

EXCESSIVE EXPLOITATION OF CENTRAL PACIFIC SEABIRD POPULATIONS AT THE TURN OF THE 20TH CENTURY

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SUMMARY

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At the turn of the century, the uninhabited atolls of the central Pacific Ocean were visited by Japanese feather collectors, whose actions devastated their seabird populations. An assessment of the historic record shows that between 1897 and 1914 over 3.5 million seabirds were killed on islands in the central Pacific Ocean in the name of fashion for the millinery trade. Introduced animals have also taken their toll. Whereas the populations have recovered on some atolls, other islands do not show the original species diversity. Today the survival of the breeding colonies is again threatened as changing global climatic conditions bring about an increased chance that the remaining populations on the generally very low-lying atolls could come under threat from typhoons and storm surges, rather than the human predation of the past. Yet, without knowledge of the historical developments the current distribution of some species can not be understood.

INTRODUCTION

At present there is much discussion on the reduction of seabird populations caused by the loss and disturbance of breeding habitats on the one hand and the impact of introduced mammalian predators (especially cats and rats) to breeding islands (Moors & Atkinson 1984), longline fishing (especially on albatrosses) and pesticide uptake on the other (Brothers 1991, Auman *et al.* 1997, Weimerskirch *et al.* 1997). Yet, at the turn of the century the single most serious threat to the survival of seabirds arrived in the form of fashion. All through Europe, and later in the U.S.A. and Australia, women's hats were adorned with exotic feathers. To satisfy the demands of an expanding market the plumage hunters continuously increased the range of their activities and several islands were stripped bare of their seabird populations.

This paper reviews the historic evidence and details the magnitude of these events. Because much of this material is contained in archival documents and comparatively obscure published sources, the paper also documents the need for ecologists to collaborate with historians in order to elucidate the historical foundations of current ecological phenomena.

GEOGRAPHY OF THE AREA

The northern Central Pacific is comprised of a number of major island groups: the Bonins and the Volcano Islands, the atolls of the Marshalls and Kiribati, as well as the Hawaiian chain and the Northern Marianas. In addition, there are some isolated atolls and islands, such as Marcus, Wake and Johnston. Farther to the south are Palau, and the Carolines with Chuuk (Truk), Pohnpei, Kosrae and their outlying atolls (Fig. 1, Table 1). Prior to colonisation by European powers many of the small atolls of the Central Pacific Ocean were uninhabited because the freshwater supply was inadequate,

the island was too small to permit the establishment of food gardens, or was prone to the impact of storm surges during typhoons. Thus these islands provided ideal undisturbed breeding grounds for seabird populations. Albatrosses, frigate birds, tropic birds, boobies, and terns frequented the islands, where they were free from predation with the exception of the occasional short-term incursion by local islanders who hunted them for a few eggs, birds and feathers for the local subsistence economy and to adorn local items such as canoes (Eisenhardt 1888, Erdland 1914, Krämer & Nevermann 1938).

Because coconut palms, the prime crop at the turn of the century, would not thrive, the atolls were of limited economic importance after their guano deposits (if any) had been mined. Because law and sovereignty enforcement actions by the colonial powers were few and far between, any unannounced activity on the islands was likely to succeed unnoticed, unless the perpetrators were surprised by the traditional users of the islands in pursuit of a similar activity (Spennemann 1998).

THE MILLINARY TRADE

By the 1890s feathered ornaments on women's hats had become fashionable in Europe and North America. Although exotic feathers, mainly from birds of paradise (Family Paradisaeidae) were the prime species sought after (Swadling 1996), the demand was so great that many other species were also exploited. As fashion descended the socio-economic ladder, the market for such hats expanded dramatically, and the demand for less expensive, yet exotic feathers increased (Anon. 1910a,b). Over time, 'osprey' became the generic term for a wide range of exotic feathers largely collected from seabird populations (Doughty 1975). To satisfy this demand, new resource localities had to be opened, and the atolls of the Pacific Islands were the perfect procurement grounds.

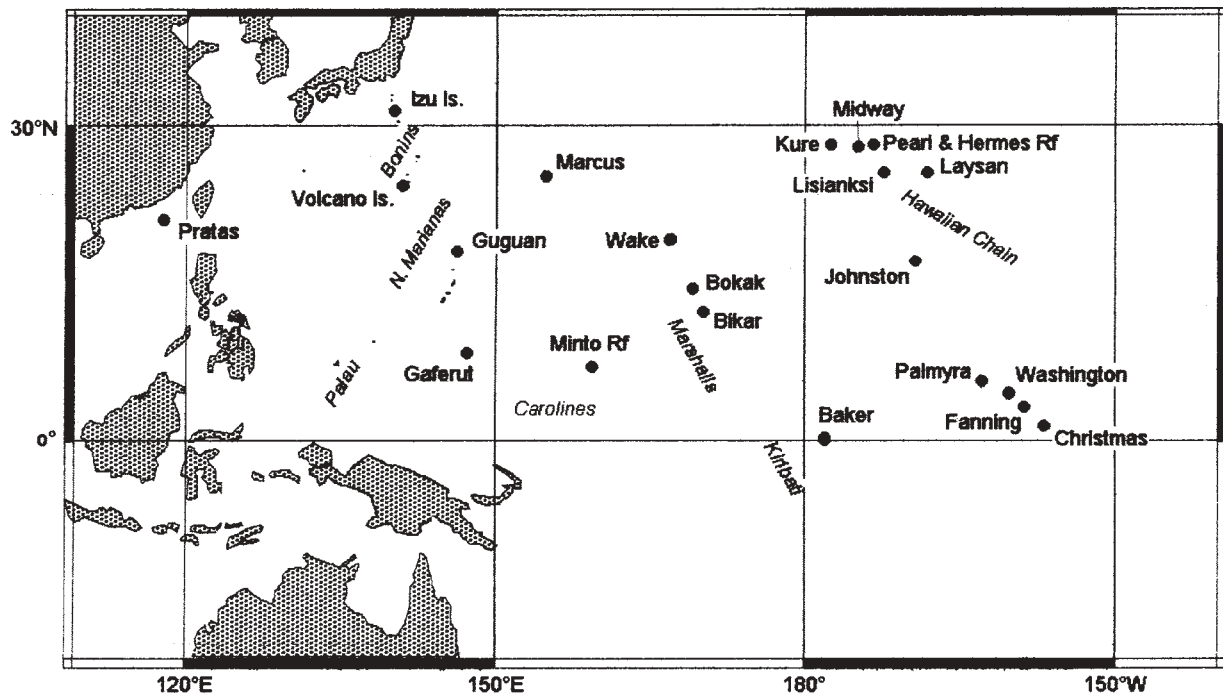


Fig. 1. Central Pacific Ocean showing the island groups discussed in the text.

TABLE 1

Coordinates of islands mentioned in the text

Island or island group	Latitude	Longitude
Baker Island	0°13'N	176°29'W
Bikar (Marshall Islands)	12°15'N	170°06'E
Bokak (Marshall Islands)	14°32'N	169°00'E
Bonin Islands	27°00'N	142°00'E
Christmas Island	1°59'N	157°32'W
Chuuk (Truk) Atoll	7°42'N	151°46'E
Fanning Island	3°51'N	159°22'W
French Frigate Shoals	23°46'N	166°16'W
Gaferut (Grimes)	9°15'N	145°40'E
Gardner Pinnacles	25°01'N	167°59'W
Guguan, Marianas Is.	17°19'N	145°48'E
Izu Islands	33°50'N	139°30'E
Johnston Atoll	16°45'N	169°39'W
Kiribati (capital Tarawa)	1°39'N	144°18'W
Kure Atoll	28°25'N	178°28'W
Laysan Island	24°07'N	171°53'W
Lisianski Island	26°00'N	173°57'W
Marcus Island	23°10'N	154°00'E
Marshall Islands (capital Majuro)	7°03'N	171°30'E
Midway Atoll	28°12'N	177°22'W
Minto Reef	8°09'N	154°18'E
Necker Island	23°35'N	164°39'W
Nihoa Island	23°06'N	161°56'W
Palau Islands (capital Koror)	7°01'N	134°25'E
Palmyra Island	5°49'N	162°11'W
Pearl and Hermes Reef	27°47'N	175°51'W
Pratas Island (Tung Sha Do, China)	20°43'N	116°42'E
Volcano Islands (Iwo Jima)	24°45'N	141°19'E
Wake Atoll	19°17'N	166°37'E
Washington Atoll	4°41'N	160°05'W

The species sought

The prized specimens sought were birds of paradise from Papua New Guinea and in response the German Government established a set of regulations governing the hunting of birds (Swadling 1996). The Pacific atoll feather trade concentrated on the following species: Laysan Albatross *Phoebastria immutabilis*, Black-footed Albatross *P. nigripes*, Masked Booby *Sula dactylatra*, Lesser and Great Frigate Birds *Fregata ariel* and *F. minor*, Red-tailed Tropic Bird *Phaethon rubricauda*, Sooty Tern *Sterna fuscata*, and various other tern species (Amerson 1971, Ely & Clapp 1973, Amerson *et al.* 1974, Clapp & Wirtz 1975, Spennemann 1998, in press a,b).

The poaching industry

The beginning of these poaching expeditions is still unclear. It is possible, though, that they are the result of the 1882 cruise of the Japanese-chartered, American-owned schooner *Ada* to the French Frigate Shoals, Pearl and Hermes Reef, Laysan and Lisianski Atolls (Amerson 1971, Ely & Clapp 1973, Amerson *et al.* 1974, Clapp & Wirtz 1975). The charterers of this vessel caught sharks (for oil, flesh and fins), a very large quantity of turtles, *beche-de-mer* and collected bird down (Hornell 1934) and may have alerted the Japanese to the profitability of the trade in the off-season from fishing. Japanese government-sponsored expeditions under the direction of Suzuki Tsusenori went to the Marshall Islands in autumn 1885 and to the north-western Hawaiian Islands from Kure Atoll to the French Frigate Shoals in spring 1887. On return Tsusenori recommended the annexation of these islands (Peattie 1989). Further, there were Japanese workers employed in the guano works on Laysan in 1900 (Ely & Clapp 1973) who may have alerted hunters of the opportunities in the region. The decline and eventual collapse of the Japanese feather collection industry on Torishima in the (Japanese-owned) Izu Islands in 1903 (Austin 1949) contributed to the need to venture farther afield.

In April 1909 the American Vice-Consul in Japan reported that at least seven vessels had left Japan in late 1908 and early 1909 on the pretext of deep-sea fishing, but that their real objective was gathering bird skins and feathers on the uninhabited north-western Hawaiian Islands (Clapp & Wirtz 1973). *The Pacific Advertiser* of 20 April 1909 shows the common cover story employed in that trade. The *Sumiyone Maru*, which had sailed for shark fishing in the Hawaiian waters in late November 1908, had been disabled by a storm and drifted to Laysan Island, where it arrived on 4 January 1909. About four weeks later 18 'ship-wrecked' sailors had been 'rescued' from that island by the *Niigata Maru* which had drifted under similar conditions. Both ships had been reported as two of the seven feather poaching vessels (Jacobs 1910). The need for such elaborate cover stories shows that feather poaching was considered a doubtful enterprise, if not illegal, even before the north-western Hawaiian Islands became a bird reservation following a Presidential order in 1909 (Palmer 1913).

Economic returns

The main markets for the feather trade were Hamburg and Paris, and, to a lesser degree, London. The material collected by the Japanese in the Pacific was landed in Yokohama, classed and transhipped to the main markets. The trade was sufficiently lucrative, a trip on average grossing close to US\$ 100 000. According to statements by Japanese arrested on Bokak, the minimum price fetched at Yokohama for a pair of wings from frigate or tropic birds was Imperial Marks 0.50 and for a full bird skin between Imperial Marks 0.5 and 1.5 (Spennemann 1998). Prices quoted for the specimens collected on Laysan were US\$ 0.33 per wing and US\$ 6.00 per pound of feathers (Jacobs 1910). However, as the German government found out when it wished to sell a load of confiscated wings and feathers, the Japanese had been more interested in quantity than quality (Spennemann 1998). A similar observation had been made by William Bryan on Marcus Island (Bryan 1904, Ely & Clapp 1973).

Establishment of Japanese birding operations

From various islands we have a description of these operations, which allows us to develop a composite picture of the ideal set-up aimed at by the Japanese trading houses (Anon. 1910b, Jacobs 1910, Ely & Clapp 1973, Amerson *et al.* 1974, Spennemann 1998). Due to the lack of water and similar resources the Japanese had to import all goods required. Whereas several islands were visited on separate occasions in consecutive years, others, it seems, were visited during the breeding season by several vessels about once every two to four months. The vessels would land new work crews, comprising between 10 and 40 men, relieve the old crew and ship the procured feathers (Spennemann 1998, in press a).

The feather collectors had an easy game with the nesting seabirds, which knew no fear of people (Wilkes 1845, Bryan 1904, Drummond-Hay 1939). The birds could easily be grabbed and their necks broken. The breast feathers, because of their fineness the choice feathers of the trade, were pulled out and the wings cut off. The carcass of the body, it is said, was dropped where the bird had been caught. In addition, birds were caught and their wings were cut off while still alive (Bryan 1904, Buckland 1908, Jacobs 1910). The thus mutilated birds were let to run and die from blood loss or starvation, as they were no longer able to feed themselves. Those birds that survived the wing amputation and were left to starve,

lost most of their body fat and thus were easier to pluck than well-fed birds. On high islands 'the birds, which are very tame and fat, [were driven] into caves and starving them until they are emaciated, when the feathers are easily removed' (Coffee 1924). It was that kind of cruelty to animals that caught the attention of the public and began to bring about change, at least in the Hawaiian Islands (Buckland 1908, 1909, Anon. 1910a,b).

On Marcus Island the bird catchers would work mainly in the morning or during the evening hours, as the adult birds were out fishing during the day. The equipment used consisted of a bamboo pole and a large basket. Bryan (1904) mentions for Marcus that a catcher could fill such a basket in about two hours, each basket containing about 75 individuals. On average a taxidermist would prepare 50 skins per day, even though the 'world record', so stated Bryan (1904), stood at 130 skins for a single day.

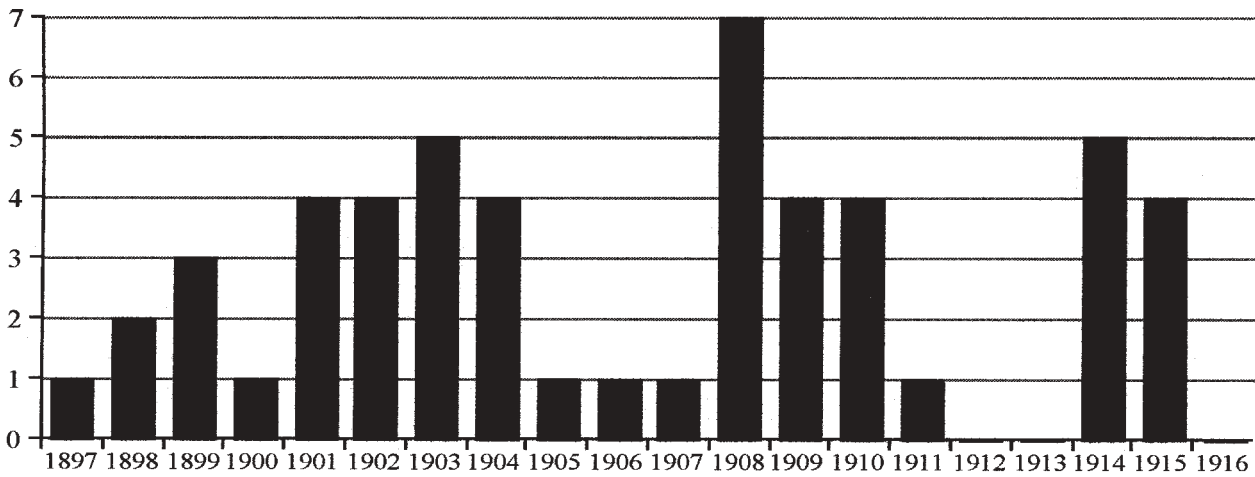
Choice down of albatross chicks, it seems, was collected by dipping the dead chicks into boiling water and then pulling out the feathers. The gathered feathers were placed on the ground and covered with weighed-down mats for drying. Finally the feathers would be bagged in bales and readied for shipment. Birds wings would be cut off, deboned and with a small amount of salt sprinkled on them, spread out on the sand. If the weather was favourable the wings would be cured in four or five days. During packing into bags or bales each layer of wings would be sprinkled with naphthalene. In case of inclement weather the feathers would be covered with mats weighed down by stones. The wings were usually cured and shipped whole, to be processed in Japan or another port (Spennemann 1998). A small number of birds would be stuffed and shipped whole, possibly for trade to museums and collections and displays for feather merchants (Doughty 1975).

CHRONOLOGY OF JAPANESE BIRDING OPERATIONS

For some of the Hawaiian feather trade, good summaries have been provided by Ely & Clapp (1973) for Laysan Island and by Clapp & Wirtz (1975) for Lisianski Island. Specific incidents of the Japanese feather trade have also been described by Spennemann (1998) for Bokak Atoll and for the Marianas (Spennemann in press a). A detailed review of the historic evidence for the trade in the Central Pacific Ocean has also been compiled (Spennemann in press b) which shall not be repeated here. Suffice it to say that there are historic records for Japanese birding operations on the French Frigate Shoals, Kure, Laysan, Lisianski, and Midway Atolls, as well as Pearl and Hermes Reef in the Hawaiian Chain, and Marcus, Wake, Johnston, Christmas and Pratas Islands (Fig. 1, Table 1). Based on this review, Table 2 compiles the presence and absence of Japanese feather collectors on the various atolls. It is clear that the Japanese operations gradually moved ever farther into the Pacific, first exploiting those atolls closer to Japan.

Figure 2 provides a frequency histogram showing the level of exploitation throughout the region, ignoring the Japanese islands of the Ryukuyus, Pescadores, Daitu, northern Bonins and the southern Izus. Reputedly five million birds were caught on these atolls in the 1890s (Yamashima, quoted after Harrison 1990, p. 109; Austin 1949).

The major hunting seasons in the Central Pacific were 1901–1904, and 1908–1910 with little exploitation between 1905 and 1907. There is another gap in birding records in the years



Number of islands targeted per collection season

Fig. 2. Frequency histogram showing the exploitation of seabird populations by Japanese plumage collectors.

1911–1913. Since activities resumed in 1914/15 in Hawaii we can assume that the trade had not completely stopped, but that it had occurred on islands where it went on undetected. The apprehension of poachers on Christmas Island in 1911 provides some clues. As the atolls nearest to Japan had been stripped of their bird populations (such as Marcus and the Bonins) or had become increasingly policed (Hawaiian Islands), more far-flung locations had to be found. Some bird populations were spared, most likely because of the arduous access to the islands such as Nihoa and Necker as well as the Gardner Pinnacles (all Hawaiian Group; Clapp & Kridler 1977, Clapp *et al.* 1977, Table 1).

But there are other 'suitable' atolls, such as Washington, Fanning, Baker, Bikar (Marshall Islands), and Palmyra. On the face of current data it would appear that the Japanese did not exploit their bird populations. That these locations should have been spared is somewhat surprising as all of the atolls mentioned are either *en route* to Christmas or near already exploited islands. We have to treat the lack of observations on these atolls with caution, however, because, as has been noted earlier, the discovery of poachers on many islands was often a lucky circumstance (or unlucky, depending on the point of view). In addition, at least Washington, Fanning, and Palmyra are atolls with higher rainfall and thus more luxuriant vegetation, such as *Pisonia grandis* trees. The collection of nests in such trees would have been more difficult, but not impossible as the evidence from the Marianas indicates (Spennemann in press a).

Likewise under-represented are sightings of poachers on Kure Atoll, Pearl and Hermes Reef and the French Frigate Shoals at the north-western end of the Hawaiian Chain. Given the long-term and repeated exploitation of Lisianski and Laysan it is likely that the three atolls mentioned also saw repeated poaching events that went unreported.

Micronesia, especially the Central Carolines, abounds in small atolls, many of which are uninhabited, such as Minto Reef, where a large nesting seabird population was found to be substantially reduced in 1906, which at the time was attributed to the Good Friday typhoon of 1905 (Berg 1905). The likewise uninhabited Gaferut ('Grimes') was also reported to have once had a very large and fearless seabird population (Senfft 1905).

Both atolls are on the northern fringe of the Central Carolines Archipelago. It cannot be determined whether, in both cases, Japanese activities went unnoticed or whether their seabird populations were reduced by the impact of the typhoons.

IMPLICATIONS

One of the issues to be highlighted here is the massive scale at which these birding expeditions were carried out. Table 2 compiles the known data for the exploitation of Central Pacific bird populations. This can only be the 'tip of the iceberg'. Because the historical sources usually do not provide catch figures on a species basis, the figures presented in Table 3 provide the totals for all species exploited.

In many cases only the numbers of bales confiscated or collected are available. These were converted based on the conservative estimates of 50 g of collectable breast feathers to a bird, 1830 wings to a bale and 200 individuals to a box (Ely & Clapp 1973). For those islands for which a hunting season is confirmed for a given year, but for which exact figures of birds killed are unknown, a standard figure of 50 000 birds per season was assumed (in Figure 3 expressed as open bars). Given the actual figures for Bokak, Laysan and Lisianski, this represents only about one-third of a good season's catch. This estimate is also low in view of the Christmas Island data, where 10 000 birds had been killed by 13 crew in only one month. It had been estimated that the total bird population on Marcus Island was over one million seabirds, yet only 350 000 have been used in the calculation.

The death toll among albatrosses, frigate birds, tropic birds, and other species was enormous: over 250 000 confirmed birds per year in 1903, 1908, 1910 and 1914, and over 400 000 in 1909 (Fig. 3, solid bars). If we correct these figures for atolls lacking exploitation data (open bars), then the 400 000 birds per year mark was reached in 1900, 1903, 1908–09 and 1914. In 1908 over half a million birds were killed.

In addition to the number of adult birds killed we have to consider the losses of unhatched eggs collected by the poachers and the deaths of chicks due to starvation once both their parents had been taken. Furthermore, some atolls, such as

TABLE 2
Japanese feather collectors – a chronology 1989 to 1916 (Sources see text)

Year	Kure Atoll	Midway Island	Pearl & Hermes Rf	Lisianski Island	Laysan Island	French Frigate	Marcus Island	Enceen-Kio	Bokak Atoll	Pratas Island	Marianas Island	Johnston Atoll	Christmas Island
1881													
1882	?	?	?	?	?	?							
1883													
1884													
1885													
1886													
1887	□	□	□	□	□	□							
1888													
1889		?											
1890		?											
1891	?	?	■	?	■	?							
1892													
1893													
1894													
1895													
1896													
1897							?						
1898	■ ?						□						
1899				□	■		□						
1900		□					■						
1901		■		?	■		■						
1902					■		■	■					
1903		■		■	?		□	□					
1904				■	?		■	■					
1905								□					
1906							■						
1907							□		?				
1908	□		□	■	■		■	■	■				
1909				■	■			■			●		
1910		■		■	■						●		
1911											?		■
1912													
1913													
1914			□	□	□		□					?	
1915			□	■	■		?						
1916													

Codes: ● Permitted exploitation; ■ Illegal exploitation confirmed; □ Inferred exploitation

Laysan Island, saw the exploitation of albatross eggs on a large scale in 1903, further delaying the recovery of the bird population after the Japanese poaching events (Harrison 1990, p. 37).

Because these seabirds commonly lay only one egg per year (Harrison 1990), and not all young can reach maturity and thus a reproductive age, the loss of close to two million birds between 1897 and 1915 is substantial, especially as the figures advanced are the bare minima only. If we add those atolls lacking exploitation data, then the total rises to 3.5 million. The real number is likely to be even greater, as the records for many atolls are incomplete.

The impact of over-collecting is well documented in the contemporary observations: on Marcus Island, following six years of exploitation, only seventeen useable birds could be caught, although the initial catches must have been in the order of 100 000 to 150 000 birds per season (Bryan in Buckland 1916). On Guguan (Marianas) it is reported that the bird numbers had been dramatically reduced, and that the birds had 'retreated to the hills' and became very hard to catch (Spennemann in press a). On Bokak (Marshalls) the commander of the *Condor*, visiting the island in September 1909, mentioned that the Japanese had been very successful because very few birds were encountered, even though the island was renowned for its plentiful bird life (Spennemann 1998).

TABLE 3
Minimum number of bird catches (Sources see text)

Year	Total annual catch	Kure Atoll	Midway Island Pearl and Hermes Rf	Lisianski Island	Laysan Island	French Frigate	Marcus Island	Eneen-Kio	Bokak Atoll	Pratas Island	Marianas Island	Johnston Atoll	Christmas Island
1896													
1897	?	?					?						
1898	?			?	?		?						
1899	?						?						
1900	200 000		?		?		200 000	?					
1901	100 000		?				100 000	?					
1902	50 000			?			50 000	?					
1903	284 000		?	284000			?	?					
1904	17						17	?					
1905													
1906	?							?					
1907	?			?	?								
1908	320 000		?	?	120 000				200 000				
1909	416 372			128 000	171 050				114 780	?	2 542		
1910	261 000	250 000*											11 000
1911													
1912													
1913													
1914	317 500			142 500	175 000							?	
1915			?										
1916													
Total	1 948 889	?	250 000	?	554 500	466 050	350 000	?	314 780	?	2 542	?	11 000

* The Japanese arrested on Christmas Island claimed that a catch of one million birds was made on Midway, but a figure of 250 000 was deemed more realistic in view of the experiences on other islands.

OTHER IMPACTS

Three other kinds of impacts reduced the number of seabirds on the far-flung atolls: victualling of passing ships and stranded sailors, the introduction of alien predators, and environmental disasters.

Seabirds as food sources for mariners

The account of the stranding of the German barque *Libelle* on Wake in 1866 mentions that seabirds were eaten (D.H.R. Spennemann unpubl. data). For Hawaii there are accounts of shipwrecked sailors feeding on the abundant seabird fauna (Harrison 1990). The captains of New England whalers used the isolated atolls to procure firewood and, if possible, seabirds when provisions were running low. This exploitation must have been constant, but, presumably, sustainable. However, Charles Wilkes, US Exploring Expedition, noted for 1841 that '[Titian] Peale found here the Short-tailed [=Laysan] Albatross, and procured an egg from its nest. The birds were quite tame, although they were not so numerous as we had before met with on uninhabited islands' (Wilkes 1845: V 284–285).

Habitat alteration and the introduction of alien species

By 1939 another menace had arrived. The need to develop many of the atolls into military bases, mainly as airfields, saw widespread destruction of habitats and collapsing of burrows (of shearwaters and petrels) during construction, as well as during subsequent bombing raids (United States Strategic Bombing Survey 1947, Bryan 1959, Harrison 1990). Furthermore, the introduction of other predatory species, mainly the Black Rat *Rattus rattus* and the Norway Rat *R. norvegicus* (Bryan 1959, Moors & Atkinson 1984, Seto & Conant 1996, Spennemann 1997b), resulted in a further reduction in the reproductive capacity of seabird populations when they had just begun to recover. On Eneen-Kio (Wake) another problem contributed, as the Japanese garrison during World War II, cut off from supplies, resorted to eating seabirds which could be caught (United States Strategic Bombing Survey 1947).

Environmental catastrophes

Superimposed onto this high level of human-induced slaughter are the effects of natural disasters, mainly typhoons, but also volcanic eruptions (on the Volcano Islands). The low-lying

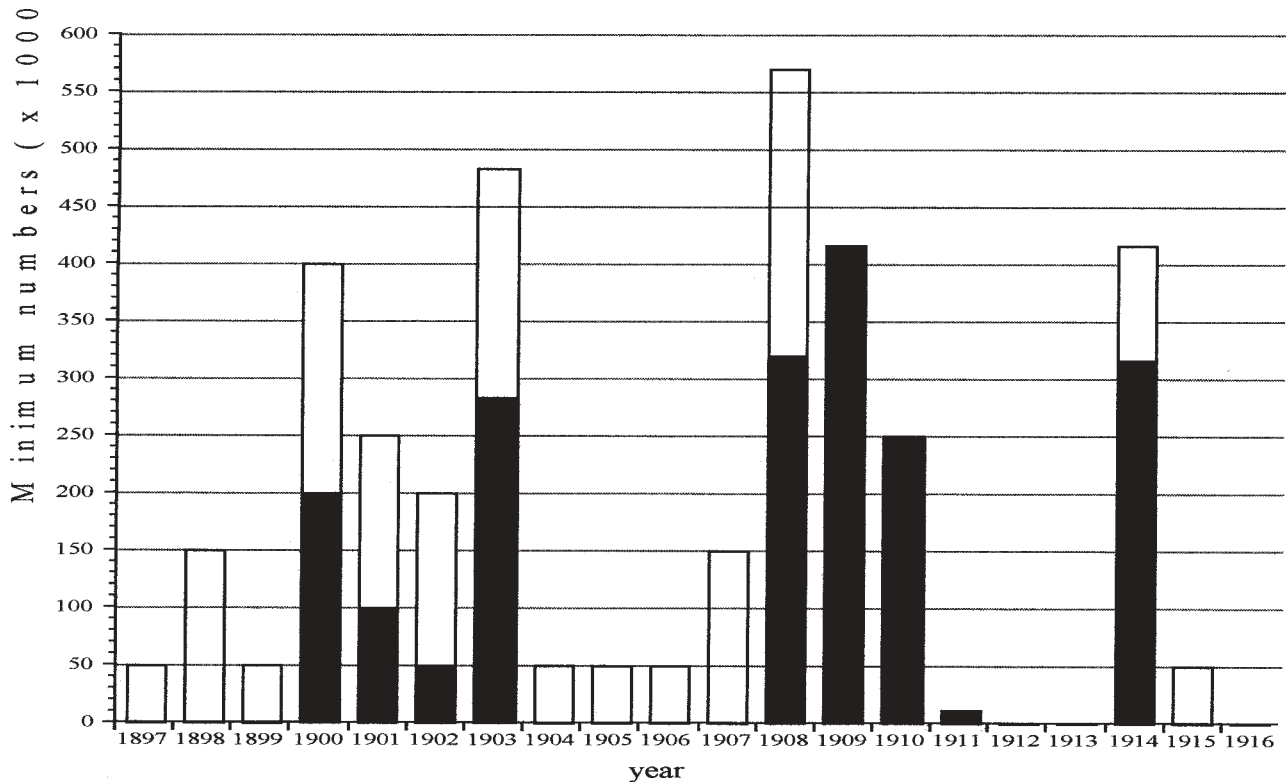


Fig. 3. Minimum number of bird catches in the Central Pacific. The solid bars show confirmed numbers, the open bars indicate inferred bird kills.

nature of most atolls makes them susceptible to the effects of storm surges. The El Niño of 1982/83, for example, had a substantial impact on the atoll populations in the North-western Hawaiian Chain due to storm surges and heavy rains inundating atolls and drowning the chicks (Harrison 1990). During the El Niño period the typhoons form farther east than normal and affect atolls that usually escape their impact (Spennemann & Marschner 1995). Global climate change is posed to result in increased sea surface temperatures. Thus what is today the exception may well become the norm, thereby threatening the survival of the populations on some atolls.

On Torishima (Volcano Islands) an active volcano caused the deaths of the albatross colonies in 1903 and 1939 by killing birds roosting in the colonies and covering the breeding grounds (Harrison 1990).

CONCLUSIONS

The impact of over-collecting led to dramatic losses in the frequency of species and to outright extirpation. What was done about it? Bird populations were seen by the governments as an exploitable resource as long as the sustainability, from an economic point of view, was not impaired. And, as an example from the Marianas shows, even if a bird population was hunted well above the level of sustainability, the government was not really interested in this fact (Spennemann in press a). The U.S. Presidential declaration of the Hawaiian bird islands as bird reservations in 1909 was a step in the right direction, and with vigilant enforcement could have eventually led to the protection of at least a part of the bird population of the Central Pacific. The event that led to the main protection, however, was the outbreak of World War I and the resultant end to the excesses of the European fashion industry.

With the collapse of the market, poaching also ended and the bird populations had time to recover. But just at the time when that recovery was under way, the events of World War II transformed many island habitats in the central Pacific Ocean into sprawling military bases and airfields, again affecting their seabird populations.

Since the turn of the century the populations of Laysan Albatrosses have recovered in Laysan and Lisianski, and the species is recolonising the Bonins and other islands in the Northern Central Pacific, regaining some of the ground lost due to feather poachers (Harrison 1990). Because Laysan Albatrosses tend to return to their original colonies to breed, the colonisation of a new locality is very uncommon. Some atolls, such as Wake and Marcus, have not been recolonised by this species (Harrison 1990). It is estimated that there are about 2.5 million Laysan Albatrosses in the Hawaiian Islands (Harrison 1990). The partial recovery of the Laysan Albatross populations in the Hawaiian Islands is most likely due to the fact that a large number of pre-breeding birds were not on the island and thus escaped the feather collectors. This is coupled with the high adult survivorship, delayed maturity resulting in large prebreeding cohorts and high hatching and fledging success of this species (E. Flint *in litt.*).

Ultimately it may have been the lull in exploitation during World War I that allowed the former pre-breeding albatrosses to return to their atolls of origin and to (re-)found the colonies. Where exploitation had gone on for too long, such as in the case of the southern Japanese islands, the colony could not be restarted by natural means. In the case of Wake Atoll, the colony could be successfully restarted, as Pan American Airways found in 1935 when it established a commercial seaplane base there (Grooch 1936). However, during World War II, the continued predation of the birds by rats as well as

the starving Japanese garrison took its toll and brought that already weakened colony to extinction.

Without the historic perspective it would be impossible, for example, to understand the current distribution patterns of Laysan Albatrosses. For some atolls the historic compilations have identified the activities of the Japanese feather collectors, but it will be only through a systematic study of the historical sources, archival and otherwise, that the extent and magnitude of the devastation can be assessed.

Today the survival of the seabird breeding colonies of the Central Pacific Ocean is again threatened as changing global climatic conditions bring about an increased chance that the remaining populations on the generally very low-lying atolls could come under threat from typhoons and storm surges, as well as outright inundation, rather than the anthropogenic disasters of the past.

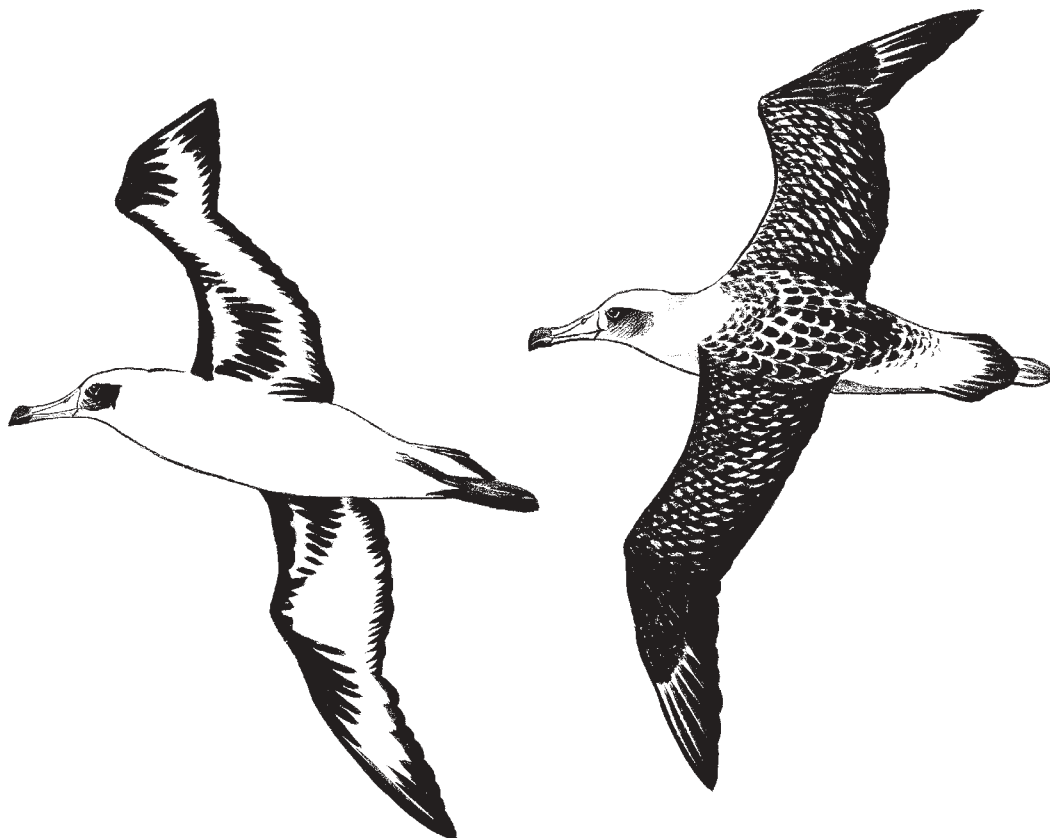
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