conservation of Albatrosses and Petrels

Third Meeting of the Parties

Bergen, Norway, 27 April – 1 May 2009

Species Information – Laysan Albatross (*Phoebastria immutabilis*)

USA

Laysan Albatross
Phoebastria immutabilis

Albatros de Laysan
Mōlī (Hawaiian)

CRITICALLY ENDANGERED	ENDANGERED	VULNERABLE	NEAR THREATENED	LEAST CONCERN	NOT LISTED

Sometimes referred to as
gooney, white gooney

TAXONOMY
Order: Procellariiformes
Family: Diomedeidae
Genus: *Phoebastria*
Species: *immutabilis*

Originally described as *Diomedea immutabilis* (Rothschild 1893), the American Ornithologist's Union (AOU) temporarily placed the three north Pacific albatrosses in the subgenus *Phoebastria* [1, 2]. Genetic analysis supported the former designation of the genus *Phoebastria* [3], a classification that was subsequently adopted by the AOU [4]. There are no recognized subspecies [5]. *P. immutabilis* and *P. nigripes* do hybridize but there is no evidence for successful breeding by a hybrid [5].

CONSERVATION LISTINGS AND PLANS

International
- 2007 IUCN Red List of Threatened Species – Vulnerable [6]
- Convention on Migratory Species - Listed in Appendix II (listed as *Diomedea immutabilis*) [7]
- USA - Canada Convention for the Protection of Migratory Birds [8]
- USA - Mexico Convention for the Protection of Migratory Birds and Game Mammals (family *Diomedeidae* listed) [9]
- USA - Japan Convention for the Protection of Migratory Birds and Birds in Danger of Extinction, and Their Environment (listed as *Diomedea immutabilis*) [10]
- USA - Russia Convention Concerning the Conservation of Migratory Birds and Their Environment (listed as *Diomedea immutabilis*) [11]
- Conservation Action Plan for Black-footed Albatross and Laysan Albatross [12]

National - Canada
- Migratory Bird Convention Act [13]
- National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries [14]

National - China
- Law of the People's Republic of China on the Protection of Wildlife [15]
- China Species Red List - Least Concern [16]

National - Japan
- Wildlife Protection and Hunting Law [17]
- Red Data Book of Japan (listed as *Diomedea immutabilis*) - Endangered [18]
- Japan's National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries [19]

National - Mexico

- Norma Oficial Mexicana NOM-059-ECOL-2001 - Listed as Amenazada (Threatened) [20]

National - Russia

- On the Protection and Use of Wild Animals [15]

National - United States of America

- Migratory Bird Treaty Act - Listed Migratory Bird [21]
- Bird of Conservation Concern [22]
- United States National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries [23]

Taiwan (Chinese Taipei)

- Taiwan National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries [24]

BREEDING BIOLOGY

Phoebastria immutabilis is a colonial, annual breeder but adults do skip breeding in some years [25, 26]. Adults return to the nesting islands in late-October to early-November, about 10–14 days later than *P. nigripes* [27]. Most eggs are laid from late-November through mid-December [26, 28] and hatch from mid- to late-January (Table 1) [26, 29]. Chicks fledge from late-June through July, when 155–165 days old [25, 26]. Juvenile birds return to the island at 2 to 4 years and may breed as early as 5 years of age, but most birds do not breed before they are 8–9 years old [30, 31].

Table 1. Breeding Cycle

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
At colonies												
Egg laying												
Incubating												
Chick provisioning												

BREEDING SITES

P. immutabilis breeds on oceanic islands across the tropical/subtropical North Pacific (Figure 1). The low coral islands of the Northwestern Hawaiian Islands (NWHI) are the core of the breeding range supporting >99% of the global nesting population (Tables 2 and 3). *P. immutabilis* also nests in the main Hawaiian Islands on Ni'ihau, Kaua'i, and O'ahu. During the 1980s, the breeding range expanded into the eastern Pacific with the establishment of colonies on Isla Guadalupe, Islas Revillagigedos (Clarión and San Benedicto), and Rocas Alijos, Mexico [32, 33]. *P. immutabilis* recolonized Torishima in the Mukojima Retto of the Ogasawara Islands in the 1970s [34], but they have not returned to nest at Torishima in the Izu Shoto since they were extirpated in the mid 1930s [35, 36]. Wake Atoll is another historical colony site and since 1996, a few pairs have nested sporadically, but 2001 was the only year in which a chick successfully fledged from this site [37]. *P. immutabilis* were extirpated from other islands in the central and western Pacific (Johnston Atoll and Minami Torishima), and have not recolonized those sites (Figure 1) [35, 36, 38]. The total breeding population was estimated at approximately 637,000 pairs in 2007 (Table 3).

Table 2. Distribution of the global *P. immutabilis* population among breeding range states.

	United States	Mexico	Japan
Breeding pairs	99%	<1%	<1%

Figure 1. The approximate range of *P. immutabilis* inferred from tracking, band recoveries, and shipboard surveys. The boundaries of Regional Fisheries Management Organizations (RFMOs) are also shown. (IATTC = Inter-American Tropical Tuna Commission, IPHC = International Pacific Halibut Commission, WCPFC = Western and Central Pacific Fisheries Commission).

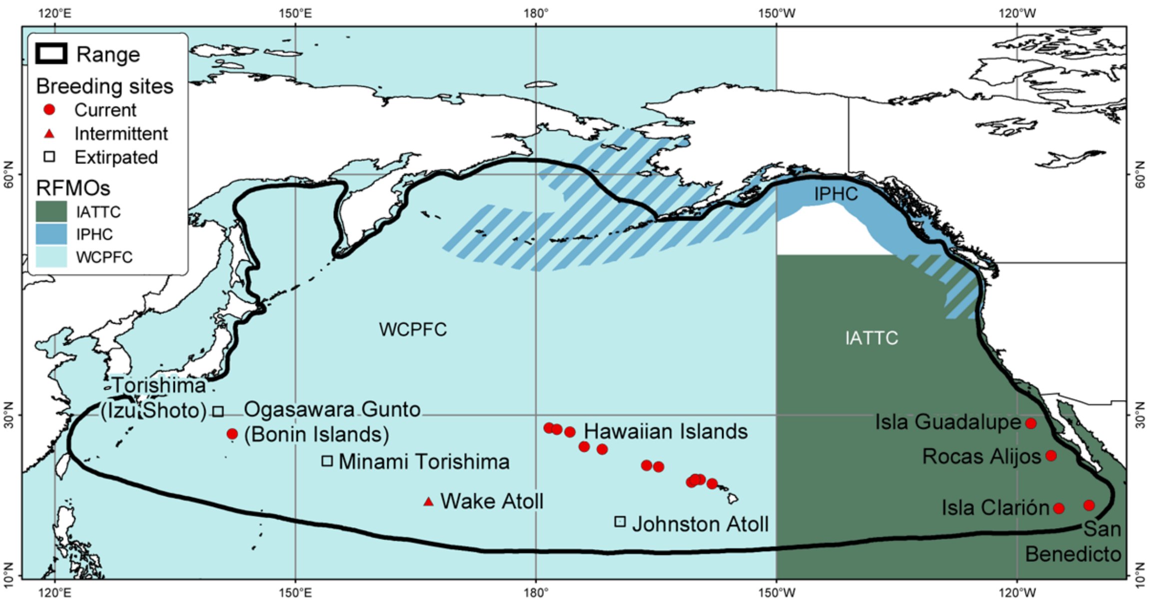


Table 3. Monitoring methods and estimates of colony size (annual breeding pairs) for active *P. immutabilis* breeding sites. Table based on unpublished data from U.S. Fish and Wildlife Service (Hawaii, except O'ahu); L. Young, University of Hawaii (O'ahu); A. Hebshi, Pacific Air Force (Wake); H. Hasegawa, Toho University (Torishima); T. Deguchi and N. Nakamura, Yamashina Institute for Ornithology (Ogasawaras); R. W. Henry, University of California, Santa Cruz (Guadalupe); Wanless and Angel, Island Conservation (Clarion); (San Benedicto & Alijos Rocks) [33] (see Glossary for monitoring method and reliability codes).

Breeding site location	Jurisdiction	Years monitored	Monitoring method	Monitoring reliability	Pairs (last census)	(Hatch Year)
Central Pacific						
Hawaii						
Kure Atoll 23°03′ N, 161°56′ W	USA	2003–2007	B	Mod	14,600[1]	(2007)
Midway Atoll 28°15′ N, 177°20′ W	USA	1991–2007	A	High	452,600	(2008)
Pearl and Hermes Reef 27°50′ N, 175°50′ W	USA	opportunistic	B	Low	6,900[1]	(2003)
Lisianski Island 26°04′ N, 173°58′ W	USA	opportunistic	B	Low	26,500	(1982)
Laysan Island 25°46′ N, 171°45′ W	USA	1992–2007	A	Med	131,200	(2008)
French Frigate Shoals 23°145′ N, 66°10′ W	USA	1980–2007	A	High	3,900	(2007)
Necker Island 23°35′ N, 164°42′ W	USA	opportunistic	B	Low	500	(1995)
Nihoa Island 23°03′ N, 161°56′ W	USA	opportunistic	B	Low	0	(2007)
Kaula 21°39′ N, 160°32′ W	USA	opportunistic	B	Low	55[1]	(1993)
Lehua 22°01′ N, 160°06′ W	USA	opportunistic	A&B	Med	61	(2007)
Ni'ihau 21°54′ N, 160°10′ W	USA	NA			190	(2002)
Kaua'i 22°05′ N, 159°30′ W	USA	1982–2007	A	High	271	(2008)
O'ahu 21°28′ N, 157°59′ W	USA	2003–2007	A	High	65	(2008)
Marshall Islands						
Wake Atoll 19°18′ N, 166°35′ E	USA	opportunistic	A&B	Med	0[2]	(2008)
Western Pacific						
Ogasawara (Bonin) Islands						
Mukojima Retto 27°40'N, 142°07'E	Japan		B	High?	20[1]	(2006)
Eastern Pacific						
Isla Guadalupe 29°02′ N, 118°17′ W	Mexico	2003–2008	A&B	High	351	(2008)
Rocas Alijos 24°58′ N, 115°45′ W	Mexico	opportunistic			4	(2003)
Islas Revillagigedos						
San Benedicto 19°19′ N, 110°48′ W	Mexico	opportunistic			17	(2003)
Clarion 18°21′ N, 114°43′ W	Mexico	opportunistic	A	Med	46	(2003)
Total Pairs (rounded to nearest thousand)					**637,000**	

1. Estimate of breeding pairs based on a survey of chicks, adjusted for nest failure; 2. A single pair successfully nested on Wake Atoll in 2001 [37].

CONSERVATION LISTINGS AND PLANS FOR THE BREEDING SITES

International

Conservation Action Plan for Black-footed Albatross and Laysan Albatross [12]

Ogasawara Islands, Japan

- UNESCO World Heritage Site (tentative) [39]

Northwestern Hawaiian Islands, United States

- UNESCO World Heritage Site (tentative) [39]

National - Japan

Ogasawara Islands

- Ogasawara National Park [40, 41]

National - Mexico

Isla Guadalupe

- CONANP Biosphere Reserve [42]

Archipiélago de Revillagigedo

- CONANP Biosphere Reserve [42, 43]

National - United States

Hawaiian Islands

- Papahānaumokuākea Marine National Monument (encompassing Midway Atoll and Hawaiian Islands National Wildlife Refuges, and Kure Atoll Seabird Sanctuary) and Draft Management Plan [44]
- Kilauea Point National Wildlife Refuge, Kaua'i [45]
- Ka'ena Point Natural Area Reserve, O'ahu [46]
- Regional Seabird Conservation Plan, Pacific Region [45]

POPULATION TRENDS

Populations of all three North Pacific albatrosses were devastated by feather hunters around the turn of the 20th century [47] and many colonies, especially in the central and western Pacific were extirpated.

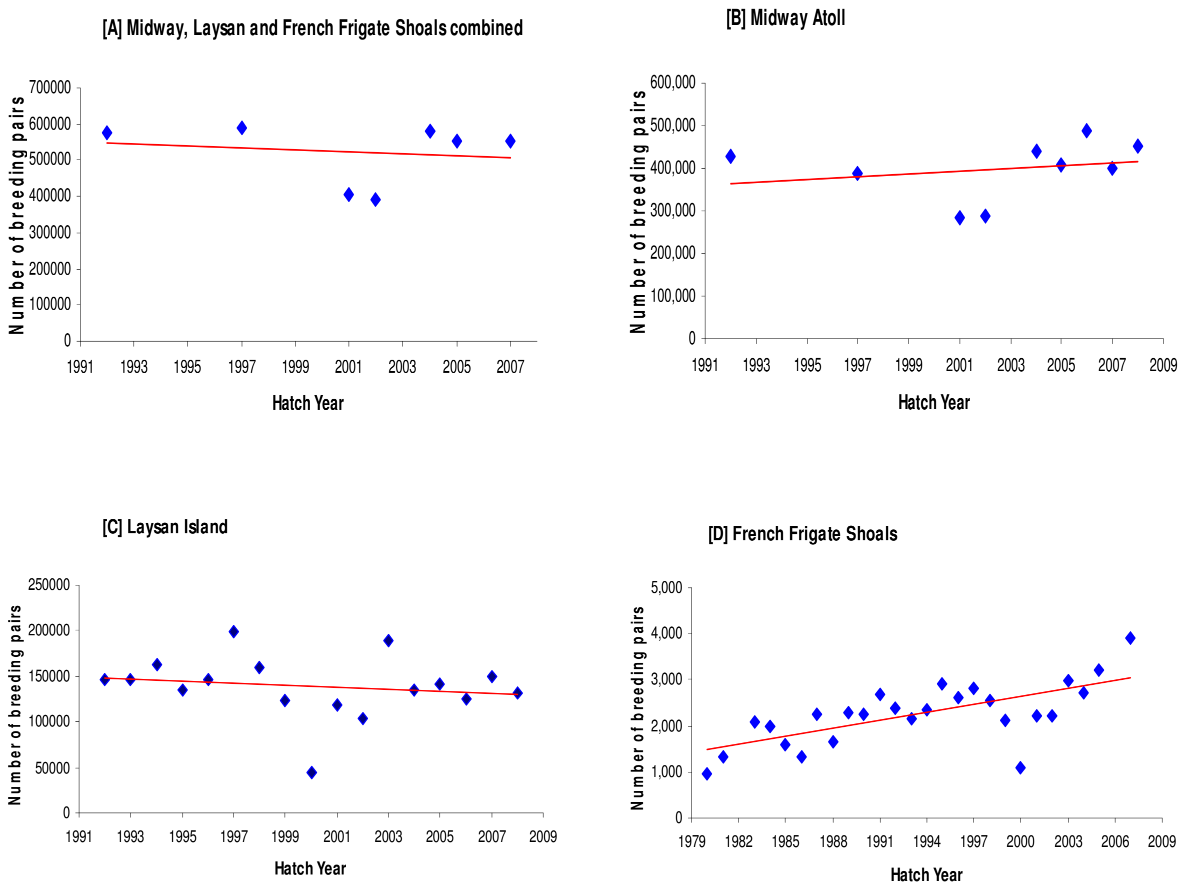
Northwestern Hawaiian Islands

In response to the destruction by feather hunters, the Hawaiian Islands Bird Reservation (later renamed the Hawaiian Islands National Wildlife Refuge) was established in 1909. The Reservation extended from Kure to Nihoa, but did not include Midway Atoll. It was unlawful to kill or molest the birds within the Reservation, but there was little enforcement and feather raids continued until at least 1915 [47,48]. Population estimates prior to these exploitations are extremely rare but estimates for Laysan Island alone, the largest known colony, were as high a two million birds [49]. If this estimate is reduced by 50% (to account for non-breeders on the colony), then perhaps as many as half a million pairs historically nested on Laysan Island.

Wetmore visited the NWHI during the late spring and summer of 1923, when nesting numbers were at their lowest level following years of feather hunting [50]. He estimated 11,500 breeding pairs for all of the NWHI colonies [35, 50] (approximately 18,000 pairs when adjusted for nest loss prior to the surveys [51]). Numbers of breeding birds increased following the cessation of the feather hunting, and by 1956–1958 approximately 280,000 pairs nested in the NWHI colonies [38]. The most recent estimate is approximately 637,000 pairs (Table 3). Current estimates of colony size at Laysan and Lisianski are comparable to estimates from 50 years ago, while estimates for Midway, Kure, and French Frigate Shoals (the three NWHI formerly occupied by the military) are significantly greater than 50 years ago [51].

Standardized counts of active nests have been conducted since 1980 at French Frigate Shoals and since 1991 and 1992 at Midway and Laysan, respectively [52]. Midway and Laysan are the world's largest *P. immutabilis* colonies, and together support more than 90% of the global breeding population (Table 3) [52]. The trend for the three islands combined is relatively stable or slightly decreasing (Table 4, Figure 2). There was dramatic decline in the number of nesting pairs at all three colonies from 1999–2002; however, nesting populations appear to have rebounded by 2004 (Figure 2).

Figure 2. Counts of *P. immutabilis* nests at three regularly monitored colonies in the Northwestern Hawaiian Islands [A] Midway, Laysan, and French Frigate Shoals (combined), [B] Midway Atoll, [C] Laysan Island, and [D] French Frigate Shoals, with a simple regression lines fitted. Figures generated from unpublished U.S. Fish and Wildlife Service data [52, 53].



Midway Atoll

Midway Atoll is the most altered of the NWHI, having sustained continuous human occupation for more than a century, starting with the U.S. Marines and Pacific Cable Company (1903–1952), Pan American Airlines (1935–1947), the U.S. Navy (1939–1997), and finally the U.S. Fish and Wildlife Service (1988–present) [54]. Initially, changes by island residents enhanced the habitat for albatross nesting but military activities during and after World War II (including base developments that led to loss and degradation of habitat, and large scale albatross control programs intended to increase the safety of aircraft operations), had a negative effect on the size of the albatross colonies [38, 55]. Conversely, military activities greatly increased the size of the islands, providing additional habitat for nesting [54]. Numbers of all nesting seabirds increased after Midway Atoll National Wildlife Refuge was established and overlaid on the Naval Air Station in 1988.

Today Midway hosts the world's largest *P. immutabilis* colony, which is estimated at 400,000–450,000 pairs, and represents approximately 71% of the global nesting population (Table 3). The highest count (487,527 nests) was obtained in 2006, and the lowest counts in recent years were in 2001 and 2002 when about 285,000 pairs nested (Figure 2). Nest counts are available for nine of the past 17 years, with a relatively stable to slightly increasing trend indicated (Table 4, Figure 2).

Table 4. Summary of population trend data for the regularly monitored *P. immutabilis* colonies. These data are based on counts of active nests from U.S. Fish and Wildlife Service (unpublished data) [52, 53].

Breeding Site	Current Monitoring	Trend Years	% average change per year [51] (95% Confidence Interval)	Trend
Laysan Island	Yes	1992 - 2008	- 0.85 (- 0.83, - 0.87)	Decreasing
Midway Island	Yes	1992 - 2008*	0.16 (0.14, 0.18)	Stable/Increasing
Fr. Frigate Shoals	Yes	1980 - 2007*	2.40 (2.28, 2.52)	Increasing
All Three Islands	Yes	1992 - 2008	- 0.13 (- 0.11, - 0.15)	Stable/Decreasing

* Missing data: Midway Island (1993-1996, 1998-2000, 2003); French Frigate Shoals (1982, 2006, 2008)

Laysan Island

Historically Laysan Island supported the largest *P. immutabilis* colony in the world [38]. Today, it is the second largest colony with approximately 20% of the global breeding population (Table 3). Estimates of the colony size over the past five years (125,000 to 150,000 pairs) are comparable to estimates from 1957 (130,000 pairs) [38]; however, the results from the standardized counts (1992–2008) indicate a slightly declining trend (Table 4).

French Frigate Shoals

French Frigate Shoals supports a relatively small number of nesting pairs (<1% of global); but it has the longest continuous time-series of population data, having been monitored annually since 1980 [52]. In 1957, during the period of military occupation, there were 1,500 pairs [38]. The number of breeding pairs has steadily increased since the military left French Frigate Shoals in 1979 and administration of the island was transferred to USFWS (Figure 2, Table 4). The 2007 count of 3,900 pairs was the highest census result on record [52].

BREEDING SITES: THREATS

By 1997, the military had closed its bases on Kure, Midway, and French Frigate Shoals and management of the islands had been transferred to state and federal wildlife agencies. Many of the threats to the NWHI colonies have been addressed through management actions[45]. All introduced mammals, except house mice (*Mus musculus*) on Midway, were eradicated from the NWHI. Polynesian rats (*Rattus exulans*) were eradicated from Kure in 1993, as were black rats (*R. rattus*) from Midway in 1997. Non-native plants such as golden crown-beard (*Verbesina encelioides*) and ironwood (*Casuarina equisetifolia*) have degraded nesting habitat for albatrosses at Kure, Midway, and Pearl and Hermes Reef. *Verbesina* forms dense stands that limit available nesting habitat. The USFWS is actively working to control or eradicate this invasive species but this is a long-term and costly endeavor [12, 45]. Mosquitoes were introduced, and are now established, at Midway Atoll and the main Hawaiian Islands, where they serve as vectors for avian pox [45, 56]. *P. immutabilis* chicks are afflicted with the disease however, it does not appear to affect reproductive success in this species [56]. Lead poisoning (from lead paint on old buildings) may affect up to 5% of *P. immutabilis* chicks on Midway Atoll [12, 57] and the USFWS continues efforts to reduce these impacts. Finally, potential sea level rise is a threat to the low-lying islands and atolls of the NWHI and central Pacific [12].

Outside of the NWHI, an eradication program for feral cats (*Felis catus*) at Wake Atoll appears to have been successful, but black rats and Asian rats (*R. tanezumi*) remain a threat at this site [37]. Polynesian rats are present on Lehua and black rats on Kaula. Goats (*Capra hircus*) significantly altered and degraded habitat on Isla Guadalupe before a successful eradication program was initiated in 2004 [58]. Feral cats were likely responsible for the extinction of the Guadalupe storm-petrel (*Oceanodroma macrodactyla*) [59] and they remain a major threat to nesting albatrosses and limit expansion of the colony. Eradication programs have been considered or are planned for mammalian predators at all of the sites discussed above. Predator eradication is not a viable option in the Main Hawaiian Islands, where a suite of predators, including feral cats and dogs (*Canis lupus familiaris*), and rats threaten nesting albatrosses [12, 46]. Fences and predator control programs are the primary means for controlling introduced predators at these sites. Non-native predators may be a factor inhibiting recolonization at some historical sites. Military training exercises at Kaula Rock may be affecting this small colony [12].

Table 6. Summary of known threats at the breeding sites of *P. immutabilis*. Table based on unpublished data and input from J. Klavitter, E. Flint, and B. Zaun, U.S. Fish and Wildlife Service (Hawaii, except O'ahu); L. Young, University of Hawaii (O'ahu); A. Hebshi, Pacific Air Force and M. Rauzon, Marine Endeavors (Wake); N. Nakamura, Yamashina Institute for Ornithology (Japanese Islands); and, B. Tershy and R. W. Henry, University of California, Santa Cruz (Mexico). (see Glossary for codes).

Breeding site location	Human disturbance	Human take	Natural Disaster	Sea level rise	Habitat alteration (human)	Habitat alteration (alien species)	Predation (alien species)	Increased impact by native species	Contamination
Central Pacific									
Kure Atoll	No	No	No	Low	Low	Yes	No	No	Unk
Midway Atoll	Low	No	No	Low	Yes	Yes	No	No	Low
Pearl and Hermes Reef	No	No	No	Low	No	Yes	No	No	No
Lisianski Island	No	No	No	Low	No	Yes	No	No	No
Laysan Island	No	No	No	Low	No	Yes	No	No	No
French Frigate Shoals	No	No	No	Low	Yes	Yes	No	No	No
Necker Island	No	No	No	No	No	Yes	No	No	No
Nihoa Island	No	No	No	No	No	Yes	No	No	No
Kaula	Med	No	No	No	Yes	Yes	Yes	No	No
Lehua	No	No	No	No	No	Yes	Yes	No	No
Kaua'i	Yes	No	No	No	No	Yes	Yes	No	No
O'ahu	No	No	No	No	No	No	Yes	No	No
Johnston Atoll	No	No	No	Low	Yes	Yes	No	No	Unk
Wake Atoll	Low	No	Low	Low	Low	Low	Low	No	Unk
Western Pacific									
Torishima (Izu Shoto)	No	No	High	No	No	Unk	No	No	No
Mukojima Retto	No	No	No	No	No		No		
Eastern Pacific									
Isla Guadalupe	Low	No	No	No	No	No	Yes	No	No
San Benedicto	No	No	Low	No	No	No	No	Unk	Unk
Clarion	Med	No	No	No	No	High	No	Unk	Unk
Rocas Alijos	No	No	Low	Low	No	No	No	No	Unk

MARINE DISTRIBUTION

P. immutabilis ranges over most of the North Pacific, from the Bering Sea (approximately 62ºN) and the Sea of Okhotsk south to the Hawaiian Islands. In the eastern and central North Pacific, the 'normal' southern boundary is most likely around 15ºN [60] (Figure 1). However, *P. immutabilis* has been observed on several occasions in the southern hemisphere, to at least 37ºS [35]. The species occurs throughout international waters and within the Exclusive Economic Zones (EEZs) of Mexico, the United States, Canada, Russia, Japan, China, North and South Korea, the Federated States of Micronesia, and the Republic of the Marshall Islands [12].

Based upon satellite-tagged birds captured in the central Aleutian Islands, this species remains largely north of 45ºN and west of the International Date Line; in contrast, *P. nigripes* was observed to travel much further south of 45ºN and remain almost entirely east of the International Date Line [61]. *P. immutabilis* is abundant off Japan, and is particularly known for its use of the Kuroshio-Oyashio Extension [62, 63, 64, 65, 66]. Many young birds spend their first summer between 40ºN and 45ºN from Japan east to at least 172ºW [64, 66]. Over the next few summers the average center of the population (of subadults) shifts east-northeast to the adult summering area south of the Aleutian Islands (between 170º E and the International Date Line) [67]. Although most birds remain within the North Pacific Transition Domain or cooler waters [61], the southern limit of where most *P. immutabilis* occur appears to coincide with the northern edge of the westward flowing North Equatorial Current, west of the Hawaiian chain; and with the northern limit of the North Pacific Equatorial Waters, between Hawaii and Central America [62].

Where sympatric, *P. immutabilis* uses a narrower range of marine habitats than the *P. nigripes* with *P. immutabilis* strongly associating with nutrient-rich oceanic waters, and seldom visiting waters low in chlorophyll concentration [62, 68,69]. The differences in spatial distribution between these two albatross species have been noted by others [70, 71, 67, 69]. Although regularly found over the middle continental shelf in the northern Gulf of Alaska [72]; elsewhere, *P. immutabilis* seldom frequents shelf waters [73, 74].

Based upon satellite-tracked birds from the Hawaiian colonies during the breeding season, the at-sea range of *P. immutabilis* overlaps almost exclusively with the Western and Central Pacific Fisheries Commission (WCPFC) area [69], and to a much lesser extent with International Pacific Halibut Commission (IPHC) waters (Figure 1 and 3). However, other data indicates that birds nesting on Tern Island will forage as far east as 125°W (primarily north of 40°N) [65, 75] but the distribution depends highly on the phase of breeding [69]. Birds tracked during the breeding season from Isla Guadalupe overlapped almost exclusive with IATTC waters, and mostly north of 25°N (Figure 1 and 3). Birds tracked during the non-breeding season, overlapped extensively with WCPFC waters [69], and to a lesser extent with the IPHC area (Figure 1 and 4).

Figure 3. Tracking data for breeding adult P. immutabilis. Map based on data contributed to BirdLife Global Procellariiform Tracking Database by: S. Shaffer, M. Kappes, Y. Tremblay, D. Costa, R. Henry, D. Croll (University of California Santa Cruz) and D. Anderson, J. Awkerman (Wake Forest University).

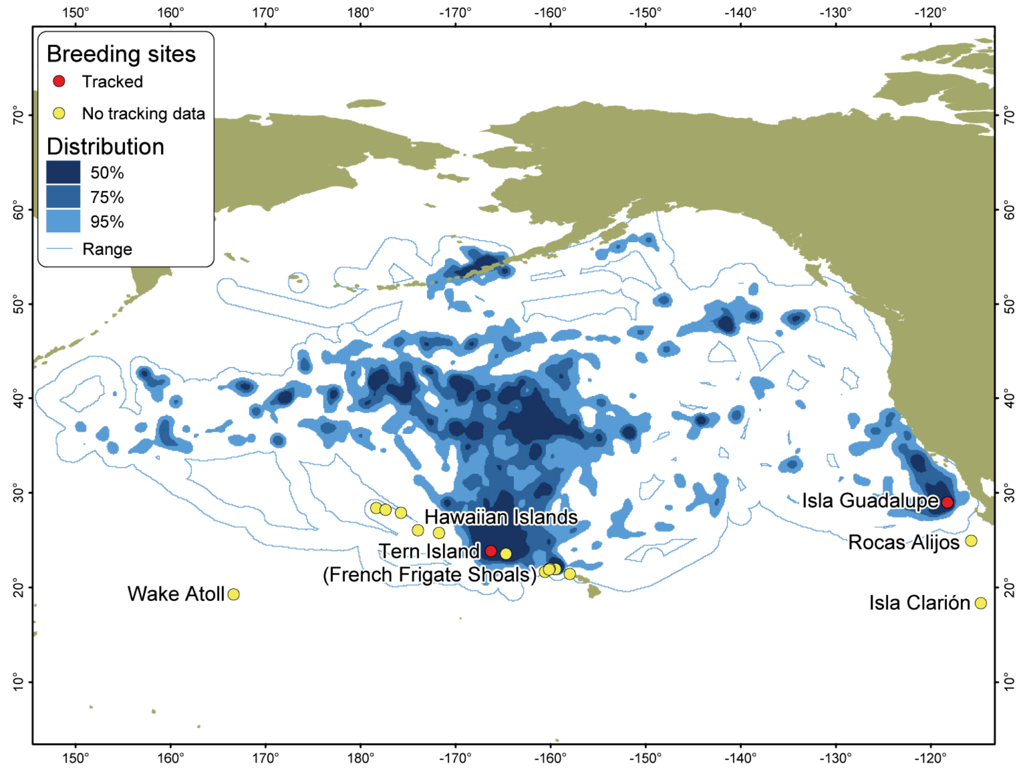
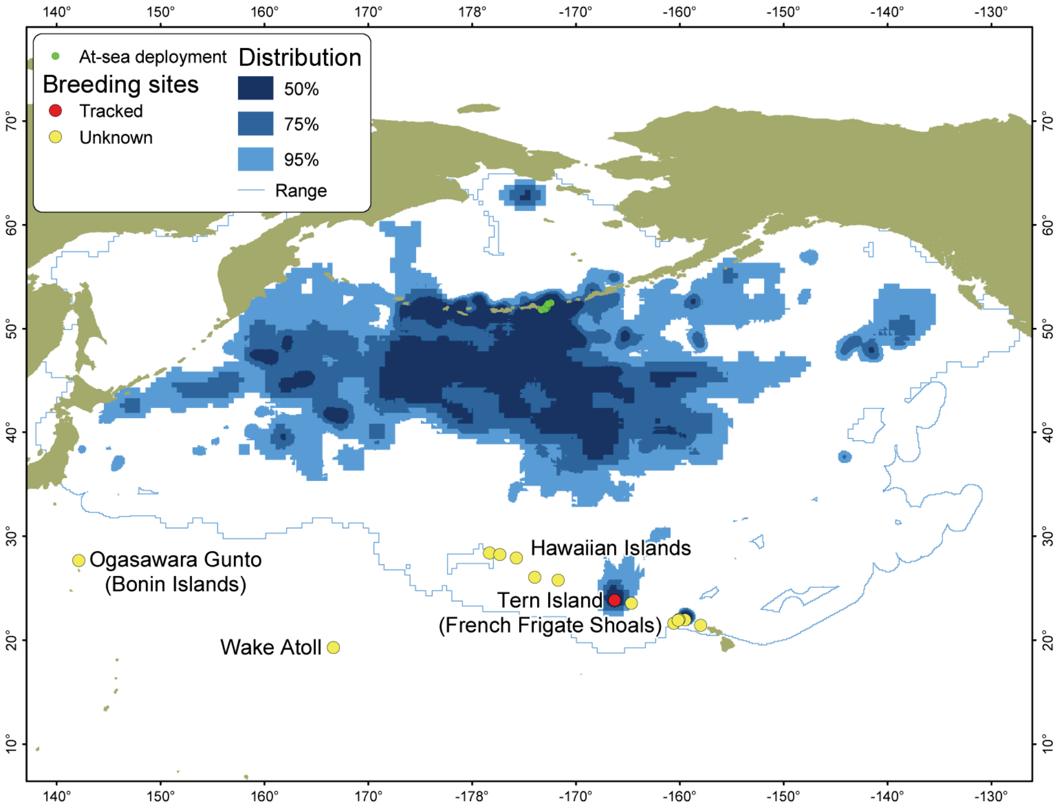


Figure 4. Tracking data from non-breeding adults and fledgling P. immutabilis. Map based on data contributed to BirdLife Global Procellariiform Tracking Database by: S. Shaffer, M. Kappes, Y. Tremblay, D. Costa, R. Henry, D. Croll (University of California Santa Cruz) and D. Anderson, J. Awkerman (Wake Forest University); and R. Suryan, K. Fischer (Oregon State University); and G. Balogh (U.S. Fish and Wildlife Service)



FORAGING ECOLOGY AND DIET

P. immutabilis generally forages singly, although large flocks (100's) will occasionally form when feeding on fisheries discards. They feed by surface-seizing and scavenging [5]. The majority of diet information comes from three sources: regurgitated samples collected during the chick-feeding stage from Hawaiian colonies (1978–1980) [76]; stomach samples collected from birds killed in driftnet fisheries (primarily between 35° and 46°N and from 145°W to 145°E) [77]; and regurgitated pellets collected on Isla Guadalupe at the end of the 1999–2000 breeding season [33]. Based upon their diet and levels of rhodopsin in their eyes, it was postulated that *P. immutabilis* feeds on vertically migrating squid at night, when they are near the surface [76]; however, most prey are captured during the day [78].

Summarizing chick diet information from Hawaii, oil constituted about 10% of the stomach volume. When oil was excluded, the chick diet consisted of approximately 65% squids, 9% fishes, 9% crustaceans, and 4% coelenterates [76]. Flying squids (*Ommastrephidae*), flying fishes (including eggs, *Cypselurus* sp.), by-the-wind-sailors (*Vellela vellela*), and mysids (*Gnathophausia gigas* and *G. ingens)* were the most important prey identified; however, due to the poor condition of the samples, less than 6% of the squids could be identified. Pacific sauries (*Cololabis saira)* were also consumed (as fishes and as egg masses) [76].

In Mexico, cephalopods represented 99.7% of the prey items; the remainder included two hagfish (*Eptatretus* spp.) and an unidentified teleost. More than 97% of the squid beaks were identified; and many families including *Cranchiidae* (32% of the total number of beaks), *Histioteuthidae* (27%), and *Gonatidae* (20%) were represented, but not *Ommastrephidae* [33]. The absence of *Ommastrephidae* from the Mexican colony suggested that either the Hawaiian samples had reflected the diet of birds that had scavenged from North Pacific driftnets; or that Hawaiian birds foraged in different regions than birds from Mexico, as supported by satellite tracking data. The deep-water squids identified in the Mexican study may have been scavenged after they had died and floated to the surface [33].

P. immutabilis scavenged extensively on North Pacific driftnet fisheries (1978–1992) [77], where they frequently became entangled in nets and were killed in high numbers [79]. The main food items identified were neon flying squids (*Ommastrephes bartrami*, 68% by mass), and Pacific pomfrets (*Brama japonica*, 14%). Other prey items (assumed captured away from the nets) included myctophids (*Electrona risso, Symbolophorus californiense, Lampanyctus jordani*) and Pacific sauries; all occurring in excess of 5% of the samples [77].

MARINE THREATS

Fisheries bycatch is a noted source of mortality for *P. immutabilis* in the North Pacific Ocean [6, 51]. The development of pelagic longline fisheries for tuna and billfish in the early 1950s, and the pelagic driftnet fishery in the late 1970s added a new mortality source for the species [51]. *P. immutabilis* preyed heavily on food made available by driftnet fishing operations and an estimated 17,500 were killed in these high seas squid and large-mesh driftnet fisheries in 1990 [80]. The large number of seabirds and other marine animals caught by driftnets caused the fishery to close in 1992 (resulting from a United Nations high-seas driftnet moratorium, UNGA Resolution 46/215) [81]. The fishery closure resulted in a significant reduction of the overall number of *P. immutabilis* killed [51].

In contrast to the now inactive high seas driftnet fishery, pelagic longline fisheries continue to threaten Pacific albatrosses. Currently, pelagic longline fisheries in the North Pacific are considered the primary threat to *P. immutabilis* [82, 51]. Fleets from the United States, Japan, Korea, and Taiwan operate in the North Pacific [83] and albatrosses have likely been incidentally killed in this fishery since at least 1951 [51]. The total impact of the pelagic longline fisheries on *P. immutabilis* will only be known once seabird bycatch data becomes available for all fisheries incurring bycatch mortality.

Reliable estimates of the number of albatrosses killed annually as a result of fisheries interactions are difficult to determine because of the paucity of data from most fisheries. Bycatch numbers have been estimated from data that are available for a relatively small subset of the North Pacific fisheries: high seas driftnet (international), pelagic longline (USA), and demersal longline (Canada, USA) [51] and trawl (USA).

Arata et al. [51] compiled the existing bycatch information and estimated annual bycatch for the period from 1951 to 2005. Overall, they estimated the rate of bycatch of *P. immutabilis* was typically less than 10,000 albatrosses/year, but during the period of high seas driftnet fishing (1978 to 1992), the rate increased substantially to a maximum of 27,800 albatrosses/year.

In recent years, U.S. North Pacific longline fleets have implemented seabird deterrence measures that have reduced seabird bycatch in longline gear. The bycatch of *P. immutabilis* in the Hawaii-based pelagic longline fishery has decreased from over 1,000 birds taken annually in 1999 and 2000 to less than 100 in 2007 [85]. The average annual bycatch estimate for other fisheries (trawl and demersal longline) off Alaska, from 2002 through 2006, was less than 150 birds [86]. Bycatch rates in the halibut fishery are unknown.

Taiwan's first reports of estimated seabird bycatch in its longline fisheries in the Pacific Ocean, based on observer trips from 2002 to 2006, indicate an area with one of the highest bycatch rates occurred between 25 to 40°N [87], where the bycatch sample consisted of *P. nigripes* and *P. immutabilis* [88]. Bycatch of *P. immutabilis* from the Isla Guadalupe colony has been documented from the longline shark fishery and preliminary data analysis suggests relatively high levels of bycatch may be occurring [58, 84].

High levels of organochlorine contaminants [89, 90, 91, 92] and mercury [93] have been documented in *P. immutabilis*. Mean PCB levels were one or two orders of magnitude higher than those of southern albatrosses, but lower than levels found in *P. nigripes* [91]. Concentrations of PCBs and DDE in both *P. nigripes* and *P. immutabilis* have increased over the last decade [93]. Diet is thought to be the primary route of exposure [93].

Over the past 30 years, there have been several oil spills in the vicinity of the large albatross colonies in the NWHI [94]. Oiled albatrosses have been recorded at the colonies but the number of affected birds is relatively small and the source of the oil is unknown [95]. Given the vast at-sea distribution of both species, they could be encountering oil anywhere in the North Pacific. Analysis of oil from Isla Guadalupe birds oiled during tracking studies, indicate that at sea dumping of bilge waste in shipping lanes is responsible for some of the observed oiling [58].

North Pacific albatrosses ingest a wide variety of plastics and there have been several studies investigating the effects of plastic ingestion by *P. immutabilis* chicks [96, 97, 98]. Ingested plastics can cause death of a bird by perforating the digestive tract, but most of these studies have not been able to show conclusively that plastic ingestion is a significant source of direct mortality [96, 97]. However, ingested plastics may be a contributing factor to other causes of mortality. In a summary of the work of many researchers, starvation, suppressed appetite and reduced growth, decreased fat accumulation, lower fledging weight gut obstruction, and increased susceptibility to dehydration and lead poisoning were listed as possible effects of ingested plastic [98].

KEY GAPS IN SPECIES ASSESSMENT

Standardized counts at Midway, Laysan, and French Frigate Shoals provide an accurate reflection of the annual breeding effort at these colonies. Other colonies in the NWHI are surveyed opportunistically, usually late in the season, and assessing trends for colony size are compromised by nest loss prior to the counts. Standardized, early season counts of colonies at Kure, Pearl and Hermes Reef, and Lisianski, at c.10 year intervals, would provide valuable data for all of the large NWHI colonies (>99% of the breeding population). Regular monitoring of recently recolonized and range expansion colonies in Japan and Mexico, is also important.

Because a proportion of adults skip breeding in a given year and inter-annual variability in the number of breeding pairs is high, population trends can be difficult to document from colony counts, alone. In addition, juvenile mortality will not be reflected in colony counts for 5–15 years. There is a need for targeted, standardized, documented data collection to monitor demographic parameters such as annual survival rates and frequency of breeding, in addition to estimates of colony size. These data will facilitate efforts by modelers to assess the relative impacts of all sources of mortality. To address this need, USFWS initiated a new monitoring program in 2005, that will provide annual estimates of adult survival, the proportion of adults nesting in a given year, and reproductive success. U.S. Geological Survey (USGS) and USFWS are conducting a status assessment for both *P. immutabilis* and *P. nigripes* [49], which needs to be finalized so that these data are available.

Currently, fisheries bycatch is the greatest known source of mortality for *P. immutabilis*, yet only a small fraction of the nations' commercial fleets fishing in the North Pacific monitor and report seabird bycatch. Characterization of the North Pacific fishing fleets (*e.g.,* gear, vessel size/configuration, target species, spatial/temporal distribution of effort, type of bycatch monitoring, mitigation required/used, and management authority) and bycatch monitoring for all fleets that potentially catch albatrosses, is needed.

In order to effectively protect *P. immutabilis*, there is a recognized need to integrate at-sea survey results with satellite and GPS tracking data, to derive a more complete understanding of its spatio-temporal use of the North Pacific Ocean [12]. Through the integration of all marine distributional data, associations with oceanographic features could be characterized and mapped at a basin-wide level. These maps, overlaid with seasonal fishing effort data, would provide range states with valuable tools to identify high-risk areas and high-risk fisheries.

Considerable data on habitat utilization at-sea have been collected over the past three to four decades by ships of opportunity, and in more recent years via satellite and GPS tracking. Most of the tracking data for breeding and non-breeding birds have been obtained from the small colonies of Tern Island (French Frigate Shoals) and Isla Guadalupe (Figure 3). Results indicate significant differences in the at-sea distribution of birds from these two colonies [75]. Tracking birds from the largest colonies (Midway and Laysan), could provide valuable insight into colony specific foraging distribution for core population centers of this species. Also, although some recent information exists for fledglings from Midway Atoll [99], greater characterization of the distribution, movement patterns, and habitat use by fledgling albatrosses is needed.

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