MARINE CONSERVATION INSTITUTE

A Brief History of Human Activities in the US Pacific Remote Islands

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Preface

The Pacific Remote Islands Marine National Monument (Monument) was designated by Presidential Proclamation in January 2009 to preserve the marine environment in these isolated ocean areas. The ecosystems surrounding the islands and atolls within the Monument are believed to be flourishing with healthy coral reefs, large numbers of apex predators and high fish biomass. In order to effectively protect these areas and natural resources, Monument management plans are being prepared by NOAA Fisheries and the Fish and Wildlife Service. However, even as the plans are being developed many important questions remain unanswered. In order for the Monument's managers to develop comprehensive and effective management plans they must review and consolidate data on natural resources, understand and manage for ecological interactions among species (such as seabirds and pelagic fishes), as well as develop a clear picture of current and historical human activities and their impacts.

This report will help provide answers to questions about the ecological history of the Monument and will inform managers that are tasked with the management of its resources. Preparation of this report entailed a thorough search of literature and other sources to summarize what is known about the historical status and trends of natural resources of the islands and their surrounding waters, and how they may have changed over time. In addition to the more generalized search for information about historical conditions, specific attention was given to quantitative and anecdotal information about seabirds and their prey. This information will help public officials set a benchmark of what a restored natural monument would be like for management planning -- a goal of the Antiquities Act proclamation.

While this is not a definitive assessment of historical baselines and conditions in the Monument, this report provides a well-documented summary of existing information sources along with interviewee names and contact information. Visits to the Smithsonian Institution, Bernice P. Bishop Museum, and Huntington Library, Art Collections and Botanical Gardens proved to be productive endeavors. Due to budget and time limitations, only several institutions that were confirmed to have useful information were visited. With the assistance of museum and library staff, we were able to identify unpublished data and anecdotal information pertaining to changes over time in Monument. Please see Appendix A for details about the institutions visited and raw data collected.

Terms of Reference

Conduct a rapid assessment of the ecological history of the central Pacific region. Search the literature and other sources to summarize what is known about the historical status and trends of natural resources of the islands and their surrounding waters, and how they may have changed over time. This will enable the public officials to set a benchmark of what a restored natural monument would be like for management planning -- a goal of the Antiquities Act proclamation.

A written report will be provided with an annotated bibliography and sources of information such as interviewee names and contact information. (Note: This assessment will not seek to be a definitive study of historical baselines and conditions in the Monument, but will assess likely sources of information, and identify other potential historical sources that would require more extensive research (e.g., museum and library archives, etc.)

Acknowledgments

We gratefully acknowledge the support of the Pacific Islands Regional Office of the National Marine Fisheries Service. Additionally Roger Clapp, Claudia Angle and Gary Graves of the Smithsonian Institution provided invaluable access and discussion of Pacific Ocean Biological Survey Program activities and data. Mark Rauzon provided additional insights to the history of the region. Beth Flint and others in the Fish Wildlife Service provided valuable assistance identifying pertinent data and coordinating contacts during the visit to Oahu. Desoto Brown, B. J. Short, Suzanne Harter, Tia Reber, Charles Myers, Arnold Suzumoto, Richard Pyle, Lydia Garetano, Pumehana Imada, Lu Eldredge and Holly Bolick of the Bishop Museum provided guidance through their extensive and diverse collections. To the many collection managers who gave us access to the holdings of the Smithsonian Institution, Bishop Museum and Huntington Library we are indebted.

Introduction

The following is a summary of human activities in the Pacific Remote Island Marine National Monument (PRIMNM) and adjacent pelagic waters. The purpose of the research was to identify human activities, primarily before WWII, that may have had an effect on the flora and fauna of island, nearshore and pelagic ecosystems encompassed buy the Monument.

Availability and reliability of data varied. Information about pelagic fauna was notably the most difficult information to locate. Due to time constraints it was necessary to omit thorough searches of primary sources such as expedition and whaling logs. It is possible that observations recorded by early explorers and traders that were crossing the Pacific Ocean in the 16th and 17th centuries could contain information pertinent to this topic. In addition, whalers' accounts from the central Pacific Ocean during the mid-19th century provide data about whale populations and possibly information about whales and their interactions with other taxa, but reviewing that material was outside the scope of this project. As a result, the sources identified in this summary

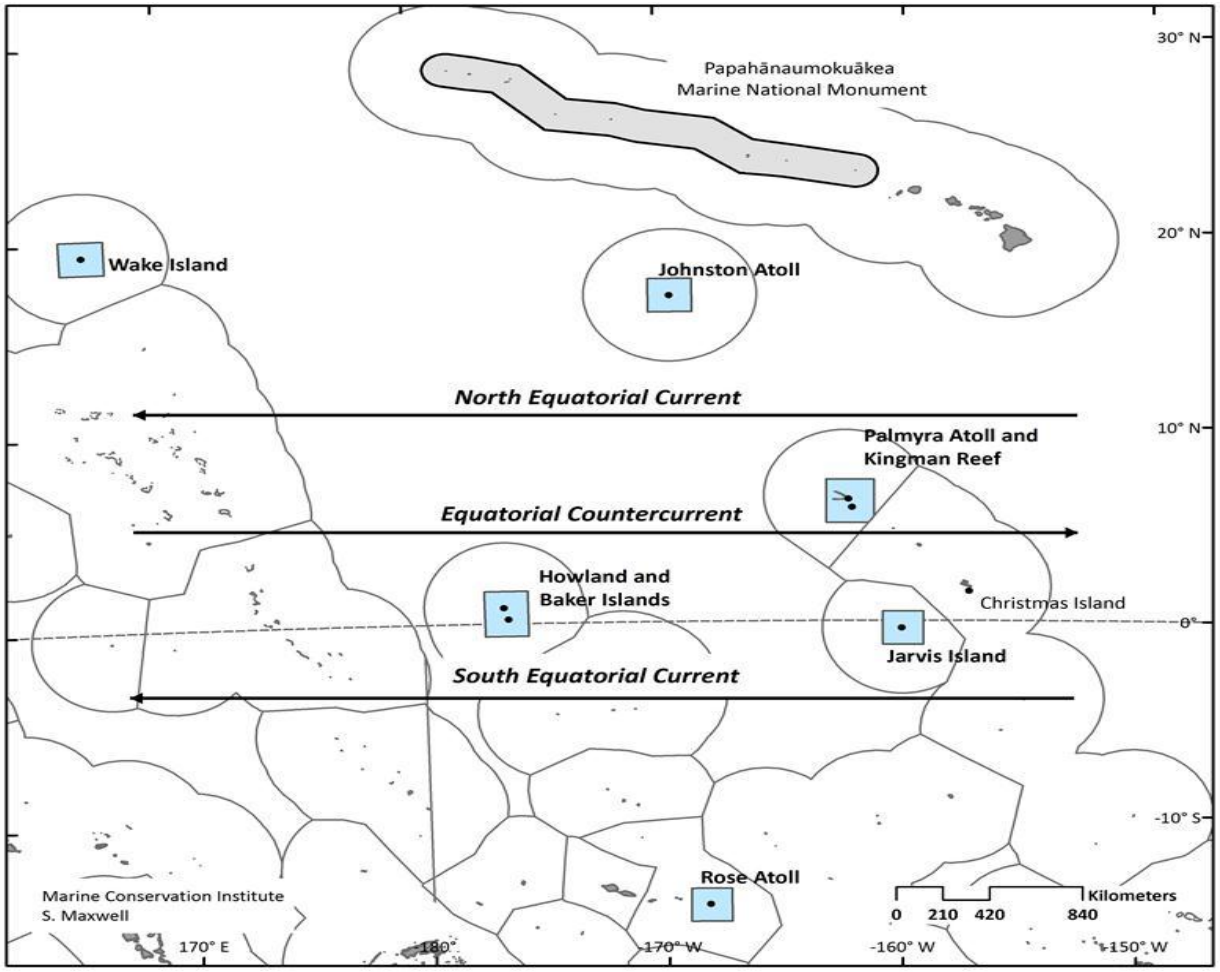

Figure 1. Major currents, atolls and islands within the PRIMNM (Maxwell and Morgan 2011).

reflect information that did not require transcription or significant time investment to locate.

The US Pacific Remote Islands Marine National Monument (Monument) encompasses an area of approximately 86,888 square miles and is crossed by the North Equatorial Current, Equatorial Current and the South Equatorial Current. Interspersed across this region are the islands, atolls and reefs that are the cornerstones of this monument. Howland, Baker and Jarvis Islands are closest to the equator and are sandwiched by the Equatorial Current and South Equatorial Current. Palmyra Atoll and Kingman Reef are approximately 350 miles north of the equator in between the North Equatorial Current and Equatorial Current; Johnston Atoll is approximately 823 miles southwest of Honolulu, and far north of the North Equatorial Current. Wake Atoll is the westernmost feature in the Monument, located more than 2,235 miles west of Honolulu, HI. The combination of distance from other landforms, regional oceanographic conditions and weather patterns influence accessibility, habitat suitability and terrestrial and marine resource availability, for plants, animals and humans. All of these variables have played different roles in shaping the effects humans have had on the atolls and islands throughout history (See Appendix B. Timeline of major periods of human interaction with Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Kingman Reef, Palmyra Atoll and Wake Atoll).

Early human expansion into the Pacific Remote Islands Area

The equatorial islands were reached relatively late in the chronology of expansion across Oceania due to the evolution of sailing techniques by Polynesians (Denoon et al 1997). The order of

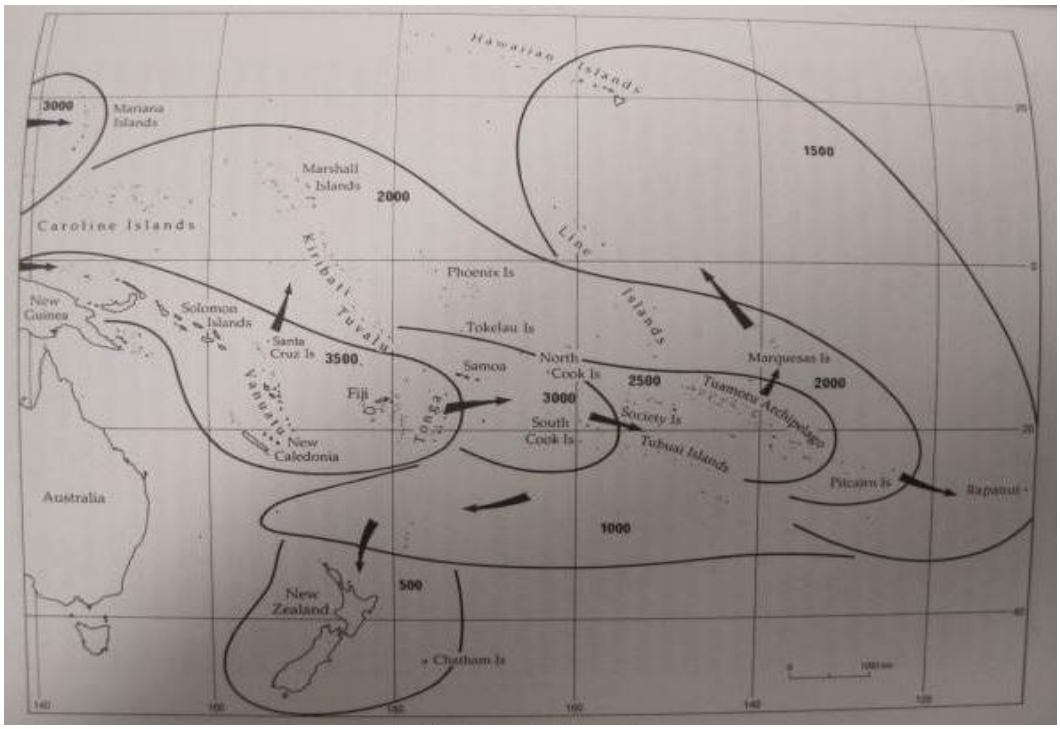

Figure 2 "Settling the region" (Denoon et al 1997).

discovery can be explained by the theory that movement across the Pacific Ocean was wind driven so that areas that were upwind of the points of origination, were discovered first, and islands that were closer to the point of origination, such as New Zealand located just south of New Guinea and closer to the point of origination, were discovered later (Figure 2). This hypothesis is consistent with the technology that was available at the time.

George Irwin, a preeminent researcher in this area of study, proposed a model which:

> *"accounts for variations in settlement dates and for why islands were not always settled in order of cartographic closeness. Thus Hawaii and New Zealand (and some of the intermediary islands such as Norfolk, the Kermadec Islands and Line Islands) lie outside this exploratory pattern of upwind sailing and thus were last to be discovered. Meanwhile, tiny isolated islands, such as Easter Island, were discovered sooner because they lay in the upwind direction. Only with the development of crosswind exploration could places outside that strategy zone be located. Cross and downwind navigational techniques were made after upwind exploration, and suggest a learning process which altered exploration strategies. Hawaii was reached crosswind, New Zealand down the wind (Thomas 1997)."*

Figure 3. A Canoe of the Sandwich Islands, the Rowers Masked (Nantucket Historical Association).

No permanent settlements were established in the equatorial islands of the Monument. Their remote location and lack of fresh water may have saved the islands and their nearshore communities from extended periods of habitation and as a result there were likely minimally exploited by Polynesians. There is evidence that freshwater is available on Palmyra in the form of intermittent freshwater pools, and Hutchinson (1950) states that coconut trees were observed on

Palmyra Atoll in 1802, suggesting that Polynesians had visited the atoll, but there is no evidence that Palmyra was ever inhabited for extended periods of time (Hathaway et al 2011, Hutchinson 1950). While long-term settlement is unlikely, short-term visits may have occurred. On Howland Island, J. D. Hague found evidence of occupation in the form of artifacts and alterations to the island that were indicative of "South Sea Islanders" (Hague 1862).

European expeditions across the Pacific Remote Islands Area

The next people to arrive in the region were the European explorers who had developed sailing technology that was much more advanced than that of the early Polynesians. Early explorers and traders would have encountered islands and atolls such as Palmyra Atoll that were along trade routes (See Appendix C). The well-established trade routes between the western coasts of Mexico and South America, and their destinations in China and the Philippines are good examples of such routes (Figure 4).

Journal entries from Captain Cook's voyages provide us with insight about the nature of exploitation when islands were encountered. On Captain Cook's third voyage, two ships traveled from Christmas Island to the Sandwich Islands (Hawaii). This part of his voyage would have brought him just adjacent to Jarvis Island. The crews landed at Christmas Island on December 25, 1777, departed on January 2, 1778 and arrived at the Sandwich Islands on January 18, 1778. Christmas Island, which is referred to as "Sandy Island" in the journal entry, shares some similarities with Howland, Baker and Jarvis Islands. The Island is reportedly "quite low, the soil

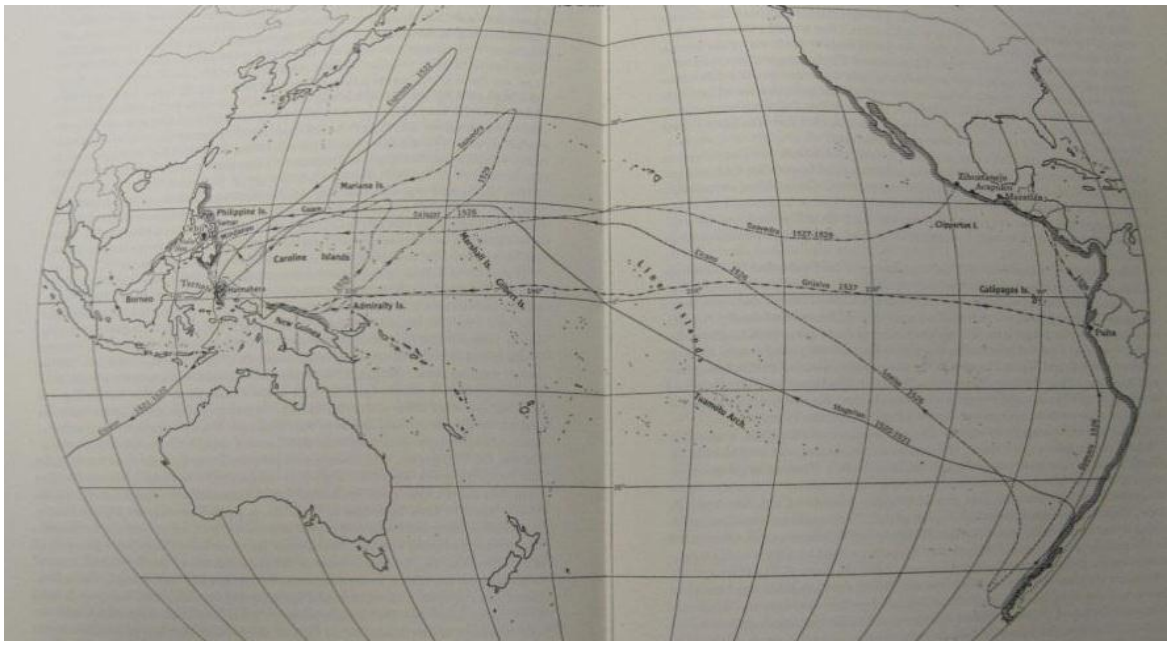

Figure 4. Spanish explorer routes (adapted from Friis 1967).

being a fine white sand with no trees whatever but overgrown with bushes. There is a great abundance of large and beautiful birds which are quite tame and many fishes and turtles". In addition fresh water was non-existent—"Because of our terrible thirst we dug into the ground and found water at a depth of about 5 to 6 feet; however, it was more salty than the sea water and therefore unfit to drink" (Beaglehole 1934). Through his journal entries we catch a glimpse of activities that might take place when a voyaging party encountered a location that provided sources of food replenishment (Zimmerman 1930). An entry from one of Captain Cook's crew members, indicates that sea turtles were a preferred source of food that were sometimes the most easily attainable source of nutrition,

> *We then went ashore with the oncoming night caught a great number of turtles where they commonly gather on the land after dark. Most of these turtles weighed about two hundredweight.*[1] *We collected them, laid them on their backs so that they could not escape, and the next day returned to the ship with a load of them and told of our lucky find. Having been provided with rations of fresh water we were ordered to return to make another catch the following night.*
>
> *Upon our return we had found that the other boats had all been sent out fishing and we were told that should we meet any of them they were to go with us to bring back a load of upturned turtles. We encountered two of these boats on the way whose occupants had already eaten their provisions.*

The sea turtles were kept alive on the ship with relatively little maintenance until the crew was ready to eat them,

> *This island we called Sandy Island and left it on the 2nd of January 1778 after having gathered such a supply of live turtles that we ate nothing else for four or five weeks; we kept them alive during that time by washing their eyes every day.*

Visitations to these islands appear to be punctuated as explorers and traders were not interested in settling for long periods of time on these islands.

Whaling comes to the central Pacific Ocean

New England whalers that originated from Connecticut, New York and Massachusetts ventured into the central Pacific Ocean in the in the early 19th century (Hilt 2007). Their unrelenting pursuit of whales was the first large scale, post-Polynesian resource driven expansion into the central Pacific Ocean. Whale populations throughout the region were negatively impacted. Due to their high market value and dense aggregations along the equator, sperm whales (*Physeter*

[1] One hundredweight = 112 American pounds (Nicholson 1912).

macrocephalus) were hunted intensively (Figure 5).[2] Sperm whale populations experienced their first major decline during this period (Taylor 2008). At the peak of whaling efforts in the 1950's the IUCN estimates up to 25,000 sperm whales were taken world-wide per year (Taylor 2008). Ships' logs, personal journals and newspaper articles provide clear information that Howland, Baker and Jarvis Islands were visited by whalers. Howland, Baker and Jarvis Islands were visited by

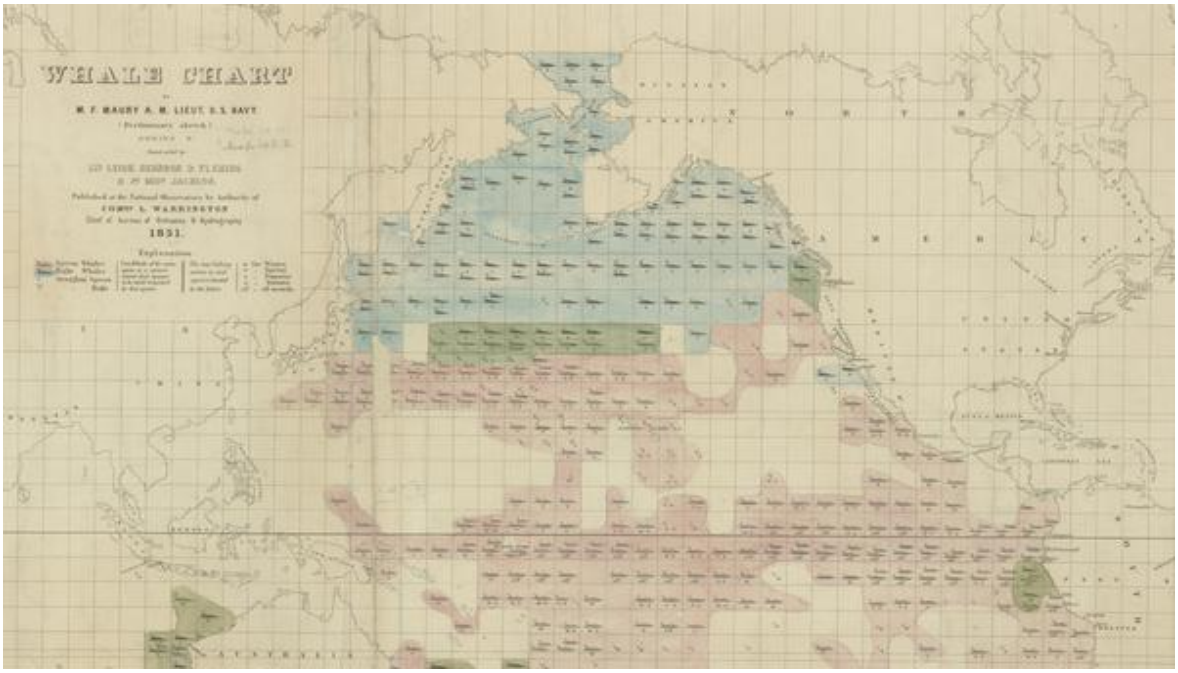

Figure 5. Map depicts the distribution of sperm (red area) and right whales (green and blue). Two whales per square indicates high frequency (Maury 1851).

whalers who used nearshore marine life, including birds, sea turtles and edible eggs to restock their ships' supplies. George E. Netcher, a mariner and whaler from New Bedford, Massachusetts, reported in an article, "I saw the Island [Howland] before mentioned many times that year [1842], repeatedly sent my boats on shore to get eggs" (Ward 1966). In the case of Baker Island, in 1869 an unknown author wrote,

> *Previous to its coming into possession of its present owners, it was occasionally visited by ships, chiefly sperm-whalers, that frequent these waters. A weather-beaten piece of timber, firmly planted in the ground, bearing a rude but secure letter box, still stands like a beacon upon the most prominent part of the island. For many years it served as a seaport office—a sort of news exchange station, where passing vessels left papers letters and long books, and*

[2] The creator of the whaling chart in Figure 4 was Matthew Fontaine Maury. He was an American naval officer and oceanographer who served as the Superintendent of the U.S. Navy Depot of Charts and Instruments (later the U.S. Naval Observatory) from 1842 to 1861. He compiled this map from various sources including logs from whaling ships.

thus, received now and then, crumbs of intelligence from the great world from which they had been so long shut off from (Bryan 1938b).

Island ecosystems would have been heavily impacted by the removal of wood for fuel from forested islands and atolls, including Palmyra and Wake. Tree nesting seabirds such as the great frigatebird (*Fregata minor*), red-footed booby (*Sula sula*), white-tailed tropicbird (*Phaethon lepturus*), black noddy (*Anous minutus*), brown noddy (*Anous stolidus*), white tern (*Gygis alba*), may have been negatively impacted by the removal of native forests but these effects have not been quantified. The literature does not suggest that Johnston Atoll was a major stop for whaling ships (Amerson et al 1976). Howland, Baker and Jarvis proved to be formidable hazards to whaling ships as shown by numerable reports in the newspapers about wrecks. Often lives were saved, but loads of oil and guano were lost. The *Columbian Centinel*, Boston, Mass reports on December 14, 1825, "The Mary, with 1800 bbls. sperm oil, and Bridges, with 100 tons do. (both of London) have been totally lost, the former on Jarvis' Island, and the latter on the Marquesas Islands" (Amerson et al 1976).

The whaling industry during the early to mid- 19th century likely contributed to the long-term decline of sperm whale populations, and temporarily caused declines in seabird and sea turtle populations. Wildlife populations may have been able to recover from the whalers' activities were it not for the cumulative impacts of people that came after them.

Guano rush

Although the need for whale oil declined once terrestrial sources of oil were discovered, the exploitation of marine life in the central Pacific Ocean did not end. Identifying and recovering high quality sources of guano became a lucrative endeavor in the 1850's. An excerpt from the Daily Evening Standard, "New Bedfort Mass." recounts how guano was discovered on Baker Island (Ward 1966).

Death of Captain Baker.-- We have just received intelligence of the decease of Capt. Michael Baker, of South Dartmouth, Mass., on the last day of 1860.

The commercial and agricultural world will long hold his name in grateful remembrance, as the discoverer of guano on "New Nantucket", now called "Baker's" Island.

The discovery was on this wise. On board of the ship commanded by Captain Baker in the year 1841, there was an orphan, named Warren Wilbut. This young man was fatally injured by falling from the look-out loft, and his dying request to Captain Baker, who watched over and cared for him as if he had been his own son, was to bury him on land and not in the ocean. Captain Baker promised to do so if possible, and being in the vicinity of Baker's Island, interred him there. In digging the grave, he discovered what he then thought to be a most remarkable kind of soil, the dust of which so enveloped and choked the men, that they

were compelled to abandon the place first attempted, and choose another nearer the shore, where it was not so dry. Thus while engaged in performing an act of kindness, which always characterized his life, sprang there up a basis of food for millions of men.

Daily Evening Standard, New Bedfort Mass.

Jan. 7, 1861

Guano mining scouts like J. D. Hague (1962) provide us with some of the most detailed accounts of the central tropical Pacific Islands prior to the 1860's. In addition to Hague's detailed observations of seabirds in particular, he states,

The above are kinds of birds most numerously represented and to which we owe the existing deposits. When the islands were first occupied they were very numerous but have since been perceptibly decreasing.

The seabirds he refers to are noddies, frigatebirds and boobies. When speaking about the boobies, he mentions that "they are gross feeders, and I have often seen one disgorge three or four large flying fish fifteen or eighteen inches in length" (Hague 1962). Hague was not a biologist, but rather trained as a geologist and as a result he was a trained to be an attentive observer. More observations of this sort would be useful to corroborate his biological observations.

Figure 6. Two colonists holding a shark caught at Baker Island. March - Oct. 1940. *Source: Bernice P. Bishop Museum, Honolulu, HI.*

Throughout the world, guano accumulates in drier locations where seabirds occur. As a result, the equatorial islands of Howland, Baker and Jarvis proved to be profitable sources of guano. An estimated 624,000 tons of guano were removed from Howland, Baker and Jarvis Islands (Hutchinson 1950). Guano was also removed from Johnston Atoll (Amerson et al 1976). The wetter atolls of Palmyra and Wake did not produce high quality guano and were never mined. Guano mining activities had catastrophic consequences on cavity and open ground nesters such as petrels, shearwaters, boobies, noddies and sooty terns (Hague 1862).[3]

[3] Hague 1862 states "noddies" that "burrow holes in the guano in which they live and raise their young, generally inhabiting that part of the deposit which is shallowest and driest". His observations are useful, but his species identification is most likely incorrect as the noddy that occurs on Howland, Baker and Jarvis is the brown noddy (*Anous stolidus*) which tends to nest on open ground or in trees (Schreiber 2002, pers. comm. Roger Clapp July 12, 2011).

In addition to these direct impacts, ships that visited the islands during this period likely introduced non-native plants and animals.

Millinery feather trade

From the late 1890's until the beginning of WWI, seabird feathers were collected by Japanese throughout the north and central Pacific Ocean islands and atolls for the millinery trade with Europe and the United States (Spenneman 1998a). The Pacific atoll feather trade was primarily focused on Laysan albatross (*Phoebastria immutabilis*), black-footed albatross (*P. nigripes*), masked booby (*Sula dactylatra*), lesser frigatebird (*Fregata ariel*), greater frigatebird (*Fregata minor*), red-tailed tropicbird (*Phaethon rubricauda*), sooty tern (*Sterna fuscata*) and various other species of tern (Spenneman 1998a). In 1923 the Tanager Expedition found the ruins of a Japanese camp on Peale Island which is one of the three coral islands that makes up Wake Atoll. Some of the remnants of the camp included a pile of bird bones. "The pile of bird bones were frigate birds, boobies and terns… the fact that they [albatrosses] were not among the recent bones left by plume hunters indicates extermination long before 1923" (Rice and Kenyon 1962, Rauzon 2008). Within the Monument, historical records of Japanese bird collection activities are most complete for Wake and Johnston atolls (Spenneman 1998a, 1998b).

Collection typically took place when the birds were breeding because seabirds were easily collected while they sat on the nest. Using available data, but not accounting for eggs, and juvenile birds impacted by collection activities, Spenneman (1998a) concluded that a conservative estimate of the number of birds killed in the central Pacific from 1897 to 1915 is two million. If estimates for atolls that do not have collection records are added, he concluded the number was increased to more than 3.5 million seabirds taken from the central and northern Pacific Ocean islands and atolls in under twenty years (Spenneman 1998a). Between WWI and WWII the seabirds in the Monument experienced a relative lull of human activity. This allowed seabird populations the opportunity to recover. Laysan albatrosses on Wake are an example of a species that simply could not recover from the pre-WWI impacts. Several nesting attempts have been recorded between 1996 and 2008. There is only one record of a successful nesting season. It took place in 2001 and produced one individual (Rauzon 2008). The possibility of exploitation on Howland, Baker and Jarvis should not be discounted simply due to a lack of historical information.

United States colonization of the Equatorial Islands

At the request of the United States military, from 1935 to 1942, young Hawaiian men known as the Hui Panala'au, or the "colonists", occupied various islands and atolls in the central Pacific Ocean, including Howland, Baker and Jarvis Islands. Their activities on the islands, including their utilization of terrestrial and marine fauna for food, are well documented (Piianaia et al 1936). With the exception of cats that were covertly brought onto the islands by the young men, many references are made about their interactions with non-native plants and animals. There are many accounts of planting non-native species including coconut trees, as well as efforts to eradicate rats (Piianaia 1935). On Baker Island they held a "rat drive" in the evening. They declared in the journal, "the purpose of the drive is to kill as many rats as we can" (Piianaia 1935). Below are brief excerpts from the Hui Panala'au journals. These journals which served to document daily activity were mandatory for the young men. Entries from Baker Island 1935 (Piianaia 1935):

Figure 7. Kamakuai Field. In preparation for Amelia Earhart landing. Prepared by the "colonists". Photo taken in 1937. *Source: Bernice P. Bishop Museum, Honolulu, HI.*

> *June 29, 1935 "gathered wood for cooking"*
>
> *July 2, 1935 "We weeded our lawn and spred dirt over our lawn so that the grass could grow better…"*
>
> *July 3, 1935 "We planted radishes, lettuce, and onions…"*
>
> *July 7, 1935 "Boys fished today and caught 2 uhus, 1 manini, 2 ulaulas, and 1 poopaa."*
>
> *July 14, 1935 "Boys went fishing today, and caught two mullets, seven aholeholes, two maninis, and one squid."*
>
> *July 28, 1935 "At eleven o'clock, we watched the Frigates (or Iwa's) swoop down from a thousand or so many feet upon a school of fish. There were more then [sic] five hundred of them swooping down on the school."*
>
> *Sept. 6, 1935 … "This is the 'mating' season for the 'Terns'…*

Sept. 13, 1935 … "The terns are mating now, and they are rather disturbing with all the chirping they do."

Specifically, the journals provide information about the seasonality and patterns of arrival and departure on both a daily and annual basis for the most conspicuous species. There are gaps in this data because the young men were not explicitly tasked with collecting this type of information. They young men were, however, excellent observers and serve as our eyes and ears on these islands during this time period. Below are notes they recorded about golden plovers;

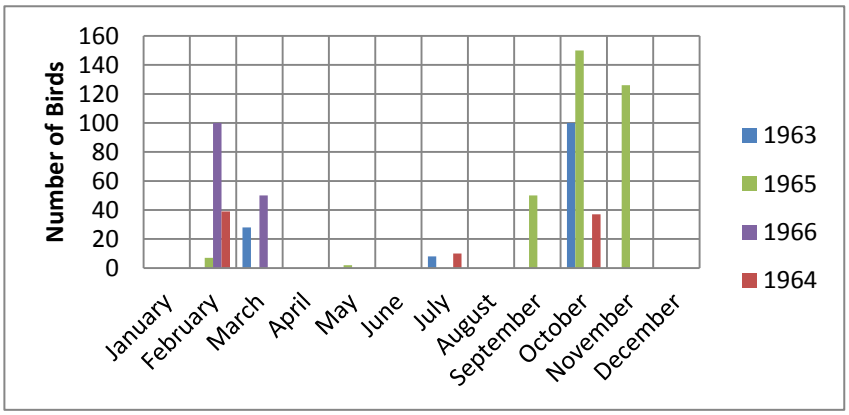

Figure 8. Golden plover (*Pluvialis dominica*) population March 1963 - March 1966 on Baker Island (Sibley 1965).

Sept. 22, 1935

… "I have just seen the first golden plover on this island since we've been here. They must have just migrated here because they seem to be tired and look very skinny…

Sept. 26, 1935

… "Two golden plovers have been hanging around our mess tent lately. They seem to be getting bolder and tamer everyday [sic]. In trying to befriend them, we have put a water can near the water drums from which the plovers have been drinking whenever they care to."

These observations are consistent with Pacific Ocean Biological Survey Project (POBSP) observations for Baker Island. From March 1963 to March 1966, golden plover "was commonest in the fall and early winter months" (Hackman 1966b). Agreement between the two datasets substantiates the reliability of observations recorded by the colonists. In some cases the anecdotal information is quite specific and in the case of records of fish caught, and weather conditions (their official mission on the islands) data were recorded reliable every day. Other bits of information are detailed but recorded only when significant to the colonists, and as such provide us with a picture full of many gaps.

Pan American Airways Clippers Ply the Skies of the Pacific

Pan Am Clippers: The answer to long-distance flight over the Pacific Ocean

In the early 19th century, Juan Trippe, the visionary owner of Pan American Airways (Pan Am) recognized that routes from the west coast of the United States to westward towards China, and

southwestward towards New Zealand and Australia were the last remaining lucrative civilian aviation routes to be developed. As a result of Tripp's foresight, Pan American Airways was the first civilian airline carrier to establish regular routes across the Pacific Ocean. In the early 19th century the primary barrier to civilian trans-Pacific air travel was the distance between suitable refueling locations. This was due to mechanical limitations of the planes at that time combined with the lack of hard landing locations south or west of Hawaii. Trippe's solution was to work with Sikorsky and Martin to develop a seaplane that could travel further than any other seaplane had traveled before. This eliminated the need to establish landing fields on American-owned hard surfaces that were few and far between in the Pacific (D. 1939). At the same time, use of seaplanes allowed Pan Am to take advantage of the many coral atolls that provided protected lagoons that were well suited for landing seaplanes (D. 1939).

After much consideration Pan Am determined that their first route across the Pacific to Hong Kong would originate in San Francisco with the first opportunity for refueling in Honolulu, HI. This distance of 2,400 miles was the longest non-stop flight a plane had made to date. A little more than two years after Pan Am contracted Sikorsky and Martin to build "two huge flying boats" designed by Colonel Lindbergh, Pan Am successfully completed its first survey flight from the Bay Area to Hawaii in April of 1935 (Unknown 1934, Windsor 1935, Daley 1980). Sikorsky and Juan Trippe, founder and chief executive of Pan Am, reportedly named the airplanes Clippers because of their resemblance to the Clipper ships that had plied the Pacific Ocean a mere century before (Daley 1980).

Pan Am trans-Pacific routes

Once the routes had been established, Pan Am had two Clipper routes that crossed the Pacific-- a northern route and a southern route. The northern route originated in San Francisco and continued on to Hawaii, Midway, Wake, Guam, and on to the Philippines and Hong Kong. The south Pacific route to Auckland began in Hawaii, and continued on to Kingman Reef, Pago Pago and then to Auckland. This route was only traveled twice during the route development stages. After the Samoan Clipper was lost in a crash shortly after leaving Pago Pago on January 11, 1938, the route was suspended due to the loss of the plane and the events of WWII (Shepard 1939).

After WWII a new route was established to Auckland. It began in Hawaii, and continued on to Canton Island, Fiji and then on to Auckland (Shepard 1939, Sommerich 1940).

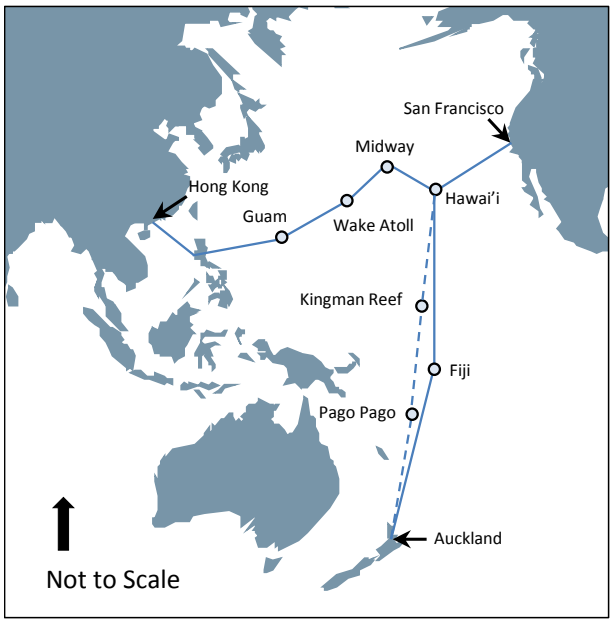

Figure 9. Clipper routes from San Francisco. Adapted from Fleming 1984

How arrival of Pan Am to the Pacific changed the atolls of the Pacific Remote Islands Marine National Monument

The literature suggests that Kingman Reef and Wake Atoll were the two locations within the PRIMNM modified to accommodate the expansion of Pan Am operations across the Pacific. Kingman Reef was only used for a couple of survey flights from Honolulu to Auckland before a new route to Auckland was established. In comparison, Wake Atoll became an important stopover site that provided passengers with overnight accommodations that rivaled some mainland hotels.

Pan Am's time at Kingman Reef was brief. The first survey flight to Kingman Reef was flown in March 1937. That same plane, the Samoan Clipper crashed in January 1938 just after leaving Pago Pago (Daley 1980, Trautman 2007). Only a few landings had been made at the reef prior to the crash. Kingman Reef was,

> *"the tiniest target any oceangoing aircraft had ever elected to try to hit. It was smaller than Wake Island, smaller than most ships. It was 120 feet long and 90 feet wide—too small even to plant Leuteritz's adcock there. It was totally nude except for three small palm trees, and rose barely three feet above sea level at high water. It was, however, like Wake, a drowned mountain summit, and the reef that surrounded the tiny bit of sand also enclosed a big sheltered lagoon on which flying boats could land—if they could find it. Well, a ship could find it, and planes could come home in on the ship."*

On Juan Trippe's orders, the tanker North Wind, "was hired, loaded with aviation gasoline and radio direction-finding gear, and sent to anchor in the Kingman Reef lagoon" (Daley 1980). The landings and take-offs at Kingman Reef were acceptable, but the topography of Pago Pago demanded pilots to make steep landings and rapid accents to take off. By the time a new Clipper had been assigned to the route, "the Department of Commerce had withdrawn its approval for the company to use Pago Pago, which meant that the New Zealand route was closed also, and service on it was suspended for more than a year while a new route was set up. This one passed via Canton Island, still another uninhabited, waterless atoll" (Daley 1980).

Unlike Kingman Reef, both marine and terrestrial habitats on Wake Atoll were modified to accommodate Pan Am's Clipper operations. The lagoon was cleared of coral heads to ensure that the underside of the Clippers would not be damaged when they landed. "The channel to be cleared had to be one mile long and about three hundred yards wide" (Daley 1980). Information gleaned from journal entries indicates that the team cleared coral heads for approximately nine months. At one point the team had cleared one hundred and fourteen coral heads and they were not nearly done clearing the channel (Daley 1980). In addition to the intentional modifications made to the atoll, harsh weather conditions made it difficult for crews to avoid unintentionally impacting the marine ecosystems.

The following account describes an incident in the lagoon;

"A tropical storm struck, and the lagoon filled up over the level of the dock, which broke loose and floated away. The gasoline drums were floating across the lagoon also. Then the storm stopped, and all that water began to spill out over the reef. Dock and drums were moving toward the reef too, and had to be rescued by swimmers" (Daley 1980).

Wake's terrestrial landscape was dramatically modified as Pan Am mobilized and built infrastructure suitable for passengers to stay overnight. Initially the plan was to build a compound that consisted of a main office building surrounded by a cluster of other buildings, on Wilkes. The group sent ashore to do recon reported that there was "clear evidence of flooding all over Wilkes." The ground on Peale, which was across the lagoon, "looked somewhat higher and the vegetation more dense" (Daley 1980). The North Haven could not safely moor off of Peale so the men had to unload "three thousand tons of stores" onto Wilkes and then take the cargo nearly one mile across the lagoon to Peale. This task was completed with brute force until a manually run railroad was installed to aid with cargo transportation (Daley 1980).

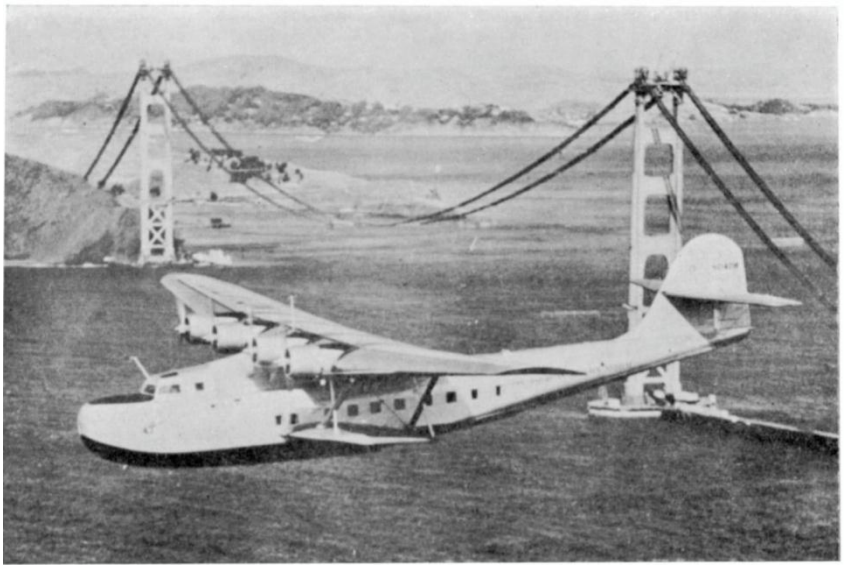

Figure 10. Captain Edwin Musick flew the China Clipper over the uncompleted Golden Gate Bridge on the first air-mail flight to Manila in 1935. (Courtesy Department of Special Collections, University of California at Los Angeles.)

The North Haven brought two loads of cargo to Wake Atoll. The first load included the materials necessary to begin setting up the compound. The second load carried two hotels, one of which was sent to Midway. No detail was spared in the design on the hotels. The hotel on Wake consisted of "two wings built out from a central lobby, wide verandas, each room having a bathroom with hot-water shower. Every detail Simmons beds, coat hangers, ashtrays, even cashiers' cages and materials for building aquariums—hotel lobbies were to be decorated with brilliant fish native to each atoll" were brought onto the Atoll (Daley 1980, Trautman 2007). The hotel had a total of 45 passenger rooms. With the shipment of hotels came "tons of rich soil for the gardens at Midway Island and Wake Island to provide a growing base for special grass. Juan Trippe wanted to provide a pleasant atmosphere around the Pan American hotels on the islands for the passengers. They would move from the luxury of the aircraft to the luxury of the island hotel" (Trautman 2007). In additional to grass, "part of the planning for the hotel on Wake Island included growing vegetables and produce to feed the hungry passengers and staff. Gardens would reduce the cost of transporting fresh vegetables and produce to the island bases. Growing soil was discovered to be inadequate, so tons of soil had to be shipped from Guam to create the bathtub garden of Wake Island. Pan

American engineers contracted experts in hydroponics at the University of California" (Trautman 2007). The hydroponicum proved to be a great success.

Howland Island was also modified for aviation purposes, but not as a direct result of Pan Am's expansion of its routes. A landing field was prepared for Amelia Earhart's expected arrival in July of 1937. The location was considered to be suitable as a stopover site for landplanes as an alternative to Fiji, but the focus at the time was on developing routes for seaplanes, and as a result, was never used by Pan Am.

Future Research

The literature on this topic references survey flights that were conducted with the goal of searching for suitable landing locations. The Special Collections of the University of Miami Libraries houses the Pan American World Airways, Inc. records. The technical, mechanical and research reports may be of particular interest for future research on the subject of the condition of islands and atolls located within the PRIMNM prior to WWII. For example, there are four folders pertaining to the first Auckland survey using the narrow search term "Kingman". It is likely that this collection has additional information on Pan Am's activities on Kingman Reef as well as other topic's related to Pan Am's activities within the PRIMNM. The library refers to the 938 page container list as a "folder-level inventory [that] provides a brief overview of the contents of the files." This collection is extensive, detailed and well-cataloged (Pan American World Airways, Inc.).

World War II and beyond

The advent of long distance air travel, along with WWII and the need for strategic military outposts introduced the islands and atolls to a new type of habitat alteration. Coral reefs were blown up to provide aggregate for the construction of runways on Howland, Baker, Jarvis, Palmyra, Johnston and Wake. Palmyra's landscape was dramatically altered with the construction of roads and dredging for submarine access. From 1936 until 2004 Johnston Atoll served a variety of uses for the United States military. Portions of Johnston were dredged and filled with aggregate sourced from adjacent coral reefs, it served as an air station in early WWII, patrol submarines used it as a refueling base, there were seaplane landing areas, bomb shelters, living quarters, landplane runways, storage sheds, and gun emplacements. By 1944 Johnston Atoll was one of the busiest air transport terminals in the Pacific. After WWII nuclear weapons were tested from the atoll. And finally, during the 1970's various chemical agents left over from Vietnam were stored on Johnston. In its final military chapter, Johnston Atoll was the site of the Johnston Atoll Chemical Disposal System (JACADS)—the first full-scale chemical weapons disposal facility in the United States. Construction of the facility began in 1985, and after completion of incineration of chemical weapons was complete in 2004 JACADS was closed (US Army Chemical Materials Agency 2010). Wake Atoll, the site of a significant battle with the Japanese during WWII, was later utilized as a large military installation and eventually witnessed the disappearance of the

endemic Wake rail (*Gallirallus wakensis*). Howland, Baker and Jarvis were bombed by the Japanese in 1942, and were subsequently utilized for their airstrips and as staging areas for the US military.

Beginning in roughly 1963, various islands and atolls throughout the region were visited by scientists with Pacific Ocean Biological Survey Program (POBSP) (Massa et al 2006). Efforts were made on Howland, Baker, Jarvis and Palmyra to remove rats, cats and other non-native mammals. Subsequent monitoring on Howland, Baker and Jarvis Islands demonstrates that removal of mammalian predators, specifically cats and rats, is one of the most effective and efficient methods of facilitating restoration of seabird colonies on these remote islands and atolls (Rauzon et al 2011).

Figure 11. UDT blasting coral heads from beaching area. Howland Island (US Atomic Energy Commission 1963).

The impacts humans have had on the seabird populations in the central Pacific Ocean go beyond the initial impact of harvesting seabirds and their eggs, or introducing mammalian predators that caused declines in seabird numbers. For example, punctuated natural disturbances such as ENSO events or typhoons may have uncharacteristically large impacts due to the cumulative effect of both the ENSO event and previous impacts such as habitat loss and artificially lowered population numbers that would make the population uncharacteristically vulnerable to extirpation (or extinction in the case of the Wake rail).

Summary

The islands and atolls of the Pacific Remote Islands Marine National Monument are slowly recovering some of their former character as managers address the multiple impacts of previous human visitation and occupation of the region. For example, efforts made by managers to eradicate cats over the past 30+ years have resulted in quantifiable increases in seabird populations on islands in the PRIMNM. Records show a history of whale, seabird, sea turtle and fish exploitation in the region. While most fish populations appear to be abundant, and seabird populations (with a few notable exceptions) appear to be healthy or recovering, the same is probably not true for sea turtles and sperm whales, species which are still endangered globally (and federally listed species under the ESA 1973). Fishing that occurred in the 1850's likely caused the first major decline in sperm whale populations. As large-scale whaling came to an end in about 1980, the direct impacts to the islands and waters adjacent to the PRIMNM including

removal of adult nesting seabirds and their eggs, and harvesting of sea turtles, may have decreased, but the of decline of sperm whale populations continued, and has not shown significant increases despite the end of large-scale whaling around 1980 (Taylor et al. 2008). Additional research is warranted to better understand the history of exploitation of these species.

Specific Recommendations for future work include:

1. Compare historical records of species occurrences to data from more recent monitoring events. Bishop Museum data would be a good place to start for historical data.
2. Archive Pacific Ocean Biological Survey Program (POBSP) field notes, slides, photographs, background research and raw data for future research into historical baselines.
3. Replicate one of the various mini-studies conducted by POBSP in order to compare data that has been collected using comparable methodologies.
4. Create maps to depict historical Bishop Museum data holdings where spatial information is available.
5. Access additional archives of various New England Whaling museums such as the Nantucket Historical Association Research Library and Archives.

Appendix A. Summary of sources of US Pacific Remote Island Area data: Institutions and People

Smithsonian Institution

The Bird Division of the Smithsonian Institution houses a large majority of the data that remains from the Pacific Ocean Biological Survey Program with the exception of data that might be held by participants and their family members. This collection includes bound copies of project reports and original journals kept by all researchers, slides from project areas, black and white site photos and aerial photos, and primary literature amassed in preparation for surveys.

With approval from one of the SI or USGS staff members, access to the collection is unrestricted. Note that Roger Clapp and Claudia Angle are exceedingly helpful when it comes to research. It is always necessary to get the approval from Gary Graves, curator of birds for the SI, to view any part of the collection. He will most likely grant permission but he needs to know because the collection belongs to the SI. It is also a good idea to ask for his permission to make copies or if you want to spend a significant amount of time with the collection.

Division of Birds
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National Museum of Natural History
10th and Constitution Ave, NW
Washington, DC 20560
http://vertebrates.si.edu/bird

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Huntington Library, Art Collections and Botanical Gardens

The Huntington Library houses papers from J. D. Hague, one of the first American surveyors of guano sources on Howland, Baker and Jarvis Islands. There are other useful sources of historical information as well, but this was the primary focus of research at this location.

Access to the library's holdings is restricted. It is necessary to be a Reader at the Huntington to have access to these papers. In addition, these papers may require additional clearance from the curator of the collection to review them.

There is no primary contact for Huntington Library. If someone would like to view these papers they would contact the library's Reader's Services and apply to become a Reader which is done on a project by project basis.

The Huntington Library, Art Collections and Botanical Gardens
1151 Oxford Road
San Marino, CA 91108
Ph: 626.405.2100
www.huntington.org
Research Resources page (http://www.huntington.org/huntingtonlibrary.aspx?id=576)

The Bernice P. Bishop Museum

The Cultural Resources Division of the Bishop Museum houses the largest collection of Hui Panala'au journals. Their collection consists of approximately 12 journals. Cultural Resources staff is in the process of transcribing these journals. Access to the original journals is most easily granted by coordinating with the collection curator, Dr. Desoto Brown. These journals contain specific information, recorded on a daily basis, of fishing activities, camp maintenance, gardening activities and general observations of life on the Howland and Baker and Jarvis Islands. Weather data that was collected on an almost hourly basis in logs on the islands were called in via radio after the first year colonization.

The Bishop Museum houses extensive collections of flora and fauna collected in the central tropical Pacific. With a few exceptions, the oldest specimens were collected by the Whippoorwill and Tanager expeditions in the early 1920's. Dr. Arnold Suzumoto was particularly helpful and generous with his time. The Ichthyology Department has a database that staff can search for you by a variety of parameters. Lydia Garetano, and Pu Imada handle the vertebrate collection. Holly Bolick handles the invertebrate collection. Lu Eldredge is with the invertebrate group. He has a wealth of knowledge of historical documentation and research in the region.

Access restrictions to the collections are collection specific. It is necessary and helpful to contact the curator of the collection you are interested in directly. The library is open to the public, but it is helpful to have a contact at the library/archives before arriving.

Please see the attached DVD for the following datasets provided by the Bishop Museum:
1. Invertebrates: 2,082 records
2. Vertebrates (not including fish and herps): 84 records
3. Fish: 1,182 records
4. Herps: 53

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The following three people are very helpful when it comes to locating and identifying useful resources in the archives. They can be contacted via archives@bishopmuseum.org, or individually using the email addresses below.

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Appendix B. Timeline of major periods of human interaction with Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Kingman Reef, Palmyra Atoll and Wake Atoll.

Figure B-1. Chronology of events on Howland Island

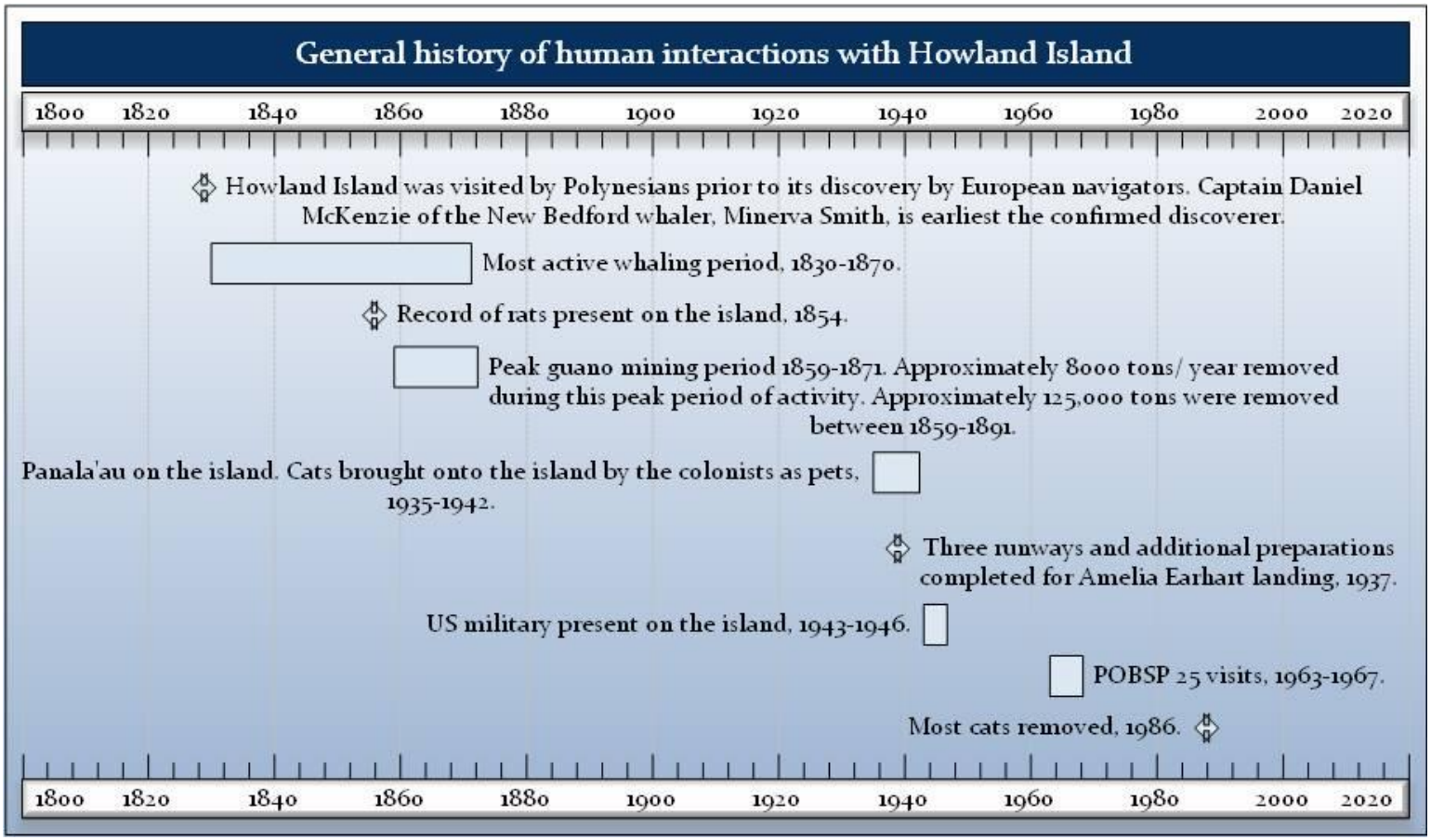


Figure B-2. Chronology of events on Baker Island

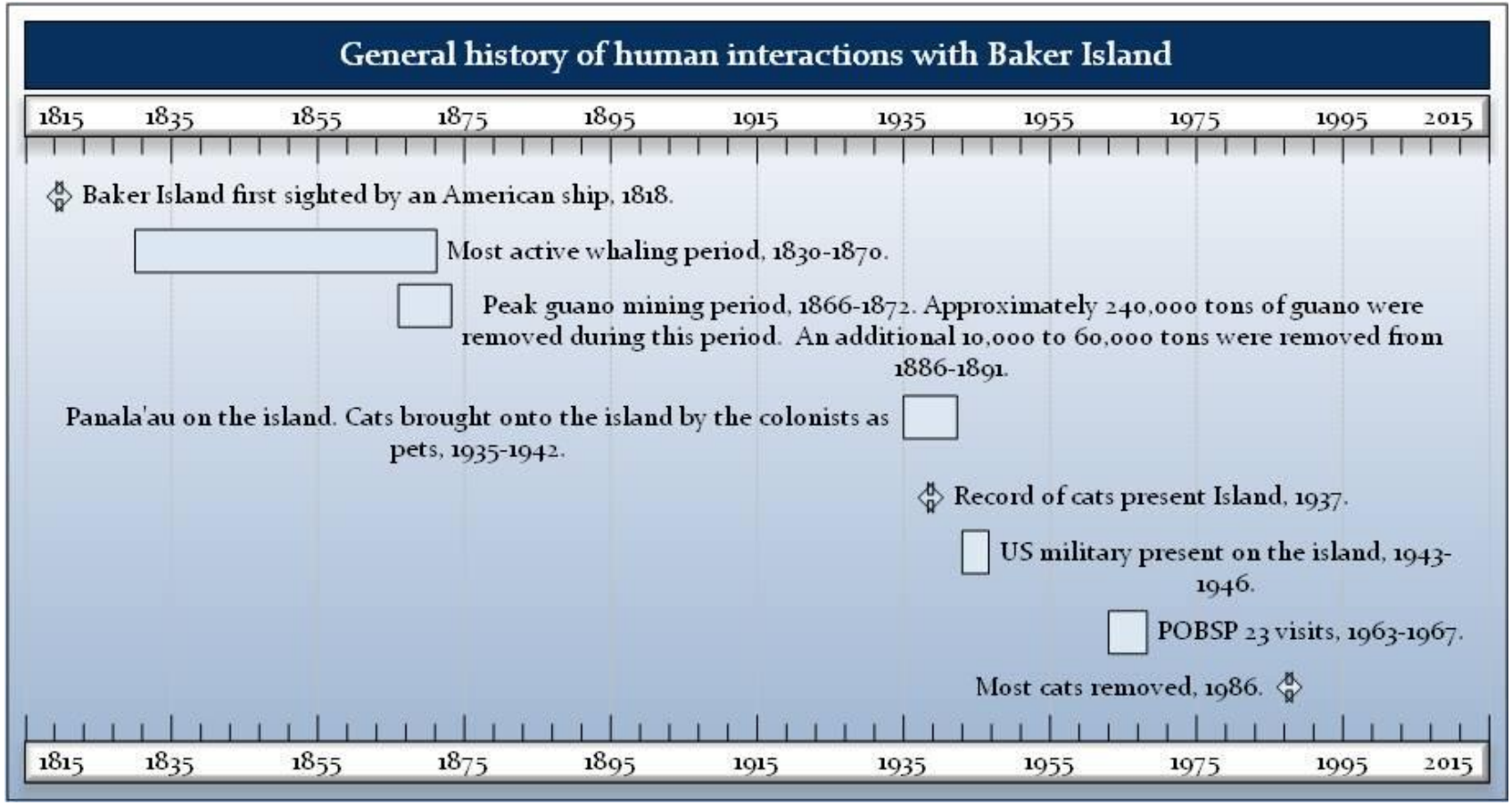


Figure B-3. Chronology of events on Jarvis Island

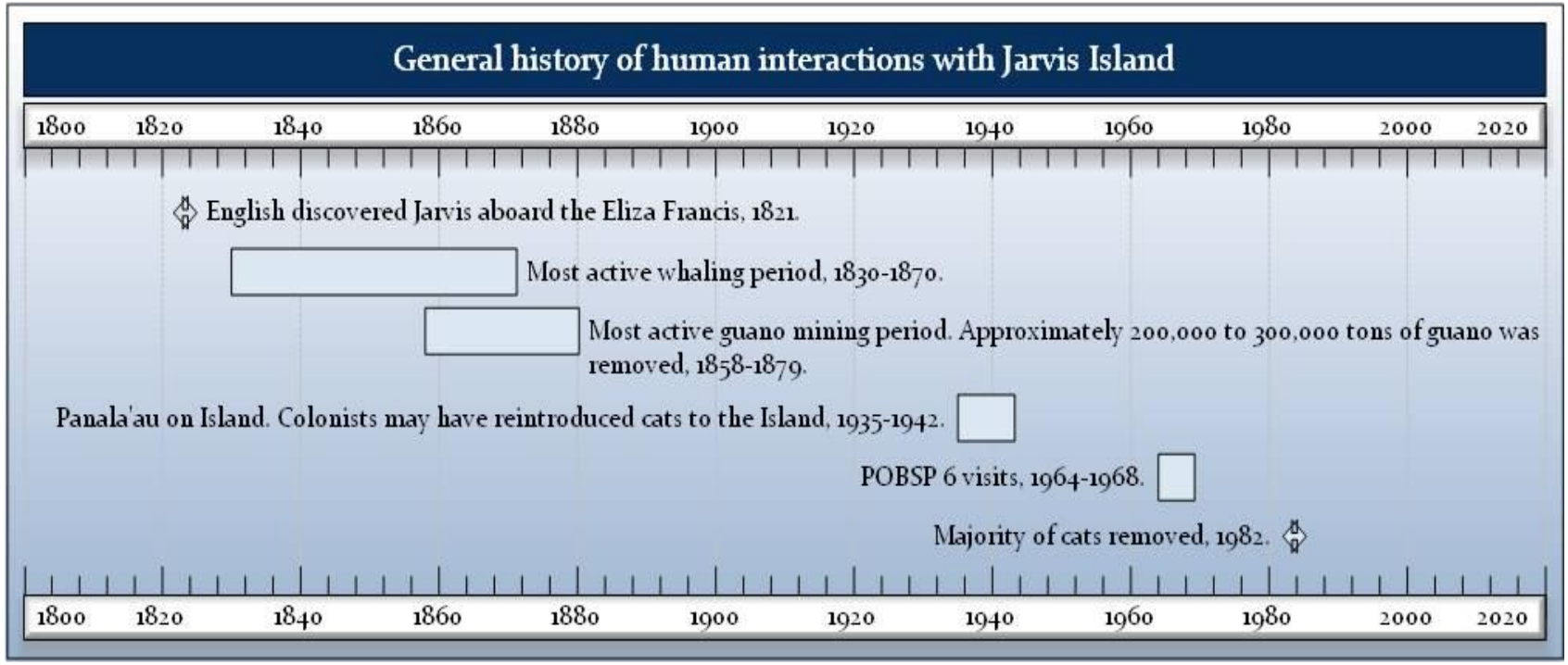


Figure B-4. Chronology of events on Palmyra Atoll and Kingman Reef

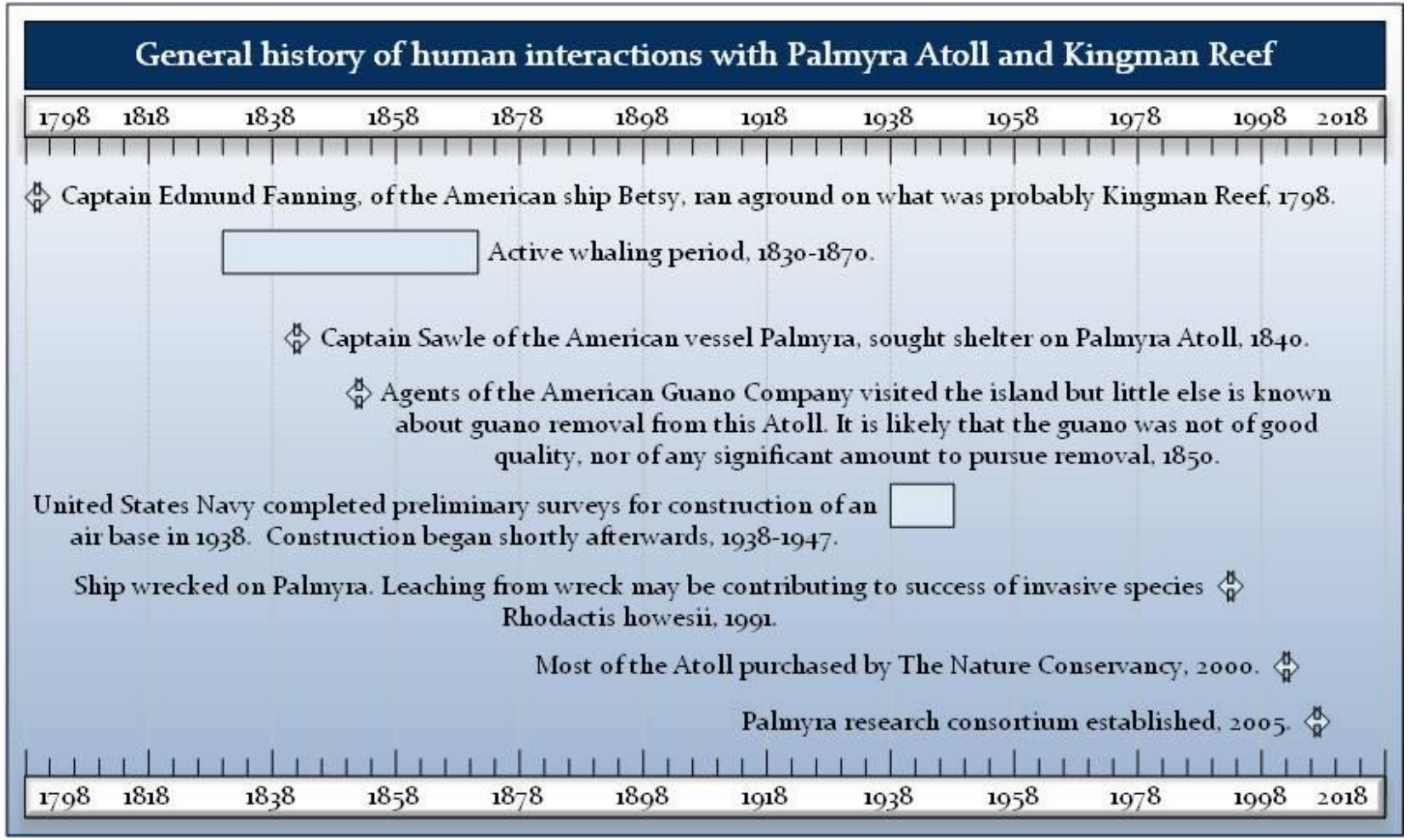


Figure B-5.Chronology of events on Johnston Atoll

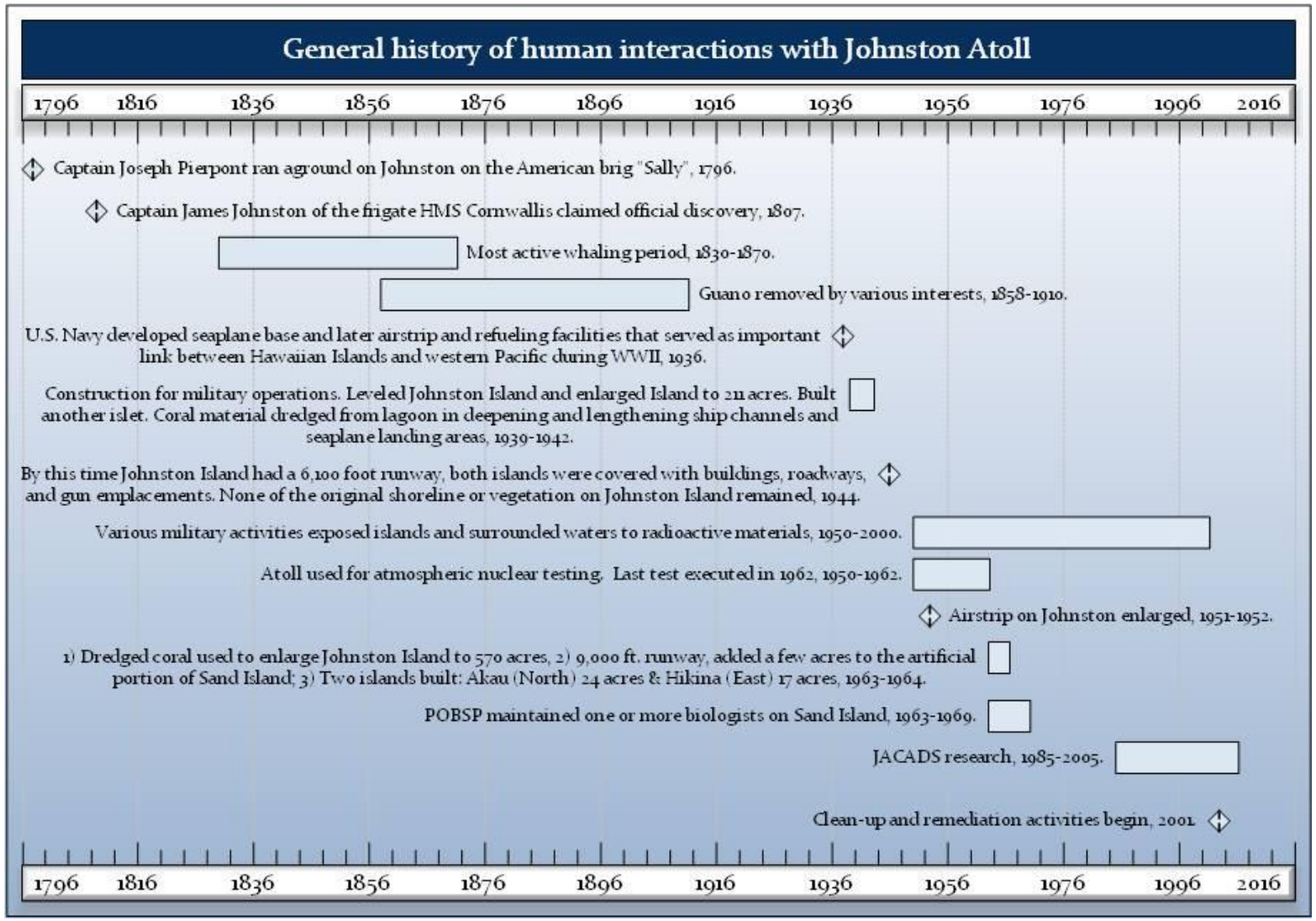
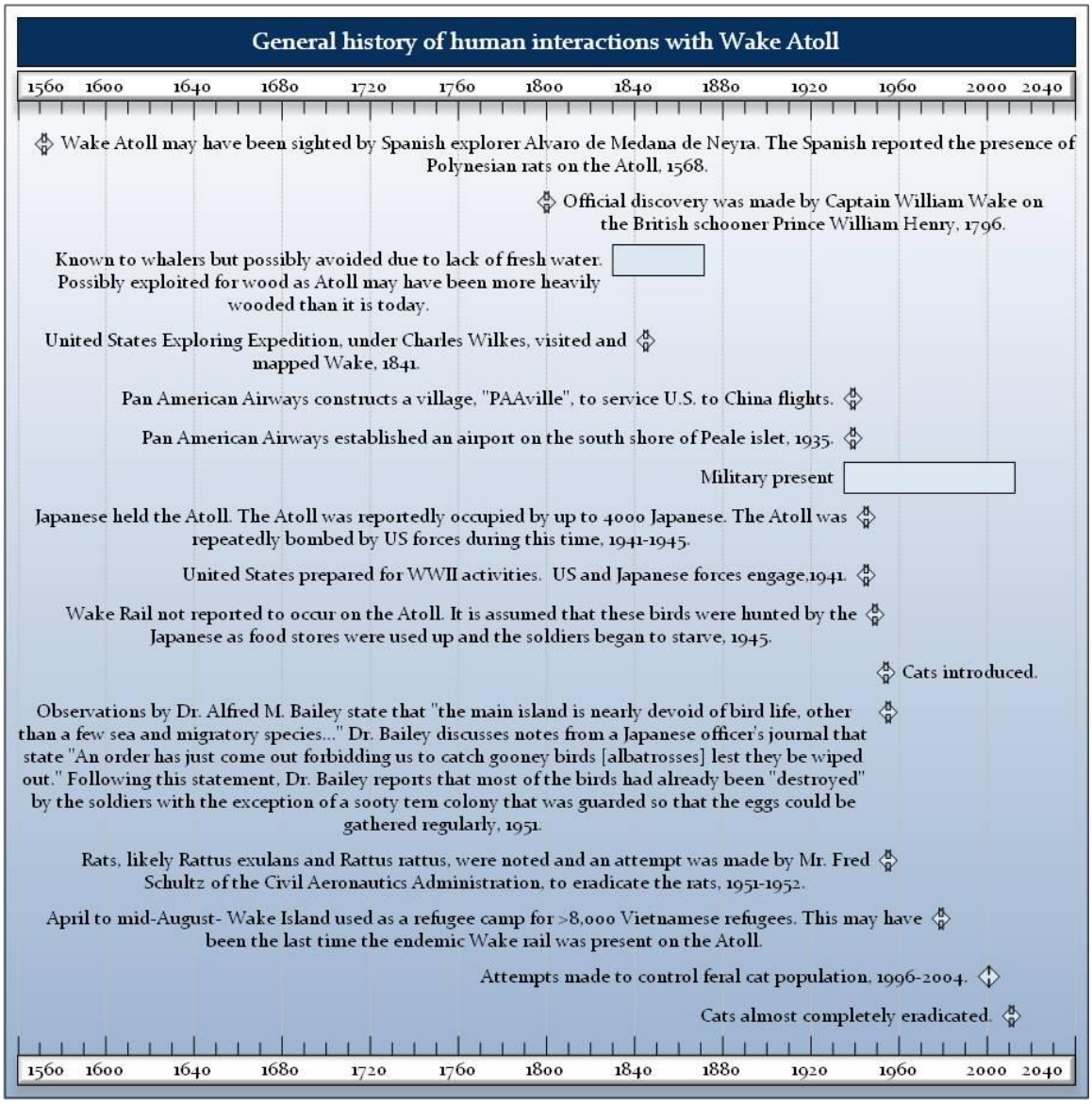


Figure B-6. Chronology of events on Wake Atoll



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Appendix C. Voyages from 1520 to 1842 that traveled through, or adjacent to the U. S. Pacific Remote Islands Marine National Monument

Table Appendix D-1 Voyages from 1520 to 1842 that traveled through or adjacent to the Monument (Friis 1967).

Year	Captain	Sponsoring Country	May have traveled within close proximity to the Monument	Within area encompassed by the Monument
1520-1521	Magellan	Spain		✓
1537	Grijalva	Spain	Possibly	✓
1542-1543	Villalobos	Spain		✓
1564-1565	Legazpi	Spain		✓
1564-1565	Arellano	Spain		✓
1577-1578	Drake	Britain		✓
1679-1691	Dampier	Britain		✓
1708-1710	Woods-Rogers	Britain		✓
1741-1744	Anson	Britain		✓
1771-1773	De Fresnes and Crozet	France		✓
1776-1780	Cook	Britain	Possibly Jarvis*	✓
1785-1788	La Perouse	France		✓
1815-1818	Kotzebue	Russia	Possibly	✓
1817-1820	De Freycinet	France		✓
1830-1842	Wilkes	United States	✓	✓

*Cook's crew landed on Christmas Island.

Possible sources for observations of the pelagic fauna.

De Freycinet (France) **1817-1820**: En route from Hawaii to Port Jackson (Sydney) went through the middle of the area encompassed by the Monument.

Drake 1577-1578; **Dampier 1679-1691**; **Woods-Rogers 1708-1710**; **Anson 1741-1744** (British): All four traveled in between Hawaii and the northern Line Islands. All traveling from east to west.

Notes on voyages from Table 1 that may have sailed adjacent to the northern Line Islands.

Magellan 1520-1521: Moving from SE to NW, Magellan crossed the equator between 180 degrees longitude and 150 degrees west longitude. He does not appear to have gone close enough to the islands to be within the Monument.

Grijalva 1537: Moving west along the equator. Traveled just north of Howland and Baker Islands. Trip originated in Paita, Peru and was traveling towards New Guinea.
All heading west from Navidad: **Villalobos 1542-1543**, **Legazpi 1564-1565**, and **Arellano 1564-1565**. All went just north of the northernmost Line Islands, through the center of the Pacific Ocean that is encompassed by the Monument.

De Fresnes and Crozet 1771-1773 (French): Heading from the south in a northwesterly direction, from New Zealand to the Philippine Islands and beyond. Traveled just to the west of Howland and Baker. Again, according to their estimated route, the ship would likely have been too far away to see the islands.

Cook 1776-1780: Traveled just to the west of Jarvis Island. He encountered Christmas Island. He was in transit from the Society Islands to the Sandwich Islands (Hawaii).

La Perouse (French), **1785-1788**: En route from Kamchatka south to Botany Bay and beyond, traveled just to the east of the Howland and Baker Islands. According to the estimated route, the ship would have been too far away from the islands to see them.

Kotzebue (Russian cruise), **1815-1818**: May have sighted Howland or Baker Islands. Would have been heading from the SE towards the NW. May have also been close to Wake Atoll, when traveling from the Hawaiian Islands to the Marshall Islands.

United States Exploring Expeditions 1830-1842: While the region encompassed by the Monument was not the primary focus of the expedition, between 1830 and 1842 the United States Exploring Expedition was in the region.[4] Aboard the ship the *Peacock,* en route from the Hawaiian Islands, the expedition may have come into contact with Jarvis Island.

[4] The Smithsonian Institution's website on the United States Exploring Expedition is an excellent source of information (Smithsonian Institution 2004; http://www.sil.si.edu/DigitalCollections/usexex/).

Appendix D. Summary of findings at the Smithsonian Institution, January 18-25, 2011

Introduction

The focus of this trip was to characterize the Smithsonian Institution's holdings of data that was collected during the Pacific Ocean Biological Survey Program (POBSP). The POBSP began in 1962 when the Smithsonian Institution entered into a grant agreement with the Department of Defense. The project area encompassed the area from 30 degrees north latitude to 10 degrees south latitude and from 150 degrees west longitude to 180 degrees west longitude. From January 1963 through June 1969, Smithsonian Institution employees surveyed the area with the following goals: 1) learn what plants and animals occurred on the islands, 2) document seasonal variation in their numbers and reproductive activities, and 3) study the distribution and population of the pelagic birds of the area. By the conclusion of the POBSP a total of 1,800,000 birds were banded, and approximately 150,000 observations of pelagic birds at sea were made.

Data collected on the POBSP expeditions were summarized in cruise reports that were bound into a collection of data books that consists of 94 bound volumes of cruise/data summaries, several miscellaneous technical reports, copies of researchers' field notebooks and published journal articles. Approximately half of these volumes contain data collected within, or adjacent to the Monument. I was not able to spend as much time in the "attic" which contains the majority of the museum's holdings, so the following list includes information that pertains to the entire POBSP with a portion of it pertaining to the Monument. This portion of the collection includes, aerial photographs, site photographs, 720 notated slides, almost 2000 journal articles that were part of the primary literature search for the project includes all publications about the study area prior to 1963, at least 8000 bird banding recovery cards, approximately 250 stomach content data cards, and automated data query results. All of this data is available only in hard copy. In addition, there are the personal records that Mr. Roger Clapp, POBSP researcher, has in his files. All of the information is referenced in a very well organized card catalog. The catalog also contains notes that were taken by POBSP researchers along with source citations.

Southern island cruises within the Pacific Remote Islands Marine National Monument

The search for applicable information was focused on southern island cruises (SIC) that visited Wake Atoll, Johnston Atoll, Palmyra Atoll, Kingman Reef, Jarvis Island, Howland Island or Baker Island. The final volume in this series of POBSP volumes, which number 94 in total, is an index, which contains cruise location descriptions by islands, atolls, reefs, and the general summaries and special reports that were generated by the cruises. The information about cruise ID and papers generated are referenced by location as well (Table D-1, Table D-3).

Table D-1 Southern island cruises: Cruise ID, date, report titles and location information.

Cruise	Dates	Preliminary Report Title	Author
SIC 1	1963 Feb 7- Apr 1	ATF Trip No. 1(Laysan, Lisianski, Pearl & Hermes, Midway, Kure, Howland, Baker)	F. Sibley
SIC 2	1963 Jun 30- Jul 22	HOWLAND, BAKER, ENDERBURY (Howland, Baker, Enderbury)	(F. Sibley)
SIC 3	1963 Oct 3- Nov 26	HOWLAND, BAKER, and the PHOENIX ISLANDS (Howland, Baker, Canton, McKean, Gardner, Hull, Sydney, Phoenix, Birnie, Enderbury)	F. Sibley
		First Progress Report (Howland, Baker)	F. Sibley
		Second Progress Report (Howland)	F. Sibley
		Third Progress Report (Canton to Phoenix)	F. Sibley
		Fourth Progress Report (Samoa, Birnie)	F. Sibley
		Fifth and Last Progress Report (Enderbury)	F. Sibley
SIC 4	1964 Feb 3- Mar 6	(First ATF) Progress Report (Howland, Baker, McKean, Birnie, Phoenix, Ender	F. Sibley
	1964 March 7- April 7	(Second) ATF Progress Report (Samoa, Jarvis, Christmas, Fanning, Washington, Palmyra)	F. Sibley
SIC 5	1964 Jun 1- July 30	Phoenix and Line Islands (Palmyra, Washington, Christmas, Malden, Starbuck, Hull, Phoenix, Enderbury, McKean, Baker, Howland)	F. Sibley, R. Clapp
		(First) Progress Report—ATF (Palmyra to Starbuck)	(F. Sibley)
		Second Progress Report (Hull to Howland)	F. Sibley
SIC 6	1964 Oct 1- Dec 3	ATF Trip No. 6 (Howland, Baker, Canton, McKean, Gardener, Sydney, Phoenix, Birnie, Enderbury, Jarvis, Christmas, Washington, Palmyra)	F. Sibley
		Progress Report No. 1 (Howland, Baker)	Anon.

		Progress Report No. 2 (Canton to Sydney)	Anon.
		Progress Reprot No. 3 (Phoenix to Enderbury)	Anon.
		Last Progress Report (Jarvis to Palmyra)	Anon.
SIC 7	1965 Jan 25- Mar 22	SIC Trip No. 7 (Howland, Baker, McKean, Hull, Birnie, Enderbury, Canton, Samoa, Jarvis, Christmas, Palmyra) Detailed section on Tokelaus	M. Thompson
		(First) Progress Report (Howland to Canton)	Anon.
		(Second) Progress Report (Tokelaus, Jarvis to Palmyra)	Anon.
SIC 8	1965 May 10- Jul 8	SIC Trip No. 8 (Baker, Howland, Hull, Phoenix, Enderbury, Canton, Tongareva, Vostok, Caroline, Starbuck, Malden, Christmas, Fanning)	Anon.
SIC 9	1965 Sept 7- Nov 5	SIC Trip No. 9—Islands (Howland (2), Baker (2), McKean, Hull, Phoenix, Enderbury, Christmas, S. Grid No. 1, S. Grid No. 2)	Anon.
SIC 10	1965 Nov 15- Dec 12	Cruise Report, SIC 10 (Howland, Baker, S. Grid No. 3)	(R. Crossin)
SIC 11	1966 Jan 24- Mar 19	Southern Island Cruise Number Eleven (Island Report) (Howland (2), Baker (2), Hull, Enderbury, Swain's, Christmas, S. Grid No. 4, S. Grid No. 5, N. Grid No. 27)	M. Thompson
SIC 12	1966 Feb 26- Apr 9	(No General Report) (Howland, Baker, S. Grid No. 5A, N. Grid No. 28, Grid No. 29)	
SIC 13	1966 Mar 29- Apr 22	SIC 13 (First Half) (Howland, Enderbury, Phoenix, Hull, McKean, S. Grid No. 6, N. Grid No. 30)	M. Thompson
	1966 Apr 27- May 21	(Second half-no General Report) (McKean, Baker, Howland, Palmyra, S. Grid No. 7)	
SIC 14	1966 Jul 5- Aug 26	Survey Report, SIC 14 (Howland (2), Baker (2), McKean, Gardner, Swain's, Jarvis, S. Grid No. 8, S. Grid No.9)	K. Balcomb
SIC 15	1966 Sep 7- Oct 25	Survey Report, SIC 15 (Howland (2), Baker (2), Enderbury, Swain's, Hull, Phoenix, Birnie, S. Grid No. 10, S. Grid No. 11, N. Grid No. 31, N. Grid No. 31, N. Grid No.	P. Woodward

		32A)	
		Ectoparasite Summary Report for SIC 15	F. C. Thompson
		Terrestrial Reptiles on SIC 15	J. Fitch
SIC 16	1966 Nov 4- Dec 23	Southern Island Cruise No. 16 (Howland (2), Baker, Swain's, Phoenix, Enderbury, S. Grid No. 12, S. Grid No. 13, N. Grid No. 33)	K. Balcomb
SIC 17	1967 Jan 9- Mar 3	Cruise Report, SIC No. 17 (Howland (2), Baker (2), Enderbury, Phoenix, Hull, S. Grid No. 14, S. Grid No. 15)	R. Chandler
SIC 18	1967 March 10- May 1	Cruise Report, SIC 18 (Kingman Reef, Palmyra, Washington, Fanning, Christmas, Jarvis, Malden, Starbuck, Swain's, Baker, Howland, S. Grid No. 16)	R. Tuxson
SIC 19	1968 Jun 8- July 20	(No General Report) (Jarvis, Malden, Starbuck, Sydney, Enderbury, McKean, S. Grid No. 17, N. Grid No. 38)	
SIC 20	1968 Oct 7- Nov 3	(No General Report) (McKean)	

Table D-2 Summary of southern island cruises.

Cruise	Year	S. Grid	N. Grid	Howland	Baker	Jarvis	Kingman	Palmyra
SIC 1	1963			X	X			
SIC 2	1963			X	X			
SIC 3	1963			X	X			
SIC 4	1964			X	X	X		X
SIC 5	1964			X	X			X
SIC 6	1964			X	X	X		X
SIC 7	1965			X	X	X		X
SIC 8	1965			X	X			
SIC 9	1965	X	X	X (2)	X(2)			
SIC 10	1965	X		X	X			
SIC 11	1966	X (2)	X	X(2)	X(2)			
SIC 12	1966	X	X(2)	X	X			
SIC 13	1966	X(2)	X	X(2)	X			X
SIC 14	1966	X(2)		X(2)	X(2)	X		
SIC 15	1966	X(2)	X(2)	X(2)	X(2)			
SIC 16	1966	X(2)	X	X(2)	X			
SIC 17	1967	X(2)		X(2)	X(2)			
SIC 18	1967	X		X	X	X	X	X
SIC 19	1968	X	X			X		

Wake Atoll data is referenced in a slightly different manner, with the reports that include information about the Atoll listed independently, and not associated with a specific SIC (Table 4).

Table D-3 Summary of POBSP Wake Atoll expeditions and reports.

Dates	Report title	Author
1963 June 8-17, July 20-27	Wake Island Report, June- July 1963	R. MacFarlane
1963 June 8-17, July 20-27,	Summary of 1963 Investigations on Wake Island	R.

December 21- 1964 Jan 5		MacFarlane
1964 April 11- 17	Ornithological Investigations on Wake Island in April, 1964	D. Johnston
	Wake Island Field Observations, April 1964	R. MacFarlane
1964 August 22-30	Wake Island Field Observations	R. MacFarlane
1964 Dec 19- 1965 Jan 10	Wake Island Field Observations	R. MacFarlane
1965 March 17-19 (non-POBSP)	Excerpts of Notes of Chief Garagosian on Wake Island, 17-19 March 1965	
1965 Apr 27- May 7	Banding Notes –Wake Island, and Bi-Weekly Summary Report	L. Huber
1965 May 8-23	Wake Island Observations—Returns from Wake Island, Chief Garagosian	R. MacFarlane
1965 July 5-11 (non- POBSP)	Wake Island Returns—Chief Garagosian	
1966 February (non- POBSP)	Notes from Wake Island (from G. Young)	
1966 June 14-21	Wake Island Survey, June 1966	L. Huber
1966 mid-August (non- POBSP)	Notes from Wake Island (from G. Young)	
1966 Oct 12 & mid Dec (non-POBSP)	Messages from Wake Island	
1966 December 27- 1967 Jan 4	Wake Island, Dec 27, 1966 to Jan 4, 1967	R. Chandler
	Message from Wake, late October 1967	
1968 March 1- 15	Wake Island Survey, 1- 15 March 1968	R. Schreiber
1968 July 9 (non- POBSP)	Trip to Wake Island, 9 July 1968	(R. Amerson)
1968 August 18 (non- POBSP)	Band Returns, Wake Island, August 18, 1968	(R. Amerson)
1968 September 5- 7	Survey of Wake Island, Sept 4- 7, 1968	J. Fitch
1968 October 4- 11 (non-POBSP)	Field Notes from R. Amerson	

The reports for Johnston Atoll are unique as well. A POBSP station at Sand Island, Johnston Atoll, was established on July 7, 1963, and was manned continuously until 1968 with the exception of two periods, the first was between September 12, 1967 to February 13, 1968, and the second was

between December 3 and 16, 1968. For the months the station was occupied in 1963 to 1966 and part of 1967 semi-monthly Progress Reports were completed. From the mid -1967 until 1968, monthly Progress Reports were issued in place of the semi-monthly Progress Reports. The progress reports typically include information about bird densities, banding, egg-size and a variety of other types of information. In addition, there were five special reports issued for Johnston, including information about rodent studies, and vegetation surveys.

Southern island cruise at-sea observations

In addition to the information collected about the islands themselves, at-sea data was collected as well. At-sea data was split up into observations by grid and non-grid efforts. There were three grids used—Northern Grid, Southern Grid, and the Eastern Grid. Please see the last section of this appendix for images of the three grids. At-sea non-grid observations on SIC 1, 3, 4, 5 and 6, are mentioned in the Progress Reports for those cruises. At-sea non-grid observations for SIC 8 – 20 have separate reports. In addition, there were three miscellaneous Pacific cruises (MPC) that contain data relevant to the study area (MPC 2, 8 and 9). Both diurnal and nocturnal observations were recorded. Occurrence and density data were collected in one fashion or another, either in birds/hour, birds/mile etc. Unfortunately, descriptions of feeding behavior and interactions of seabirds with other species are sparse. R. Clapp (pers. comm. Jan. 2010) confirmed that it is likely that these types of observations were rare.

Typically the at-sea survey reports contain the following information; itinerary, introduction with summary of dates, time spent observing, names of participating biologists and ship, and notable occurrences, species accounts including the number counted and additional comments about trends observed. Most reports do not include the lat/long of these observations. The species accounts occasionally mention feeding habits, but this is rare, and the descriptions when recorded are general with basic identification of fish species and approximate size. Results are typically then summarized and broken out into grid and non-grid observations and diurnal and nocturnal observations within those categories. Maps diagraming the cruise route and number of birds seen per day per leg are sometimes included. There are variations in the reports depending on the author.

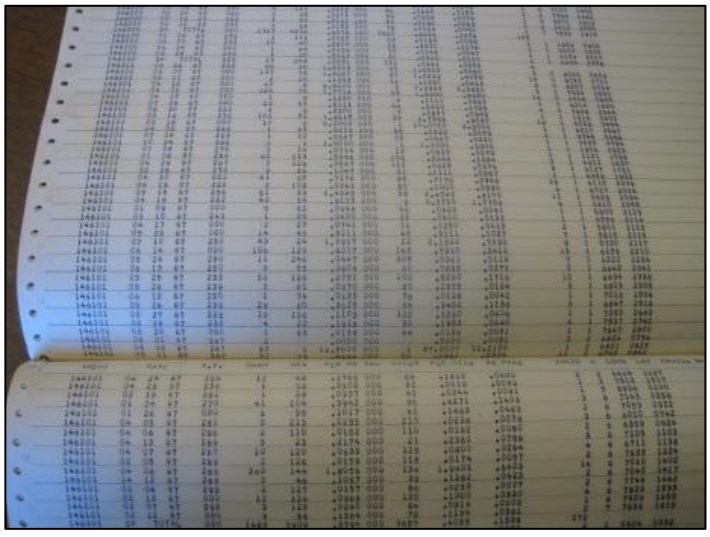


Figure D-1. Data printout

In addition to the at-sea reports that were created to summarize the data and present results, a vast amount of data was collected and entered into an automatic data processing program.

Every observation had a numeric code that was correlated with parameters. This likely explains the lack of positional and observational data. All of this information is described in detail in a 1967 publication of *Proceedings of the United States National Museum* (King et al 1967). The program made it possible to collect at least 27 parameters. The data collected was intended to be stored electronically. Unfortunately it is likely that the electronic data has been lost. There is however a hard copy printout of at-sea observations entitled *Selected Species Grid and Non-Grid Location Summaries: 1963-1969* (Figure D-1). The parameters on the printout are species identification code, date, S.T., Quantity, Hours, per hour, sal(?), miles, per mile, sq mile, incident, O (octant?) Long, Lat, and Cruise ship. The observational data parameters are numerous. Complete descriptions of these parameters are available in King et al 1967. There are easily thousands of records that were collected from 1963 thru 1969 (74 pages per line X 8 lines = 592; 60x592= 35,520 records). These data are available in hardcopy only.

Data parameters

- Ship name
- Cruise number
- Date
- Local time
- Position
- Species identification
- Association code
- Species identification reliability
- Number
- Number reliability
- Direction of bird movement
- Behavior
- Color marking
- Method of marking
- Age
- Sex
- Color-plumage phase
- Molt
- Where or not a specimen was collected
- Food association
- Special weather conditions
- Special information
- Duration of sighting (minutes)
- Ship's speed (knots)
- Ship's direction
- Distance to nearest breeding area (nm)

Figure D-2. POBSP data parameters collected on cruises and stored electronically.

Collected bird specimens

There are a total of 2,482 bird collection records for the entirety of the POBSP. There are 356 specimens collected within Monument boundaries with the majority of those being collected around Howland & Baker, and Johnston Islands. The collected specimens are stored as skins, skeletons, or in alcohol at the Smithsonian Institute. Associated data are, USNM#, Family #, Family, Current Identification, Date Collected, Country/Continent/Ocean, Latitude, Longitude, Collector(s), Field#(S), Sex: Stage, Preparation, Weight, and Remarks. These data are digital.

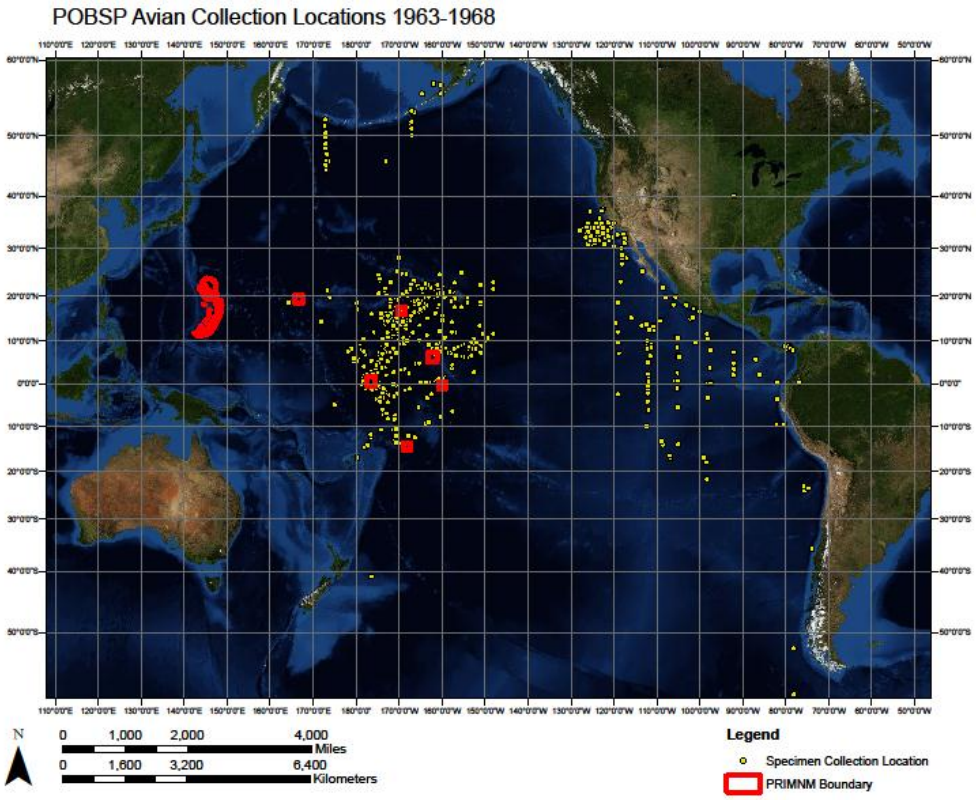


Figure D-3. POBSP Avian Collection Location 1963-1968.

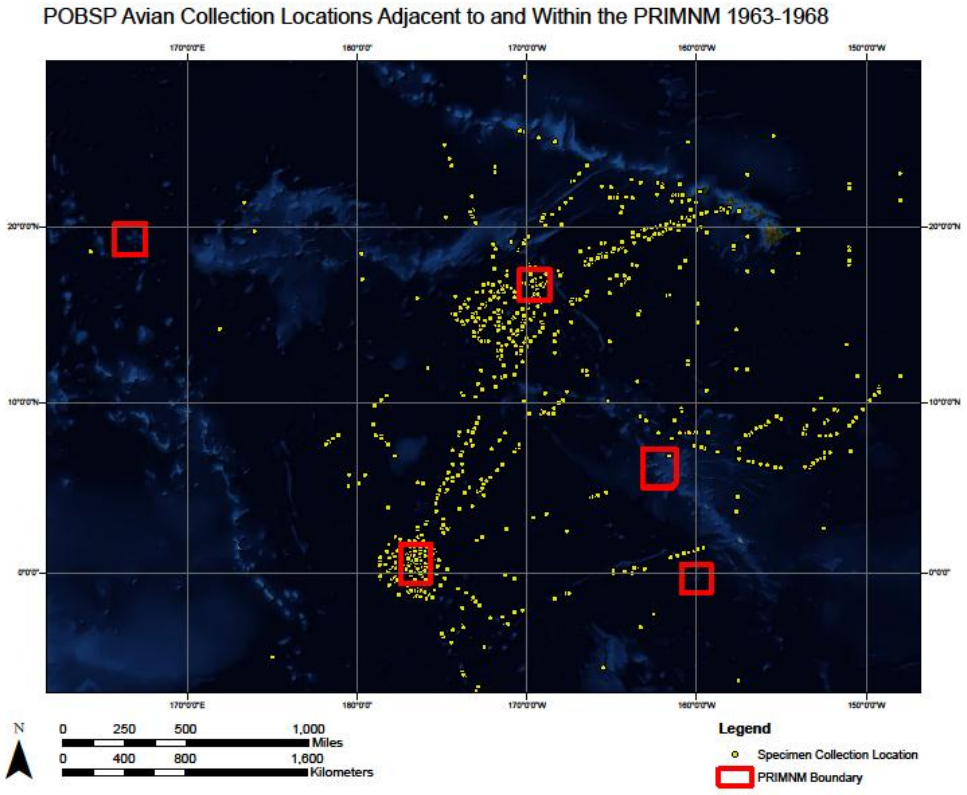


Figure D-4. POBSP Collection Locations Adjacent to and Within the PRIMNM 1963-1968.

Table D-4. Species Collected during the POBSP within the Boundaries of the PRIMNM of Howland and Baker Islands.

Scientific Name	Common Name
Order	PROCELLARIIFORMES
Pterodroma externa	Juan Fernandez Petrel
Pterodroma heraldica	Herald Petrel
Pterodroma inexpectata	Mottled Petrel
Pterodroma nigripennis	Black-winged Petrel
Pterodroma cookii	Cook's Petrel
Pterodroma leucoptera	Gould's Petrel
Bulweria bulwerii	Bulwer's Petrel
Puffinus pacificus	Wedge-tailed Shearwater
Puffinus griseus	Sooty Shearwater
Puffinus tenuirostris	Short-tailed Shearwater
Puffinus lherminieri	Audubon's Shearwater
Oceanites oceanicus	Wilson's Storm-petrel
Oceanodroma leucorhoa	Leach's Storm-petrel
Order	PELECANIFORMES
Phaethon lepturus	White-tailed Tropicbird
Phaethon rubricauda	Red-tailed Tropicbird
Fregata ariel	Lesser Frigatebird
Fregata minor	Great Frigatebird
Sula dactylatra personata	Masked Booby
Sula leucogaster	Brown Booby
Sula sula rubripes	Red-footed Booby
Order	CICONIIFORMES
Heteroscelus incanus	Wandering Tattler
Pluvialis dominica	Golden Plover
Order	CHARADRIIFORMES
Sterna fuscata	Sooty Tern
Anous stolidus	Brown Noddy
Anous tenuirostris	Lesser Noddy

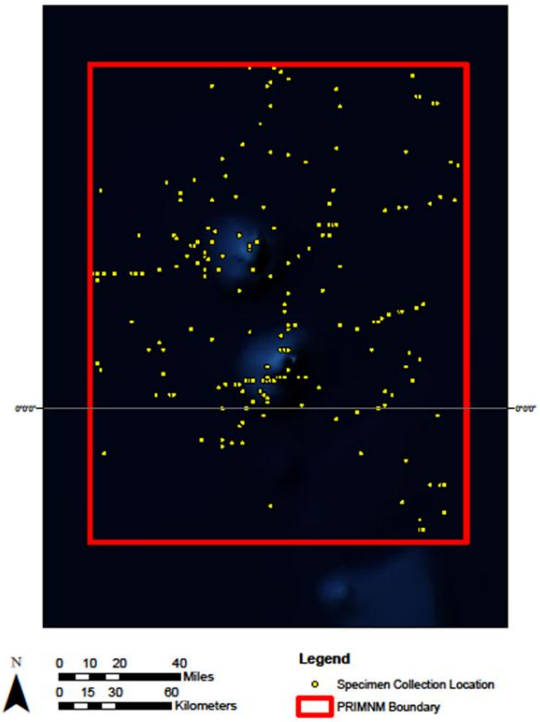
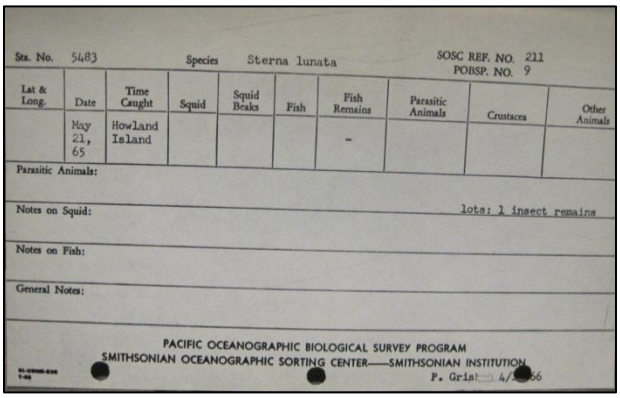


Figure D-5. POBSP Specimen Collection with PRIMNM Boundary around Howland and Baker Islands superimposed.

Stomach content data

Seabird stomach contents were collected by the POBSP. For the most part, the cards contain general information about stomach contents indicating whether there was evidence of fish or squid. Unfortunately the contents are no longer available for additional analysis that might have provided more specific information. Stomach content data were collected from specimens throughout the POBSP study area. Unfortunately time did not allow for thorough examination of all the cards, and it is unclear how many contain data collected within the Monument. It is likely, however, due to the organization of these archives, that many cards contain information collected within, or adjacent to the Monument.

Figure D-6. Small pile of remaining stomach content data cards.


Sta. No. 5483 Species Sterna lunata SOSC REF. NO. 211 POBSP. NO. 9

Lat & Long.	Date	Time Caught	Squid	Squid Beaks	Fish	Fish Remains	Parasitic Animals	Crustacea	Other Animals
	May 21, 65	Howland Island				-			

Parasitic Animals:

Notes on Squid: lots: 1 insect remains

Notes on Fish:

General Notes:

PACIFIC OCEANOGRAPHIC BIOLOGICAL SURVEY PROGRAM
SMITHSONIAN OCEANOGRAPHIC SORTING CENTER——SMITHSONIAN INSTITUTION

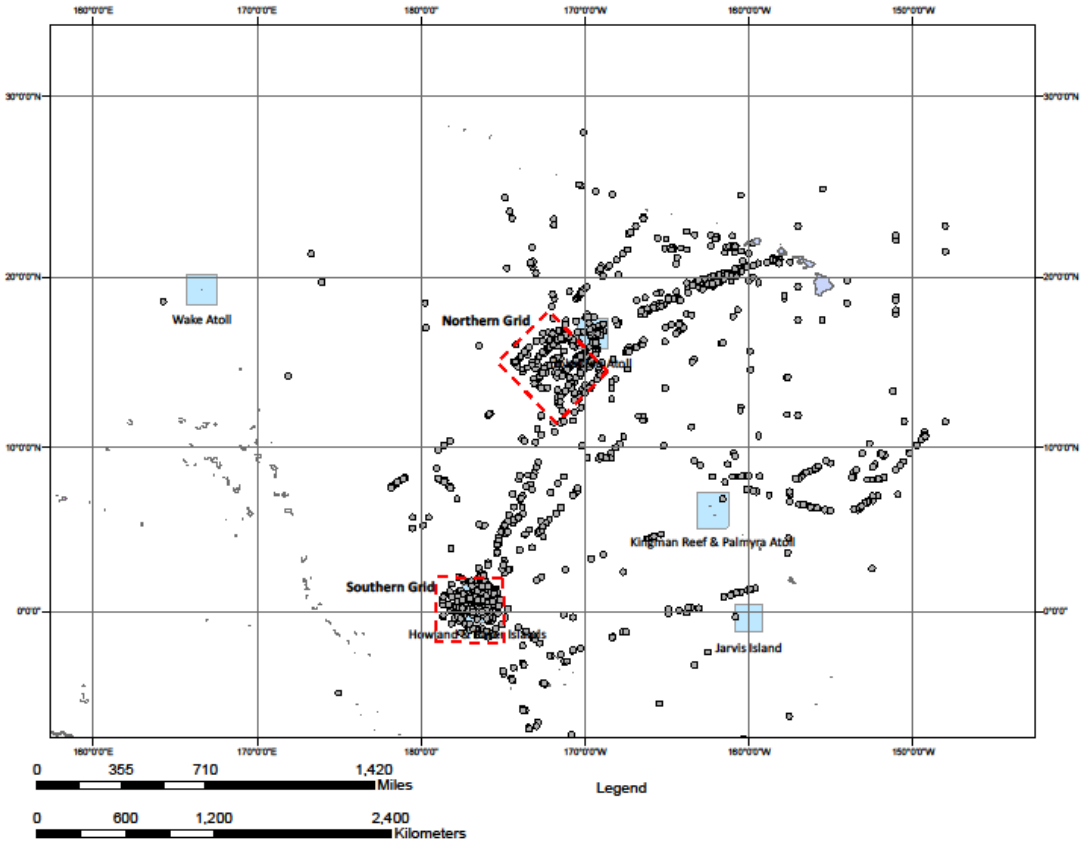
Figure D-7. Stomach content data card.

Smithsonian Institution files and reports

Mr. Clapp is a Museum Specialist (USGS) at the Smithsonian Institute, and was one of the early participants in the POBSP. He and his colleagues conducted the extensive background research for the project. All of their notes, from the initial research phases through to data analyses of the work conducted in field, are held at the Smithsonian. Mr. Clapp is one of the last remaining employees that retain in-depth knowledge of this collection of notes, data, photographs and collected papers. Mr. Clapp offered me access to all files, but the focus for this one week visit was on the Monument. These files and reports provided extensive information about the natural history of the islands. The information for Howland and Baker was synthesized into two independent reports (Clapp et al 1965, Sibely et al. 1965). The information collected on Jarvis was never completely synthesized. Mr. Clapp created an inventory of ships that visited Howland, Baker and Jarvis beginning in the 19th century. These notes contain >300 records from 1852 to approximately 1861. Notes about shipwrecks and other events are included as well. There are notes regarding sources identified at the national archives and from various other sources. In addition, notecards with citations and quotes with useful information are in these files.

Additional Reports and Notes

In addition to the seabird data, a great amount of additional data was collected by POBSP researchers. This information would provide us with a greater understanding of the state of islands, and possibly pelagic ecosystems during this time.



Grid name	Description	Point 1		Point 2		Point 3		Point 4	
		Lat.	Long	Lat.	Long.	Lat.	Long.	Lat.	Long.
Northern Grid (Grid #1)	Adjacent to Johnston Atoll	Between 17° N and 18° N	172° W	15° N	Between 175° W and 174° W	12° N	Between 172° W and 171° W	Between 15° N and 14° N	Between 169° W and 168° W
Southern Grid (Grid #2)	Includes Howland and Baker islands	2° N	179° W	2° S	179° W	2° S	175° W	2° N	175° W

Figure D-8. Approximate location of POBSP at-sea grids within or adjacent to the US Pacific Remote Islands Marine National Monument.

Appendix E. Key sources of quantitative historical data for the U. S. Pacific Remote Islands Marine National Monument

Historical ecologists depend on a variety of sources to reconstruct historical ecological conditions including anecdotal observations made by both amateur and experienced observers, and scientific studies that document flora, fauna and physical parameters. The reliability of the data we seek is dependent upon the accuracy of the observer and the quality of the notes left behind.

What follows is an annotated bibliography of some of the earliest efforts to record quantitative information about the flora, fauna and other ecological parameters within the Pacific Remote Islands Area. These sources have been singled out because they provide relatively accurate data about the region, with far fewer uncertainties that are often associated with anecdotal information. This review demonstrates that consistently reliable quantitative data collected earlier than 1950's is somewhat sparse. Ideally, by comparing historical species lists and other data, to more current data about the same parameters, these studies could be used to create a more complete picture of how the flora and fauna of the region have changed over time.

This list does not include more recent data collected by various research expeditions or coral reef data collected by NOAA's Coral Reef Ecosystem Division (please see for http://www.pifsc.noaa.gov/cred/index.php CRED data). In addition, more recent published and unpublished data collected by the US Fish and Wildlife Service has been omitted but may be obtained by contacting Monument staff/managers. Please see the bibliography for more recent sources of data pertaining to the flora and fauna of the islands and atolls of the Monument. Note that some of the studies in the bibliography are follow-up efforts to the original studies cited in this appendix. With regards to the Pacific Ocean Biology Survey Program (POBSP) data, we have included citations for peer reviewed published and unpublished reports that incorporate data collected in the field. The raw data, collected specimens, and summary reports are available from the Smithsonian Institution, but have not been included in this list of sources.

Table E-1. Annotated citations for published historical data collected on Howland Island (H), Baker Island (B), Jarvis Island (J), Johnston Atoll (JO), Palmyra Atoll and Kingman Reef (P) and Wake Atoll (W).

	Islands and Atolls					
Annotated citation	**H**	**B**	**J**	**JO**	**P**	**W**
Amerson, A. B., Jr. and P. C. Shelton. 1976. The Natural History of Johnston Atoll, Central Pacific Ocean. Atoll Research Bulletin 192, 502 p. *A comprehensive synthesis of data collected on, and adjacent to, Johnston Atoll from 1963-1969 during the POBSP, and additional data collected in 1973 by the Ecology Program. Physical environment, history, and biota of Johnston Island with plant and animal lists. Special mention of ciguatera in fishes and detailed description of avifauna and nesting behavior. Includes photographs, charts and bibliography.*						
Atomic Energy Commission. 1963. Reconnaissance Survey Report: Howland, Baker & Canton Islands. Las Vegas, NV.						
Bernice P. Bishop Museum. Invertebrate Zoology collection. *Collected invertebrate specimens from various expeditions. A total of 2,082 specimens, that were collected between 1913 and 2000, on or adjacent to Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Palmyra Atoll, Kingman Reef and Wake Island are cataloged. Most of these specimens were collected in the early to mid-1900s. Please see Appendix A for invertebrate collection manager contact information.*						
Bernice P. Bishop Museum. Vertebrate Zoology collection. *Collected vertebrate specimens from various expeditions. A total of 137 specimens, that were collected between 1923 and 1992, on or adjacent to Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Palmyra Atoll, Kingman Reef and Wake Island are cataloged. Most of these specimens were collected in the early to mid-1900s. All the 53 reptile and amphibian specimens were collected from 1922-1935. Please see Appendix A for vertebrate collection manager contact information.*						

	Islands and Atolls					
Annotated citation	**H**	**B**	**J**	**JO**	**P**	**W**
Bernice P. Bishop Museum. Ichthyology collection. *Collected fish specimens from various expeditions. A total of 1,182 specimens, that were collected between 1913 and 2003, on or adjacent to Howland Island, Baker Island, Jarvis Island, Johnston Atoll, Palmyra Atoll, Kingman Reef and Wake Island are cataloged. Most of these specimens were collected in the early to mid-1900s. Please see Appendix A for ichthyology collection manager contact information.*						
Buggeln, Richard G. and Roy T. Tsuda. 1969. A Record of Benthic Marine Algae from Johnston Atoll. *Atoll Research Bulletin* No. 120:1-22. *Annotated list of marine benthic algae from Johnston Atoll.*						
Christophersen, E. 1927. Vegetation of Pacific Equatorial Islands. Bernice P. Bishop Museum Bulletin 44: No. 2. 79 p. *Includes separate enumerations of the then-known vascular plants of Jarvis, Kiritimati, Tabuaeran, Teraina and Palmyra Islands as well as those of Howland and Baker Islands. Each list, accompanied also by general remarks on climate, soils, vegetation and land use, contains notes on life-form, habitat, occurrence and biology for the species covered, as well as citations of specimens and some taxonomic remarks. At the end of the monograph are notes on dispersal methods of the plants, introduced species, and a list of references; pp. 73-76 furthermore give a tabular summary of geographical distribution of species within the islands concerned. (Summary from Frodin 2011)*						
Clapp, R. B., C. F. Sibley and C. R. Long. 1965. Biological Survey of Baker Island, March 1963 – May 1965. Unpublished Report of Pacific Ocean Biological Survey Program, Division of Birds Smithsonian Institution, Washington D.C. Division of Birds, Smithsonian Institution, Washington, D. C. 63 p. *Document summarizes data collected by Smithsonian Institute scientists for the Pacific Ocean Biological Survey Program (POBSP) on Baker Island from March 1963 to May 1965. Document includes information about the geology, climate, early history, history of the guano period and twentieth century*						

	Islands and Atolls					
Annotated citation	**H**	**B**	**J**	**JO**	**P**	**W**
history. Zoology section includes information about the mammals, seabird data including species accounts, population estimates and records of birds banded by POBSP. The botany section includes a vascular plant survey and vegetation history.						
Fosberg, F. Raymond and Marie-Hélène Sachet .1969. Wake Island Vegetation and Flora, 1961-1963. *Atoll Research Bulletin* No. 123:1-15. *Vegetation and Flora of Wake Island with observations concerning habitat recovery 10 years following the typhoon of 1952.*						
Fosberg, F. Raymond. 1959. Vegetation and Flora of Wake Island. Atoll Research Bulletin No. 67:1-20. *Description of climate, soils, vegetation, and flora of Wake. Comparison with 1953 observations.*						
Hutchinson, G.E. 1950. The Biochemistry of Vertebrate Excretion. Bull. Amer. Museum Nat. Hist. 96. 554 p. *The purpose of the survey is to bring together, and publish as a series of monographs, the available information on all aspects of the interrelation of biology and geochemistry.*						
Rauzon, M. J. Feral Cats on Jarvis Island: Their Effects and Their Eradication. Atoll Research Bulletin 282. *Contains estimates of breeding and non-breeding seabirds during the following months and years: 1963-1966, 1976 (Nov.), 1977 (Oct.), 1978 (Oct.), 1982 (Jul.) and 1983 (Nov.). Contains data on causes of mortality of cats, baiting and trapping success, and data on additional characteristics of the cats, such as sex, color and weight. Also contains two vegetation survey figures, one more recent the other from 1942. Another figure of interest is Figure IV: Location of Collared Cats During Ratio-telemetry Fixes.*						
Rauzon, M. J., D. Boyle, W. T. Everett and J. Gilardi. 2008. The status of the birds of Wake Atoll. Atoll Research Bulletin 561.						

	Islands and Atolls					
Annotated citation	**H**	**B**	**J**	**JO**	**P**	**W**
Comprehensive documentation and consideration of historical information about seabirds and shorebirds on Wake Atoll.						
Shun, Kanalei. 1987. Archaeological Reconnaissance Site Survey and Limited Subsurface of Baker and Howland Islands Final Report: Prepared for U.S. Army Engineer District, Honolulu Corps of Engineers, Fort Shafter, HI.						
Sibley, C. F., R. B. Clapp and C. R. Long. 1965. Biological Survey of Howland Island, March 1963 – May 1965. Unpublished Report of Pacific Ocean Biological Survey Program, Division of Birds Smithsonian Institution, Washington D.C. Division of Birds, Smithsonian Institution, Washington, D. C. *Document summarizes data collected by Smithsonian Institute scientists for the Pacific Ocean Biological Survey Program (POBSP) on Howland Island from March 1963 to May 1965. Document includes information about the geology, climate, early history, history of the guano period and twentieth century history. Zoology section includes information about the mammals, seabird data including species accounts, population estimates and records of birds banded by POBSP. The botany section includes a vascular plant survey and vegetation history.*						
Tsuda, R. T. and G. Trono, Jr. 1968. Marine Benthic Algae from Howland Island and Baker Island, Central Pacific. Pacific Science XXII, April. 4 p. *Presents an annotated listing of the marine benthic algae collected by Mr. C. Long, under the auspices of the Pacific Ocean Biological Survey Program, Division of Birds, Smithsonian Institution, from Howland Island and Baker Island. Species lists are gleaned from Pacific Ocean Biological Survey data collected in 1964. Provides species list, description and location where the species was observed when available.* *Tsuda and Trono report that a survey of the literature at that time reveals no published papers on the algae from these two islands, although Degener and Gillaspy (1955), Degener and Degener (1959), and Dawson (1959) reported on the algae of Canton Island, in the Phoenix Group. At the time this paper was written, all specimens were deposited in the herbarium of Dr. Maxwell S. Doty, University of Hawaii. It is unknown if these specimens are currently in this location.*						

	Islands and Atolls					
Annotated citation	**H**	**B**	**J**	**JO**	**P**	**W**
U.S. Atomic Energy Commission (USAEC). 1963. Reconnaissance Survey Report. Howland, Baker & Canton Islands. October, 1963. U.S. Atomic Energy Commission, Nevada Operations Office. Prepared by: Holmes & Narver Inc. Logistics Planning Group. Las Vegas, NV.						

Appendix F. Bibliography

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Adler, G. H. 1992. Endemism in birds of tropical Pacific islands. Evolutionary Ecology **6**:296–306.

Agassiz, A. Notes from the "Albatross" 1899-1900 expedition to Japan and the South Pacific., Spec. Coll. MCZ 015. Ernst Mayr Library, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

Alling, A., O. Doherty, H. Logan, L. Feldman and P. Dustan. In Press. Catastrophic coral mortality in the remote Central Pacific Ocean: Kiribati, Phoenix Islands. Atoll Research Bulletin.

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