Status and conservation of North Pacific albatrosses

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Abstract

Three species of albatrosses are distributed in the Temperate North Pacific Ocean: the Laysan *Diomedea immutabilis*, the Black-footed *D. nigripes*, and the Short-tailed *D. albatrus* albatrosses. The world's breeding population of Laysan Albatrosses is estimated at 380 000 pairs with a total population of nearly 2.5 million birds. There are an estimated 200 000 Black-footed Albatrosses, with a breeding population of approximately 50 000 pairs. In contrast, there are only an estimated 575 individual Short-tailed Albatrosses worldwide and a current breeding population of about 123 pairs. Although this is still a perilously small population, the number of Short-tailed Albatrosses has increased more than 10-fold over the past 50 years. The marine distribution (current and historical) of all three species covers most of the Temperate North Pacific Ocean, including, to a certain degree, coastal regions.

Résumé

Les zones tempérées du Pacifique Nord sont fréquentées par trois espèces d'albatros : l'Albatros de Laysan *Diomedea immutabilis*, l'Albatros à pattes noires *D. nigripes* et l'Albatros à queue courte *D. albatrus*. Dans le monde entier, on évalue le nombre d'Albatros de Laysan nicheurs à 380 000 couples, pour une population totale d'environ 2,5 millions d'individus. Ces chiffres sont considérables quand on les compare aux 50 000 couples d'Albatros à pattes noires (200 000 individus) et encore plus considérables quand on les compare aux 123 couples d'Albatros à queue courte (575 individus). Malgré ces chiffres qui indiquent que l'espèce est toujours en péril, le nombre d'Albatros à queue courte a plus que décuplé au cours des 50 dernières années. Actuellement et historiquement, les trois espèces d'albatros sont réparties dans presque toutes les zones tempérées du Pacifique Nord, y compris, dans une certaine mesure, les régions côtières.

1. Introduction

Three species of albatrosses breed in or adjacent to the Temperate North Pacific: the Laysan Albatross *Diomedea immutabilis*, the Black-footed Albatross *D. nigripes*, and the Short-tailed Albatross *D. albatrus*. We define the Temperate North Pacific (TNP) as those waters north of the Tropic of Cancer (23°27′N) to the Bering Sea. However, because the majority of the nesting islands are situated south of the Tropic of Cancer, and because their pelagic wanderings often take these birds well beyond the boundaries of the TNP, we have extended the geographical extent of our discussion.

In the late 19th and early 20th centuries, albatross feathers were the preferred feather of the millinery trade. During that period, feather hunters slaughtered millions of albatrosses (Rice and Kenyon 1962). Although Laysan and Black-footed albatrosses suffered great losses, and were extirpated from many islands (Bryan 1906; Kuroda 1954; Rice and Kenyon 1962), Short-tailed Albatrosses were most affected. It is estimated that between 1887 and 1903, more than five million of this species were taken. Egg collecting further accelerated their decline and, as a result, by the 1940s it was thought that the Short-tailed Albatross was extinct (Austin 1949). However, nesting was rediscovered on a single island off Japan in 1950 and slowly, as a result of conservation efforts, their numbers have increased (Hasegawa and DeGange 1982).

2. Breeding range and nesting habitat

2.1. Laysan Albatross

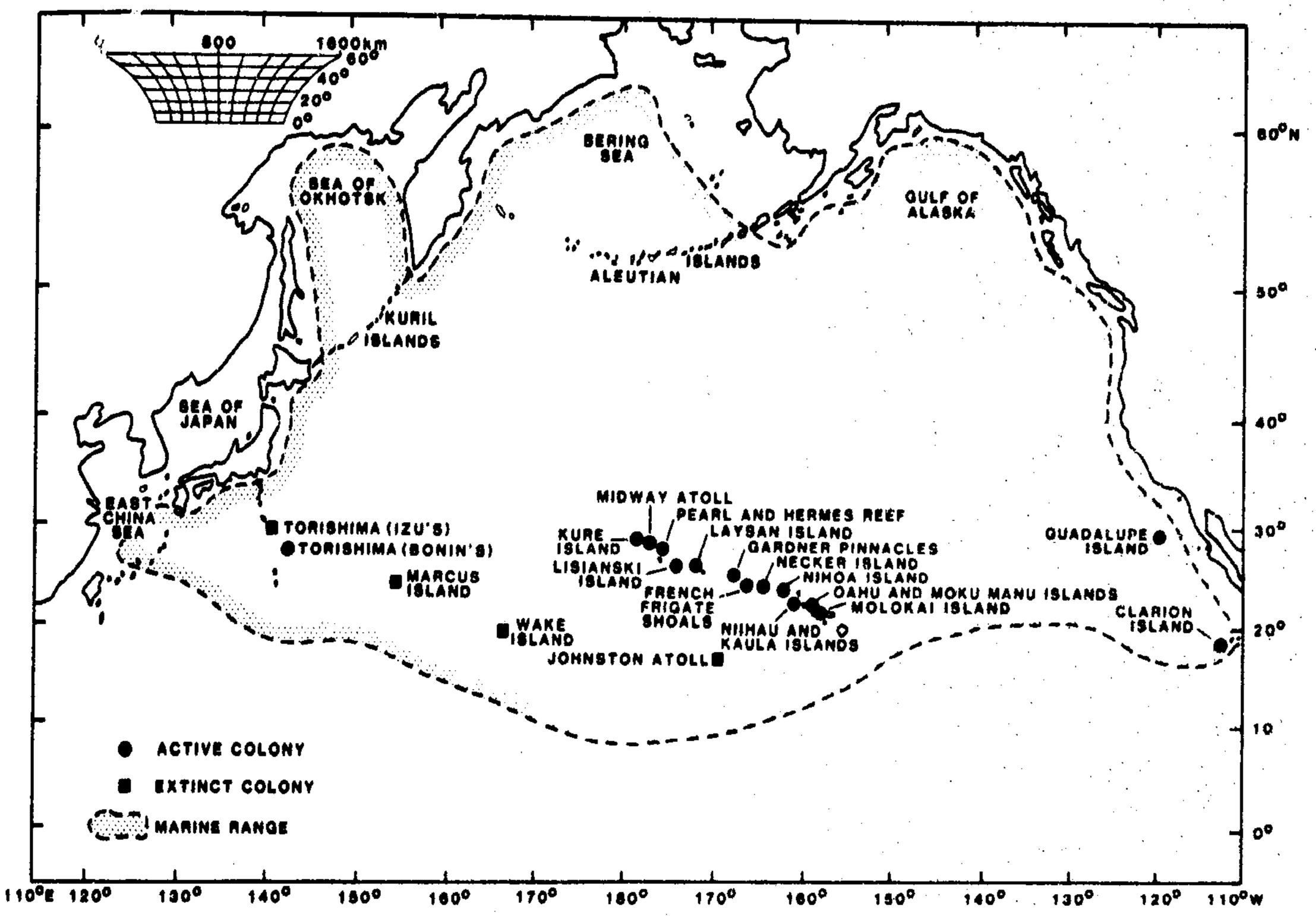
The majority of the estimated 380 000 nesting pairs of Laysan Albatrosses (worldwide) breed in the northwestern Hawaiian Islands (Fig. 1), especially on Midway Atoll, Laysan and Lisianski islands, Pearl and Hermes Reef, Kure Island, and French Frigate Shoals (Harrison 1990). They were extirpated from Torishima (in the Izu Islands), Marcus and Moku Manu islands, Johnston Atoll, and possibly Wake Island (Hasegawa 1978). In recent years they have established small breeding colonies on the main Hawaiian Islands (Moku Manu, Oahu, Kauai, Niihau, and Kaula islands; Rice 1984; Moriarty et al. 1986). In 1977, breeding was discovered on Torishima Island (in the Bonin Islands; Kurata 1978); this was the first known nesting in the western TNP since the turn of the century. Laysan Albatrosses have further extended their breeding range; in 1986, nesting was confirmed on Guadalupe Island off Baja California (Pitman 1988). In 1988, a small colony (30 birds) was discovered on Clarion Island (the Revillagigedo Islands), off the coast of Guadalajara, Mexico (Howell and Webb 1989).

Laysan Albatrosses generally nest in large colonies; the largest, on Midway Atoll, contains an estimated 200 000 pairs (Fefer et al. 1984). The nest sites chosen by this species are typically open areas with short grassy vegetation. Nests are relatively deep depressions scraped out of the sand and vegetation.

2.2. Black-footed Albatross

Out of an estimated worldwide population of 200 000 Black-footed Albatrosses, the majority of the 50 000 breeding

Figure 1
Active and extinct breeding colonies, and the approximate marine distribution of Laysan Albatrosses (all seasons combined). Adapted from Shuntov (1972), Robbins and Rice (1974), and Sanger (1974a).



pairs nest on Laysan Island, Pearl and Hermes Reef, Midway Atoll, French Frigate Shoals, and Lisianski and Kure islands (Harrison 1990). There are also small colonies on Kaula, Necker, and Nihoa islands (Fig. 2). They were extirpated from Wake and Marcus islands, Torishima, Johnston Atoll, Taongi Atoll (Marshall Islands), Muko Jima and Iwo Jima (Bonin Islands). Since the cessation of feather hunting, Torishima and Muko Jima have been recolonized, and now small colonies also occur on the southern Ryukyu Islands (Rice and Kenyon 1962; Harrison 1983; Rice 1984). The breeding population in all of the Japanese islands is estimated to be less than 1500 pairs (Hasegawa 1984). Black-footed Albatrosses tend to select exposed beach areas for their nests, which simply consist of shallow cup-like depressions in the sand.

2.3. Short-tailed Albatross

Short-tailed Albatrosses historically bred on remote, uninhabited islands in the western North Pacific and East China Sea (Hasegawa and DeGange 1982; Hasegawa 1984; Melville 1984). Harrison (1990) stated that this species was eliminated from the southern Ryukyus, Pescadores, Daitos, northern Bonins, and 10 other colonies in the southern Izus. Until recently, breeding was restricted to Torishima Island (Fig. 3). However, in 1987, nesting was confirmed on a second island: Minami-kojima in the southern Ryukyu Islands (Amaral 1988).

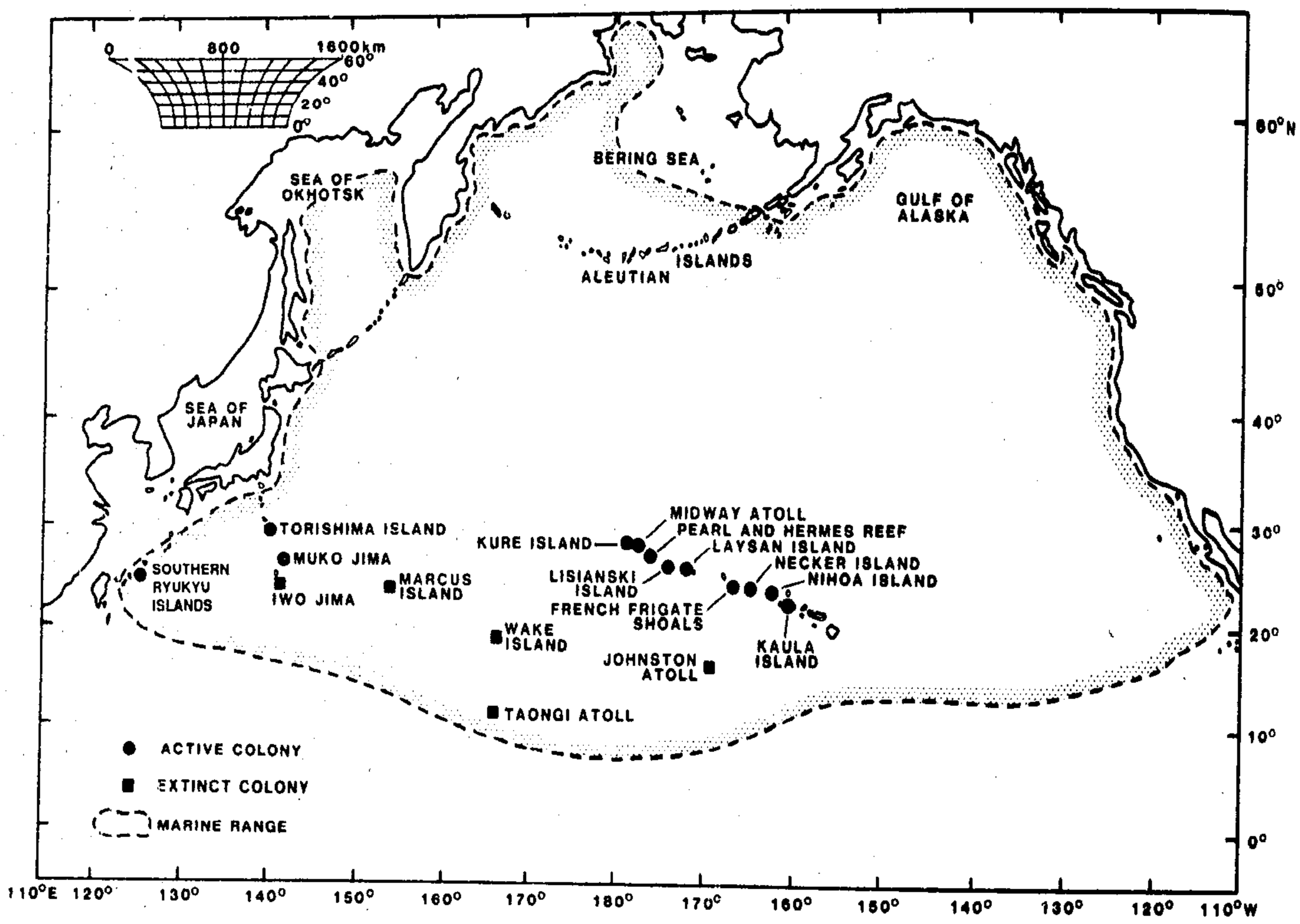
On Torishima, Short-tailed Albatrosses historically nested on level, open areas adjacent to tall clumps of grass. Volcanic eruptions have reduced the extent of this preferred habitat, and they now nest only on the open, sparsely vegetated slopes above the south coast of Torishima. During the nesting period, the vegetation is quickly trampled by the birds. With the degradation of the vegetation, the volcanic soils become destabilized and nesting birds are exposed to increasing amounts of airborne ash (Hasegawa and DeGange 1982). Nests of Short-tailed Albatrosses consist of scrapes in the ash lined with and built up with grass (Tickell in Hasegawa and DeGange 1982).

3. Population trends

3.1. Laysan Albatross

The most recent surveys of Laysan Albatross populations (1979–1982) indicate that there are approximately 380 000 breeding pairs and a total world population of nearly 2.5 million birds (Fefer et al. 1984). Earlier counts by Rice and Kenyon (1962) estimated that between 1956 and 1958 there were only 280 000 breeding pairs. Most of this perceived

Figure 2
Active and extinct breeding colonies, and the approximate marine distribution of Black-footed Albatrosses (all seasons combined). Adapted from Palmer (1962), Shuntov (1972), Robbins and Kane (1974), and Sanger (1974b).



breeding population growth has occurred in the northwestern Hawaiian Islands, especially on Midway Atoll.

Breeding survey data from Midway Atoll, Laysan Island, and French Frigate Shoals are presented in Tables 1 and 2. These locations account for almost 90% of the total breeding population (53%, 35%, and 0.3% respectively). However, because of annual breeding population fluctuations, and variations in the census techniques employed, we must caution the reader that much of the perceived population growth may be an artefact. Therefore, the following discussion should be considered as a generalized summary of the population trends.

3.1.1. Midway Atoll

When Munro visited Sand Island (Midway Atoll) in July 1891 he did not observe any fledgling albatrosses (Munro 1942, 1943). It is thought that neither Laysan nor Black-footed albatross has ever nested in high numbers on Sand Island, even prior to human settlement, primarily due to the scarcity of vegetation and the resultant continuous shifting of the sand (Bryan 1906; Hadden 1941). In contrast, Eastern Island, which is heavily vegetated to the beach, has supported many birds. Bryan (1906) observed thousands of Laysan Albatross carcasses on Eastern Island in 1902, after feather hunters had visited the island.

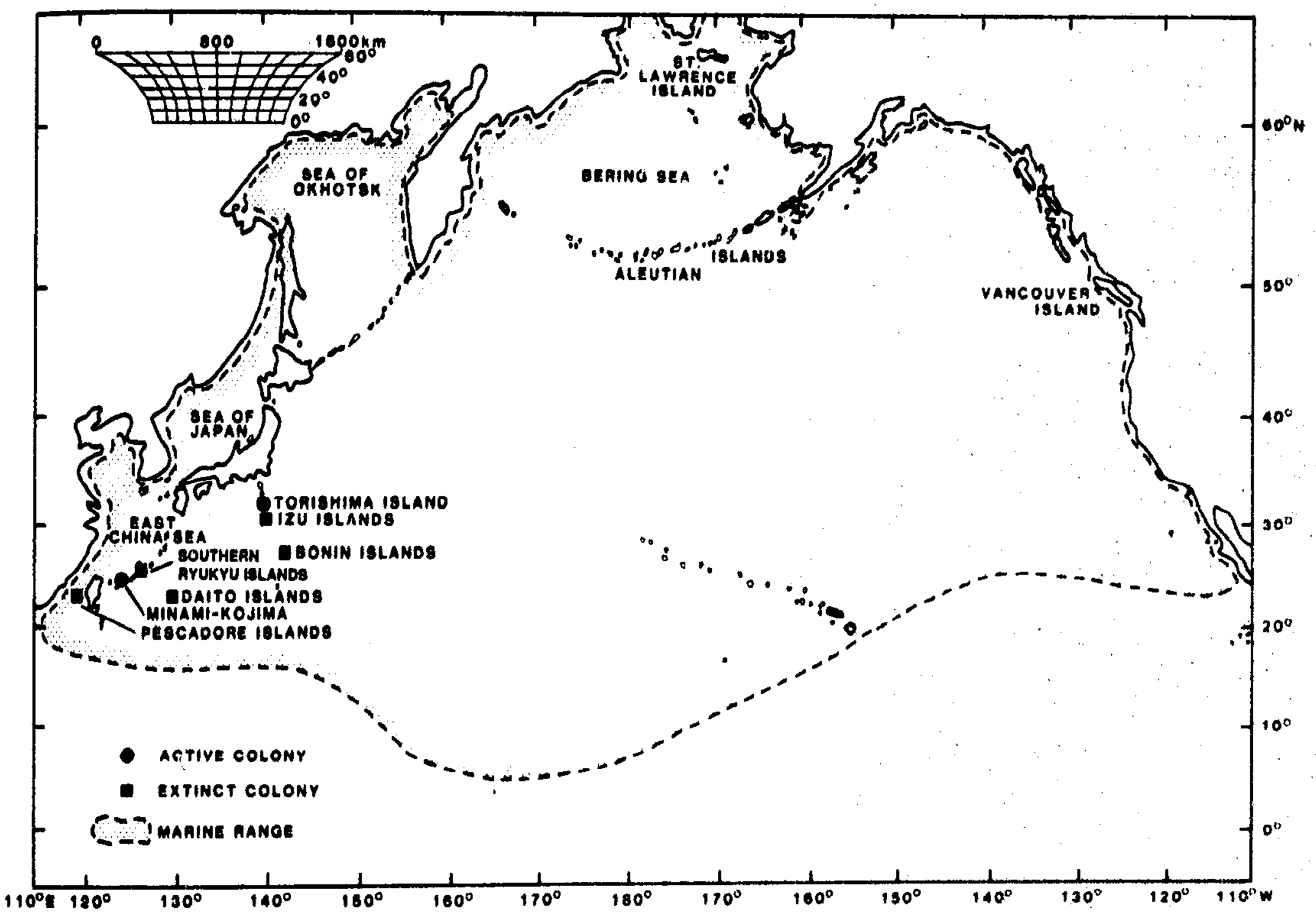
Between 1920 and 1940, there was little human disturbance at Midway Atoll (Fisher 1949) and, consequently, albatross numbers grew steadily (Table 1). The U.S. military arrived in 1940 and, by 1945, thousands of birds had been killed (Fisher 1949) and as many as 15 000 people were inhabiting the atoll (Harrison 1990). After the war ended, military activities declined, and Laysan Albatross numbers increased. The maturation of exotic vegetation also benefited this species, by providing shade and reducing the blowing sands (Rice and Kenyon 1962).

In 1957 there was a resurgence of military activities; with the increase in air traffic and higher albatross numbers, conflicts arose. Consequently, between 1957 and 1964, more than 60 000 Laysan Albatrosses were intentionally killed to reduce the number of airstrikes (Fisher 1966). Control measures stopped in 1964 and by 1981 the breeding population had returned to about 200 000 pairs.

3.1.2. Laysan Island

The earliest survey of Laysan Albatrosses on this island was a rough estimate of two million birds in the 1890s (Nutting 1903). The first systematic surveys occurred after feather hunters had visited the island (Dill and Bryan 1912); it is thus assumed that the numbers were previously much higher.

Figure 3
Active and extinct breeding colonies and the estimated historical marine distribution of Short-tailed Albatrosses (all seasons combined). Adapted from Palmer (1962).



Henshaw (1912) estimated that by 1911 at least 300 000 Laysan Albatrosses had been killed on Laysan Island. The current estimates indicate that Laysan Albatrosses have returned to approximately the 1910–11 population level, but we suggest that they have not fully recovered from the feather hunting slaughter.

3.1.3. French Frigate Shoals

Population trends at French Frigate Shoals are difficult to interpret prior to 1953 (Table 2). The 1922–23 counts were undertaken late in the season and consequently did not include mortalities that had occurred during the nesting period. Natural mortality in these colonies can be high due to their susceptibility to overwashing by storm surges (U.S. Fish and Wildlife Service [USFWS], unpubl. data). Although feather hunters also visited these islands, the number of birds taken is not known (Amerson 1971).

Between 1932 and 1942, military operations at the French Frigate Shoals utilized East Island as a base of operations, no doubt impacting upon nesting birds. From 1942 to 1952, the U.S. Coast Guard established a LORAN station on East Island, with year-round occupation; this apparently kept the number of albatrosses abnormally low (Amerson 1971). During this period, the military was transforming Tern Island from a 4.5-ha sparsely vegetated islet to a 14 ha dredge filled landing strip. The island was occupied by the Coast Guard until 1979, when the USFWS assumed management responsibilities. The USFWS's year-round presence has permitted regular counts throughout the atoll. Tern Island's population not only has increased dramatically since the earliest estimate of a few hundred pairs in 1912 (Bailey 1956), but has also gained significantly in importance relative to other colonies.

3.2. Black-footed Albatross

The most recent estimates of the number of breeding pairs of Black-footed Albatrosses took place between 1979 and 1982. USFWS surveys estimated that 50 000 pairs nest annually (Fefer et al. 1984). The population trends of Black-footed Albatrosses breeding on Laysan Island, Midway Atoll, and French Frigate Shoals are summarized in Tables 3 and 4. These islands account for 67% of the worldwide breeding population (43%, 15%, and 9% respectively).

3.2.1. Laysan Island

Population estimates of Black-footed Albatrosses at Laysan Island are not available for the period before the slaughters of 1909–10 (Ely and Clapp 1973). After the last raid in 1915, the population apparently grew steadily until the 1950s

Table 1
Estimates of breeding pairs of Laysan Albatrosses at Midway Atoll (1922–1981) and Laysan Island (1910–1980)

Season	No. of pairs	Source
Midway Atoll		
1922–23	2 800	Rice and Kenyon 1962
1944–45	55 000	Fisher and Baldwin 1946
1954–55	47 600	Dumont and Neff 1955
1956–57	104 000	Rice and Kenyon 1962
1959–60	75 000	Robbins 1966
1960–61	57 000	Robbins 1966
1961–62	71 000	Robbins 1966
1962–63	72 000	Robbins 1966
1981–82	200 000	Fefer et al. 1984
Laysan Island		
1910–11	90 000	Dill and Bryan 1912
1912–13	12 312	Bailey 1952
1950–51	103 900	Brock 1951
1956–57	131 328	Rice and Kenyon 1962
1957–58	130 554	Rice and Kenyon 1962
1979–80	132 000	Fefer et al. 1984

Table 2
Estimates of breeding pairs of Laysan Albatrosses at Tern Island and throughout the entire French Frigate Shoals (1922–1991). Numbers in parentheses are the percentage (of the total atoll birds) nesting on Tern Island.

	No. of pairs			
Season	Tern		Atoll	Source
1922–23	?		138	Rice and Kenyon 1962
1953–54	28	(4%)	700	Richardson 1954
1957–58	24	(4%)	584	Rice and Kenyon 1962
1979–80	483	(48%)	1000	Fefer et al. 1984
1982–83	797	(39%)	2026	USFWS, unpubl. data
1983–84	854	(43%)	1985	USFWS, unpubl. data
1986–87	1032	(46%)	2262	USFWS, unpubl. data
1987–88	990	(37%)	2641	USFWS, unpubl. data
1988–89	1060	(47%)	2275	USFWS, unpubl. data
1989–90	1303	(58%)	2242	USFWS, unpubl. data
1990–91	1570	(57%)	2769	USFWS, unpubl. data

Table 3
Estimates of breeding pairs of Black-footed Albatrosses at Laysan Island (1912–1979) and Midway Atoll (1922–1981)

Season	No. of pairs	Source
Laysan Island		
1912–13	7 722	Bailey 1952
1950–51	18 240	Brock 1951
1956–57	32 128	Rice and Kenyon 1962
1957–58	33 523	Rice and Kenyon 1962
1963–64	29 000	Walker 1963
1979–80	21 000	Fefer et al. 1984
Midway Atoll		
1922–23	2 000	Rice and Kenyon 1962
1944–45	26 500	Fisher and Baldwin 1946
1954–55	9 700	Dumont and Neff 1955
1956–57	6 600	Rice and Kenyon 1962
1957–58	8 521	Rice and Kenyon 1962
1959–60	2 835	Robbins 1966
1960–61	6 850	Robbins 1966
1961–62	6 900	Robbins 1966
1963–64	4 700	Robbins 1966
1981–82	7 500	Fefer et al. 1984

Table 4
Estimates of breeding pairs of Black-footed Albatrosses at Tern Island and throughout the entire French Frigate Shoals (1922–1991). Numbers in parentheses are the percentage (of the total atoll birds) nesting on Tern Island.

	No. of pairs			
Season	Tern		Atoll	Source
1922–23	?		403	Rice and Kenyon 1962
1953–54	6	(0.3%)	1700	Richardson 1954
1957–58	2	(0.1%)	1400	Rice and Kenyon 1962
1979–80	82	(2%)	3960	Fefer et al. 1984
1982–83	193	(4%)	4045	USFWS, unpubl. data
1983–84	221	(5%)	4561	USFWS, unpubl. data
1986–87	448	(9%)	5158	USFWS, unpubl. data
1987–88	451	(7%)	6210	USFWS, unpubl. data
1988–89	516	(12%)	4407	USFWS, unpubl. data
1989–90	618	(14%)	4502	USFWS, unpubl. data
1990–91	690	(18%)	3911	USFWS, unpubl. data

(Table 3). The most recent counts (1979–80 season) indicate a decline in the number of breeders. However, since there have been relatively few systematic surveys of Black-footed Albatrosses on Laysan Island, we cannot determine if this decline warrants concern, or simply reflects year-to-year variability in the number of birds, amplified by differences in the timing and survey methodologies used.

3.2.2. Midway Atoll

There are no estimates of the number of Black-footed Albatrosses nesting on Midway Atoll prior to 1903. As stated earlier, when Munro visited the atoll in July 1891, he noted both an absence of albatrosses on Sand Island and, contrastingly, high numbers on Eastern Island (Munro 1942, 1943). By 1902, poachers had visited Midway Atoll and killed thousands of birds (Bryan 1906; Hadden 1941; Fisher 1949). Bryan (1906) estimated that Black-footed Albatross carcasses outnumbered Laysan Albatrosses by roughly three to one on Eastern Island.

Although the Midway Atoll breeding population apparently increased between 1923 and the early 1940s (Table 3), undoubtedly in response to the termination of feather hunting, systematic surveys were not conducted during that period. Wartime preparations, which began in 1940, accounted for the deaths of thousands of albatrosses (Fisher 1949). The continued decline in numbers between the mid-1940s and mid-1950s was also the result of the military. Birds were killed to minimize the airstrike hazard (Fisher 1949); imported vegetation decreased their preferred open habitat (Rice and Kenyon 1962); and physical alteration of the islands reduced preferred shoreline nesting areas. Although at least 2500 Black-footed Albatrosses were intentionally killed between 1955 and 1964 (Rice 1959; Fisher 1966; Robbins 1966), the number of nesting pairs has remained relatively stable between the late 1950s and the current population.

3.2.3. French Frigate Shoals

There are no data on the number of breeding albatrosses on East Island during the period it was occupied by the military and the Coast Guard, although Amerson (1971) stated that the numbers were low. After the departure of the Coast Guard in 1952, the breeding population increased from around 80 pairs in 1949 (Amerson 1971) to 1900 in 1990 (USFWS, unpubl. data).

During the time that the military were utilizing Tern Island, the number of breeding Black-footed Albatrosses was also kept small; as late as 1969 there were fewer than 10 pairs (Amerson 1971). Following the assumption of management by the USFWS in 1979, the number of nesting pairs increased from 82 in 1979 to 690 in 1990 (Table 4).

Throughout all of the French Frigate Shoals the breeding population has increased, reaching a high of over 6200 nests in 1987. However, since that year the number of nests has decreased by 37%. A comparison of atoll-wide counts with counts from Tern Island shows that the number of

breeding birds on Tern Island is increasing, while atoll-wide counts are declining (Table 4).

It appears that Black-footed Albatross nesting populations have benefited from human impacts on the atoll. The main reason for this has been the increased land mass at Tern Island and the resultant reduced vulnerability to over-washing. However, the overall decline in the total number of breeders at French Frigate Shoals may be signalling a decline in numbers throughout its range. However, because of insufficient data from other colonies, we can only speculate and suggest that the status of Black-footed Albatrosses should be closely monitored.

3.3. Short-tailed Albatross

Short-tailed Albatross populations have increased from a period of little or no breeding and suspected extinction during the 1940s to a breeding population estimated at 123 pairs in 1990 (Hasegawa 1991). Torishima Island, the largest breeding colony, currently supports about 108 pairs. People first settled the island in 1887, and by 1900 there were at least 300 inhabitants, the majority of them harvesting albatrosses. The slaughter continued steadily until 1922, and sporadically until 1933; by that time, fewer than 50 birds remained (Hasegawa and DeGange 1982).

Between 1950 and 1977, the number of adults observed at the colony during the nesting season increased from six to 73 birds (Fig. 4)—an average growth of about 2.5 adults/year. Since 1977, the number of adults seen has dramatically increased, with an average increment of 11.0 adults/year. This suggests not only that adult survival has been high, but also that many immatures have reached breeding age. In 1990, out of 108 eggs produced, 66 juvenile Short-tailed Albatrosses fledged, for a reproductive success of 0.61 fledglings/egg laid (Fig. 4; H. Hasegawa, unpubl. data).

Hasegawa (1991) observed 10 nestlings in March of 1990 on Minami-kojima; he estimated that there were approximately 15 pairs and a total population of about 75 birds. That brings the current worldwide population of Short-tailed Albatrosses to an estimated 575 birds.

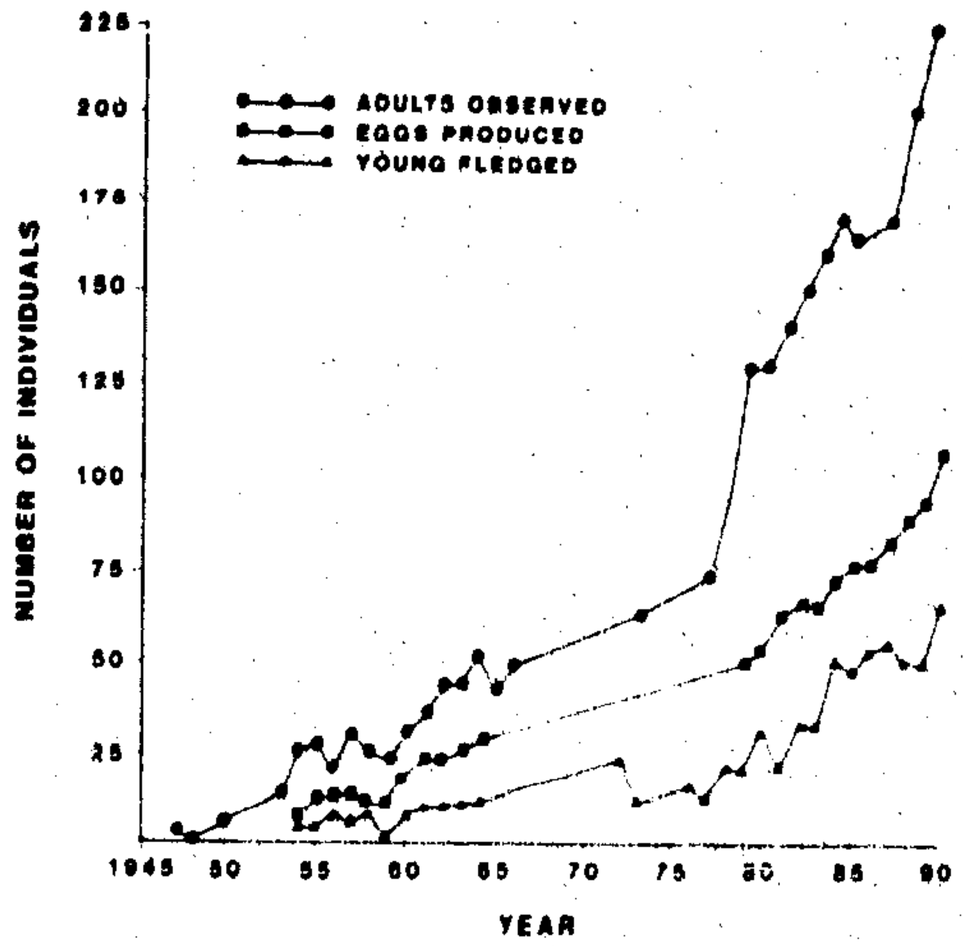
Since 1971, adult and/or immature Short-tailed Albatrosses have overwintered on several of the Hawaiian Islands (Midway Atoll, Tern and Laysan islands, and French Frigate Shoals; Hasegawa and DeGange 1982; Harrison 1990). Although it is doubted that nesting has ever occurred in the Hawaiian chain, it is possible that these birds may form the nucleus of a new colony in the future.

4. Marine distribution

4.1. Laysan Albatross

Although Laysan and Black-footed albatrosses reach sexual maturity at about seven years of age, it is estimated that less than 75% of the adults breed in a given year (Shuntov 1972). Nesting Laysan Albatrosses return to their colonies during early November, whereas subadults return between December and May (Fisher and Fisher 1969). Departure of both young and adults takes place from June through mid-August. Young birds generally spend their first summer between 40°N and 45°N, and they range from Japan east to at least 172°W. Robbins and Rice (1974) observed that more than half of all band recoveries of birds during their fledgling summer came from within 500 km of the east coast of Japan. During the next four summers, the average population centre (of subadults)

Figure 4
Numbers of adult Short-tailed Albatrosses observed, eggs produced, and young fledged on Torishima Island. Data compiled by H. Hasegawa.



shifts gradually east-northeast to the adult summering area south of the Aleutian Islands, between 170°E and 180°.

Shuntov (1972) stated that Laysan Albatrosses occur from Japan to North America, and from the southern Bering Sea to the Hawaiian Islands; the average southern boundary of dispersal is between 28°N and 30°N in the western TNP and approximately 35°N to the east; and in the Hawaiian Island region, the dispersal limit was farther south. The southern limit of Laysan Albatrosses appears to coincide with the northern edge of the westward-flowing North Equatorial Current, west of the Hawaiian Islands; and of the North Pacific Equatorial Waters between Hawaii and Central America (Fisher and Fisher 1972). Sanger (1974a) stated that the winter distribution of Laysan Albatrosses paralleled the circulation of cyclonic currents, whereas summer concentrations occurred mostly within the western Subarctic and Alaskan gyres and north of the West Wind Drift.

Robbins and Rice (1974) suggested that the calm equatorial waters of the central Pacific represent an impenetrable barrier to albatrosses. According to Cone (1964), all species of albatrosses are incapable of sustained flight in calm air. Consequently, Robbins and Rice (1974) claim that an albatross attempting to cross the equator would not survive long in those calm waters. To substantiate this, they pointed out that as of 1974, there had been only a single band recovery of a Laysan Albatross south of the equator.

Gould et al. (1982), Vermeer and Rankin (1984), Briggs et al. (1987), Wahl et al. (1989), and Morgan et al. (1991) noted that Laysan Albatrosses are more frequently observed at and seaward of the continental slope, over areas of strong, persistent upwelling, and at the boundaries between different water masses. Fisher and Fisher (1972) stated that Laysan Albatrosses prefer sea surface temperatures between 4.4°C and 18.3°C, whereas Shuntov (1972) noted that they were most often observed over waters from 7°C to 14°C. Although their range spans surface temperatures from 2.2°C to 28.9°C, King (1970) and Sanger (1970) reported that Laysan Albatrosses were

seldom encountered over waters warmer than 23°C and were less adapted to warm water than the Black-footed Albatross.

King (1970) and Sanger (1970) suggested that sea surface salinity in part determines the distribution of Laysan Albatrosses. Sanger (1970) found that off Washington and Oregon, this species was observed within a very narrow salinity range, avoiding waters with salinities lower than 32‰. Thomson (1981) noted that shelf waters along British Columbia are considerably less saline than those further offshore due to extensive freshwater runoff. Vermeer and Rankin (1984) suggested that it is this low salinity that limits the inshore distribution of albatrosses off British Columbia.

The preferred habitats of Laysan Albatrosses may in part be related to food distribution. Ainley and Sanger (1979) stated that the species feeds almost exclusively on squid. The distribution of squid may in turn be determined by the distribution and abundance of euphausiids (Fisher and Fisher 1972). According to these authors, the larger euphausiids occur mostly in near-surface, eutrophic, cold waters. Fisher and Fisher (1972) suggested that it is the restriction of large euphausiids to cold waters that determines the southern limits of Laysan Albatrosses. Although food may in part determine the distribution of Laysan Albatrosses, it is not the entire answer; they are often found in high numbers in areas of low productivity (Shuntov 1972).

The following summary of the occurrence of Laysan Albatrosses on a quarterly basis is based on the following: Kenyon (1950), Sanger (1970, 1974a), Gruchy et al. (1972), Shuntov (1972), Wahl (1978), Roberson (1980), Gould et al. (1982), Vermeer et al. (1983), Briggs et al. (1987), and Morgan et al. (1991).

December–February: majority of birds are located between Japan, the Aleutians, and Hawaii; common and abundant within a few hundred kilometres of Hawaii; uncommon south of 20°N, but present to 13°N; relatively common in low numbers offshore from northern Baja to central British Columbia; rare in the Gulf of Alaska but to at least 53°N; rare in the southern parts of the Bering Sea and the Sea of Okhotsk.

March–May: most are still found in the open sea between Japan, the Aleutians, and Hawaii; rare south of 23°N in the central TNP; declining numbers offshore California to British Columbia as overwintering birds migrate north; increasingly abundant in western Gulf of Alaska as birds move towards Aleutians and the Kuril Islands; present to at least 59°N.

June–August: towards latter half of this quarter most are found north of 40°N(western TNP) and 45°N (eastern TNP); rare off Hawaii (postfledging); northward migration rapid; rare off Oregon and Washington; initially rare off British Columbia with increasing numbers in August; common in the western Gulf of Alaska, increasingly more abundant towards Aleutians; in low numbers in the Sea of Okhotsk; absent from the Sea of Japan; present to at least 52°50′N.

September–November: during first half of this quarter scarce in central TNP; rare off southern California; annual peak abundance off British Columbia during September and October; common far offshore Washington and Oregon; declining numbers off the coast of North America in the second half of this quarter as adults return to colonies; abundant in northwestern Hawaiian Islands.

4.2. Black-footed Albatross

The Black-footed Albatross is the most common albatross in the eastern TNP (Miller 1940; McHugh 1955; Sanger 1972; Morgan et al. 1991), but is relatively scarce in the western half (Starrett and Dixon 1946; Aronoff 1960; Sanger 1974b). Most adults arrive at the colonies in late October, whereas subadults show up between January and March. The pelagic range of nesting Black-footed Albatrosses is most restricted in February, when adults are making the shortest and most frequent foraging trips to feed their chicks. The range expands in March as foraging trips become longer and as chick mortality relieves many adults of their duties (Robbins and Rice 1974).

The northward migration of failed breeders and non-breeders may begin in April, and, by the end of July, all birds have left the colonies. Most fledglings fly northwest towards Japan (Robbins and Rice 1974), whereas postbreeding adults disperse towards the west coast of North America (Gould et al. 1982). From band recoveries, Robbins and Rice (1974) determined that although most fledglings spend their first summer and fall west of 180°, subsequent summers and winters are spent primarily in the eastern TNP. They also noted that in their second through fifth summers, most Black-footed Albatrosses remain relatively close to the coast of North America and, with each year, shift gradually northwards.

The maximum range limits of the Black-footed Albatross are the coasts of China, Japan, and Russia east to continental North America; and from the Sea of Okhotsk and the Bering Sea southwards to about 18°N and occasionally to 10°N in the central Pacific (Shuntov 1972; Robbins and Rice 1974; Sanger 1974b).

The southern limit of their distribution roughly corresponds with the southern sweep of the California Current off Baja in the eastern TNP, and the North Equatorial Current in the central TNP. Although La Touche and Cheng (in Sanger 1974b) stated that this species occurs off China, Black-footed Albatrosses seldom range far west or south of the Kuroshio Current. From winter to early summer, Black-footed Albatrosses off Japan occur almost exclusively south of the Kuroshio–Oyashio convergence. As summer progresses and the front advances, the albatrosses follow the warmer waters northwards.

Although the central Pacific is considered to be the preferred wintering area for nonbreeding adults (Kenyon 1950; Robbins and Rice 1974), low numbers of Black-footed Albatrosses are found in the eastern TNP throughout the entire winter as far north as 55°N (Shuntov 1972; Sanger 1974b).

Miller (1940), Vermeer et al. (1983, 1987), Briggs et al. (1987), and Morgan et al. (1991) reported that Black-footed Albatrosses are more abundant over the outer continental shelf, especially at the shelf break, than elsewhere. Areas with strong, persistent upwelling, or the boundaries of different water masses, are also favoured (Sanger 1974b; Wahl et al. 1989). Although they are considered to be an offshore species, Black-footed Albatrosses (unlike Laysan Albatrosses) are often observed within a few kilometres of continental North America (Sanger 1974b; Campbell et al. 1990; Morgan et al. 1991).

This species is a surface-feeding generalist that consumes fish, squid, jellyfish, shrimp, amphipods, polychaetes, carrion, and offal (Ainley and Sanger 1979). The concentration of Black-footed Albatrosses over the continental slope may in part be a result of the distribution of fishing vessels (Martin and Myres 1969; Shuntov 1972). Wahl and Heineman (1979) reported that this species was significantly

more abundant on days when fishing vessels were present than on boatless days. The authors suggested that the Black-footed Albatrosses were not just responding locally to fishing vessels, but were being influenced over a considerable area.

Kuroda (1960), Shuntov (1972), and Gould (1983) stated that Black-footed Albatrosses were more tolerant of warmer waters than Laysan Albatrosses. Although this species has been found over waters ranging between 3.4°C and 30°C, Sanger (1974b) suggested that Black-footed Albatrosses were most often found in association with water temperatures between 14°C and 22°C. Vermeer et al. (1992) found a significant, positive correlation between the abundance of this species and sea surface temperatures (between 8°C and 17°C). In contrast, Thompson (1951) observed that at higher temperatures (from 14°C to 28°C), the number of Black-footed Albatrosses was inversely related to sea surface temperatures. Vermeer et al. (1992) also noted that the abundance of this albatross was significantly, positively correlated with sea surface salinity, water depth, and distance from land.

The following summary of the occurrence of Black-footed Albatrosses on a quarterly basis is based upon the work of Yocom (1947), Kenyon (1950), Thompson (1951), McHugh (1955), Martin and Myres (1969), Sanger (1974b), Shuntov (1972), Robbins and Rice (1974), Wahl (1978), Gould et al. (1982), Vermeer et al. (1983), Briggs et al. (1987), and Morgan et al. (1991).

December–February: most birds are on the Hawaiian breeding colonies or in the central Pacific (between 165°W and 175°W and between 37°N and 43°N); low numbers from central British Columbia to northern Baja, primarily between 120°W and 140°W; very rare in extreme southeastern Gulf of Alaska; low numbers off Japan; uncommon south of 20°N in eastern Pacific, 25°N in the west, but present to approximately 15°N in central Pacific.

March–May: abundant near Hawaiian Islands, range expands as foraging adults roam further from colonies; common in central TNP as failed breeders and nonbreeders disperse; increasingly more abundant and closer to continental North America; a northward shift in the centre of abundance from late March onwards with peak numbers off southern California in March and maximal numbers off northern California in May; present but rare in southern Gulf of Alaska by March; rare off Japan, with most birds found near the Kuroshio–Oyashio convergence.

June–August: rare near Hawaii (postbreeding); decreasing abundance off southern California, high numbers maintained off northern California through July; annual peak abundances off Oregon, Washington, and British Columbia during August to early September; common in Gulf of Alaska; regular but low numbers off Japan, north into the Sea of Okhotsk and Bering Sea to at least 65°N; rare in central TNP south of 30°N.

September–November: maximal numbers in the Gulf of Alaska occur in September; numbers decline from British Columbia to Oregon in late September through October; irregularly observed in October and November along the Aleutians and southern Bering Sea; a pronounced shift towards more offshore locations in latter part of this quarter; increasingly abundant in central TNP as birds return to Hawaiian colonies.

4.3. Short-tailed Albatross

Relatively little is known about the seasonal movements or the factors determining the marine distribution of the Short-tailed Albatross. It is believed that the species was formerly common off China, in the Japan Sea, the Sea of Okhotsk, the Bering Sea north to the Bering Strait, and throughout the entire TNP from Alaska to Baja (Palmer 1962; Gould et al. 1982; Hasegawa and DeGange 1982). Areas of high productivity, such as along the Pacific coast of North America, in the Aleutians, and the Bering Sea, were favoured (Hasegawa and DeGange 1982).

The Short-tailed Albatross is considered to be mainly an inshore species (Miller 1940; Palmer 1962; Hasegawa and DeGange 1982). The statement is supported by the high number of bones of this species found in middens from California north to St. Lawrence Island (Turner 1886; Howard and Dodson 1933; Friedman 1934; Yesner 1976; McAllister 1979). In marked contrast, remains of Laysan or Black-footed albatrosses have never been identified from these sites. High numbers of Short-tailed Albatrosses must have ventured close enough to land in order for this species to be so prevalent in the natives' diets (Hasegawa and DeGange 1982).

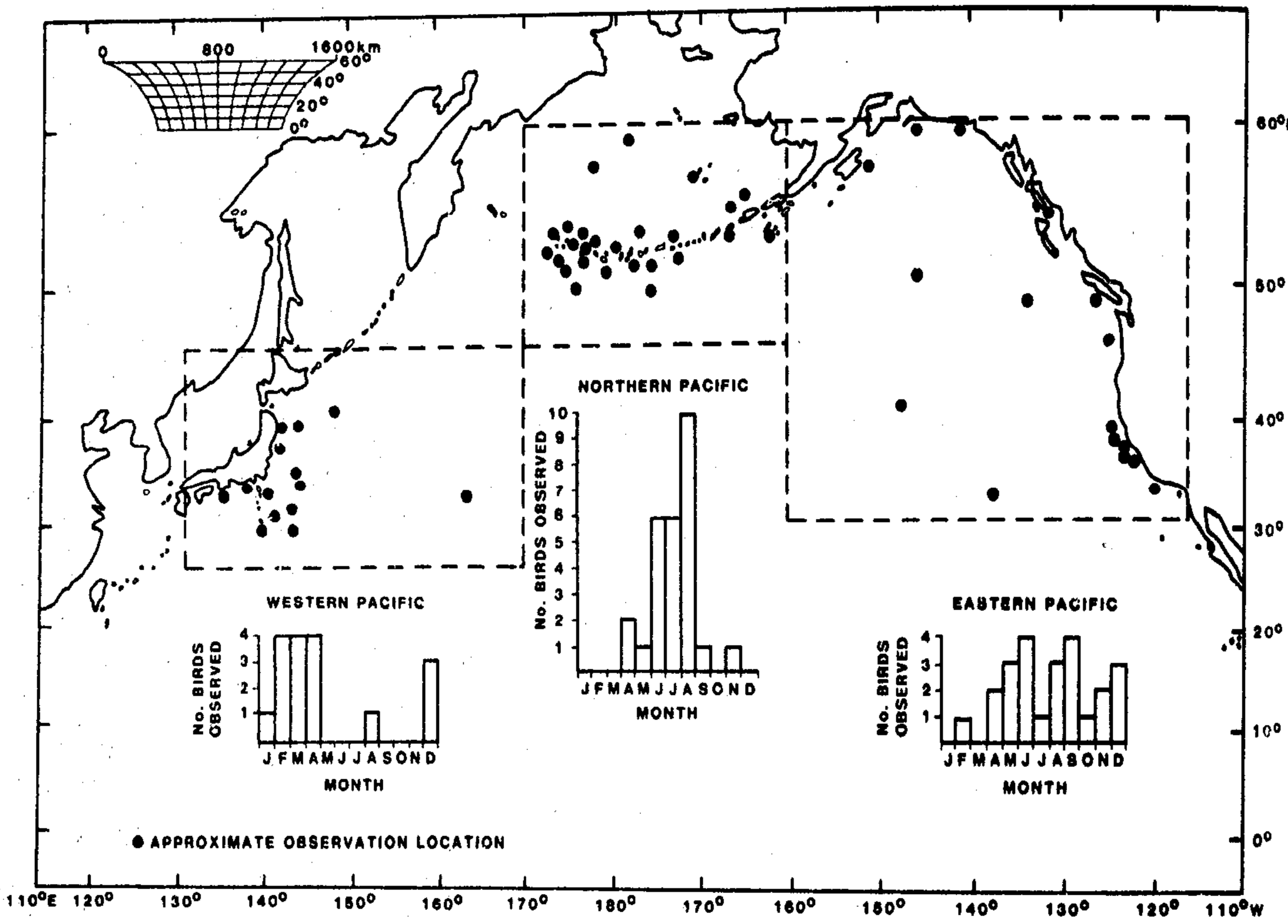
Birds begin to arrive at Torishima in early October, breeding commences in late October, and successful breeders and fledglings depart from late May through June. Failed breeders and nonbreeders leave the island from late winter through spring (Hasegawa and DeGange 1982). It is presumed that after the birds departed from their colonies, the majority dispersed towards the Aleutians and the Bering Sea, with many moving down along the west coast of North America, some as far south as Baja (Palmer 1962).

Hasegawa and DeGange (1982) updated Sanger's (1972) summary of sightings of Short-tailed Albatrosses to 1982; we have repeated this process, incorporating more recently published reports (*American Birds*, vols. 36–45). In addition, an unpublished observation in July 1991, by the second author, has been included. Questionable sightings, as well as the annual visitors to the Hawaiian Islands, listed in Hasegawa and DeGange (1982), have been excluded from our update.

Figure 5 shows the approximate locations as well as the monthly frequency distribution of the Short-tailed Albatrosses observed in three oceanic areas, all years combined. As many reports do not include a position, there are fewer locations indicated than the data points used to generate the histograms. If we assume that these data approximate the seasonality and distribution of the species, certain patterns are apparent. It appears that in the western TNP, Short-tailed Albatrosses are found primarily around the Izu–Bonin chain, primarily from December through April. This roughly coincides with their breeding chronology. The apparent rarity of the species in the western TNP during May through November suggests that the postbreeding dispersal is rapid. The concentration of sightings around the Aleutians, mostly from June through August, mirrors their historic summer preference for these productive waters. More than 60% of all sightings in the eastern TNP occurred between May and September, with the majority seen near shore.

Between December and the end of April, most Short-tailed Albatrosses (adults and immatures) are located relatively close to the breeding colonies. Postbreeding, young, and adult birds disperse towards the northeast. Although all (but one) adults reported have been observed near the Aleutians during the period May through September, many immature birds have been seen far from these northern waters. Considering the entire year, proportionately more immatures (than adults) have been observed in the eastern and northern regions

Figure 5
Approximate observation locations of Short-tailed Albatrosses reported between 1940 and 1991, and the numbers observed each month in three oceanic areas. Data from Hasegawa and DeGange (1982) and *American Birds* (vols. 36–45).



of the TNP (85.7% and 66.7% immatures respectively) than in the western TNP (52.9% immatures). This suggests that young birds wander farther (than adults) into the northeastern and eastern TNP and for longer periods. Unfortunately, we cannot discount a second possibility: that an unknown number of the reported immature Short-tailed Albatrosses were in fact old or aberrant Black-footed Albatrosses or Black-footed/Laysan albatross hybrids. It should also be emphasized that an unknown portion of the apparent patterns presented in Figure 5 have been a function of the timing and routes of the major ship traffic. As Hasegawa and DeGange (1982) stated, much of the Short-tailed Albatross's marine range is seldom visited by experienced observers.

5. Conservation issues

Despite the fact that the major breeding colonies of Laysan and Black-footed albatrosses are safeguarded by National Wildlife Refuge designation, that the nesting islands of Short-tailed Albatrosses are protected under Nature Reserve status in Japan, and that the Short-tailed Albatross is protected in both Japan and the United States, it appears that albatross numbers have not yet fully recovered. The number of Short-tailed Albatrosses is still very low; Black-footed Albatross populations may currently be declining at some locations; and Laysan Albatrosses have yet to recolonize several of their historical breeding areas. Therefore, the following issues warrant addressing in terms of their potential impacts.

5.1. Habitat

We suggest that loss of habitat now represents the greatest threat to Short-tailed Albatrosses. Recent volcanic eruptions have reduced the preferred breeding habitat on Torishima (Harrison 1990; Hasegawa 1991); a major event could severely retard the recent gains this species has made. Fortunately, the recolonization of Minami-kojima in the southern Ryukyu Islands does provide some insurance against disasters that occur on Torishima.

5.2. Fisheries

5.2.1. Driftnet fishery

TNP driftnet fisheries are responsible for the deaths of hundreds of thousands of seabirds (D. Johnson et al., unpubl. data). During the 1990 season, an estimated 17 548 Laysan Albatrosses and 4426 Black-footed Albatrosses were taken by the Japanese squid, Japanese large-mesh, Korean squid,

Taiwanese squid, and Taiwanese large-mesh fisheries. In relation to the total populations of these two species, the incidental take is likely to impact the most on Black-footed Albatrosses (approximately 2.2% of the worldwide population; P.J. Gould, unpubl. data). However, there are indications that the widespread condemnation of driftnet fishing has had an impact; Japan phased out all driftnet fishing by the end of 1992. We are guardedly optimistic that other countries will follow Japan's example.

5.2.2. Longline fisheries

The Hawaiian longline fishing fleet has increased from 50 vessels in 1987 to 152 in 1991 and is operating closer to the northwestern Hawaiian Islands. A typical vessel sets a 16–48-km longline, with up to 1000 branch lines and an equal number of hooks. The Western Pacific Regional Fishery Management Council estimated that during the first half of 1991, more than seven million hooks were set by vessels operating out of Hawaii. Fishermen report that hundreds of albatrosses are killed incidental to this fishery; the birds either become hooked before the bait sinks or are intentionally killed to prevent damage to the gear or loss of catch. Similar longline fisheries operating in the South Pacific have reported incidental catches of albatrosses at a rate of 0.41 birds per 1000 hooks set (Brothers 1991).

Brothers (1991) reported that he has developed techniques that reduce the incidental catch of albatrosses. He estimated that approximately a 70% reduction in bait loss could be accomplished by the use of bird scaring streamer lines, weighting hooks, reducing offal, improving bait throwing techniques, and setting lines during darkness.

Regulations have recently been implemented that limit the number of vessels in the Hawaiian longline fleet. Additionally, a protected species zone has been established around the northwestern Hawaiian Islands, excluding longline fishing within 80 km of the islands.

5.3. Marine debris

The ingestion of marine debris (primarily plastic) by albatrosses may represent a major area of concern, although direct mortality as a result of ingestion is rare. The frequency of occurrence of plastics in Black-footed and Laysan albatrosses is among the highest of any species studied (Day et al. 1985). Plastics were ubiquitous in Black-footed and Laysan albatross chicks sampled at various Hawaiian locations during 1986 and 1987 (Sievert et al., in press), and ingestion has also been documented in seven out of 11 Short-tailed Albatross chicks examined (H. Hasegawa, pers. commun.).

Growth studies of Laysan Albatross chicks have indicated that chicks with high volumes of plastic had significantly lower fledging weights than chicks with less plastic. Additionally, deaths from dehydration may in part be related to high volumes of proventricular plastics. The reduction in the amount of food that can be ingested by the chick at a given feeding may contribute greatly to dehydration (Sievert and Sileo, this volume).

5.4. Problems associated with recolonization of the main Hawaiian Islands

With the recent recolonization of the main Hawaiian Islands by Laysan Albatrosses, and because of their preference for open areas, more birds are being attracted to airfields. Due to the higher probability of airstrikes, various agencies (State of Hawaii, Navy and Marine Corps) have contracted the U.S. Department of Agriculture, Animal Damage Control Division, to discourage the birds from using these areas.

Colonies that become established away from airfields fall victim to dog predation. One such colony is located in the Kilauea Point National Wildlife Refuge on Kauai. Despite the perceived protection provided by the refuge, each year eggs, chicks, and adults are killed by dogs (USFWS, unpubl. data).

6. Recommended research and management actions

In recognition of the above-mentioned concerns, and the gaps in our knowledge of the life histories of these three albatross species, we recommend the following actions.

6.1. Short-tailed Albatross

(a) Efforts to stabilize the volcanic soils of Torishima by planting grasses should be continued.

(b) Methodologies should be devised and attempted (on a small scale) for transplanting Short-tailed Albatrosses to historic nesting sites.

(c) Monitoring of the expanding Black-footed Albatross colony on Torishima should be continued; control measures may be required if overcrowding reduces the reproductive success of Short-tailed Albatrosses.

6.2. Laysan, Black-footed, and Short-tailed albatrosses

(a) Breeding surveys of all colonies should be conducted regularly (every three years), and historic sites should be visited frequently (every five years).

(b) Research into the age structure of populations, annual survival, and factors contributing to population fluctuations should be continued.

(c) Long-term studies of the diets should be initiated in order to better understand the annual, seasonal, and geographical variation in prey taken; variability in the distribution and availability of prey; and the potential impacts of overharvesting the prey.

(d) TNP fisheries (including driftnet and longline) that take high numbers of nontarget species should be banned, restricted in location and season, or modified in such a manner that these nontarget kills are minimized.

As a final comment, we suggest that Black-footed and Laysan albatrosses could function as valuable thermometers of the health of the TNP. The combination of extensive ranges, the accessibility of most of the breeding populations, their synchronous breeding cycles, the high number of banded individuals, and their extreme docility sets these two species apart from most other marine birds in the TNP.

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Literature cited

Ainley, D.G.; Sanger, G.A. 1979. Trophic relations of seabirds in the northwestern Pacific Ocean and Bering Sea. Pages 95–122 *in* Bartonek, J.C.; Nettleship, D.N. (eds.), Conservation of marine birds of northern North America. U.S. Fish Wildl. Serv. Rep. No. 11. Washington, DC.

Amaral, M. 1988. Prospects believed to be improving for the Short-tailed Albatross. U.S. Fish Wildl. Serv. Endangered Species Tech. Bull. 13(9–10). Washington, DC.

Amerson, B.A. 1971. The natural history of French Frigate Shoals, northwestern Hawaiian Islands. Atoll Res. Bull. No. 150.

Aronoff, A.E. 1960. Some observations on birds of Torishima. Tori 15:269–279.

Austin, O.L., Jr. 1949. The status of Steller's Albatross. Pac. Sci. 3:283–295.

Bailey, A.M. 1952. Laysan and Black-footed albatrosses. Denver Mus. Nat. Hist. Mus. Pict. No. 6.

Bailey, A.M. 1956. Birds of Midway and Laysan Islands. Denver Mus. Nat. Hist. Mus. Pict. No. 7.

Briggs, K.T.; Tyler, W.B.; Lewis, D.B.; Carlson, D.R. 1987. Bird communities at sea off California: 1975 to 1983. Stud. Avian Biol. 11.

Brock, V.E. 1951. Laysan Island bird census. 'Elepaio 12(3):1–2.

Brothers, N. 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the southern ocean. Biol. Conserv. 55:255–268.

Bryan, W.A. 1906. Report of a visit to Midway Island. Bernice P. Bishop Mus. Occas. Pap. No. 2: 291–299.

Campbell, R.W.; Dawe, N.K.; McTaggart-Cowan, I.; Cooper, J.M.; Kaiser, G.W.; McNall, M.C.E. 1990. The birds of British Columbia. Vol. 1. Nonpasserines; loons through waterfowl. Royal British Columbia Museum and Canadian Wildlife Service, Victoria.

Cone, C.D. Jr. 1964. A mathematical analysis of the dynamic soaring flights of the albatross with ecological interpretations. Va. Inst. Mar. Sci. Spec. Sci. Rep. 50:1–104.

Day, R.H.; Wehle, D.H.S.; Coleman, F.C. 1985. Ingestion of plastic pollutants by marine birds. Pages 344–386 *in* Shomura, R.S.; Yoshida, H.O. (eds.), Proceedings of the workshop on the fate and impact of marine debris. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-SWFC-54.

Dill, H.R.; Bryan, W.A. 1912. Report of an expedition to Laysan Island in 1911. U.S. Dep. Agric. Biol. Surv. Bull. No. 42:1–30.

Dumont, P.A.; Neff, J.A. 1955. Report on Midway Islands albatross study. Unpublished report by Bureau of Sport Fisheries and Wildlife for Military Air Transportation Service.

Ely, C.A.; Clapp, R.B. 1973. The natural history of Laysan Island, northwestern Hawaiian Islands. Atoll Res. Bull. No. 171.

Fefer, S.I.; Harrison, C.S.; Naughton, B.N.; Shallenberger, J.S. 1984. Synopsis of results of recent seabird observations in the northwestern Hawaiian Islands. Pages 9–76 *in* Grigg, R.W.; Tanoue, K.Y. (eds.), Resource investigations in the northwestern Hawaiian Islands. Vol. 1. Sea Grant College Program. Univ. of Hawaii, Honolulu.

Fisher, H.I. 1949. Populations of birds on Midway and the man-made factors affecting them. Pac. Sci. 3:103–110.

Fisher, H.I. 1966. Airplane–albatross collisions on Midway Atoll. Condor 68:229–242.

Fisher, H.I.; Baldwin, P.H. 1946. War and the birds of Midway Atoll. Condor 48:3–15.

Fisher, H.I.; Fisher, M.L. 1969. The visits of Laysan Albatrosses to the breeding colony. Micronesica (J. Coll. Guam) 5:173–221.

Fisher, H.I.; Fisher, J.R. 1972. The oceanic distribution of the Laysan Albatross, *Diomedea immutabilis*. Wilson Bull. 84:7–27.

Friedman, H. 1934. Bird bones from Eskimo ruins on St. Lawrence Island, Bering Sea. J. Wash. Acad. Sci. 24:83–96.

Gould, P.J. 1983. Seabirds between Alaska and Hawaii. Condor 85:286–291.

Gould, P.J.; Forsell, D.J.; Lensink, C.J. 1982. Pelagic distribution and abundance of seabirds in the Gulf of Alaska and eastern Bering Sea. U.S. Fish Wildl. Serv. Off. Biol. Serv. FWS/OBS-82/48. Washington, DC.

Gruchy, C.G.; Dykes, A.A.R.; Bowen, R.H. 1972. The Short-tailed Albatross at Ocean Station Papa, North Pacific Ocean, with notes on other birds. Can. Field-Nat. 86:285–287.

Hadden, F.C. 1941. Midway Islands. The Hawaiian Planter's Record 45:179–221.

Harrison, C.S. 1990. Seabirds of Hawaii; natural history and conservation. Cornell Univ. Press, New York.

Harrison, P. 1983. Seabirds: an identification guide. Houghton Mifflin, Boston.

Hasegawa, H. 1978. The Laysan Albatross breeding in the Ogasawara Islands. Pac. Seabird Group Bull. 5(1):16–17.

Hasegawa, H. 1984. Status and conservation of seabirds in Japan, with special attention to the Short-tailed Albatross. Pages 487–500 *in* Croxall, J.P.; Evans, G.H.; Schreiber, R.W. (eds.), Status and conservation of the world's seabirds. Int. Counc. Bird Preserv. Tech. Publ. 2. Cambridge, U.K.

Hasegawa, H. 1991. Red data bird: Short-tailed albatross. World Birdwatch 13(2):10.

Hasegawa, H.; DeGange, A.R. 1982. The Short-tailed Albatross, *Diomedea albatrus*, its status, distribution, and natural history. Am. Birds 36(5):806–814.

Henshaw, H.W. 1912. Our mid-Pacific bird reservation. Dep. Agric. Year Book 1911:155–164.

Howard, H.; Dodson, L. 1933. Bird remains from an Indian shell-mound near Point Mugu, California. Condor 35:235.

Howell, N.G.; Webb, S. 1989. Additional notes from Isla Clarion, Mexico. Condor 91:1007–1008.

Kenyon, K.W. 1950. Distribution of albatrosses in the north Pacific and adjacent waters. Condor 52:97–103.

King, W.B. 1970. The trade wind zone oceanography pilot study. Part VII: observations of seabirds March 1964 to June 1965. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. No. 586. Washington, DC.

Kurata, Y. 1978. Breeding record of the Laysan Albatross, *Diomedea immutabilis* on the Ogasawara Islands (prelim. rep.). Misc. Rep. Yamashina Inst. Ornithol. 10(1,2):189.

Kuroda, N. 1954. Report on a trip to Marcus Island with notes on the birds. Pac. Sci. 8:84–93.

Kuroda, N. 1960. Analysis of seabird distribution in the northwest Pacific Ocean. Pac. Sci. 14:55–67.

Martin, P.W.; Myres, M.T. 1969. Observations on the distribution and migration of some seabirds off the outer coasts of British Columbia and Washington state, 1946–1949. Syesis 2:241–256.

McAllister, N.M. 1979. Avian fauna of the Yuquot excavation. Pages 103–174 *in* The Yuquot project. Vol. 2. History and Archaeology No. 43. Parks Canada.

McHugh, J.L. 1955. Distribution of Black-footed Albatross, *Diomedea nigripes*, off the west coast of North America. Pac. Sci. 9:375–381.

Melville, D.S. 1984. Seabirds of China and the surrounding seas. Pages 501–511 *in* Croxall, J.P.; Evans, G.H.; Schreiber, R.W. (eds.), Status and conservation of the world's seabirds. Int. Counc. Bird Preserv. Tech. Publ. 2. Cambridge, U.K.

Miller, L. 1940. Observations on the Black-footed Albatross. Condor 42:229–238.

Morgan, K.H.; Vermeer, K.; McKelvey, R.W. 1991. Atlas of pelagic birds of western Canada. Can. Wildl. Serv. Occas. Pap. No. 72. Ottawa.

Moriarty, D.; Bottomley, R.; Fefer, S.; Telfer, T. 1986. The status of Laysan Albatross on Kauai. 'Elepaio 46(9):95–97.

Munro, G.C. 1942. An ocean cruise. 'Elepaio 3(6).

Munro, G.C. 1943. An ocean cruise. 'Elepaio 3(7).

Nutting, C.C. 1903. Bird rookeries on the island of Laysan. Pop. Sci. 63:321–332.

Palmer, R.S. 1962. Handbook of North American birds. Vol. 1: Loons through flamingos. Yale Univ. Press, New Haven, CT.

Pitman, R.L. 1988. Laysan Albatross breeding in the Eastern Pacific and a comment. Pac. Seabird Group Bull. 15(1):52.

Rice, D.W. 1959. Birds and aircraft on Midway Islands: 1957–58 investigations. U.S. Fish Wildl. Serv. Spec. Sci. Rep. 44.

Rice, D.W. 1984. Albatrosses. Pages 32–41 *in* Haley, D. (ed.), Seabirds of eastern North Pacific and arctic waters. Pacific Search Press, Seattle, WA.

Rice, D.W.; Kenyon, K.W. 1962. Breeding distribution, history, and populations of North Pacific albatrosses. Auk 79:365–386.

Richardson, F. 1954. Notes on the birds of French Frigate Shoals. 'Elepaio 14:73–75.

Robbins, C.S. 1966. Birds and aircraft on Midway Islands: 1959–63 investigations. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. No. 85.

Robbins, C.S.; Rice, D.W. 1974. Recoveries of banded Laysan Albatross *Diomedea immutabilis* and Black-footed Albatross *Diomedea nigripes*. Pages 232–277 *in* King, W.B. (ed.), Pelagic studies of seabirds in the central and eastern Pacific Ocean. Smithson. Contrib. Zool. No. 158. Washington, DC.

Roberson, D. 1980. Rare birds of the west coast of North America. Woodcock Publ., Pacific Grove, CA.

Sanger, G.A. 1970. The seasonal distribution of some seabirds off Washington and Oregon, with notes on their ecology and behaviour. Condor 72:339–357.

Sanger, G.A. 1972. The recent pelagic status of the Short-tailed Albatross. Biol. Conserv. 4:189–193.

Sanger, G.A. 1974a. Laysan Albatross *Diomedea immutabilis*. Pages 129–153 *in* King, W.B. (ed.), Pelagic studies of seabirds in the central and eastern Pacific Ocean. Smithson. Contrib. Zool. No. 158. Washington, DC.

Sanger, G.A. 1974b. Black-footed Albatross *Diomedea nigripes*. Pages 96–128 *in* King, W.B. (ed.), Pelagic studies of seabirds in the central and eastern Pacific Ocean. Smithson. Contrib. Zool. No. 158. Washington, DC.

Shuntov, V.P. 1972. Seabirds and the biological structure of the ocean. Far Eastern Publishing House, Vladivostok. Translated from Russian by J. Allardi (1974) (NTIS-TT-74-55032).

Sievert, P.R.; Sileo, L.; Fefer, S.I. In press. Prevalence and characteristics of plastic ingested by Hawaiian seabirds. *In* Shomura, R.S. (ed.), Proceedings of the 2nd International Conference on Marine Debris, Honolulu, HI.

Starrett, W.C.; Dixon, K.L. 1946. The scarcity of the Black-footed Albatross in parts of its known range. Condor 48:268–271.

Thompson, D.Q. 1951. Notes on distribution of north Pacific albatrosses. Auk 68:227–235.

Thomson, R.E. 1981. Oceanography of the British Columbia coast. Can. Spec. Publ. Fish. Aquat. Sci. 56. Ottawa.

Turner, L.M. 1886. Contributions to the natural history of Alaska. Washington, DC.

Vermeer, K.; Rankin, L. 1984. Pelagic seabird populations in Hecate Strait and Queen Charlotte Sound: comparison with the west coast of the Queen Charlotte Islands. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 52.

Vermeer, K.; Robertson, I.; Campbell, R.W.; Kaiser, G.; Lemon, M. 1983. Distribution and densities of marine birds on the Canadian west coast. Canadian Wildlife Service and Chevron Standard Ltd., Spec. Publ., Calgary.

Vermeer, K.; Hay, R.; Rankin, L. 1987. Pelagic seabird populations off southwestern Vancouver Island. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 87.

Vermeer, K.; Morgan, K.H.; Smith, G.E.J. 1992. Habitat analysis and co-occurrence of seabirds on the west coast of Vancouver Island. Pages 78–85 *in* Vermeer, K.; Butler, R.W.; Morgan, K.H. (eds.), The ecology, status, and conservation of marine and shoreline birds on the west coast of Vancouver Island. Can. Wildl. Serv. Occas. Pap. No. 75. Ottawa.

Wahl, T.R. 1978. Seabirds in the northwestern Pacific Ocean and south central Bering Sea in June 1975. West. Birds 9:45–66.

Wahl, T.R.; Heinemann, D. 1979. Seabirds and fishing vessels: co-occurrence and attractions. Condor 81:390–396.

Wahl, T.R.; Ainley, D.G.; Benedict, A.H.; DeGange, A.R. 1989. Associations between seabirds and water masses in the northern Pacific Ocean in summer. Mar. Biol. 103:1–11.

Walker, R.L. 1963. Unpublished report on a survey trip to Laysan Island, December 3–10, 1963. Hawaii Dep. Fish Game, Honolulu.

Yesner, D.R. 1976. Aleutian Island albatrosses: a population history. Auk 93:263–280.

Yocom, C.F. 1947. Observations on birdlife in the Pacific Ocean off the North American shores. Condor 49:204–208.