

Seabirds

Kaylene E. Keller¹, Angela D. Anders², Scott A. Shaffer³, Michelle A. Kappes³, Beth Flint⁴ and Alan Friedlander^{5,6}

INTRODUCTION

The Northwestern Hawaiian Islands (NWHI) provide habitat for an estimated 5.5 million nesting seabirds representing 22 different species (see Figures 7.1 and 7.2 and Fefer et al., 1984). For many of these species, the Monument provides the majority of available nesting habitat. Nesting occurs throughout the year, varying by species and within species, and by annual food availability (Harrison, 1990). The largest breeding populations occur at Midway Atoll, Laysan Island and Nihoa (USFWS, 2005). While the Monument protects seabird breeding and nesting habitat, the foraging ranges for most of these species extend beyond the Monument's boundaries, with foraging distances ranging from 3 km to several thousand kilometers (e.g., Fernández et al., 2001). Some seabird species occur year-round in the Monument, while others migrate to other parts of the Pacific when not breeding. Juvenile birds may also remain at sea for several years before returning to their breeding colonies inside Monument water. Overall, the NWHI provide high-quality breeding habitat, with low predation risk and low disturbance conditions (Table 7.1).

The distribution of seabirds within the Monument reflects, to some extent, the nesting habitat currently available on the islands (Tables 7.2 and 7.3). Nesting distribution has also been affected by human disturbance in the late 19th and 20th centuries, including egg and feather hunting, and destruction of habitat due to military activities during and after World War II. For example, populations of many of the seabird species on Laysan Island are likely still recovering after the devegetation of the island by guano miners and hunter-introduced feral rabbits in the early 1900s (Ely and Clapp, 1973). Further habitat losses have occurred from the introduction of non-native plants like golden crown-beard (*Verbisena encelioides*) and rodent pests like rats and mice. Numbers of nesting adults of some species are also still increasing on Tern and East Islands at French Frigate Shoals after the decommissioning of Naval and Coast Guard stations following World War II (Amerson, 1971).



Figure 7.1. A Red-footed Booby. Red-footed Boobies nest on all islands and atolls in the NWHI. Photo: J. Watt.



Figure 7.2. Brown Noddy Terns and Brown Boobies at Pearl and Hermes Atoll. Photo J. Watt.

1. NOAA/NOS/ONMS/Papahānaumokuākea Marine National Monument
2. Clancy Environmental Consultants, Inc.
3. University of California Santa Cruz
4. U.S. Fish and Wildlife Service
5. NOAA/NOS/NCCOS/CCMA Biogeography Branch
6. The Oceanic Institute

Table 7.1. Life history and management information for selected seabirds of the NWHI. Source: USFWS, unpub. data.

				BREEDING PERIOD							FEEDING BEHAVIOR		ESTIMATED FORAGING RANGE FROM COLONIES		
Common Name	Protection Status	IUCN	ESA	Primary Months of Presence	Months When Breeding		Fish	Fish Eggs	Cephalopods (squid, octopus)	Ephemeroids (krill)	Crustaceans	Feeding Habits	Feeding Activity	Distance	Source
					Eggs	Chicks									
Procellariiformes (Albatrosses, Petrels and Shearwaters)															
Laysan Albatross	Highly Imperiled and High Concern	VU A4bd		Nov - Jul	Nov-Feb	Jan-Jul	X	X	X			Surface feeding	Nocturnal	1,000 km	
Black-footed Albatross	Highly Imperiled and High Concern	EN A3bd		Oct - Jul	Oct-Feb	Jan-Jul	X	X	X			Surface feeding	Diurnal	700 km	
Short-tailed Albatross		VU D2	Endangered	Nov - Feb	Oct-Jan	Jan-Jun	X	X	X			Surface feeding	Diurnal	Unknown	
Bonin Petrel	Moderate Concern	LC		Aug - Jun	Jan-March	Feb-Jun	X	X	X		X	Surface feeding	Nocturnal	Unknown	
Bulwer's Petrel	Moderate Concern	LC		Apr - Oct	May-Jul	Jul-Oct	X	X	X		X	Surface feeding	Nocturnal	Unknown	
Wedge-tailed Shearwater	Low or Not Currently at Risk	LC		May - Dec	May-Aug	Aug-Dec	X	X	X			Contact dipping / associated with large predatory fish	Diurnal	480 km	
Christmas Shearwater	Highly Imperiled and High Concern	LC		Feb - Oct	April-Jul	Jun-Oct	X		X			Contact dipping and plunging / associated with large predatory fish	Nocturnal	Unknown	
Tristram's Storm-Petrel	Highly Imperiled and High Concern	NT		Oct - May	Dec-Feb	Feb-May	X		X			Surface feeding	Nocturnal	Unknown	
Pelecaniformes (Tropicbirds, Boobies and Frigatebirds)															
Red-footed Booby	Low or Not Currently at Risk	LC		Jan - Dec	Jan - Aug	Mar - Dec	X		X			Plunge diving / associated with large predatory fish	Diurnal	276 km	Flint
Masked Booby	Moderate Concern	LC		Dec - Oct	Jan - Jul	Mar - Oct	X		X			Plunge diving / associated with large predatory fish	Diurnal	158 km	Flint
Brown Booby	Moderate Concern	LC		Jan - Oct	Feb - Aug	April - Oct	X		X			Plunge diving / associated with large predatory fish	Diurnal	80 km	USFWS, 2005
Great Frigatebird	Moderate Concern	LC		Jan - Dec	Feb - Jul	April - Nov	X		X			Surface feeding / associated with large predatory fish	Diurnal	612 km	Weimerskirch et al., 2004

Table 7.1 (Continued). Life history and management Information for selected seabirds of the NWHI. Source: USFWS, unpub. data.

				BREEDING PERIOD							FEEDING BEHAVIOR		ESTIMATED FORAGING RANGE FROM COLONIES	
Common Name	Protection Status	IUCN	ESA	Primary Months of Presence	Months When Breeding		Fish Eggs	Cephaopods (squid, octopus)	Ephausids (krill)	Crustaceans	Feeding Habits	Feeding Activity	Distance	Source
					Eggs	Chicks								
Lesser Frigatebird		LC		Feb - Jul	Feb - Jul		X	X			Surface feeding / associated with large predatory fish	Diurnal	Unknown	
Red-tailed Tropicbird	Moderate Concern	LC		Feb - Nov	Mar - Aug	April - Nov	X	X			Plunge diving	Diurnal	468 km	Flint
White-tailed Tropicbird		LC		Jan - Dec	Jan - Dec	Jan - Dec	X	X			Plunge diving	Diurnal	374 km	Flint
Charadriiformes (Terns and Noddies)														
Black Noddy	Moderate Concern	LC		year-around	Nov - Jun	Dec - Aug	X	X		X	Surface feeding / associated with large predatory fish	Diurnal	80 km	USFWS, 2005
Brown Noddy	Low or Not Currently at Risk	LC		year-around	Jan - Oct	Feb - Nov	X	X			Surface feeding / associated with large predatory fish	Diurnal	163 km	Flint
Blue Noddy	Highly Imperiled and High Concern	LC		year-around	Jan - May	Jan - Jun	X				Surface feeding	Diurnal	Near-shore	
White Tern	Moderate Concern	LC		year-around	Jan - Dec	Jan - Dec	X	X			Surface feeding / associated with large predatory fish	Diurnal	Near-shore	
Sooty Tern	Moderate Concern	LC		Mar - Sep	Mar - Jul	April - Sep	X	X			Surface feeding / associated with large predatory fish	Primarily nocturnal	740 km	Flint, 1991
Gray-backed Tern	Moderate Concern	LC		Feb - Oct	Feb - Aug	April - Oct	X	X	X	X	Surface feeding / associated with large predatory fish	Diurnal	370 km	USFWS, 2005
Little Tern	Moderate Concern	LC		Feb - Oct	Feb - Aug	April - Oct	X			X	Plunge diving	Diurnal	3 km	USFWS, 2005

[illegible]

Table 7.3. Distribution of seabirds in the Pacific, Main Hawaiian Islands (MHI) and the NWHI. Source: USFWS, 2005.

COMMON NAME	SCIENTIFIC NAME	NWHI	MHI	USPI
Procellariiformes (Albatrosses, Petrels and Shearwaters)				
Black-footed Albatross	<i>Phoebastria nigripes</i>	B	B	B
Laysan's Albatross	<i>Phoebastria immutabilis</i>	B	B	B
Short-tailed albatross	<i>Phoebastria albatrus</i>	b		
Hawaiian Petre	<i>Pterodroma sandwichensis</i>		B	
Herald Petrel	<i>Pterodroma arminjoniana</i>			B
Tahiti Petrel	<i>Pterodroma rostrata</i>			B
Bonin Petrel	<i>Pterodroma hypoleuca</i>	B	Ex	B
Phoenix Petrel	<i>Pterodroma alba</i>			Ex
Bulwer's Petrel	<i>Bulweria bulwerii</i>	B	B	B
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	B	B	B
Christmas Shearwater	<i>Puffinus nativitatis</i>	B	B	B
Newell's Shearwater	<i>Puffinus auricularis newelli</i>		B ¹	
Audobon's Shearwater	<i>Puffinus lherminieri</i>			B
Band-rumped Storm-Petrel	<i>Oceanodroma castro</i>		B	B
Black Storm-Petrel	<i>Oceanodroma melania</i>		B	
Tristram's Storm-Petrel	<i>Oceanodroma tristrami</i>	B		B
Polynesian Storm-Petrel	<i>Nesofregatta fuliginosa</i>			B
Pelecaniformes (Tropicbirds, Boobies and Frigatebirds)				
White-tailed Tropicbird	<i>Phaethon lepturus dorothea</i>	B	B	B
Red-tailed Tropicbird	<i>Phaethon rubricauda melanorhynchos</i>	B	B	B
Masked Booby	<i>Sula dactylatra personata</i>	B	B?	B
Brown Booby	<i>Sula leucogaster plotus</i>	B	B	B
Red-footed Booby	<i>Sula sula rubripes</i>	B	B	B
Great Frigatebird	<i>Fregata minor palmerstoni</i>	B	b	B
Lesser Frigatebird	<i>Fregata ariel ariel</i>			B
Charadriiformes (Terns and Noddies)				
Little Tern	<i>Sterna albifrons sinensis</i>	B		B
Gray-backed Tern	<i>Sterna lunata</i>	B	B?	B
Bridled Tern	<i>Sterna anaethetus</i>			B?
Sooty Tern	<i>Sterna fuscata oahuensis</i>	B	B?	B
Brown Noddy	<i>Anous stolidus pileatus</i>	B	B	B
Black Noddy	<i>Anous minutus marcus</i>	B	B	B
Blue Noddy	<i>Procelsterna cerulea saxatilis</i>	B	B?	B
White Tern	<i>Gygis alba alba</i>	B	B	B

Note: ¹Endemic**Abbreviations:** B = breeding; b = unsuccessful breeding attempts; B? = breeding suspected; Ex = extirpated breeders

PROCELLARIIFORMES (ALBATROSSES, PETRELS AND SHEARWATERS)

Laysan Albatross (*Phoebastria immutabilis*)

Laysan Albatrosses are a relatively small albatross species, with a body length of 79-81 cm, a wingspan of 195-203 cm, and a mean body mass of 2.4 kg (Whittow, 1993; Suryan et al. 2008; Figure 7.3). Like Black-footed Albatrosses (*P. nigripes*) and other Procellariiformes, males are slightly larger than females but feather plumage is identical for both sexes. Laysan Albatrosses have a white head, neck, and underparts, and sooty brown upper wings and trailing edges of under wings, and back. The legs, feet, and bill are pink but the bill also has a greenish tip (Whittow, 1993).

When breeding, Laysan Albatrosses nest on all of the islands and atolls of the NWHI chain, and at discrete colonies on Kauai and Oahu, Torishima Island, Japan (Kurata, 1978), and off of the west coast of Baja, Mexico (USFWS, 2005). A pair was also documented to have successfully bred on Wake Island in 2001 (USFWS, 2005; Figure 7.4). In the NWHI, egg laying and incubation are generally synchronous, occurring from November to January. Chicks are reared from late January to mid-July and fledge in mid to late July (USFWS, 2005). Most birds breed every year but will occasionally skip a breeding event (Fisher, 1976).

In the NWHI, predator control, including rat eradication, has reduced some of the threats to Laysan Albatrosses, but existing impacts to nesting habitat include the invasive wildflower golden crown-beard (*Verbesina encelioides*), other non-native plant species, obstacles to flying (USFWS, 2005), and lead toxicity in chicks at Midway from ingestion of lead paint chips from dilapidated buildings (Finkelstein et al., 2003). Threats at sea include the ingestion of marine debris (e.g., plastics), sea level rise and long-line bycatch (USFWS, 2005).

When at sea, tracking studies reveal that Laysan Albatrosses are found throughout the North Pacific (including the Bering Sea) but generally range between 30°N and 55°N (Harrison, 1987; Fernandez et al., 2001; Hyrenbach et al., 2002; Shaffer et al., 2005). During the incubation period, adults conduct foraging excursions lasting 10-30 days and may travel over 2,000 km from the nesting colony (Kappes et al., in review, Figures 7.4 and 7.5). Albatrosses studied across several consecutive years (2002-2006) show that habitat use changes across years (Figure 7.5) but the environmental cues that putatively influence foraging effort remain the same across



Figure 7.3. Laysan Albatross, Tern Island and French Frigate Shoals. Photo: C. Gregory.

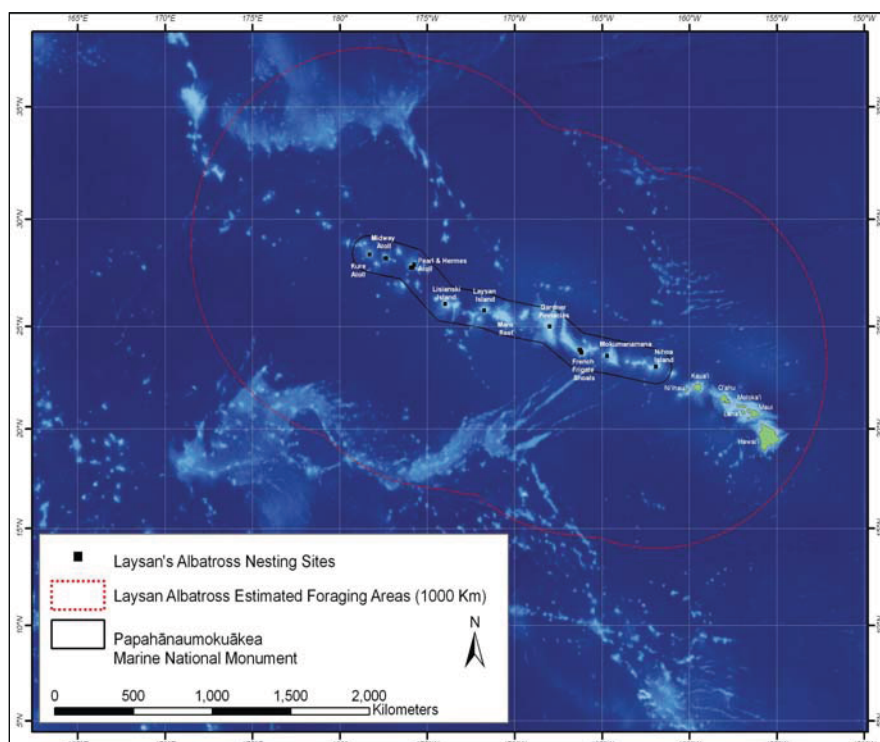


Figure 7.4. Laysan Albatross nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

years studied. That is, sea surface temperature (SST) and primary productivity levels appear to be the most important predictors of searching/foraging activity (Kappes et al., in review). During the chick-brooding period, adults are constrained by the need to provision their chick frequently so foraging excursions last only one to three days on average and range from the colony is typically less than 400 km (Kappes et al., unpublished data). When chicks are large enough to defend themselves and are thermally independent, both parents are able to forage simultaneously. During this period (i.e., chick-rearing), adults conduct both long and short duration foraging trips with some trips extending northward to the Aleutian Islands (Fernandez et al., 2001; Hyrenbach et al., 2002). When breeding is complete, adult Laysan Albatrosses depart the breeding colonies for cool waters of the Central and Western North Pacific including the Bering Sea and Aleutian Islands (Shaffer et al., submitted; Figure 7.5). Here, birds remain for most of the summer months while undergoing molt and recovering from breeding. Albatrosses return to the colonies in mid- to late-November to breed again. It is important to note the this species has only been tracked from a few of their breeding colonies, thus at sea distribution is not fully characterized. Laysan Albatrosses are surface feeders, with a diet consisting of squid, crustaceans, fish and flying fish eggs. At least 50% of the diet is composed of squid (USFWS, 2005).

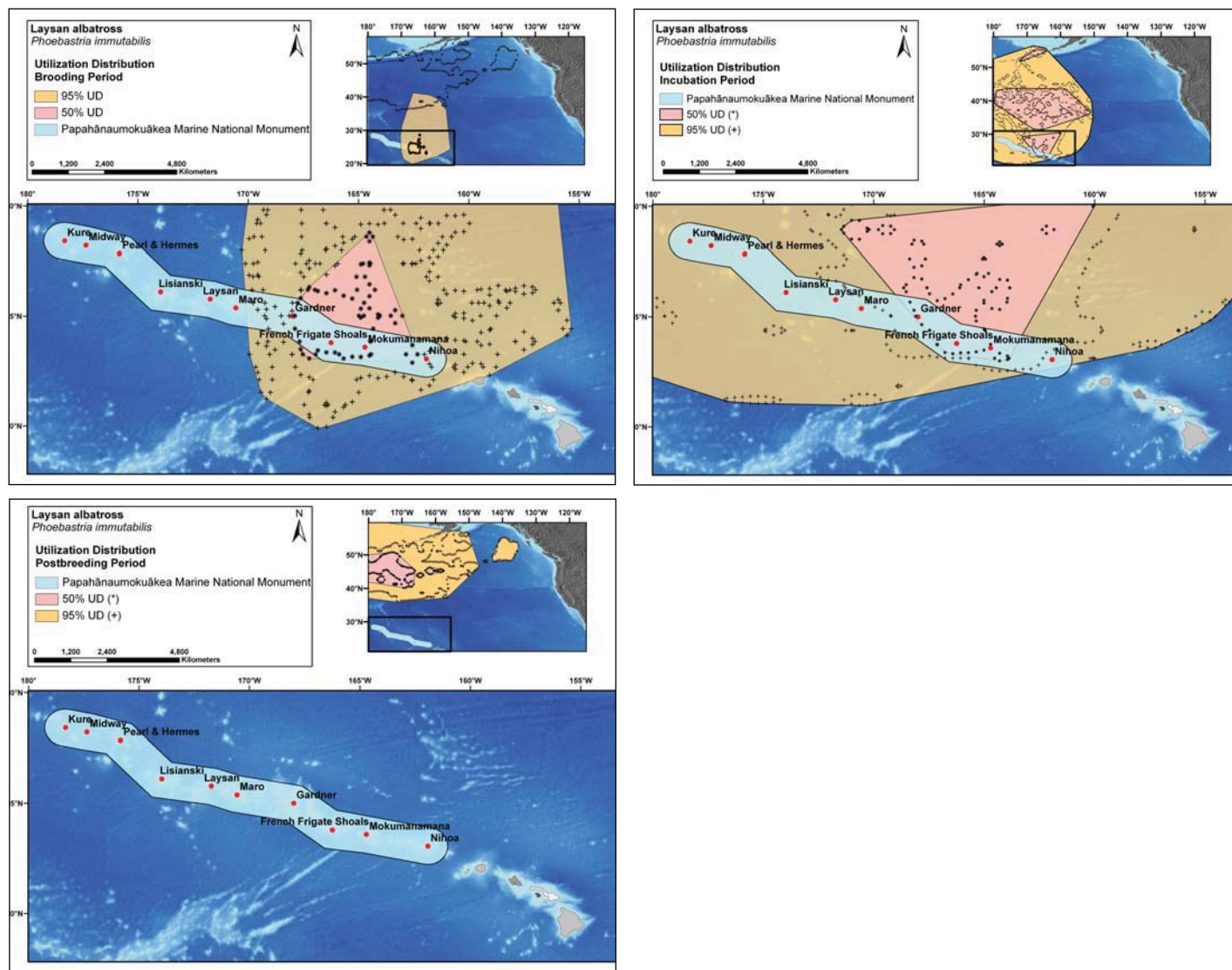


Figure 7.5. Laysan Albatross utilization distribution during brooding, incubation and postbreeding. Source: Shaffer et al., in review; maps: R. Clark.

Black-footed Albatross (*Phoebastria nigripes*)

Black-footed Albatrosses are slightly larger than Laysan Albatrosses, with a body length of 64-74 cm, a wingspan of 193-216 cm, and a mean body mass of 2.8 kg (Awkerman et al., 2008; Suryan et al., 2008; Figure 7.6). Like Laysan Albatrosses, males are slightly larger than females but plumage is identical between the sexes. Black-footed Albatrosses are dusky-brown with white fringes around the base of the bill, under the eye, under the tail, and over the base of the tail (Harrison, 1987).

Ninety eight percent of the breeding population occurs within the Monument. The species nests on all of the islands and atolls in the NWHI, with the majority of pairs nesting at Midway Atoll and on Laysan Island (USFWS, 2005; Figure 7.7). A few thousand (Awkerman et al., 2008) Black-footed Albatrosses also breed on discrete colonies in Japanese Islands, and several pairs have been observed prospecting at Guadalupe Island, Baja, Mexico. Within breeding colonies, Black-footed Albatrosses nest synchronously, with all females laying eggs within a few-week period. Throughout the Hawaiian archipelago, egg-laying and incubation generally occurs from October through December, and chicks are reared from January to June, with fledging occurring in mid-June (Awkerman et al., 2008). Historical breeding areas include the Hawaiian archipelago and Marshall, Johnston, and Torishima Islands (Harrison, 1987).

Within the Monument, many threats have been reduced over the years, but existing threats include ingestion of plastics, long-line bycatch, and sea level rise (USFWS, 2005; Lewison and Crowder, 2003). The Monument provides protection for breeding and nesting habitat, but only a small portion of the foraging range remains protected because of the wide ranging foraging behavior.

When at sea, tracking studies reveal that Black-footed Albatrosses are found throughout the North Pacific (partially the Bering Sea) but generally they range between 25°N and 50°N (Harrison, 1987; Fernandez et al., 2001; Hyrenbach et al., 2002; Shaffer et al., 2005). During the incubation period, adults conduct foraging excursions lasting 10-20 days in duration and may travel over 1,500 km from the nesting colony (Kappes et al., in review; Figures 7.7 and 7.8). Adults tend to head north-northeast of the breeding islands to warmer waters along the southern edge of the North Pacific Current. Like Laysan Albatrosses, Black-footed Albatrosses studied across multiple consecutive years (2002-2006) use slightly different habitat across years (Figure 7.8) but the environmental cues that putatively influence foraging effort remain the same across years studied. That



Figure 7.6. Black-footed Albatross, Tern Island and French Frigate Shoals. Photo: C. Gregory.

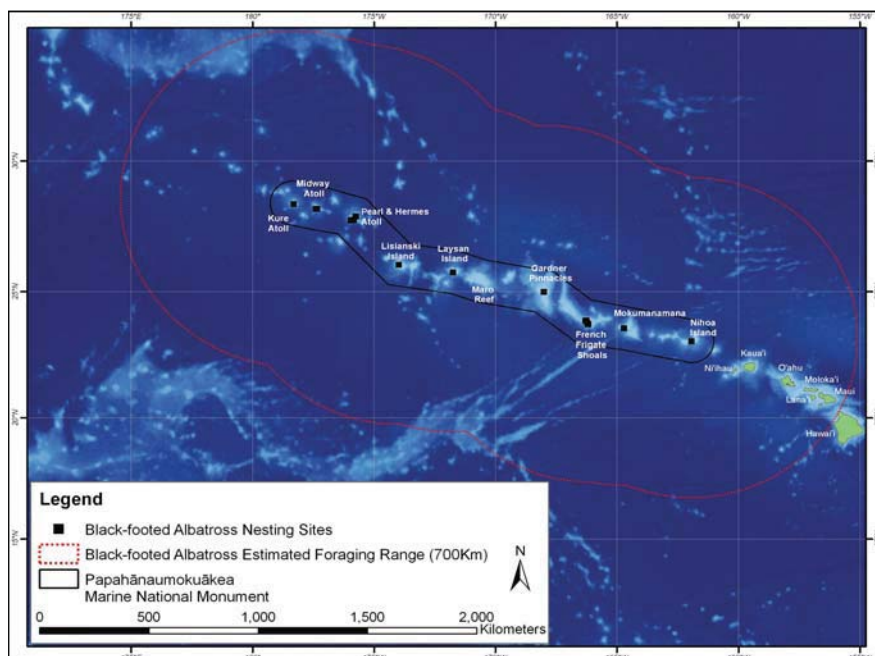


Figure 7.7. Black-footed Albatross nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

is, SST and primary productivity levels appear to be the most important predictors of searching/foraging activity (Kappes et al., in review). During the chick-brooding period, adult Black-footed and Laysan Albatrosses experience the greatest overlap in their distribution because adults are constrained by the need to provision their chick frequently; thus foraging excursions last only one to three days on average and ranges are typically less than 300-400 km from the colony (Kappes et al., unpublished data). During the chick-rearing period, adults conduct both long and short duration foraging trips with some trips extending to the west coast of the U.S. and Canada (Fernandez et al., 2001; Hyrenbach et al., 2002). After breeding, adult Black-footed Albatrosses leave the breeding colonies for rich productive waters of the California Current and Aleutian Islands (Hyrenbach et al., 2006; Fischer, 2008; Shaffer et al., submitted; Figure 7.8). Thus, the spatial overlap with Laysan Albatrosses during the non-breeding period can be relatively minor (<10%; Shaffer et al., submitted). Black-footed Albatrosses remain along the West Coast of the U.S. or Aleutian Islands for most of the summer months while undergoing molt and recovering from breeding. Albatrosses return to breeding colonies in mid- to late-October to breed again. It is important to note that this species has only been tracked from a few of their breeding colonies, thus at sea distribution is not fully characterized. The species is a surface feeder, with a diet including fish eggs, squid, crustaceans, fish, and zooplankton. Forty percent of the diet is composed of flying fish eggs (USFWS, 2005).

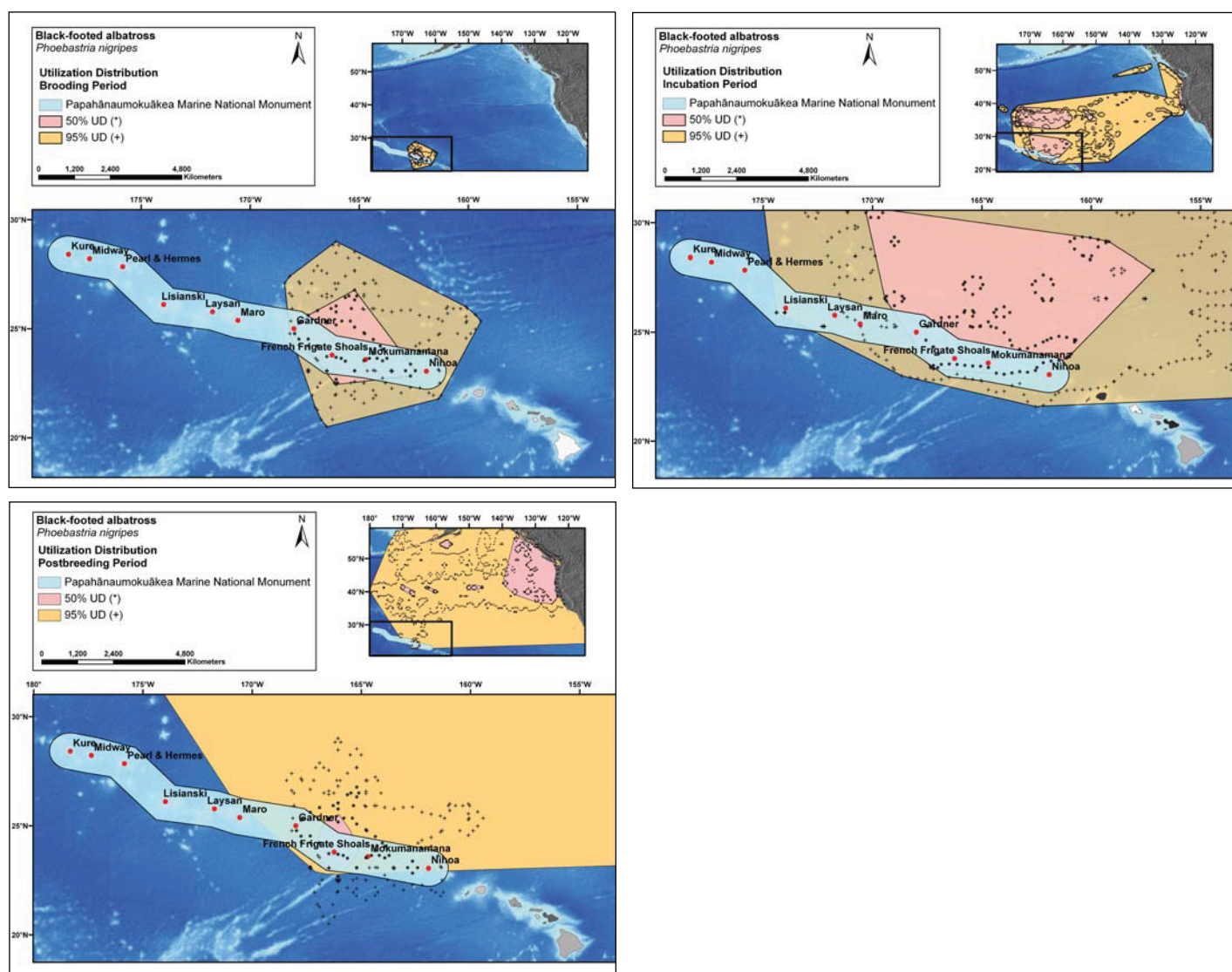


Figure 7.8. Black-footed Albatross utilization distribution during brooding, incubation and postbreeding. Source: Shaffer et al., in review; maps: R. Clark.

Short-tailed Albatross (*Phoebastria albatrus*)

Short-tailed Albatrosses are larger than Laysan and Black-footed Albatrosses, with a mean wingspan of 237 cm and mean body mass of 4.3 kg (Brooke, 2004; Suryan et al., 2008). Short-tailed Albatrosses are similar in appearance to Laysan Albatrosses, but are larger, with a heavier bright pink bill, and with a yellow wash on the white plumage of the head and neck (Harrison, 1990; Figure 7.9).

Short-tailed Albatrosses historically ranged throughout the North Pacific, but current breeding sites include only Torishima and Minami-kajima, Japan (USFWS, 2005). Short-tailed Albatrosses periodically do attempt to breed at Midway Atoll, but there are no documented accounts of successful nesting (USFWS, 2005). Eggs are laid from October to November and fledging occurs in June.



Figure 7.9. Short-tailed Albatross. Photo: J. Lloyd.

The Short-tailed Albatross is listed as Endangered under the Endangered Species Act (ESA) throughout its range. Within the Monument, threats are minimal relative to other potential colony sites, and management actions are taking place to encourage nesting at Midway Atoll. Tracking studies show that these albatrosses generally remain in the Western Pacific when breeding, and then move further north into the Bering Sea and along the Aleutian Islands (Suryan et al., 2006). Based on the large body size of Short-tailed Albatrosses compared to Laysan and Black-footed albatrosses, Short-tailed Albatrosses would appear to have a more restricted range that occurs within regions of stronger winds and larger wave heights (Suryan et al., 2008).

Bonin Petrel (*Pterodroma hypoleuca*)

Bonin Petrels are 30 cm long with a wingspan of 63-71 cm and a mean body mass of 204 g. Plumage on the upper parts is blue- to silver-gray, with a sooty head and neck, and white forehead, chin and throat. Upper wings are gray with black primaries, and the underwing is white with black margins (Seto and O'Daniel, 1999; Figure 7.10).

Bonin Petrels are found throughout the western north Pacific and breed in the NWHI and on Volcano and Bonin Islands in Japan. There are no breeding colonies of Bonin Petrels in the Main Hawaiian Islands (MHI; Harrison, 1987).



Figure 7.10. Bonin Petrel. Photo: C. Gregory.

In the NWHI, Bonin Petrels nest at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Atoll, Midway Atoll and Kure Atoll. Gardner Pinnacles may also provide nesting habitat. Lisianski Island, Laysan Island and Midway Atoll support the largest colonies in the archipela-

go (Figure 7.11). In the NWHI, eggs are laid from December to March and chicks are reared from February to May.

Bonin Petrels are nocturnal surface feeders, with a diet consisting mainly of fish (USFWS, 2005).

Habitat loss from erosion and invasive plant species are some of the main threats to the populations in the NWHI. Historically, introduced Polynesian rats posed a serious threat to Bonin Petrel populations, but rats were extirpated in the NWHI by the year 2000. The U.S. Fish and Wildlife Service (USFWS) has also modified light sources at Midway Atoll and French Frigate Shoals to reduce impacts to nocturnal seabird species, including the Bonin Petrel.

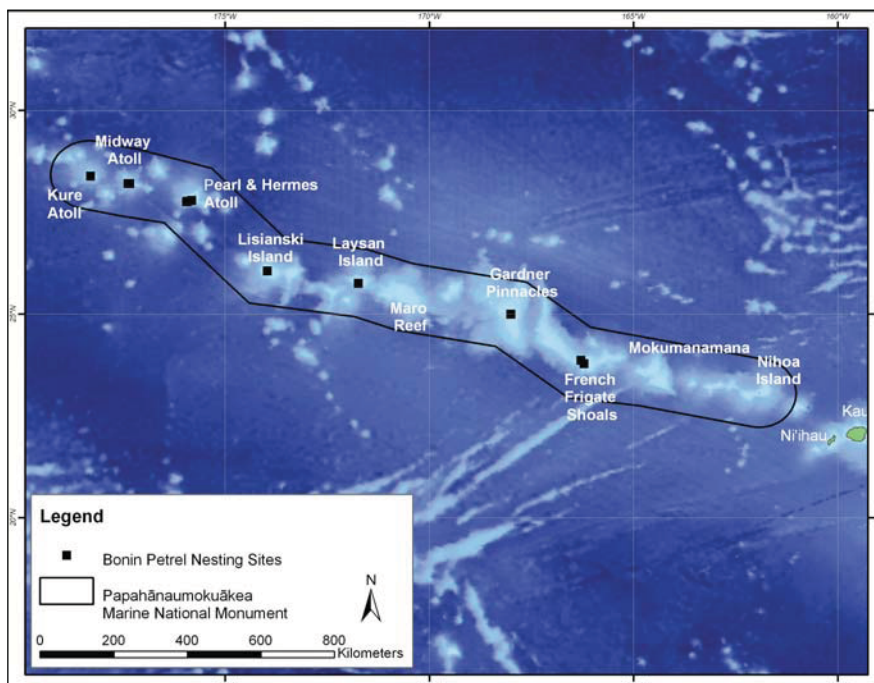


Figure 7.11. Bonin Petrel nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Bulwer's Petrel (*Bulweria bulwerii*)

The Bulwer's Petrel is 26 cm long with a 67 cm wingspan (Harrison, 1987). Plumage is sooty brown, with a lighter brown face and chin (Megyesi and O'Daniel, 1997; Figure 7.12).

The Bulwer's Petrel is a wide-ranging species occurring in the tropical and subtropical waters of the Pacific, Atlantic and Indian Oceans (Harrison, 1987). In the Pacific, Bulwer's Petrels breed in the Phoenix, Marquesas, Bonin, Volcano and Hawaiian Islands, including the NWHI and MHI (USFWS, 2005). From the little that is known about the species' at-sea distribution, it appears that the Hawaiian populations travel to the central and eastern Pacific during the non-breeding period (USFWS, 2005).



Figure 7.12. Bulwer's Petrel. Photo: USFWS.

In the NWHI, Bulwer's Petrels have been found to breed at Nihoa Island, Mokumanamana, French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Atoll and Midway Atoll (Figure 7.13). The largest breeding colony occurs on Nihoa Island. Bulwer's Petrels lay eggs in the NWHI between May and July. Chicks are present from July to October, and fledging occurs by early October.

Bulwer's Petrels are nocturnal surface feeders, with a diet composed of fish, squid, crustaceans and sea-striders. Most of the prey species are bioluminescent and are found in upwelling areas (USFWS, 2005).

As seen with many of the seabirds in the NWHI, Bulwer's Petrels suffered losses to Polynesian rat and ant introductions.

Wedge-tailed Shearwater (*Puffinus pacificus*)

The Wedge-tailed Shearwater is 43 cm long, with a wingspan of 101 cm (Harrison, 1987; Figure 7.14), and a mean body mass of 390 g (Whittow, 1997). Light-morph shearwaters are grayish brown above, with white underparts, while dark-morph individuals are sooty brown above and below (Whittow, 1997).

Wedge-tailed Shearwaters occur throughout the tropic and subtropical Pacific and Indian Oceans, including the NWHI (Harrison, 1987). The Hawaiian populations most likely migrate to the Equatorial Countercurrent and east during the non-breeding period (USFWS, 2005). This species aggregates into large multi-species feeding flocks, often associated with subsurface predators (e.g., tuna and dolphin).

Wedge-tailed Shearwaters nest on all of the islands and atolls in the NWHI (Figure 7.15). The largest colonies within the archipelago are at Nihoa Island, Laysan Island and Lisianski Island. In the NWHI, eggs are laid from June to August and chicks are present from August to December, with the majority of fledging occurring in November.

Wedge-tailed Shearwaters use contact dipping for feeding, and their diet in the Hawaiian Archipelago consists mainly of larval goatfish, flying fish, squirrelfish and squid (USFWS, 2005).

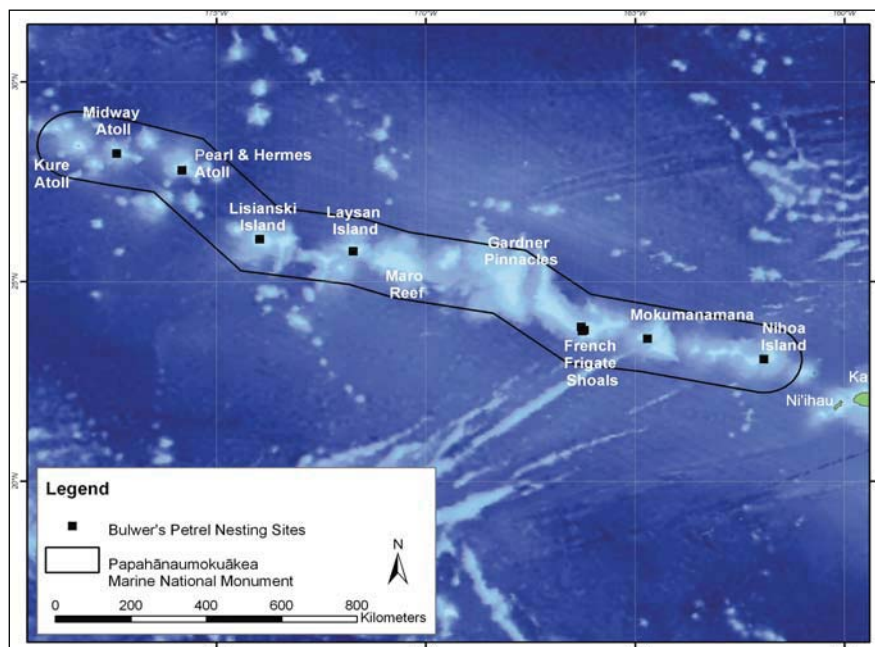


Figure 7.13. Bulwer's Petrel nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.



Figure 7.14. Wedge-tailed Shearwater light and dark morphs, Tern Island, French Frigate Shoals. Photo: USFWS.

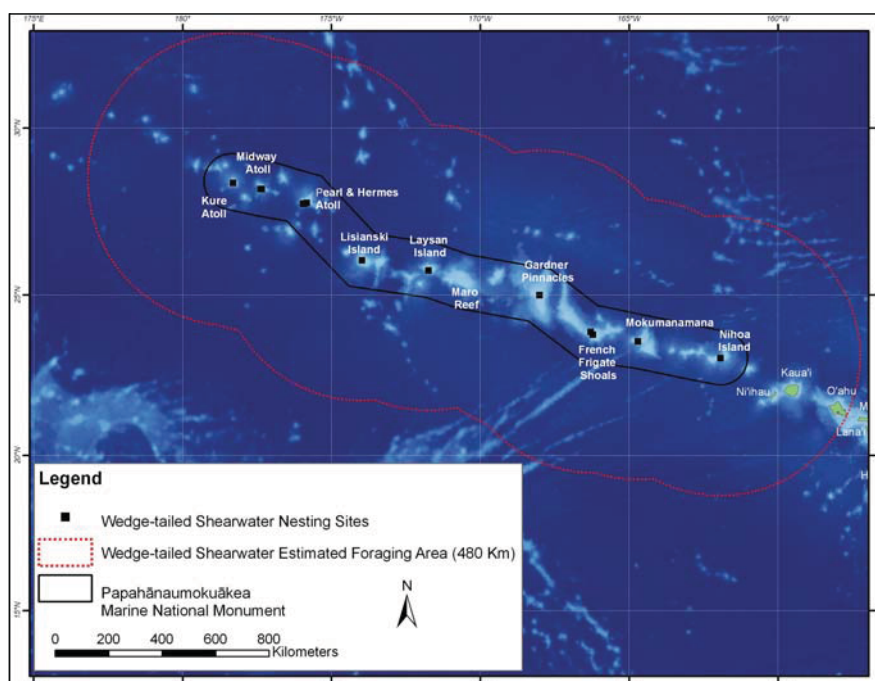


Figure 7.15. Wedge-tailed Shearwater nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Christmas Shearwater (*Puffinus nativitatis*)

Christmas Shearwaters are 36 cm long with a 76 cm wingspan (Harrison, 1987), and a mean body mass of 354 g (Seto, 2001). Plumage is dark brown throughout, with underparts slightly paler than upperparts (Seto, 2001; Figure 7.16).

Christmas Shearwaters occur in the tropical and subtropical Pacific (Harrison, 1987). The species nests on all of the islands and atolls in the NWHI, with the largest breeding colonies occurring on Laysan Island and Lisianski Island (USFWS, 2005; Figure 7.17). Females lay eggs from April through July, and chicks are reared from June to October.

Christmas Shearwaters use pursuit and plunge feeding behavior, with a diet composed of fish (goatfish, flying fish and scad) and squid (USFWS, 2005).

Nesting habitat degradation due to the spread of non-native invasive plant species is the most significant threat to the species in the NWHI.



Figure 7.16. Christmas Shearwaters, Tern Island and French Frigate Shoals. Photo: D. Wright.

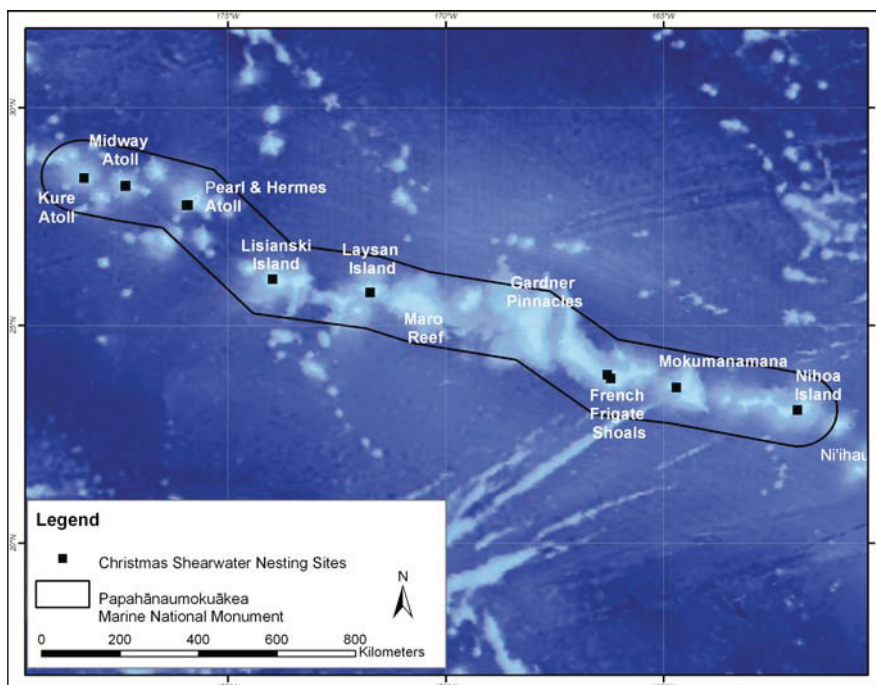


Figure 7.17. Christmas Shearwaters nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Tristram's Storm-petrel (*Oceanodroma tristrami*)

The Tristram's Storm-petrel is the smallest Procellariiformes species in the NWHI. It averages 24 cm in length, with a 56 cm wingspan and a mean body mass of 77-97 g. The species is brownish gray throughout, with a buffy brown wing bar across the upper wing (Slotterback, 2002; Figure 7.18).

The Tristram's Storm-petrel range includes the subtropical central and western Pacific and waters off of Japan. Breeding colonies occur in the NWHI, but there is no evidence of colonies in the MHI (USFWS, 2005).

The species is found on Nihoa Island, Mokumanamana, French Frigate Shoals, Laysan Island, Lisianski Island, and Pearl and Hermes Atoll. The largest colonies are at Nihoa Island, Laysan Island, and Pearl and Hermes Atoll (Figure 7.19). In the NWHI, eggs are laid from December to February, and chicks are present from February to May. Most birds have dispersed by June.

The feeding behavior of Tristram's Storm-petrels consists of pattering and snatching prey from the surface. Generally, the diet in the NWHI consists of small fish and squid and sometimes planktonic halobates (insects) and crustaceans (USFWS, 2005).

Breeding colonies were extirpated from Midway Atoll and Kure Atoll, most likely by the introduction of rats. Recolonization is possible due to the eradication of rats from these locations by the year 2000. Nesting habitat degradation from invasive plant species continues to be a threat at Pearl and Hermes Atoll.



Figure 7.18. Tristram's Storm-petrel, Tern Island and French Frigate Shoals. Photo: C. Gregory.

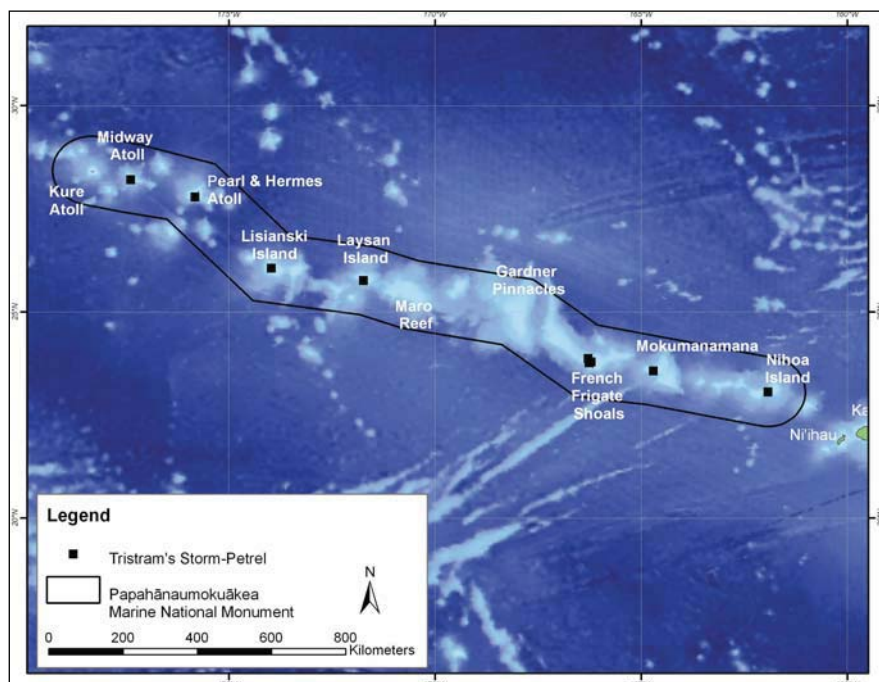


Figure 7.19. Tristram's Storm-petrel nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

PELECANIFORMES (BOOBIES, FRIGATEBIRDS AND TROPICBIRDS)

Red-footed Booby (*Sula sula rubripes*)

The Red-footed Booby is the smallest of the booby species worldwide, with a length of 69-79 cm and body mass of 850-1,100 g (Schreiber et al., 1996; Figure 7.20). Females are slightly larger than males. Adults in the NWHI are white, often with a yellowish wash on the head and neck, with black primaries, secondaries and coverts. A tan morph also occurs in the NWHI, but is present in much lower numbers and is seen only rarely (A. Anders, pers. comm.). Bills of females are blue with a pink base, and those of males lighter blue with a lime green and pink base. Legs and feet are orange-red to red (Schreiber et al., 1996).



Figure 7.20. Red-footed Boobies, Tern Island, French Frigate Shoals. Photo: USFWS.

Red-footed Boobies are a pantropical species, with the largest breeding colonies occurring in Palmyra and the Hawaiian Islands. Red-footed Boobies nest on all of the islands and atolls in the NWHI, as well as on Kauai, Oahu and offshore islets in the MHI (Figure 7.21). The species lays eggs from March to August and chicks occur from May to December.

The species forages farther than other boobies, ranging up to 276 km from the nesting colony (USFWS unpublished data; Figure 7.21). During the non-breeding period, the birds have been observed to travel several hundred kilometers from land (USFWS, 2005). The Red-footed Booby is a plunge diver, with primary prey species including flying fish and squid. This species often forages in large, multi-species flocks associated with subsurface predator.

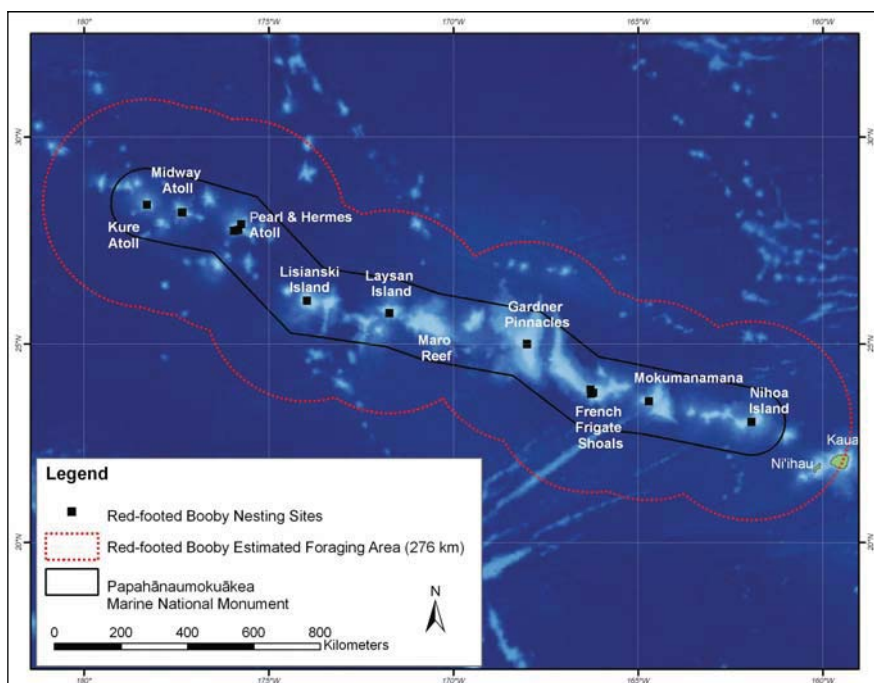


Figure 7.21. Red-footed boobies nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Habitat destruction is the main threat to populations in the NWHI (USFWS, 2005).

Masked Booby (*Sula dactylatra personata*)

Masked Boobies are the largest of the booby species, with a body length of 74-86 cm, and body mass of 1.2-2.4 kg. As with many other Pelecaniformes species, females are slightly larger than males. Adults are white with black-brown primaries, secondaries and tail, and purplish orange feet (Anderson, 1993; Figure 7.22).

Masked Boobies are a pantropical species, with the largest breeding colonies occurring on Howland, Baker and Jarvis. In the NWHI, the species occurs on all of islands and atolls (Figure 7.23). Eggs are present from January to July, and chicks occur from March to October.

During the breeding season, birds forage up to 160 km from the breeding colonies (USFWS unpublished data; Figure 7.23), and during the non-breeding period individuals may travel from 1,000 – 2,000 km from the breeding colonies (USFWS, 2005). Masked Boobies are plunge divers, with the majority of the diet consisting of fish, particularly flying fish and jacks. A very small portion of the diet is squid (USFWS, 2005).

The primary threats to the Masked booby populations in the NWHI are habitat destruction and loss of nesting habitat due to invasive plants (USFWS, 2005).



Figure 7.22. Masked Booby with chick, Tern Island, French Frigate Shoals. Photo: NOAA.

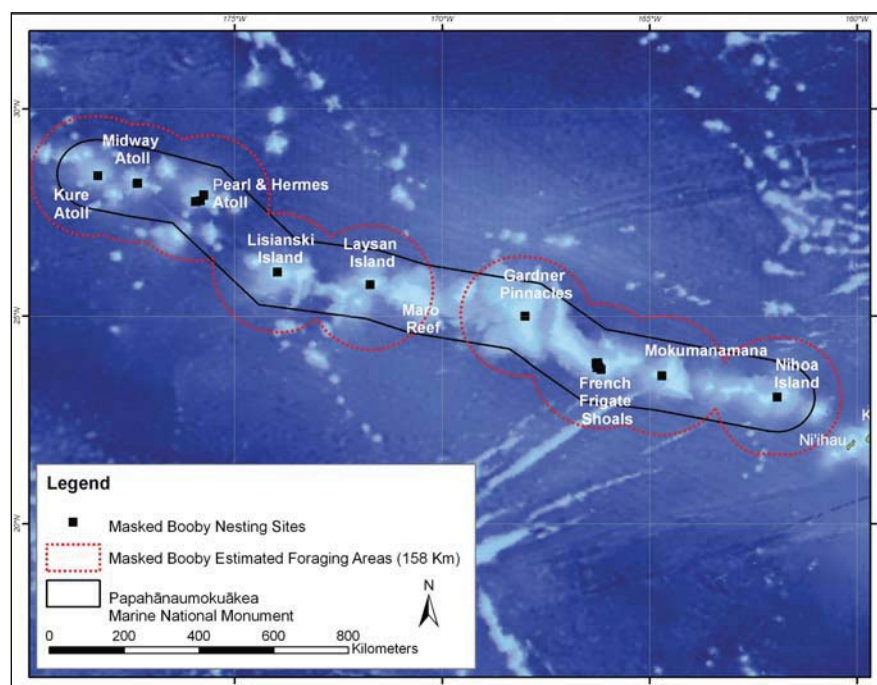


Figure 7.23. Masked Booby nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Brown Booby (*Sula leucogaster plotus*)

The Brown Booby is a medium-sized booby, with a body length of 64-85 cm, a wingspan of 132-155 cm, and body mass of 950-1,800 g (Schreiber and Norton, 2002). Females are markedly larger than males. Adults are deep brown on the back, head, neck and throat, with bright white underparts. In the NWHI, adults have a pale yellow bill with a light blue base, and bluish yellow legs and feet (A. Anders, pers. comm.; Schreiber and Norton, 2002; Figure 7.24).



Figure 7.24. Brown Booby, Tern Island, French Frigate Shoals. Photo: J. Drury.

The Brown Booby distribution overlaps with those of the masked and Red-footed Booby species, which are pantropical (USFWS, 2005). The largest brown booby populations occur in the Hawaiian Islands, including the NWHI and MHI. The species nests within all of the islands and atolls of the NWHI. Brown Boobies lay eggs from February to August, and chicks are present from April to October (Figure 7.25).

Foraging occurs near shore, at 8-70 km from land (USFWS, 2005; Figure 7.25). The species has been known to travel 2,000 km from breeding colonies during the nonbreeding season, but individuals generally remain within 80 km of land during the breeding period (USFWS, 2005). Brown Boobies are plunge divers, with primary prey species consisting of flying fish, squid, mackerel scad and juvenile goatfish (USFWS, 2005).

As with the other Booby species, the main threat to Brown Booby populations in the NWHI is habitat destruction (USFWS, 2005).

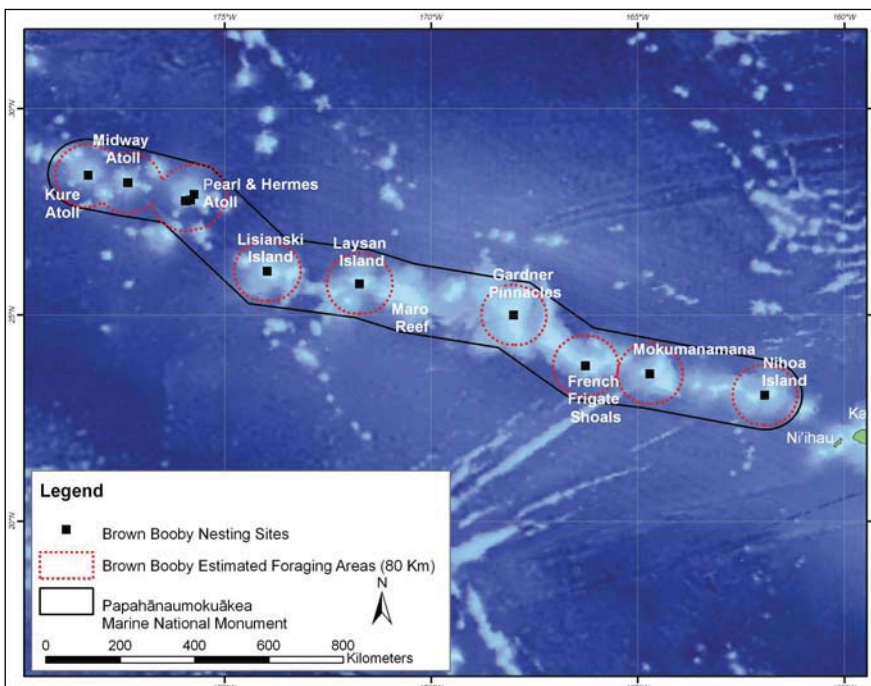


Figure 7.25. Brown Booby nesting sites and foraging areas in the NWHI. Source: USFWS, 2005; map: K. Keller.

Great Frigatebird (*Fregata minor palmerstoni*)

Frigatebirds have the largest wing-area to body mass ratio of any avian species: Great Frigatebirds, with a length of 85-105 cm and wingspan of 205-230 cm, have a body mass of just 1-1.8 kg (Gauger Metz and Schreiber, 2002). Males are black or black-brown throughout, with a purple/blue/green sheen on the dorsal feathers of the neck and nape, and a red gular sac. The gular pouch is deflated and a pale pink-orange color during the non-breeding period, and becomes bright red and is inflated during display prior to the nesting period. Females are significantly larger than males, with a white throat, breast, and underparts and no (or a greatly reduced) gular sac (Gauger Metz and Schreiber, 2002; Figure 7.26).



Figure 7.26. Male Great Frigatebird with inflated gular pouch, Tern Island, French Frigate Shoals. Photo: D. Dearborn.

The distribution of Great Frigatebirds is pantropical, with the largest breeding populations occurring on Nihoa Island and Laysan Island (USFWS, 2005). Great Frigatebirds nest on all of the islands and atolls within the NWHI except Gardner Pinnacles and Kure Atoll (Figure 7.27). In the NWHI, eggs are laid between March and July, and chicks are present from April to November.

Foraging ranges during the breeding season have been calculated to be up to 612 km (Weimerskirch et al., 2004), but frigatebirds travel up to 7,000 km during the non-breeding period (Dearborn et al., 2003; Figure 7.27). Great Frigatebirds cannot swim or land on water, and thus use surface dipping and aerial pursuit to capture prey. The main prey species are flying fish and squid (USFWS, 2005).

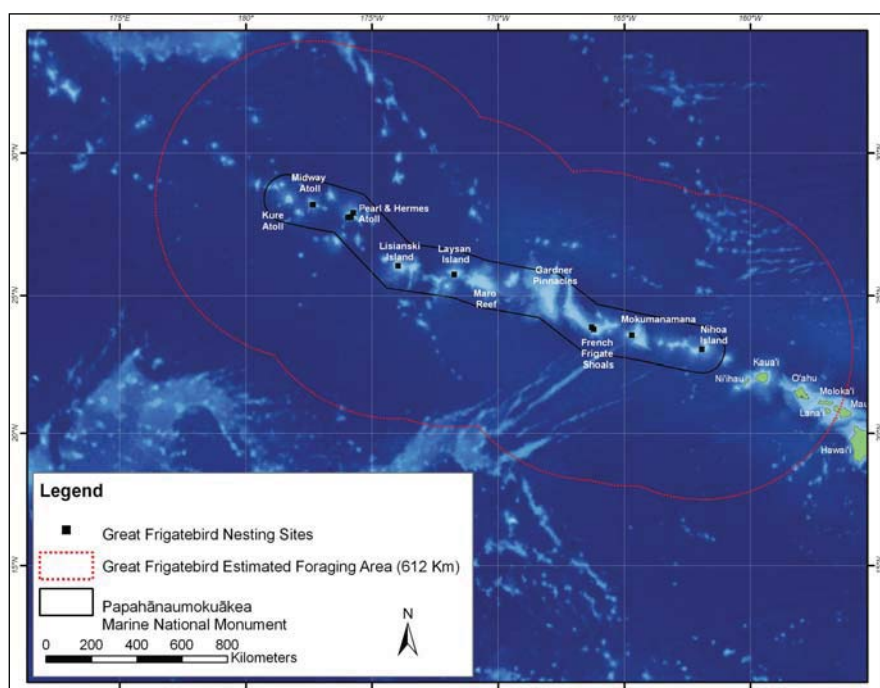


Figure 7.27. Male Great Frigatebird nesting sites and foraging areas in the NWHI. Source: Weimerskirch et al., 2004; map: K. Keller.

The greatest threats to populations in the NWHI are habitat destruction and disturbance during nesting.

Lesser Frigatebird (*Fregata ariel ariel*)

Lesser Frigatebirds are significantly smaller than Great Frigatebirds, with a mean body length of 75 cm (Lindsey, 1986). Male plumage is similar to that of the Great Frigatebird, but with overall body plumage of lessers being darker black and with a brighter purple and green iridescence to the dorsal neck and nape feathers (Figure 7.28). Lesser males also have a bright white line on the underside of the wing, providing an obvious distinction in flight to the male Great Frigatebird (A. Anders, pers. comm.). Female lesser plumage is similar to that of female Great Frigatebirds, but with darker black feathers dorsally, and a full black hood giving a black, rather than white, throat (A. Anders, pers. comm.).



Figure 7.28. Lesser Frigatebird. Photo: USFWS.

The pantropical distribution of Lesser Frigatebirds lies within that of Great Frigatebirds, with the largest breeding colonies occurring on Baker and Howland Islands (USFWS, 2005). Individuals are observed roosting regularly but in low numbers in the NWHI; successful nesting of a Lesser Frigatebird male and Great Frigatebird female (with production of hybrid offspring) has been observed in multiple years at French Frigate Shoals (Figure 7.29), and one pair of Lesser Frigatebirds has been documented nesting on Tern Island, although the nest failed prior to hatching (Dearborn and Anders, 2000).

As with Great Frigatebirds, Lesser Frigatebirds use surface dipping to capture prey, and main food items include flying fish and squid. Lesser Frigatebirds travel thousands of kilometers from the breeding colonies during the non-breeding period, but are seen most often within 80 km of breeding and roosting islands (USFWS, 2005).

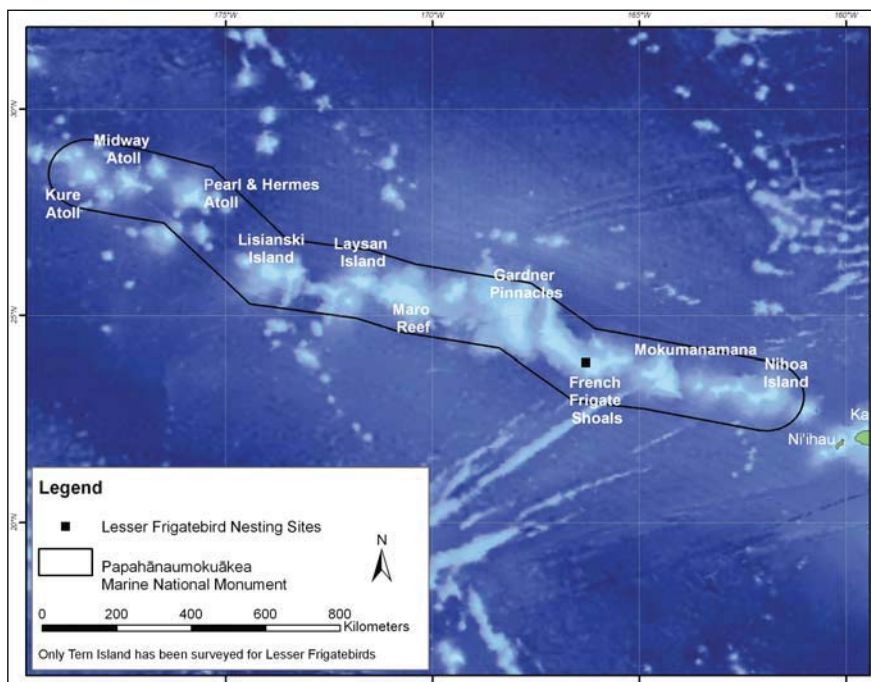


Figure 7.29. Lesser Frigatebird nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Red-tailed Tropicbird (*Phaethon rubricauda melanorhynchos*)

Red-tailed Tropicbirds are a relatively small, stout Pelecaniformes species, with a body length of 44-47 cm (80-102 cm including long central tail feathers), and body mass of 650-780 g (Schreiber and Schreiber, 1993). Plumage is white throughout, often with a pale pink wash. The bill is red-orange, and a black crescent eye ring extends to a short eye line (Figure 7.30). The tail is short and white, with two long red central rectrices.

The Red-tailed Tropicbird is distributed throughout the Indo-Pacific region between 35°N and 30°S. The largest concentration of breeding birds within the Pacific occurs in the NWHI at Midway Atoll and Laysan Island (Figure 7.31). Other smaller colonies are found on all of the other islands and atolls in the NWHI, in the MHI, and on other Pacific Islands such as Johnston Atoll, American Samoa, Wake and the Marianas (USFWS, 2005). Red-tailed tropicbirds lay eggs from March to August and chicks occur from April to November.

Foraging ranges have been calculated to be approximately 470 km from the breeding colonies, which extends beyond the boundaries of the Monument (USFWS unpublished data; Figure 7.31). Red-tailed Tropicbirds are solitary, plunge divers and feed mostly on flying fish. Other prey species include squid, mackerel scad, dolphinfish, truncated sunfish and balloonfish (USFWS, 2005). They are not associated with subsurface predator schools.

In the NWHI, rats on Midway Atoll and Kure Atoll, along with invasive plants, were the main threats to the species. Rats have been eradicated, and USFWS is currently conducting native plant restoration and other alien species removal projects to increase available nesting habitat.



Figure 7.30. Red-tailed Tropicbird, Tern Island, French Frigate Shoals. Photo: C. Gregory.

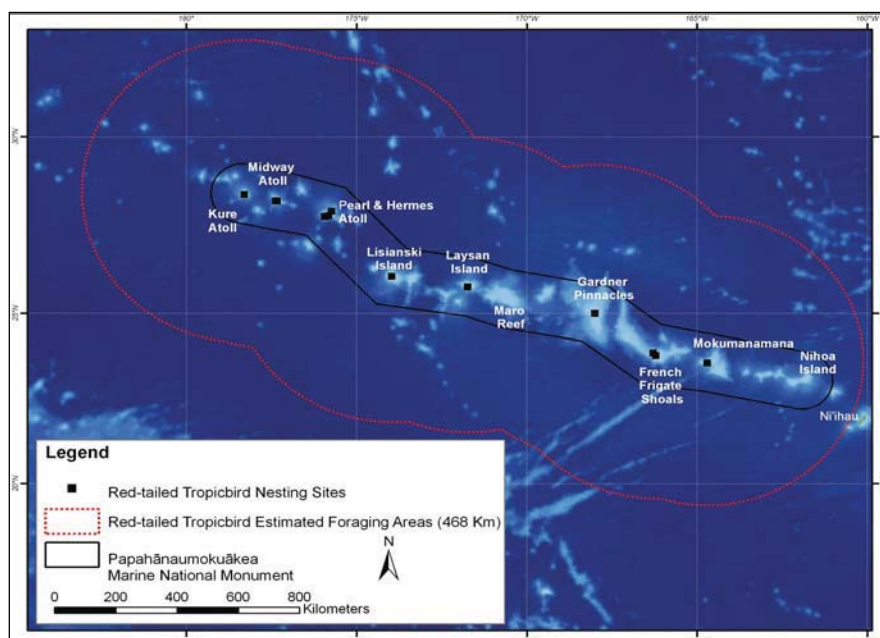


Figure 7.31. Red-tailed Tropicbird nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

White-Tailed Tropicbird (*Phaethon lepturus dorothea*)

White-tailed Tropicbirds are similar in appearance to Red-tailed Tropicbirds, but are smaller and more slender, with a total length of 60-80 cm (including the central rectrices), a wingspan of 90-95 cm, and a mean body mass of 350 g (Lee and Walsch-McGehee, 1998). As with Red-tailed Tropicbirds, body plumage is white, often with a pink wash, but the long central rectrices are white, and the bill is more orange than red (Lee and Walsch-McGehee, 1998; Figure 7.32).

White-tailed Tropicbirds range throughout the tropics with the exception of the eastern Pacific and northeastern Atlantic. The largest colonies in the Pacific occur on American Samoa and the MHI. Smaller colonies are found at Midway Atoll, Palmyra, Wake and the Marianas (USFWS, 2005). Within the NWHI, White-tailed Tropicbirds nest only at Midway Atoll, where a few pairs may breed throughout the year (Figure 7.33). White-tailed Tropicbirds may be competitively excluded from other islands in the northwestern chain by Red-tailed Tropicbirds; in areas of sympatry, the larger Red-tailed Tropicbirds do often outcompete White-tails for nest sites (Harrison, 1990).

White-tailed Tropic birds forage at distances up to 120 km from nesting colonies (USFWS, 2005; Figure 7.33), such that the foraging range extends beyond the boundaries of the Monument. The species are solitary, plunge divers and feed mainly on flying fish without aggregations into multi-species feeding flocks with other seabirds.

Introduced predators are the greatest threat throughout the breeding range.



Figure 7.32. White-tailed Tropicbird, Sand Island, Midway Atoll. Photo: K. Starr.

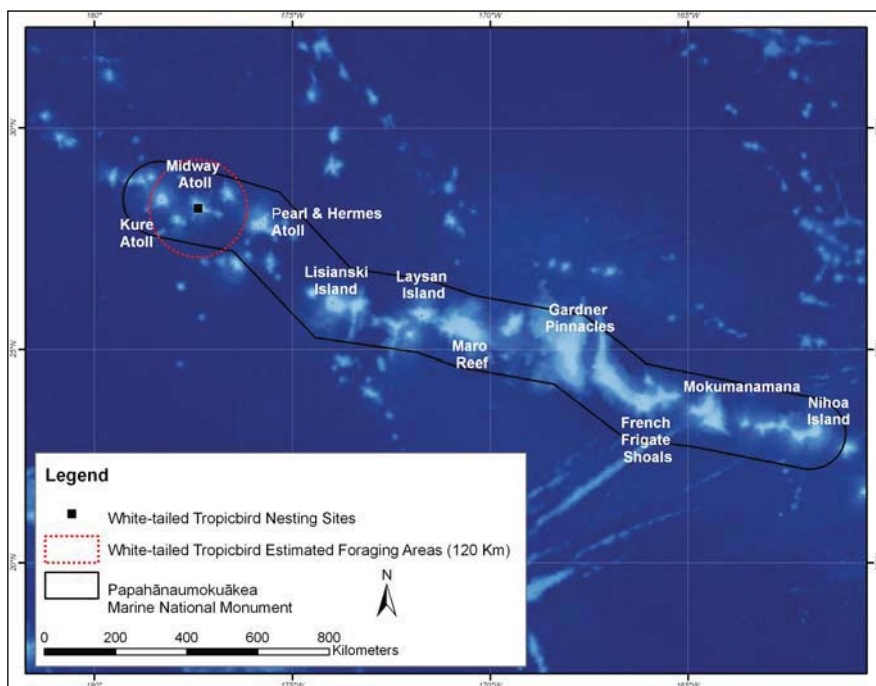


Figure 7.33. White-tailed Tropicbird nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

CHARADRIIFORMES (TERNS AND NODDIES)

Black Noddy (*Anous minutus marcusii*)

The Black Noddy is similar in appearance to the Brown Noddy, but with a smaller body size (length 35-40 cm, and body mass 85-140 g), and darker brown plumage throughout. The head is gray-brown, fading to grayish-white on the forehead, and with a white crescent on the lower eye. The bill is black, and legs and feet are reddish brown to orange (Gauger, 1999; Figure 7.34).

Black Noddies are a pantropical species, and the largest colonies in the NWHI are at Midway Atoll and Nihoa Island (USFWS, 2005; Figure 7.35). In the NWHI, Black Noddies can breed year around, but in general eggs are laid between October and June, and chicks are present from December to August.

Breeding adults forage within 80 km of nesting colonies and often forage near shore <10 fm (USFWS, 2005; Figure 7.35). Black Noddies feed by surface dipping, and prey species include juvenile and larval goatfish, lizardfish, herring, flying fish and gobies.

Habitat loss, predation, invasive species and disturbance are all threats to Black Noddy populations. Introduced insects at Kure Atoll and increases in the invasive golden crown-beard have had negative impacts on nesting habitat (USFWS, 2005).



Figure 7.34. Black Noddy, Tern Island, French Frigate Shoals. Photo: C. Gregory.

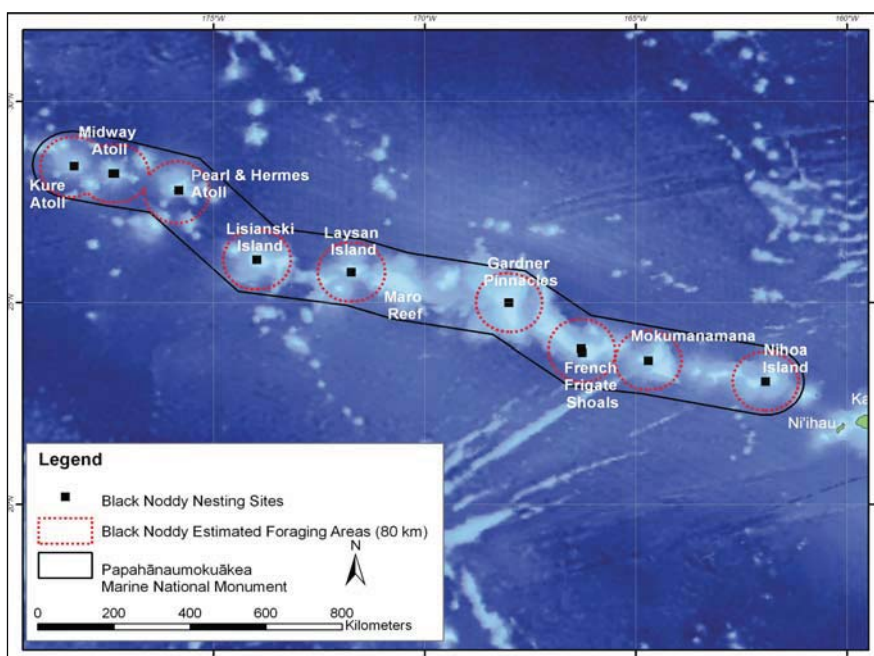


Figure 7.35. Black Noddy nesting sites and foraging areas in the NWHI. Source: USFWS, 2005; map: K. Keller.

Brown Noddy (*Anous stolidus pileatus*)

Brown Noddies are a medium-sized tern species; they are slightly larger than Black Noddies, with a length of 40-45 cm and a mean body mass of 180 g. Body plumage is chocolate-brown throughout, with a gray-brown head, grayish-white forehead, and white eye ring. The bill is black, and legs and feet are dark gray to black (Chardine and Morris, 1996; Figure 7.36).

Brown Noddies are a pantropical species, with breeding colonies occurring at American Samoa, the Marianas, Johnston Atoll and the NWHI. The largest colony in the NWHI is on Nihoa Island (USFWS, 2005; Figure 7.37). In the NWHI, females lay eggs between January and May, and chicks are present from February to November.

Foraging during the breeding season occurs within sight of the nesting colonies. During the nonbreeding season, the birds are known to stay within 100 km of the nesting colonies (USFWS, 2005; Figure 7.37). Brown Noddies feed by surface dipping, and prey includes goatfish, lizardfish, mackerel scad, flying fish and squid. (USFWS, 2005)

Predators are the greatest threat to Brown Noddy populations.



Figure 7.36. Brown Noddy, Tern Island, French Frigate Shoals. Photo: NOAA.

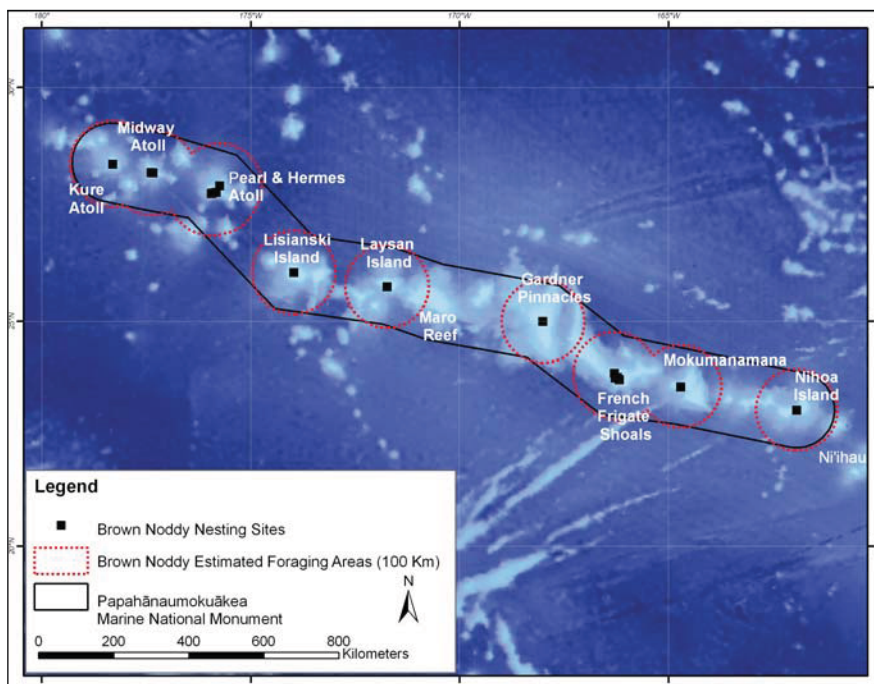


Figure 7.37. Brown Noddy nesting sites and foraging areas in the NWHI. Source: USFWS, 2005; map: K. Keller.

Blue Noddy of Blue-Gray Noddy (*Procelsterna cerulea saxatilis*)

The Blue Noddy is the world's smallest tern species. Body plumage is bluish-gray throughout, with slightly lighter coloration on the head and ventral surfaces, and a white eye ring. Primaries and tail are dark gray. Bill and legs dark gray, and feet are gray with yellow-gray webbing (http://www.state.hi.us/dlnr/dofaw/cwcs/Conservation_need.htm#Species; A. Anders, pers. obs.; Figure 7.38).

Blue Noddies are found throughout the Pacific, with the largest nesting colonies on Nihoa Island and Mokumanamana (USFWS, 2005). Blue Noddies nest in the eastern portion of the NWHI on Nihoa Island, Mokumanamana, French Frigate Shoals (on La Perouse Pinnacle) and Gardner Pinnacles (Figure 7.39). On these islands, Blue Noddies lay eggs between January and May, and chicks are present from January to June. There is some variation in breeding times between islands. The species is generally considered a year-round resident to the Hawaiian Islands.

Blue Noddies feed by surface dipping and feed mainly on larval lizardfishes, flounders, goatfishes and flying fish. They have also been known to take squid, crustaceans and halobates (USFWS, 2005).

Natural predators are the main threat to blue noddies.



Figure 7.38. Blue Noddy, La Perouse Pinnacle, French Frigate Shoals. Photo: D. Wright.

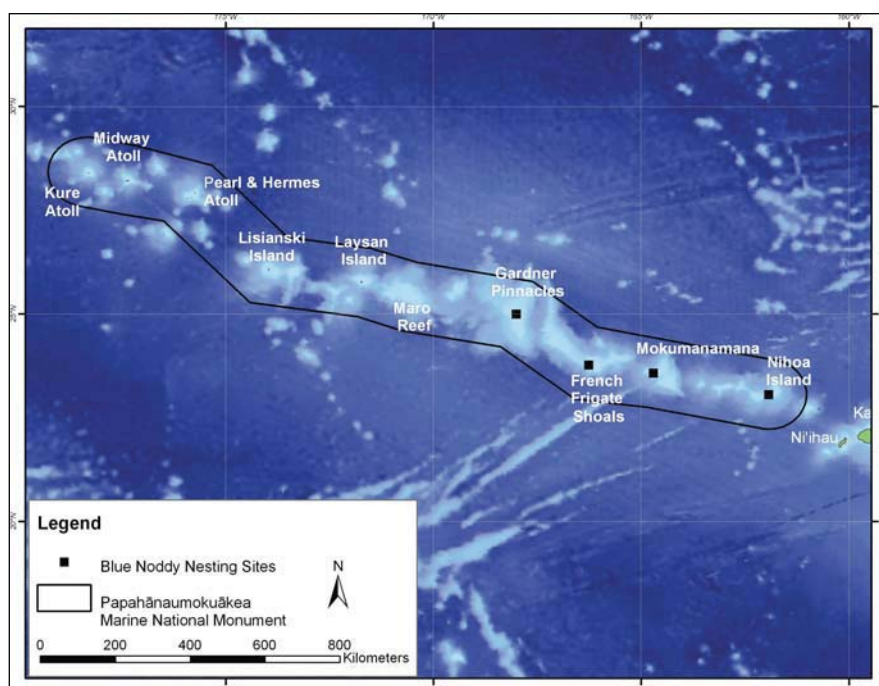


Figure 7.39. Blue Noddy nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

White Tern (*Gygis alba alba*)

White Terns are a medium-sized tern species, with a length of 27-33 cm, wingspan of 70-87 cm, and body mass of 77-157 g. Body plumage is entirely white, with a black eye ring. The bill is black, and legs and feet are gray-blue with yellow-white webs (Niethammer and Patrick, 1998; Figures 7.40).

The White Tern is a pantropical species, with the largest colonies in the NWHI occurring on Nihoa Island and Midway Atoll (Figure 7.41). Other islands including American Samoa and the Marianas also support large populations (USFWS, 2005). In the NWHI the species breeds year-around.

White Terns forage in near-shore waters during the breeding season. The species forages by surface diving, plunging and dipping. Prey includes juvenile goatfish and flying fish, while a smaller portion of the diet is composed of squid, needlefishes, halfbeaks, dolphinfishes and blennies (USFWS, 2005).



Figure 7.40. White Tern with chick, Tern Island, French Frigate Shoals. Photo: NOAA.

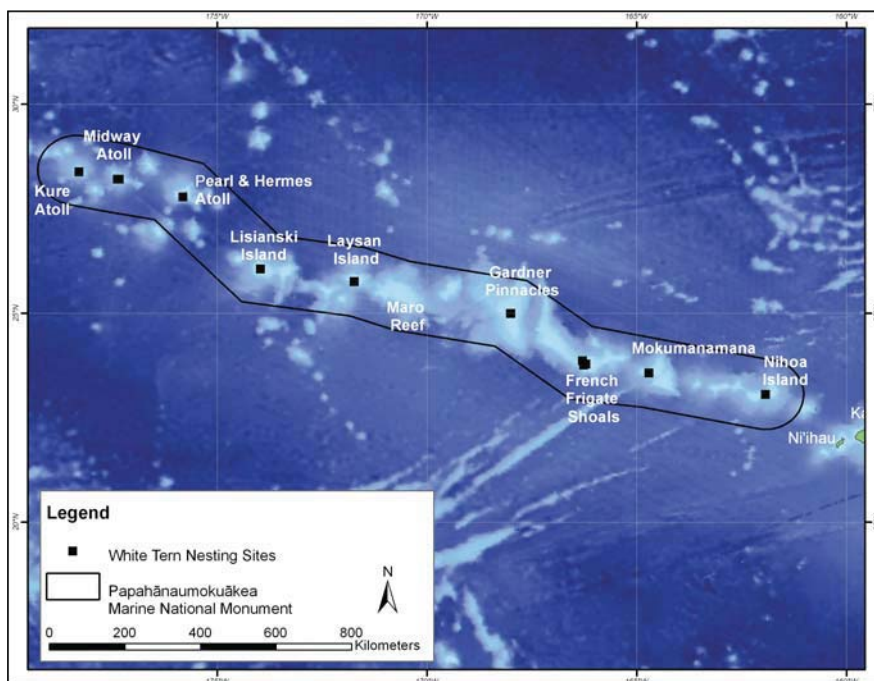


Figure 7.41. White Tern nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Sooty Tern (*Sterna fuscata oahuensis*)

The Sooty Tern is a medium-sized tern species, with a length of 36-45 cm, a wingspan of 82-94 cm, and mean body mass of 200 g (Schreiber et al., 2002). Body plumage is deep black dorsally and on the tail, with a highly-contrasting white face, throat, and underbelly. A white patch on the forehead extends to just above the eye, creating a black eyeline. The bill, legs, and feet are black (Schreiber et al., 2002; Figure 7.42).

Sooty Terns are a pantropical species. The largest colonies in the NWHI occur at Laysan Island and Lisianski Island. Baker and Jarvis support equally large populations (USFWS, 2005; Figure 7.43). Sooty Terns breed on all islands and atolls in the NWHI, with eggs laid between March and July and chicks present from April to September.

Sooty Tern foraging distances have been calculated to be 740 km (USFWS, unpublished data) during the breeding season and 5,000 km during nonbreeding season (Figure 7.43). Sooty Terns feed by surface dipping, and main prey species include squid, goatfish, flying fish and mackerel scad (USFWS, 2005).

Introduced predators are a major threat to Sooty Terns. While rats have been eradicated from the NWHI, cattle egrets continue to take chicks at Midway Atoll (USFWS, 2005). In addition to introduced predators, native predators such as Great Frigatebirds and Laysan Finches also prey on Sooty Tern eggs and chicks.



Figure 7.42. A Sooty Tern at Tern Island, French Frigate Shoals. Photo: C. Gregory.

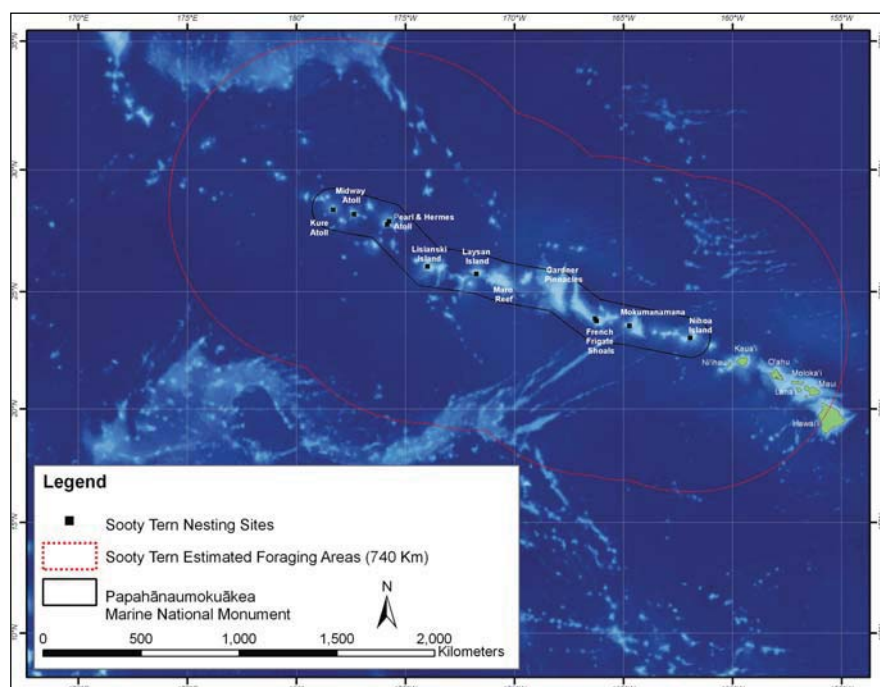


Figure 7.43. Sooty Tern nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Gray-Backed Tern (*Sterna lunata*)

Gray-backed Terns are a medium-sized Tern, with a length of 35-38 cm and body mass of 95-145 g. The upper wings, back, and tail are slate-gray, and the throat, belly, and underwings are white. The head is white with a full black cap and black eyeline, and the bill, legs, and feet are black (Mostello et al., 2000; Figure 7.44).

Gray-backed Terns are found in the tropical and subtropical Pacific, with the largest breeding colonies at Lisianski Island, Nihoa Island and Laysan Island. Smaller colonies are found on Johnston, Wake and Jarvis (USFWS, 2005). Gray-backed Terns nest on all islands and atolls in the NWHI, with eggs laid from March to July, and chicks present from April to September (Figure 7.45).

Gray-back Terns have been estimated to forage up to 370 km from land, which includes areas outside of the Monument (USFWS, 2005; Figure 7.45). Gray-backed Terns feed by hovering and dipping; prey species include five-horned cowfish, juvenile flying fish, goatfish, herring and dolphinfish. Additional prey include squid, crustaceans, mollusks, and marine and terrestrial insects (USFWS, 2005).

As with other seabird species, habitat destruction and disturbance are the greatest threats to this species in the NWHI (USFWS, 2005).



Figure 7.44.. Gray-backed Tern. Photo: F. Starr.

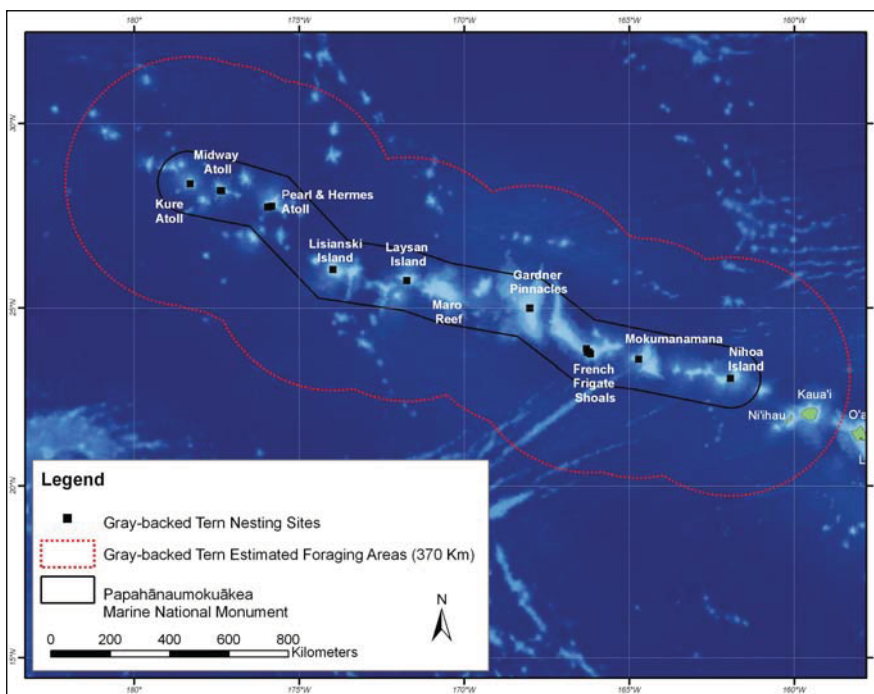


Figure 7.45. Gray-backed Tern nesting sites and foraging areas in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

Little Tern (*Sterna albifrons sinensis*)

The distribution of Little Terns (Figure 7.46) is pantropical; however, populations in the NWHI are very small and have been found only at Pearl and Hermes and Midway Atolls (USFWS, 2005), and French Frigate Shoals (A. Anders, pers. comm.; Figure 7.47). Little Terns breed in the spring.

During the breeding season, the species stays within 3 km of the breeding colonies while foraging. Little Terns are shallow-water plunge divers, with a diet consisting of small fish, crustaceans, insects, annelids and mollusks (USFWS, 2005).

Habitat destruction and disturbance are two of the threats faced by Little Terns. The breeding-season foraging range is completely protected within the boundaries of the Monument.



Figure 7.46. Little Tern. Photo: D. Mason, www.realbirder.com.

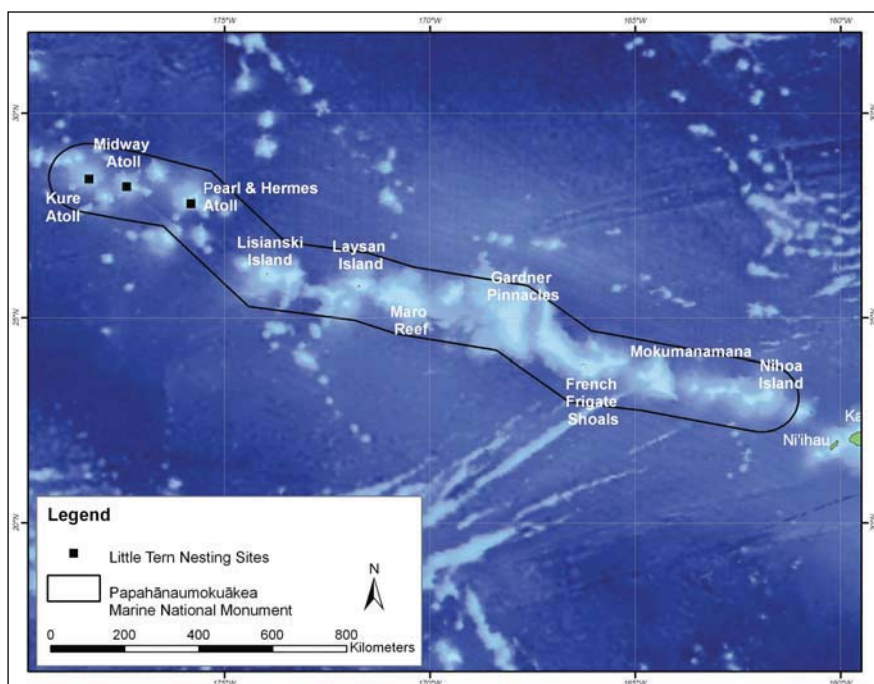


Figure 7.47. Little Tern nesting sites in the NWHI. Source: USFWS, unpub. data; map: K. Keller.

POPULATION STATUS AND TRENDS

Available Data

Large-scale monitoring of seabird populations in the NWHI began in the early 1960s, with the Smithsonian Institution's Pacific Ocean Biological Survey Program (POBSP). This program was followed by Tripartite Cooperative Agreement Studies in the late 1970s and early 1980s, and by the current long-term monitoring program initiated in 1980 by the USFWS at French Frigate Shoals, Midway Atoll and Laysan Island. The current USFWS seabird monitoring program provides information on seabird populations over time within French Frigate Shoals, Midway and Laysan, but geographical comparisons are difficult, as data collection methods have differed across these locations.

Pacific Ocean Biological Survey Program

The POBSP was conducted throughout the Pacific by the Smithsonian Institution from 1963-1970. The Smithsonian's surveys included at-sea bird observations, as well as breeding population counts and banding on islands and atolls within the NWHI from 1963-1968 (King, 1974). The resulting data provide a general baseline for five species of seabirds that breed on Nihoa, Mokumanamana, French Frigate Shoals, Lisianski, Laysan, Pearl and Hermes Atoll, Midway Atoll and Kure Atoll, including Laysan and Black-footed Albatrosses, Wedge-tailed Shearwaters, Red-tailed Tropicbirds and Sooty Terns (Table 7.4). Because the POBSP breeding population size data presented in King (1974) were not well documented in terms of the types and timing of the counts, it is not entirely clear if population estimates were total number of individuals or number of breeding pairs. It is thus difficult to compare the 1960s data to current population size estimates. However, the POBSP data do allow for general comparisons of population sizes between islands and atolls for the time period during which those data were collected (Table 7.5).

Table 7.4. Smithsonian Institution Pacific Ocean Biological Survey Program Survey Sites.

SITE	BLACK-FOOTED ALBATROSS (<i>Phoebastria nigripes</i>)	LAYSAN'S ALBATROSS (<i>Phoebastria immutabilis</i>)	RED-TAILED TROPICBIRD (<i>Phaethon rubricauda rothschildi</i>)	SOOTY TERN (<i>Sterna fuscata oahuensis</i>)	WEDGE-TAILED SHEARWATER (<i>Puffinus pacificus chlororhynchus</i>)
French Frigate Shoals	X	X	X	X	X
Kure	X	X	X	X	X
Laysan	X	X	X	X	X
Lisianski	X	X	X	X	X
Midway	X	X	X	X	X
Mokumanamana	X	X	X	X	X
Nihoa	X	X	X	X	X
Pearl and Hermes	X	X	X	X	X

Table 7.5. POBSP Seabird Population Survey Results.

SITE	SPECIES	SCIENTIFIC NAME	COMMON NAME	DATE	LOW VALUE	HIGH VALUE	UNITS
Lisianski	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	8,000	10,000	Largest number of breeders
Nihoa	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	38	Largest number of breeders
Kure	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	3,200	Largest number of breeders
MMM	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	1,650	Largest number of breeders
FFS	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	1,000	Largest number of breeders
Midway	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	110,000	Largest number of breeders
Laysan	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	300,000	500,000	Largest number of breeders
Pearl and Hermes	LAAL	<i>Phoebastria immutabilis</i>	Laysan Albatross	1963-1968	--	30,000	Largest number of breeders
MMM	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	375	Maximum number of breeding birds recorded
FFS	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	3,100	Maximum number of breeding birds recorded
Laysan	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	40,000	Maximum number of breeding birds recorded
Nihoa	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	100	Maximum number of breeding birds recorded
Lisianski	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	4,000	Maximum number of breeding birds recorded
Pearl and Hermes	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	9,000	Maximum number of breeding birds recorded
Midway	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	24,000	Maximum number of breeding birds recorded
Kure	BFAL	<i>Phoebastria nigripes</i>	Black-footed Albatross	1963-1968	--	1,150	Maximum number of breeding birds recorded
MMM	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	2,000	Maximum number recorded
Kure	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	6,230	Maximum number recorded
MMM	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	50,000	Maximum number recorded
Midway	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	353,000	Maximum number recorded
Laysan	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	2,000,000	Maximum number recorded
Nihoa	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	100,000	Maximum number recorded
Pearl and Hermes	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	22,400	Maximum number recorded
Laysan	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	200,000	Maximum number recorded
FFS	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	250,000	Maximum number recorded
Pearl and Hermes	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	40,110	Maximum number recorded
Nihoa	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	25,000	Maximum number recorded
Kure	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	48,000	Maximum number recorded
Lisianski	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	60,000	Maximum number recorded
Lisianski	SOTE	<i>Sterna fuscata oahuensis</i>	Sooty Tern	1968	--	1,000,000	Maximum number recorded
Midway	WTSH	<i>Puffinus pacificus chlororhynchus</i>	Wedge-tailed Shearwater	1963-1968	--	3,000	Maximum number recorded

Table 7.5. (continued). POBSP Seabird Population Survey Results.

SITE	SPECIES	SCIENTIFIC NAME	COMMON NAME	DATE	LOW VALUE	HIGH VALUE	UNITS
Nihoa	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	500	Maximum population estimates
Kure	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	2,500	Maximum population estimates
MMM	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	200	Maximum population estimates
FFS	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	225	Maximum population estimates
Laysan	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	4,000	Maximum population estimates
Pearl and Hermes	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	165	Maximum population estimates
Lisianski	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	3,000	Maximum population estimates
Midway	RTTR	<i>Phaethon rubricauda rothschildi</i>	Red-tailed Tropicbird	1963-1968	--	7,500	Maximum population estimates

Island/atoll abbreviations: MMM = Mokumanamana, FFS = French Frigate Shoals

Species abbreviations: LAAL = Laysan's Albatross; BFAL = Black-footed Albatross; WTSH = Wedge-tailed Shearwater; SOTE = Sooty Tern; WTSH = Wedge-tailed Shearwater; RTTR = Red-tailed Tropicbird

Tripartite Cooperative Agreement Studies

In 1975, the National Marine Fisheries Service, USFWS, and Hawaii Division of Aquatic Resources (then known as Division of Fish and Game) established a five-year Tripartite Cooperative Agreement to conduct surveys and assessments of the NWHI (Grigg and Tanoue, 1984). One of the publications resulting from this cooperative agreement included a summary of the seabird research that had been conducted in the northwestern islands, and included information on 18 species of seabirds that breed in the northwestern chain. From 1978 to 1982, USFWS conducted field studies of variable length (from five weeks to year-around) at Nihoa Island, French Frigate Shoals, Laysan Island and Lisianski Island. In addition, short field trips were conducted to most of the other islands and atolls, but these shorter trips did not produce detailed population evaluations. The data presented in the Tripartite Cooperative Agreement Studies report is a combination of POBSP data and the field data collected from 1978–1982. The report is limited in use for biogeographic comparisons between islands/atolls because the dates and methods of data collection were not reported, but it is possible to use the data as a baseline for seabird breeding population sizes within islands and atolls (Fefer et al., 1984).

USFWS Seabird Monitoring Program

The USFWS has been conducting seabird monitoring at French Frigate Shoals and Midway Atoll since 1980. Various levels of population monitoring have been conducted at French Frigate Shoals for each of the following species: Laysan Albatrosses, Black-footed Albatrosses, Bonin Petrels, Bulwer's Petrels, Wedge-tailed Shearwaters, Christmas Shearwaters, Tristram's Storm-petrels, Red-footed Boobies, Masked Boobies, Great Frigatebirds, Red-tailed Tropicbirds, Black Noddies, Brown Noddies, White Terns and Gray-backed Terns. Monitoring at Laysan Island also occurs once a year, where data are collected on Laysan Albatrosses, Black-footed Albatrosses, Red-footed Boobies and Great Frigatebirds (data from 1992-present are currently available). As time and funding allow, periodic monitoring also occurs on the other islands and atolls in the NWHI. The long-term data sets from French Frigate Shoals, Midway Atoll and Laysan Island provide information about the variability of the seabird populations within each of those islands/atolls over the past 27 years, but because monitoring methods have differed between locations, inter-island or-atoll comparisons for biogeographic assessment are limited. As a first step toward future biogeographic analysis, data layers of presence and absence of species are presented here, as are a subset of results from the long-term seabird monitoring program at French Frigate Shoals and Midway Atoll. Table 7.5 also indicates the types of monitoring data that have been collected at each island and atoll.

USFWS Monitoring at French Frigate Shoals

Methods

Since 1980, the USFWS has conducted field monitoring on Tern Island, French Frigate Shoals, to estimate the minimum number of breeding pairs and annual reproductive success of a subset of the seabird species that breed on the island. Beginning in 1980-1981, minimum numbers of breeding pairs and reproductive success were estimated annually for Laysan and Black-footed Albatrosses, Red-footed Boobies, Red-tailed Tropicbirds, Black Noddies, and White Terns (Dearborn et al., 2001). USFWS has since expanded the monitoring program on Tern Island, such that minimum numbers of breeding pairs are now estimated annually, as of 2008, for Laysan Albatrosses, Black-footed Albatrosses, Christmas Shearwaters, Bulwer's Petrels, Tristram's Storm-petrels, Red-footed Boobies, Masked Boobies, Great Frigatebirds, Red-tailed Tropicbirds, Black Noddies, Brown Noddies, White Terns and Gray-backed Terns (USFWS, 2008). In addition, annual reproductive success is now monitored for Laysan and Black-footed Albatrosses, Bulwer's Petrels, Tristram's Storm-petrels, Red-footed Boobies, Masked Boobies, Red-tailed Tropicbirds and Black Noddies (USFWS, 2008).

Estimation of the minimum number of pairs breeding on Tern Island varies by species, depending primarily upon population size and the level of breeding synchrony exhibited by the species. For the Procellariiformes, including Laysan and Black-footed Albatrosses, Christmas Shearwaters, Bulwer's Petrels, and Tristram's Storm-petrels, population sizes are relatively small, and breeding synchrony is high. For these reasons, the number of breeding pairs nesting on Tern Island are counted directly each year for each of these species (numbers of breeding pairs of Laysan and Black-footed Albatrosses are also directly counted each year at all other islands within French Frigate Shoals, such that the number of breeding pairs for the entire atoll can be estimated for these two species). In contrast, breeding within the Pelecaniformes and Charadriiformes species is highly asynchronous, and population sizes are larger, such that direct counts of breeding pairs are not possible (with the exception of Masked Boobies, for which all breeding adults on Tern Island are banded, and the breeding population consists of only a few hundred pairs; A. Anders, pers. comm.). For these species, estimates of the minimum numbers of breeding pairs are based upon mean incubation count nest censuses: for each species, a count of all nests at which an adult is incubating is conducted at a periodicity that equals the mean incubation length for that species. For example, the mean incubation length of Great Frigatebirds is 55 days, so a count of all nests at which an egg is being incubated is conducted every 55 days (USFWS, 2008). Summing the mean incubation counts over an entire year then provides information on the minimum number of breeding pairs that attempted to nest in that year (the estimate is a minimum, as some nests are initiated and fail between mean incubation count periods, so these failed breeding pairs are not counted; there is also some error introduced by the fact that within some species, individuals or breeding pairs may attempt to re-nest after nest failure within a year).

Finally, annual reproductive success is also monitored based upon species' population sizes and level of breeding synchrony. For Laysan Albatrosses, Black-footed Albatrosses, Bulwer's Petrels, Tristram's Storm-petrels, Masked Boobies, White Terns, and Gray-backed Terns, breeding populations are small enough and/or breeding is synchronous enough that virtually all nests on Tern Island are monitored to obtain an annual estimate of nesting success. In contrast, for Red-footed Boobies, Red-tailed Tropicbirds, and Black Noddies, nests are monitored year-around within multiple randomly-chosen permanent plots on Tern Island, with all nests in all plots being checked every two to four days for failure, hatching, or fledging (Dearborn and Anders, 1996). For each of these species, the reproductive success plots include approximately 20-30% of all nests on Tern Island for that particular species (Dearborn et al., 2001). Randomly-chosen permanent nest monitoring plots were also set up for Laysan and Black-footed Albatrosses beginning in 2006, in order to obtain more precise estimates of nesting success on Tern Island for these two species (USFWS, 2008; A. Anders, pers. comm.). For all species, nest monitoring methods provide data for annual estimates of hatching success, fledging success, and overall reproductive success for each species monitored. Estimates of minimum numbers of breeding pairs and for hatching, fledging, and overall reproductive success are available for all monitored species from 1996 through the present from the Pacific Seabird Monitoring Database (Pacific Seabird Group and USGS, Alaska Biological Science Center, 2007).

Results

The following figures (Figure 7.48) indicate the minimum numbers of breeding pairs of Laysan Albatrosses and Black-footed Albatrosses each year at all islands within French Frigate Shoals from 1960 – 2007 (1962 data: Rice and Kenyon, 1962; 1960-1983 data: Harrison et al., 1983; 1980-2007 data: Pacific Seabird Group and USGS, 2007). For both species, breeding population size varies annually, but both species have exhibited population increases at French Frigate Shoals since 2004.

Estimates of the minimum numbers of breeding pairs on Tern Island, French Frigate Shoals are presented in Figure 7.49 for Bulwer's Petrels, Christmas Shearwaters, Red-footed Boobies, Masked Boobies, Red-tailed Tropicbirds, Great Frigatebirds, Black Noddies, Brown Noddies, White Terns and Gray-backed Terns from 1996 – 2006 (Pacific Seabird Monitoring Database, 2008). In 2006, Bulwer's Petrel nest boxes were temporarily relocated during building construction on Tern Island, such that only natural crevices were available for nesting for this species in that year. The number of Christmas Shearwater breeding pairs appears to have declined in 2002-2006 relative to 1996-2001, and numbers of Masked Booby breeding pairs increased steadily over the 11-year period shown. All other species' breeding population sizes have fluctuated annually or remained stable from 1996-2006.

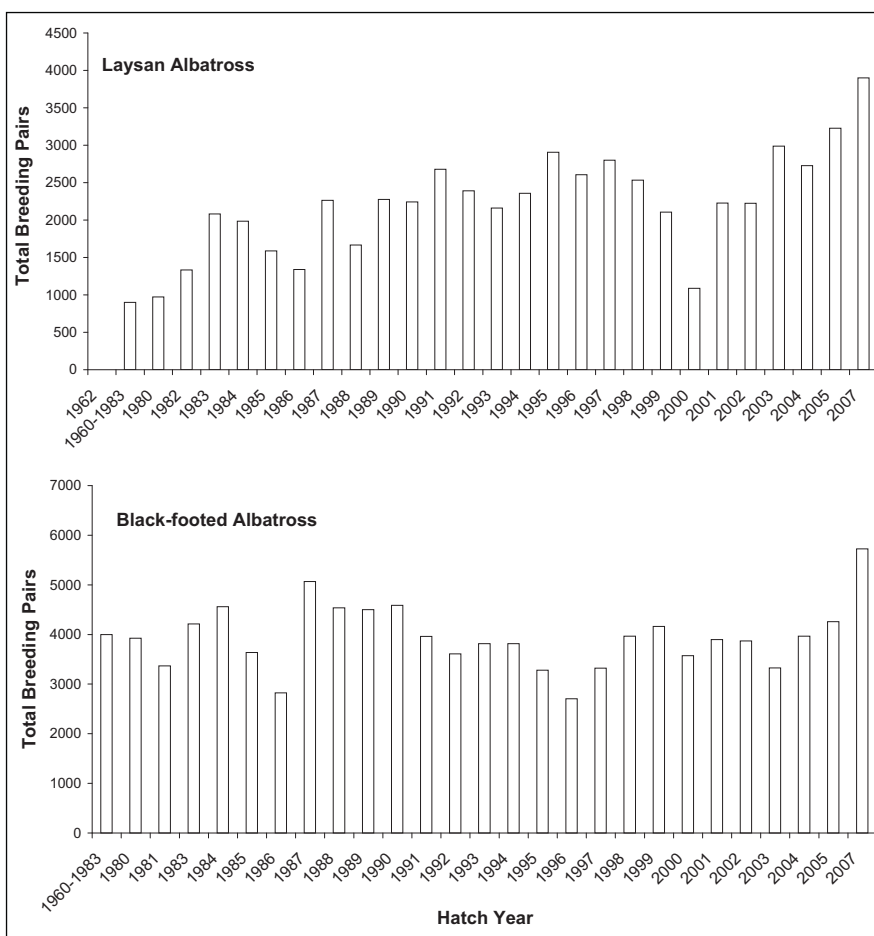


Figure 7.48. The minimum numbers of breeding pairs of Laysan Albatrosses and Black-footed Albatrosses each year at all islands within French Frigate Shoals from 1960 – 2007. Sources: Rice and Kenyon, 1962; Harrison, 1983; Pacific Seabird Monitoring Database, 2008.

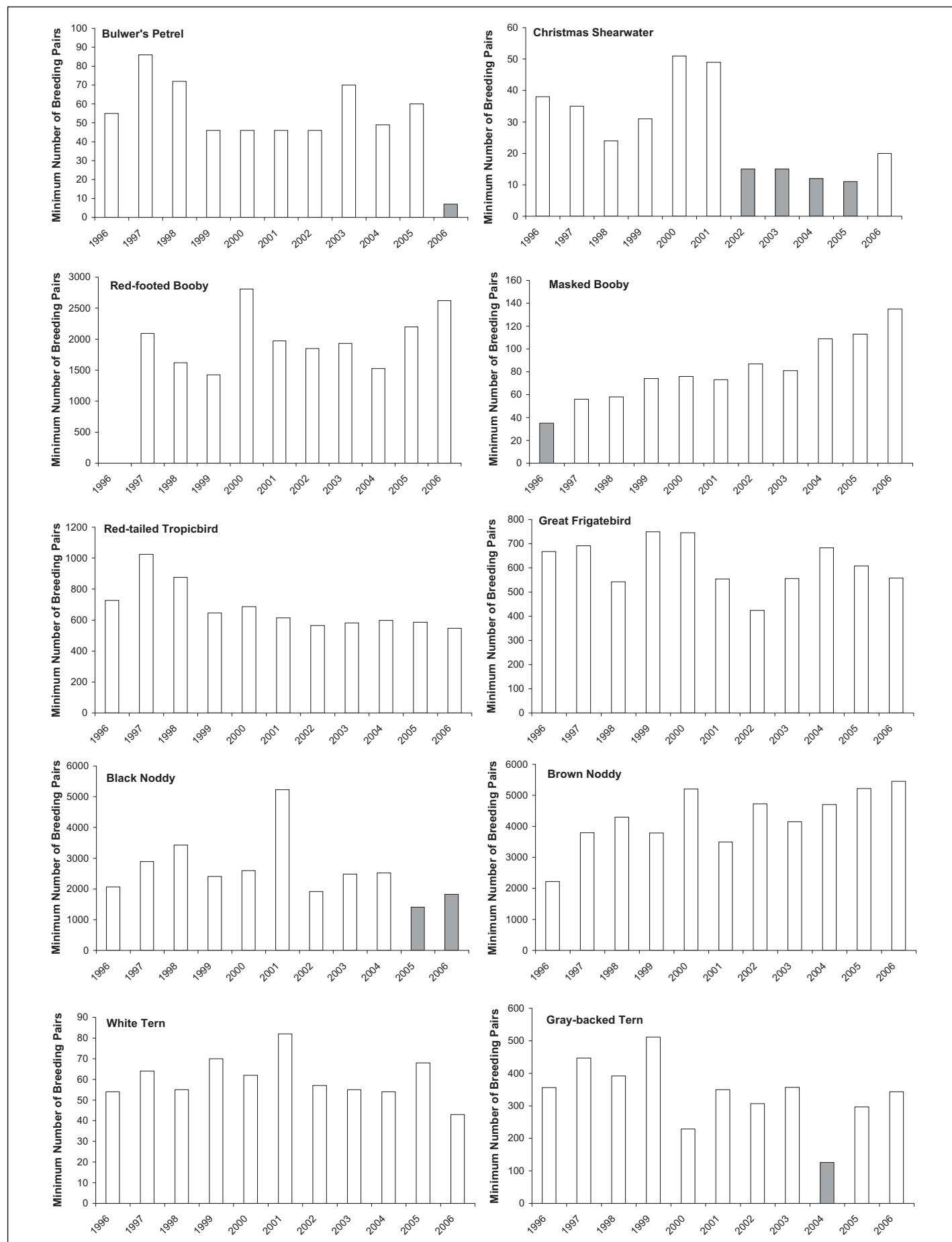


Figure 7.49. Estimates of the minimum numbers of breeding pairs on Tern Island, French Frigate Shoals from 1996-2006. Source: Pacific Seabird Monitoring Database, 2007.

Reproductive Success

Annual nesting success (total number of chicks fledged/total number of eggs laid) from 1996 – 2006 is presented in Figure 7.50 below for Laysan and Black-footed Albatrosses, Bulwer's Petrels, Red-footed Boobies, Masked Boobies, Red-tailed Tropicbirds, Black Noddies, and Gray-backed Terns. Black-footed Albatross reproductive success has remained relatively stable – between approximately 70-80% - over the 11-year period, while Laysan Albatross success has been lower and more variable – between 30% and just over 70% - during the same time period. Reproductive success for Red-tailed Tropicbirds and Gray-backed Terns appears to have declined substantially after the 1996 and 1997 breeding seasons, while all other species' nesting success fluctuated annually over that time period. Cause of the extremely low reproductive success for Black Noddies in 2002 is unknown, although for all species, overall nesting success is tied very closely to food availability in any given year (2002-2003 was an El Niño year, such that food availability may have been low for some sea-bird species during that time).

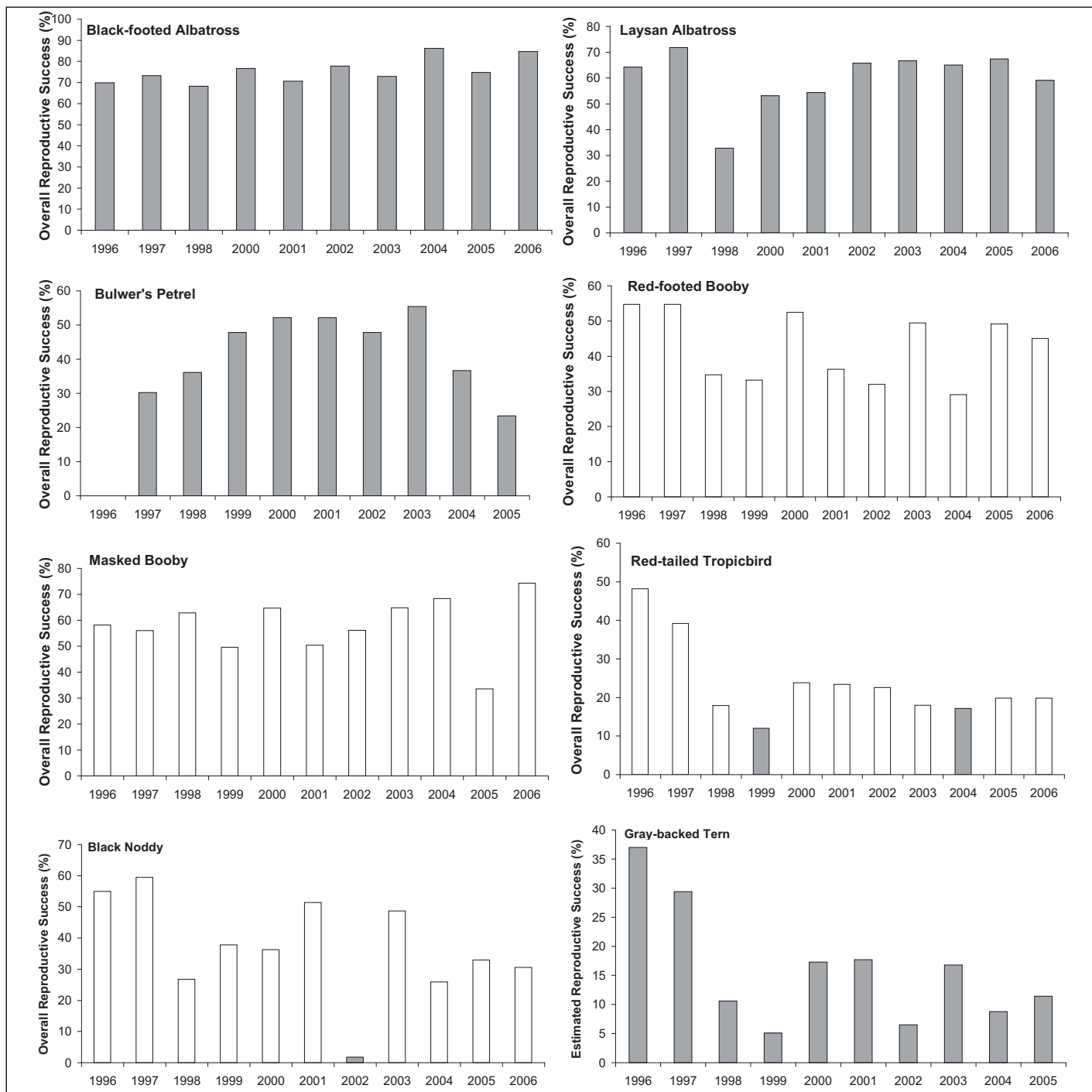


Figure 7.50. Annual nesting success (total number of chicks fledged/total number of eggs laid) from 1996 – 2006. Source: Pacific Seabird Monitoring Database, 2007.

USFWS Monitoring at Midway Atoll Methods

Laysan and Black-footed Albatross nests have been counted at Midway Atoll since 1991, and beginning in 1997, reproductive success of both species has been monitored. Hatching success, fledging success, and overall reproductive success, have been estimated for both species from 2002 – 2008 (Klavitter et al., 2009). Red-tailed Tropicbird population parameters have also been studied at Midway Atoll since 1997, including reproductive success, adult survival, and overall population trends (Laniawe and Klavitter, 2009; Laniawe, 2008). Seabird monitoring at Midway also currently includes population monitoring of Short-tailed Albatrosses, Brown Boobies, Masked Boobies, Bulwer's Petrels, Tristram's Storm-petrels, Least Terns and Little Terns (J. Klavitter, pers. comm.).

Results

Results of Laysan and Black-footed Albatross nest monitoring from 2002-2008 are presented in Figure 7.51. For this seven-year period, mean Laysan Albatross hatching success was 82% and fledging success was 85%, leading to an overall reproductive success of 69%. Black-footed Albatrosses had similar population parameters, with a hatching success of 83%, fledging success of 83%, and overall reproductive success of 70% for the entire time period. In analyzing reproductive parameters between species and years, Black-footed Albatrosses had a slightly higher hatching success than Laysan Albatrosses, but the two species had similar fledging and overall reproductive success rates (Klavitter et al., 2009).

The results of Red-tailed Tropicbird population monitoring at Midway Atoll from 1997-2007 are presented in Figure 7.52. Hatching, fledging, and overall reproductive success, as well as adult survival, varied between years, but for the entire 11-year period, reproductive success was 41%, and adult survival was 70%. These reproductive and survival rates led to an overall population trend of 0.82 for this time period, indicating that the Red-tailed Tropicbird population at Midway Atoll was declining during this time (Laniawe and Klavitter, 2009; Laniawe, 2008).

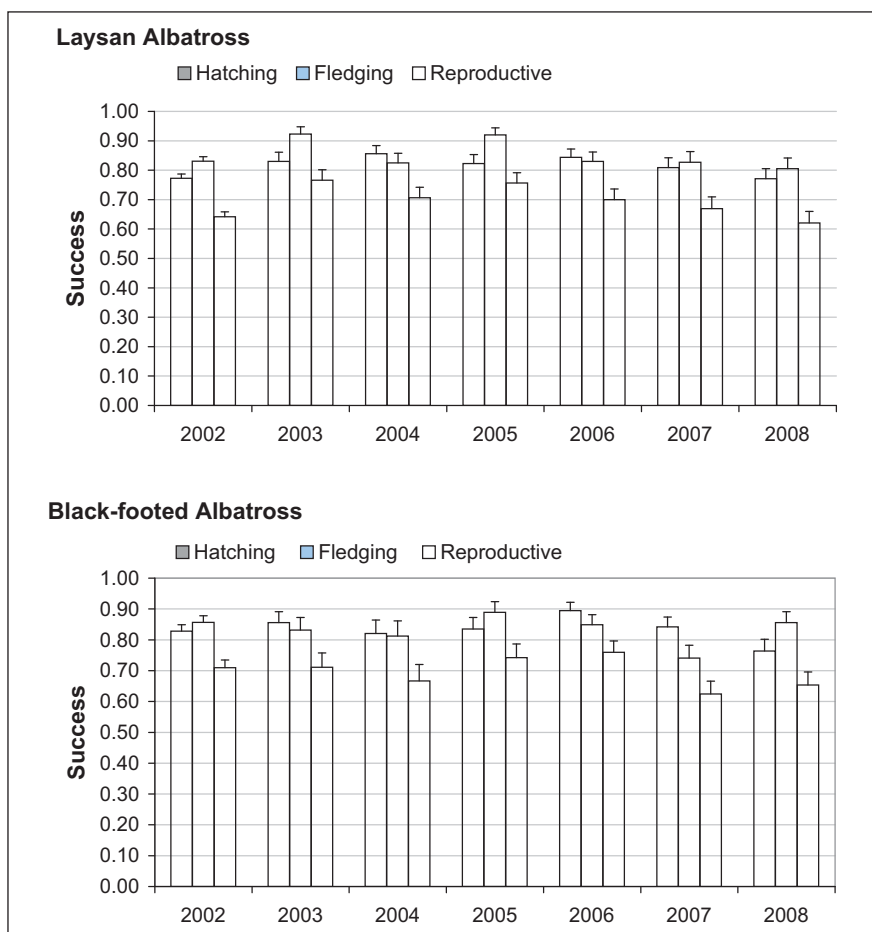


Figure 7.51. The top panel shows Laysan Albatross hatching, fledging, and overall reproductive success at Midway Atoll from 2002-2008. The bottom panel Black-footed Albatross hatching, fledging, and overall reproductive success at Midway Atoll from 2002-2008. Source: Klavitter et al., 2009.

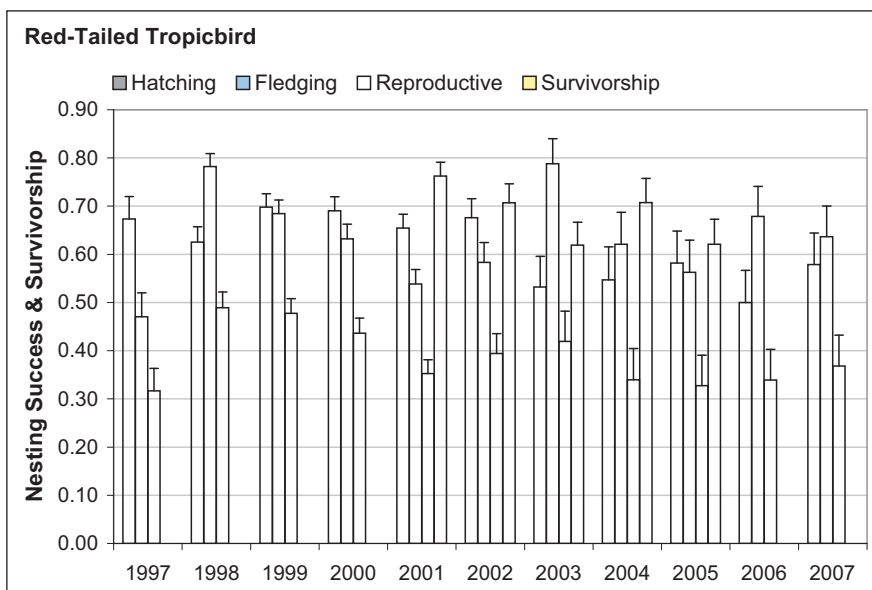


Figure 7.52. Red-tailed Tropicbird reproductive success and survival estimates for Midway Atoll from 1997-2007. Source: Laniawe and Klavitter, 2009.

EXISTING DATA GAPS

Spatial Distribution

Limiting the population monitoring data to three of the islands/atolls within the NWHI reduces our ability to analyze population productivity, survival and community composition across the archipelago. The remoteness, year-around breeding, and underground nesting habits of some of the petrel species make breeding seabird surveys at all of the islands within the Monument logistically difficult. Nest density calculations at the various islands, along with information regarding available habitat (and the extent covered by introduced plants), might allow for analysis and predictions of future impacts from changing sea levels and vegetation change over time. In addition, standardized methods for monitoring reproductive success and survival at French Frigate Shoals, Laysan and Midway Atoll would allow for more comprehensive geographic comparisons of seabirds nesting within the Monument. The collection of at sea seabird survey data should be conducted on a regular basis in order to gain a better understanding of the at sea behavior and environmental conditions for foraging. Currently a single survey was conducted by the NOAA Pacific Southwest Fisheries Science Center in 2002. This type of survey needs to be conducted again and at different times of year in order to gain a better understanding of all the seabirds in the NWHI throughout the year.

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PERSONAL CONTACTS

- Anders, A. Clancy Environmental Consultants. Honolulu, HI, USA.
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