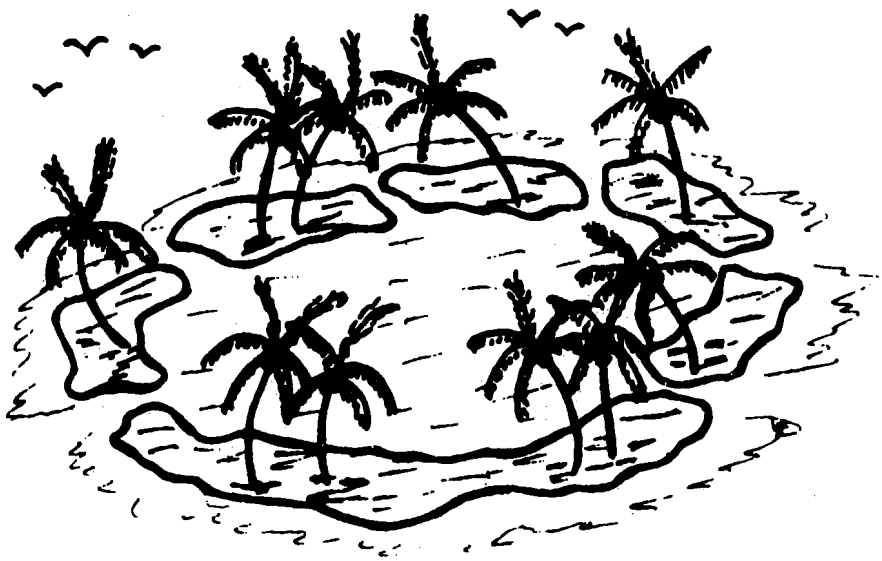
NO. 186

February 15, 1975

# ATOLL RESEARCH BULLETIN

## 186. THE NATURAL HISTORY OF LISIANSKI ISLAND, NORTHWESTERN HAWAIIAN ISLANDS



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THE SMITHSONIAN INSTITUTION

Washington, D.C., U.S.A.

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# THE NATURAL HISTORY OF LISIANSKI ISLAND, NORTHWESTERN HAWAIIAN ISLANDS

by Roger B. Clapp and William O. Wirtz, II

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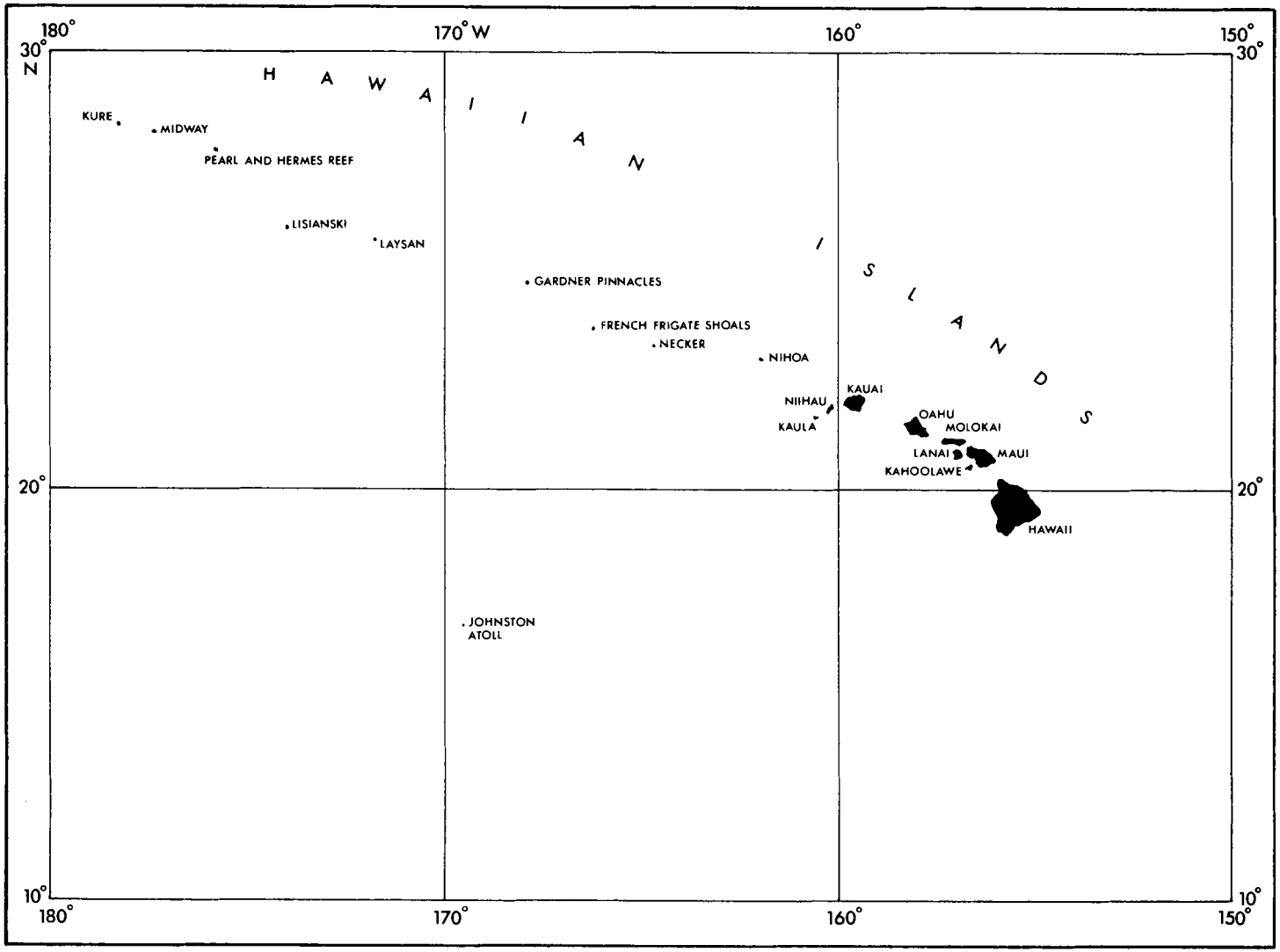


Figure 1. The Hawaiian Islands.

# THE NATURAL HISTORY OF LISIANSKI ISLAND, NORTHWESTERN HAWAIIAN ISLANDS[1]

by Roger B. Clapp[2] and William O. Wirtz, II[3]

## INTRODUCTION

Lisianski, a low sandy island in the Northwestern Hawaiian Islands (Figure 1), is located at 26°02' North and 174°00' West (Off. of Geog., 1956: 47), approximately 905 nautical miles northwest of Honolulu (Bryan, 1942: 190). The island is situated at the northern edge of a large reef bank which lies between 25°26' and 25°25' north latitude and between 173°52' and 174°01' west longitude.

Previous knowledge of the history and biota of the island is remarkably scant considering Lisianski's relatively close proximity to Honolulu. Most of what is now known about the island stems from work done by the Tanager Expedition in 1923. Publications resulting from that visit dealt primarily with vascular plants, fish, arthropods, and marine invertebrates. Information on the terrestrial biota gathered by the Tanager Expedition was necessarily slight, however, since the flora, and consequently, fauna, had been greatly reduced due to the destruction of vegetation by rabbits introduced earlier in the 20th Century.

Other primary sources of information on Lisianski prior to recent investigations are Munter's (1915) obscure and little known report of a visit made in March 1915 and Bryan's (1942) account--to date the best descriptive and historical summary of the island.

In 1963 the Smithsonian Institution's Pacific Ocean Biological Survey Program (hereafter POBSP), directed by Dr. Philip S. Humphrey, began a series of extensive surveys of Central Pacific islands. During the study period (1963-1969), Lisianski was visited thirteen times by POBSP personnel. On four of these visits POBSP personnel accompanied

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personnel from the Bureau of Sport Fisheries and Wildlife (hereafter BSFW), who, through 1969, had made eight visits to Lisianski (Table 1). From 1963 through 1969 about 27 days were spent on the island by both agencies. Data obtained on these visits form the primary basis of our recent knowledge of the island.

Also incorporated in this report is a considerable amount of unpublished data from earlier visits to Lisianski, most notably the information gathered on the birdlife in 1923 by Alexander Wetmore.

The purposes of this report are several. On the one hand, we wish to compile from diverse sources as complete and as accurate a summary of available information regarding the island as possible. On the other, we wish to report our recent studies, which have dealt primarily with the birdlife of Lisianski. We hope that this report, one of a series on the Northwestern Hawaiian Islands, will accomplish these aims as well as point out areas where our knowledge of the biota is still inadequate or incomplete.

The final draft was largely completed by late 1970 and few emendations or additions have been made since then. Data reported herein includes only that available through 1969.

## DESCRIPTION

Lisianski (Fig. 2) is a low sand and coral island of approximately 450 acres (Freeman, 1951: 331). It is situated at the northern end of a large reef bank (Fig. 3) which is about 65 square miles or 41,322 acres in area. The island, somewhat resembling a parallelogram, is approximately 2,000 yards long, north to south, and 1,100 yards wide, being somewhat wider to the north. Its circumference is about 3.23 statute miles.

The eastern beach is dominated by an exposed ledge of reef rock, with small tidal pools, behind which a narrow, rocky beach rises for about ten feet to the vegetated interior (Fig. 4). South of the rock ledge a low curving beach extends to the southeastern corner (Fig. 5). This beach rises sharply for about three to five feet to the vegetated interior. At the edge of this beach, about 300 yards south of the rock ledge, is the cross-section of a log, probably a redwood, that is much used as a roosting site by Blue-faced Boobies (Fig. 6).

The beach widens (Fig. 7) as one moves toward the southeastern corner where a large unvegetated cut, about 225 feet across at its mouth, extends inland for a somewhat greater distance. Beginning just beyond this cut is a wide triangular sandy beach, the point of which is the southeasternmost part of the island. To the north of the cut the terrain above the beach is fairly level, while to the south the terrain is composed of rolling sand dunes densely covered with Scaevola. The large cut and a smaller one (Fig. 8) just to the southwest of the dense stand of Scaevola and the southeast and south beaches are the areas in which the densest concentrations of nesting Black-footed Albatrosses are found. There is a seven foot vertical drop from the vegetated interior to the

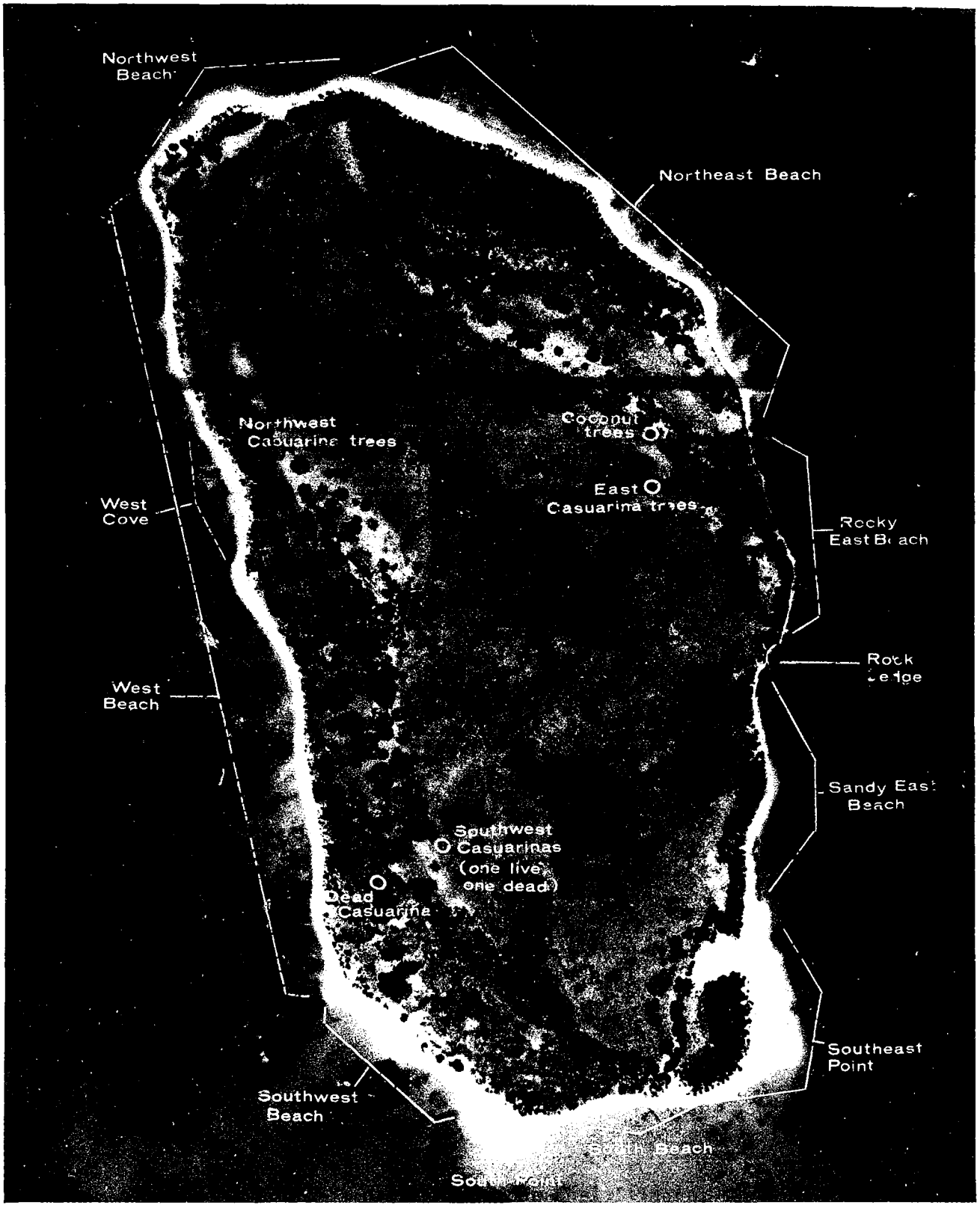



Figure 2. Aerial photograph of Lisianski Island, January 1966. U.S. Navy photograph.

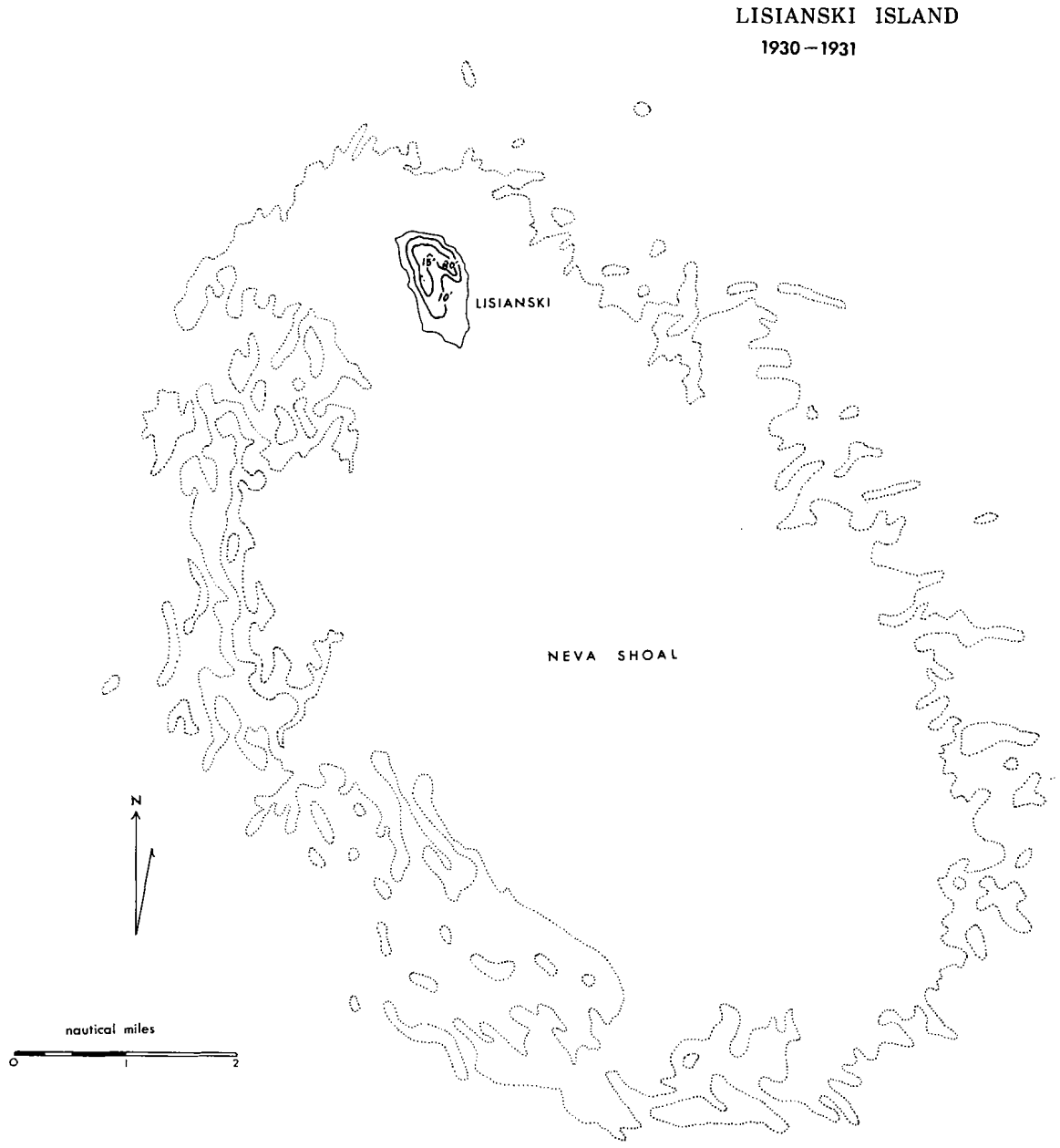



Figure 3. Map of Lisianski Island and surrounding shoal, 1930-1931. Modified from USC&GS Chart 4186, issued December 1942.

Figure 4. Rocky eastern beach north of ledge shown in Figure 5. This area and the rock ledge are much used for roosting by shorebirds, particularly Ruddy Turnstones. POBSP photograph, March 1965, by William O. Wirtz, II.

Figure 5. Looking north at rock ledge from narrow eastern beach, September 1967. POBSP photograph by R.B. Clapp.

Figure 6. Immature Blue-faced Boobies roosting on log at edge of east beach, September 1967. POBSP photograph by R.B. Clapp.

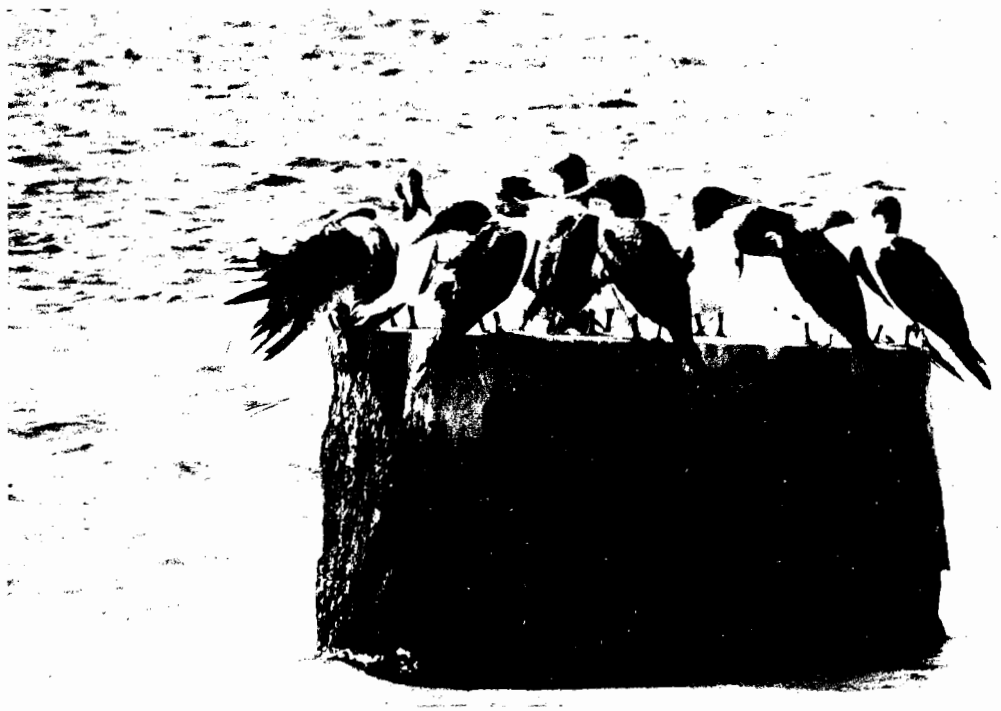


Figure 7. View, looking south, of east beach as it widens towards the southeastern corner of the island, 19 June 1966. Young albatrosses and a Brown Noddy in left fore and middle ground. POBSP photograph by P.C. Shelton.

Figure 8. View from southeastern high point of small cut inland from beach just west of large southwestern beach, 12 March 1964. POBSP photograph by A.B. Amerson, Jr.

beach at the eastern corner of the southern beach (Fig. 9). A short distance west of this area a series of dunes rises to 20 feet or more, the southeastern high point of the island. These rolling dunes, thickly covered with Scaevola, gradually decrease in height across the south end of the island (Fig. 10).

The southwest beach, relatively broad, forms two small coves (see Fig. 2). The beach along the west side of the island is fairly steep and there is a slight vertical cut and overhang at the edge of the vegetated area where erosion has occurred.

A small cove, present near the middle of the west beach, is designated as a small boat landing on the hydrographic charts. There are only a few small coral heads in the lagoon area west of this landing and a large area of clear green water lies between the landing and the reef rock to the west. Towards the north end of this cove is a group of Casuarina trees (Fig. 11), under or about which were the campsites of most recent BSFW and POBSP survey parties. (On two visits, March 1965 and September 1967, the campsite was on the east shore of the island, a few hundred feet to the south of the ledge shown in Figure 5.)

North of this cove the beach curves toward the northwest (Fig. 12). The northwest beach (see Fig. 2) is 20 to 30 feet wide and slightly inclined up to the vegetated interior. Coral rubble is scattered in the sand and several large tree trunks are buried in the beach here. Aerial photographs from 1943 and 1957 show that the southwestern end on this beach was once several hundred feet from its apex to the vegetated interior. To the east of the straight northwest beach is a crescent-shaped beach, 20 to 30 yards wide, with coral rubble and about 100 yards long. There is a slight drop from the interior to the beach here.

The northeast beach, for the most party sandy, rises gently to the interior, and is about 15 yards wide. At the top of this beach there is more coral rubble mixed with sand. The beach becomes steeper and narrower as it approaches the rocky east beach.

## Island Interior

A rim of Scaevola grows along the entire perimeter with most dense growth from the north point of the island, south along the east beach and across the south end of the island. The least dense growth is found along the northern third of the west beach and behind the northwest beach. Comparison of earlier aerial photographs with Figure 2 reveals that the Scaevola has been progressively invading the interior, particularly in the northeast and southwest portions of the island. The growth in the northeast sector is lusher than that on the southwest portion of the island (Fig. 13). Occasional patches of Scaevola are to be found in the interior but most are low, seldom exceeding 3 to 4 feet in height (Fig. 14).

The interior of the island is covered primarily with a lush growth of bunchgrass (Eragrostis) growing to a height of 3 feet or more, with

Figure 9. Looking towards south point along steep beach at eastern edge of south beach, September 1967. POBSP photograph by R.B. Clapp.

Figure 10. Looking west towards the broad sandy beach at the south point of the island, 12 March 1964. In September 1967, this beach apparently extended further south than is shown in this photograph. POBSP photograph by A.B. Amerson, Jr.

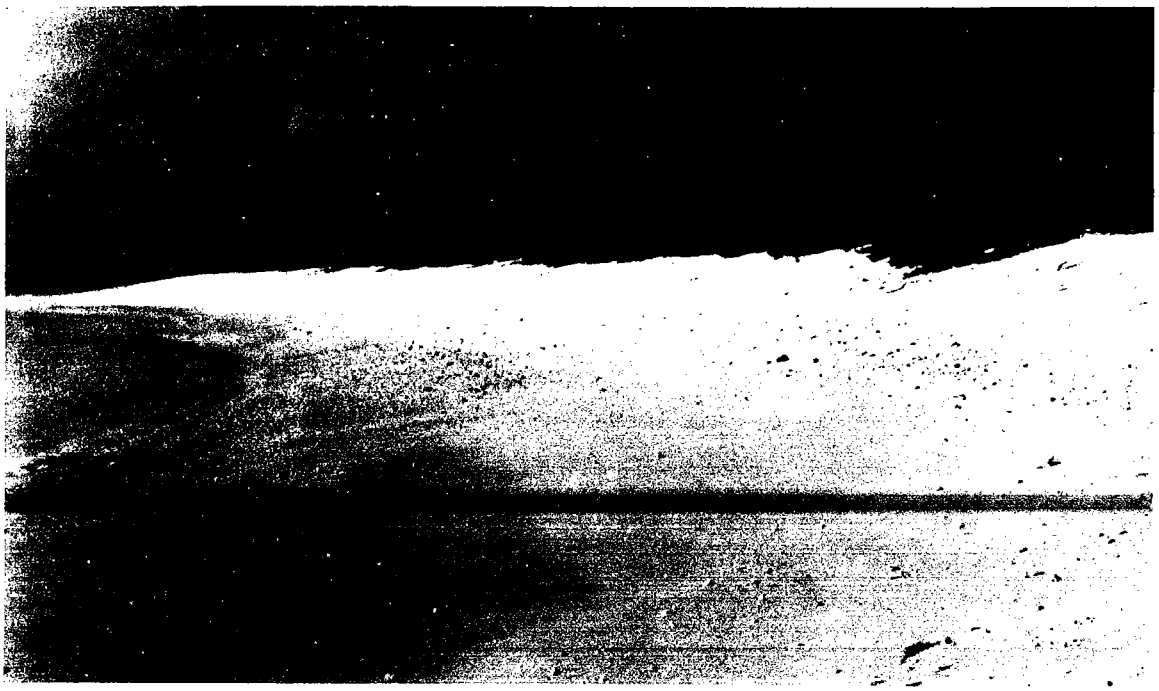


Figure 11. Looking north along west cove toward Casuarina trees, October 1966. POBSP photograph by P.J. Gould.

Figure 12. Looking south from the northern portion of the west beach, June 1966. POBSP photograph by P.C. Shelton.

Figure 13. Looking northeast from the west side of the island, 19 June 1966. Note relatively sparse growth of Scaevola. POBSP photograph by P.C. Shelton.

Figure 14. Clump of low Scaevola in island interior, looking east, 18 June 1966. Coconut trees and eastern group of Casuarina trees in background. POBSP photograph by P.C. Shelton.

several other associated plants. There are several large nearly pure stands of morning-glory (Ipomoea), notably in the south in the central depression, and at the north end, interspersed with the bunchgrass (Fig. 15). Two large palm trees grow inland from the beach in the northeast section and a few hundred feet south of them grows a small group of ironwood trees (Casuarina). Several other live Casuarina are also present: the group at the north end of the west cove mentioned previously; two, one live and one dead, found together towards the south end of the island; and a large dead ironwood, much used for roosting by Red-footed Boobies and frigatebirds, which is to the southwest of the latter group.

According to a study by the U.S. Coast and Geodetic Survey in 1931 (see Fig. 3), the topography of the island is dominated by a crescent-shaped ridge which extends from the northeast side of the island around the north and down the west side to the southwest corner. Judging from Lisiansky's description of the island, this area has been more or less elevated since 1805 (Fig. 16). A second ridge along the southern side of the island which curves northward at the southwest and southeast corners is currently obvious, and is figured on a map of the island made in 1912 (Fig. 17).

Wetmore (ms.) described the island in May 1923 as absolutely devoid of vegetation except for a narrow strip of grass and pigweed about two acres in area along the ridge at the northwest corner of the island. "It is roughly a parallelogram a nautical mile long by slightly less than a half mile wide. A low ridge on the northeast marks the highest point and there is a central depression bounded by a raised rim protecting it from the ocean that must in an earlier stage of development have been the basin of a lagoon similar to that at Laysan."

## GEOLOGY

The Hawaiian Islands are the summits of a range of volcanic mountains that stretches for more than 1,500 nautical miles in a southeast-northwest direction across the floor of the North Pacific Ocean. The entire chain is normally divided into two groups. The islands from Niihau and Kauai southeast to Hawaii are considered the main or windward group, while the tiny points of protruding land from Nihoa northwest to Kure are called the leeward group. Stearns (1966) is the most recent and comprehensive of the several papers dealing with the geological history of the group, and the following summary is based on that book. There are no papers that deal specifically with the geology of Lisianski Island.

Geological evidence suggests that the range was formed during the Tertiary Period, and that the peaks at the northwestern end of the chain were formed earlier than those to the southeast. The islands were built of successive flows of basalts and volcanic products through a fissure in the ocean bottom, some 15,000 to 18,000 feet below the present surface.

Figure 15. Interior of island, showing dense growth of bunchgrass. March 1965. Looking from south of eastern group of ironwood trees toward south ironwood tree. POBSP photograph by W.O. Wirtz, II.

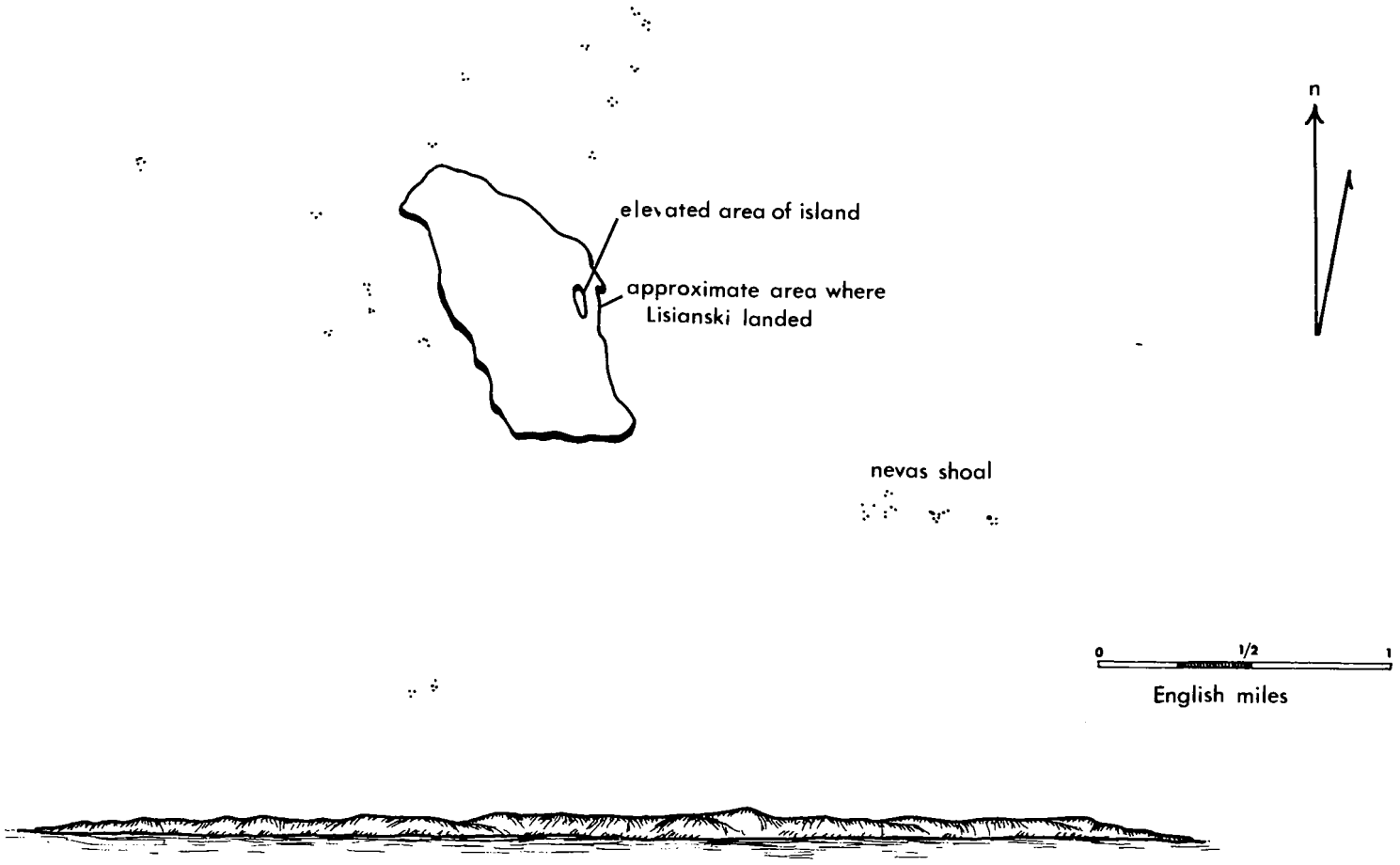



Figure 16. Map of Lisianski Island in 1905. Redrawn and modified from Lisiansky (1814).

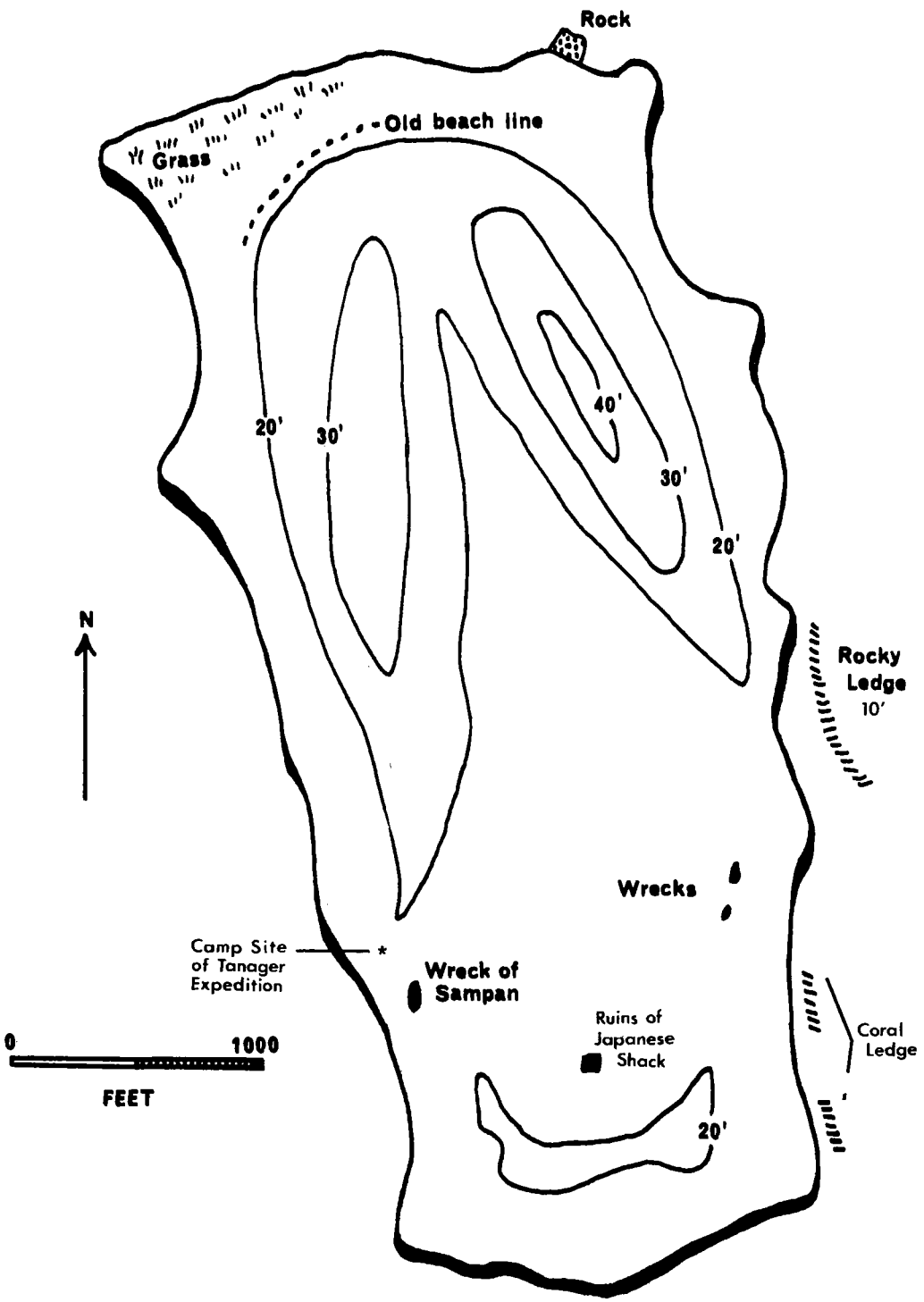



Figure 17. Map of Lisianski Island in 1923. Modified after Bryan (1938).

The formation of these volcanic islands occurred in several stages. During the submarine stage, development is due primarily to the addition of quantities of pillow lava and the production of ash and pumice as a result of the contact of magma with sea water. The soft cone is easily eroded by the sea when the peak reaches sea level. A shieldshaped dome is built from thin sheets of highly fluid olivine basalts once the cone reaches sea level. The volcano gradually collapses over the vent areas to form a caldera on the summit, and as fresh lava pours from the cone this caldera is obliterated. Erosion partly destroys the volcanic dome, and submergence may drown the dome and provide an environment suited to the development of coral reefs. Rejuvenation of volcanic activity may destroy coralline growth and the island may continue to emerge, as in the case of the main islands. Or submergence or erosion may continue with the subsequent development of an atoll.

Erosion by wind, waves, and rain reached its maximum in the fluctuating seas of the Pleistocene, when sea level may have dropped to 1,000 feet lower than it is today, and risen to 95 feet higher. Sea temperatures during glacial maxima dropped so low, corals barely survived in Hawaiian waters. But during interglacials and after the last glacial retreat, conditions were favorable for growth of corals and the coralline algae necessary to bind the more fragile corals into a resistant mass. The islands of the northwest chain result from accumulation of this material some hundreds of feet thick, overlying the volcanic bases. The forms we see of the islands are relatively transitory in terms of geological time, and depend upon the stage of submergence or emergence, and on existing wind and current patterns. The most recent event in the northwest chain was an emergence of 1 to 2 meters, as measured at Kure, Midway, and Pearl and Hermes Reef, where emergent rock ledges composed of coral aged by carbon-14 at between 1,200 and 2,400 years occur (Gross et al., 1969: 22).

Such ledges do not occur on Lisianski, at least not separated from the island. If any existed formerly they were eroded away. Lisianski Island itself is a small emergent portion of a coral platform several miles across. There is no enclosed lagoon, but the island appears to have had a small central lagoon which has been filled in with sand.

Soils on Lisianski range from pure sand and coralline gravel on the beaches, through coarse coral rock areas above the beach zone, to humus-sandy mixtures in the vegetated areas. Elschner (1915: 57) reported that the surface was bleached sand to 4 or 5 centimeters, and that the deeper strata were moist and gray. There are no more recent soil determinations for the island.

Elschner (ibid.) reported that the entire surface was partially phosphatized, there being a more or less fine film of phosphates on all sand particles. He noted that the best guano was found in the central basin, supposed by him to have once been a lagoon. Phosphate determinations (as $Ca_3P_2O_8$ in the original) by Elschner varied from 2.12 to 11.12 percent in surface sand and from 14.24 to 62.17 percent in the area of the former lagoon.

## CLIMATE

Climatic data for this area of the Pacific are available only from the Midway Naval Station, 255 miles northwest of Lisianski. No significant difference is to be expected between the general weather conditions of the two islands. The data used in this section are from a summary of the years 1953-1963 (Air Weather Service [MATS] Climatic Center, USAF).

Climate in this region of the Pacific is marine, influenced by marine tropical or marine Pacific air masses depending upon the season. During summer the Pacific High becomes dominant, with the ridge line extending across the Pacific north of Midway. This places the region under the influence of easterlies with marine tropical and trade winds prevailing. During the winter, especially from November through January, the Aleutian Low moves southward over the North Pacific, displacing the Pacific High before it. The Midway region is then affected by either marine pacific or marine tropical air, depending upon the relative intensity of the Aleutian Low and the Pacific High.

Monthly maximum, minimum, and mean temperatures for a 10-year period are shown in Figure 18. The temperature variation shown is indicative of a marine environment. The mean annual range is 16°F. From December through April the means range between 66°F and 69°F, and during the remainder of the year between 70°F and 81°F, the warmest months being July, August and September, and the coolest January, February, and April. An inexplicable departure from the normal curve occurs in maximum, minimum and mean figures for April. A 37 degree difference exists between the absolute high of 89°F and the absolute low of 52°F for this 10-year period.

Mean monthly precipitation and the number of days with measurable precipitation are tabulated in Figure 19. Rain or drizzle occur most frequently from December through May, and least frequently in June and July. The mean annual precipitation for the period is 42.59 inches, with a maximum of 5.07 inches occurring in January and August, and a minimum of 2.03 inches in November. A secondary maximum of 4.92 inches occurs in October. Combining amount of precipitation and days with measurable precipitation shows May and June to be the driest months of the year. During the remaining months measurable rain falls on from 10 to 17 days. Thunderstorms have been recorded in all months except February, March, and April but peak activity seems to occur during August, September, and November. The annual average relative humidity is 76 percent with a high monthly mean of 89 percent and a low of 62 percent.

During the periods for which data are available, no tropical storm or typhoon has passed through the area, though storms of tropical character have passed within 500 miles, causing a noticeable increase in precipitation and winds, especially in September of 1957, 1958 and 1959, October and November 1962, and December 1964.

Surface wind speeds and directions are shown in Figure 20. The prevailing wind direction 10 months of the year is easterly, and during

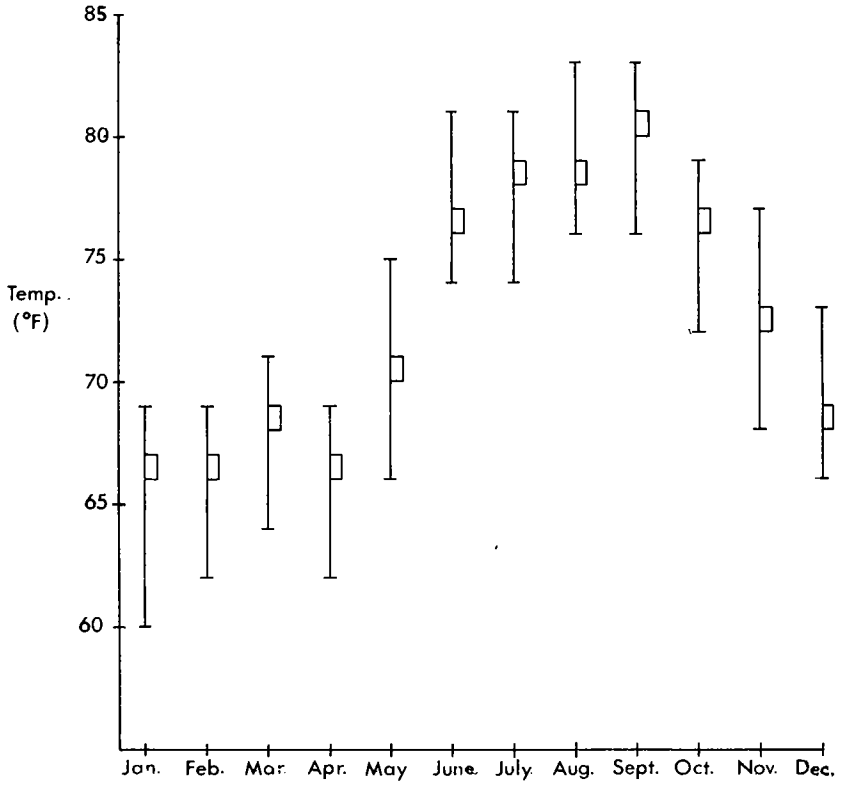
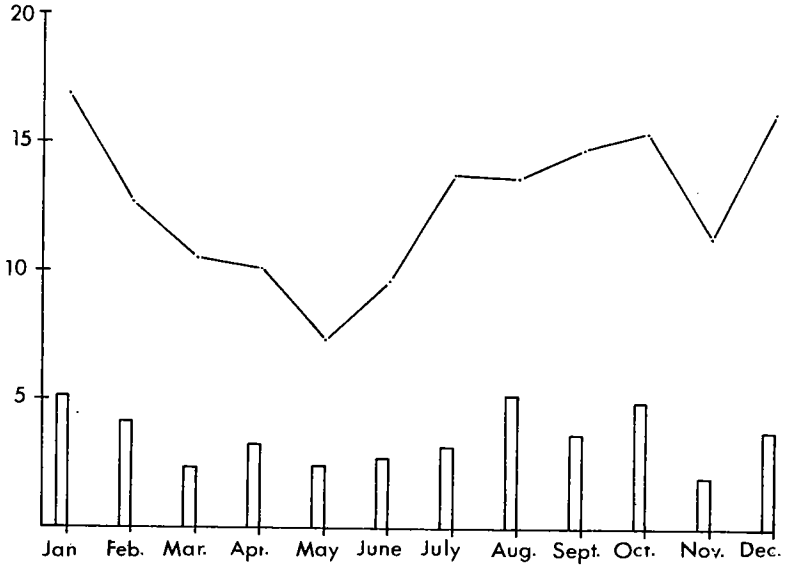



Figure 18. The mode of the monthly means for a ten-year period, 1953-1963, and the range of the maximum and minimum modes of temperature for Midway Atoll.

Figure 19. Mean monthly precipitation in inches (histograms) and mean number of days with measurable precipitation (line graph) for Midway Atoll, 1953-63.



December and January westerly. The annual mean wind speed is 10 knots with a range of 5 knots. Winds of over 4 knots generally range from northeast to southeast, while greatest mean wind speeds are recorded from south-southwest to west-northwest.

The maximum sustained wind recorded for Midway is 44 knots in January. Maximum winds are lowest in June, July and August, and high in September and December, and also low in October. Maximum winds occur generally from the east from July through October, and from the west the remainder of the year. Peak gusts of 77 and 67 knots have been recorded in December and January respectively, during the period of prevailing westerlies. From May through August peaks range from 35 to 41 knots and in the remaining months from 42 to 55 knots. Gusts are generally from the west.

The mean tenths of total sky cover is fairly uniform throughout the year, ranging from a low of 5.3 in August to a high of 7.3 in March. The yearly mean is 6.2. The occurrence of fog and haze is negligible, but highest in January and March. Conditions with visibility of less than one mile occur rarely (2 percent) at Midway, but most often from December through April, when due to rain.

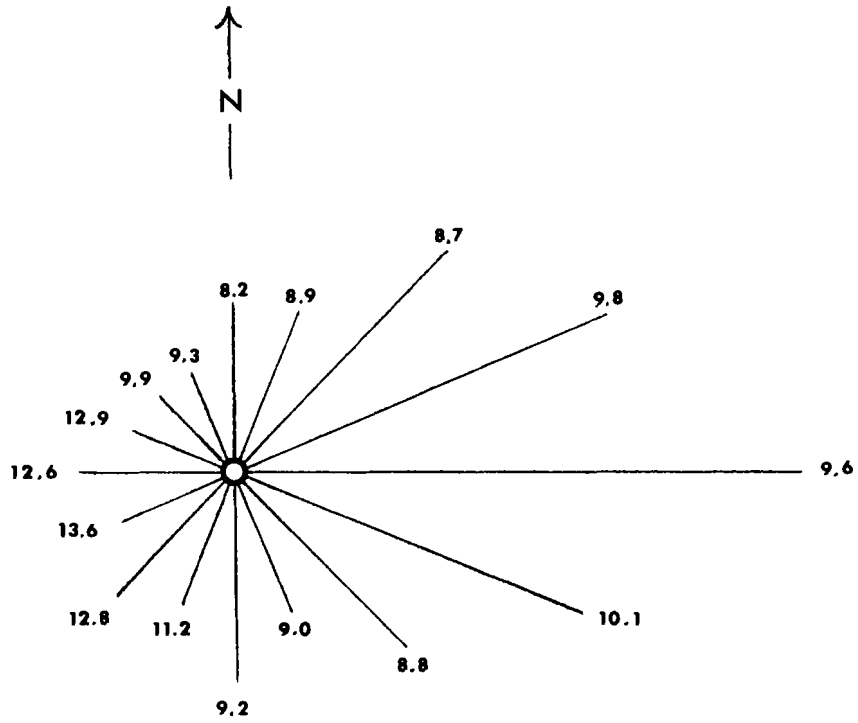



Figure 20. Wind direction and speed at Midway Atoll. 1953-63. Length of directional line indicates percent of observations from that direction; figure at end of the directional line is mean wind speed in knots.

# HISTORY

## Discovery of Lisianski Island

Lisianski was discovered when the Russian exploring vessel Neva, captained by Urey Lisiansky, grounded on a nearby reef. At the time the Neva was sailing from Sitka to rendezvous at Macao with the Nadeshda, her companion on the first Russian circum-global expedition (Buck, 1953: 72).

The Neva ran aground at 2200 on 15 October 1805 but the crew was able to refloat the vessel by throwing cannons and other heavy objects overboard. At dawn the crew observed a low sandy island to the west. Shortly thereafter the ship was driven onto another reef by a sudden squall but was refloated by 17 October when cables, anchors, and all remaining heavy items were thrown overboard.

That evening some of the ship's officers landed on the island and returned with four large seals that had been killed with hand spikes. On the 18th the crew retrieved the items that had been thrown overboard and went ashore. They found birds very numerous; at almost every step they sank almost to their knees in burrows dug by the birds. They saw seals and turtles but did not find water. A tall pole was fixed in the sand, and a bottle containing an account of the island was buried near it.

Lisiansky (1814: 256) concluded his comments on the island by stating that "this island promises nothing to the adventurous voyager but certain danger....to the southeast point of the bank where the vessel grounded, I gave the name of Neva; while the island itself, in compliance with the unanimous wishes of my ship's company, received the appelation of Lisiansky."

The next recorded visit to Lisianski occurred when Capt. Benjamin Morrell, Jr., of the ship Tartar landed there 6 July 1825. Morrell commented in some detail on the surrounding reefs but only made a few remarks about the island itself. He stated that it was "only about six miles in circumference, presenting a few small spots of vegetation, consisting of coarse grass and a little shrubery. The whole surface...[was] nearly covered with rookeries of different kinds of birds, among which are whale-birds, wake-up-kittles, man-of-war birds, gulls, and tropic-birds. On the shores we found an abundance of sea-elephants and green turtles, but nowhere...could obtain fresh water" (Morrell, 1841: 216).

## First Scientific Visit

The next known visit to the island was by another Russian exploring vessel, the Moller, commanded by Capt. Stanikowitch. A party landed on the island on 3 April 1828 and the ship's surgeon, Herr C. Isenbeck, "did his best to bear all he saw in mind, and to prepare and keep as many of the birds, which were mostly caught by hand, as the very unfavorable circumstances allowed him to do" (von Kittlitz in Rothschild, 1893-1900: ii).

Several years later his observations were reported to F.H. von Kittlitz who subsequently wrote a paper that was translated by Rothschild (op. cit.).

Isenbeck's observations comprise the first list of birds from the island, but in many instances his observations are of doubtful validity, both as to specific identifications and as to observations on breeding biology.

## Shipwrecks

Lisianski, like other Northwestern Hawaiian Islands, has had its share of shipwrecks. The accounts of these wrecks clearly show the tenacity and resourcefulness of early voyagers in the Pacific.

### Wreck of the Holder Borden - 1844

The first known wreck was that of the 442-ton whaler Holder Borden of Fall River, Massachusetts. The ship, captained by Javes J. Pell (from whom Lisianski derived one of its earlier, alternative names), ran aground on a sandbank at 0300 on 12 April 1844.[1] Shortly thereafter the ship swung around onto a coral reef from which she could not be extricated. By morning there was 4 feet of water in the hold and the crew, observing a low sandy island some 4 or 5 miles away, abandoned the ship, taking everything of value with them to the island.

Members of the crew spent some 5 months on the island, living on ship's provisions and on seals, turtles, and birds. During their stay they built a 38-ton schooner from the wreckage of the Holder Borden. By September 8 they had completed their vessel, "painted, sheath, and copper-fastened throughout," which was named the Hope. On 14 September she sailed for Honolulu with Captain Pell and most of the crew and arrived there on 8 October. Eleven men were left on the island to look after the rest of the wreckage and its cargo of whale oil (Ward, 1967: 31-54).

Pell then purchased the American brig Delaware and set forth on 20 October to recover the men and supplies left on Lisianski. He arrived there on 1 November and spent 42 days loading oil and other salvage from the wreck. Before departing on 14 December, Pell planted about 80 coconuts on the southeast point of the island (Ward, op. cit.).

### Wreck of the Konohasset[2] - 1846

Two years later another whaler, the 426-ton Konohasset, of Sag Harbor, met a similar fate. This ship, captained by Theron B. Worth, struck a reef under full sail about 17 miles from Lisianski at 0100 on on 24 May 1846. All hands were forced to leave in lifeboats when the ship was bilged by increasing swells over the reef. The following morning they reboarded the ship and sighted Lisianski from aloft. They proceeded to the island where they found the remains of the Holder Borden, and a house and well that had been constructed by the crew of that ship.

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[1] Not November 1844 as indicated by Bryan, 1942: 192.

[2] Another account spelled the name Conohasset but we did not resolve which spelling was correct.

During the following days the crew returned to the wreck and salvaged materials from which they built an 8-ton, 22-1/2-foot sailing sloop which they named the Konohasset, Jr. The keel was laid on 28 May and the ship was completed but 18 days later. Captain Worth and six other crew members then sailed for Honolulu, arriving there 31 July 1846 after 42 days at sea. The rest of the crew was subsequently taken off the island by the Hawaiian schooner Halilee, which the American Consul had dispatched to rescue them (Ward, 1967: 55-67).

Wreck of the Wanderer - 1872

In 1872 Captain E. Wood of the Kamehameha V found the remains of yet another ship that was lost on the treacherous reefs surrounding Lisianski. When the Kamehameha V arrived at Lisianski on 24 July the crew saw a wreck on the reefs to the southeast. During the afternoon two boats from the Kamehameha V went ashore and found evidence that the crew of the ill-fated Wanderer had landed there. On the beach were the remains of clothing, some food, water, and other debris. The ship's longboat, rigged for sea, was found on the northeast corner of the island where it had drifted ashore and the Wanderer's quarterboat was found moored to two water casks and a grapnel offshore.

The wrecked ship itself was visited the following day. On board was found the log, its last entry dated May 9, which identified the ship as the North German brig Wanderer of Hamburg (The Friend, 2 October 1872: 81). The crew was never found, leaving this one of the great shipwreck mysteries of the Pacific.

Wreck of the Afton - 1887

In 1887 still another ship was wrecked on the reefs. The bark Afton, carrying a cargo of coal from New South Wales to California, went aground on 13 April and could not be gotten off. Captain Gilmour and the crew abandoned the ship on the 16th and sailed for Honolulu in the ship's two 28-foot lifeboats.

After sailing about 120 miles to the E-SE, they found they could make no headway against the Northeast Trades; they then decided to turn about and run before the wind to Guam. Despite much suffering from thirst and the loss of the first mate overboard, the lifeboats eventually arrived at Guam, covering some 3,000 miles of open sea in 29 days (Cresswell, 1939: 53).

## Other Visits in the 19th Century

Visit of the Manuokawai

On 10 May 1857[3] Captain John Paty landed on the island from the Hawaiian schooner Manuokawai. His purpose in visiting the island was to

[3]Hawaiian Privy Council documents, vol. 10: 154. State of Hawaii Archives, Honolulu.

ascertain the nature and amount of guano deposits and to take possession of the island for the Hawaiian Kingdom. He reported that the surface was obtained by digging a hole 5 feet deep in the center of the former lagoon. His party found lumber, a house, and other artifacts left from the wreck of the Holder Borden, and noted that birds, fish, seals, and turtles were plentiful, though not so abundant as on Laysan. No trace was found of the coconuts planted by Pell (Paty, 1857: 40; Bryan, 1942: 191-192).

Visit of the Gambia

Captain N.C. Brooks visited Lisianski on the Hawaiian bark Gambia about May 1859. His comments on its position, the surrounding reef, sailing directions for the island, and observations on the island scarcely differ from Paty's. One observation of note was the discovery on the west beach of a notice that had been left by the San Diego, 27 April 1859, taking possession of the island for parties in San Francisco (Brooks, 1860: 501-502).[4]

Visit of the Ada

In 1882 Lisianski was twice visited by the crew of the Ada, a British schooner that was engaged in harvesting fish, sharks, turtles, and bêche-de-mer in the Hawaiian leewards. On her first visit to Lisianski on 24 January, 13 turtles and 47 bêche-de-mer were collected. On her second visit in early May, 107 turtles and 307 bêche-de-mer were taken (Hornell, 1934: 432-433).

Visit by the Rothschild Expedition

The second visit to Lisianski of ornithological interest occurred during the summer of 1891 when the island was surveyed for a few days by the Rothschild Expedition. Henry Palmer and his assistant, George C. Munro, had been engaged by Walter Rothschild to collect birds in the Northwestern Hawaiian Islands. The schooner Kaalokai, captained by F.D. Walker, had been hired to transport them to the various islands. They landed on Lisianski on 29 June and remained there until 7 July. In all, 16 species of birds, four of them shorebirds, were recorded and bird specimens were obtained. (See Appendix Tables 1 to 3 for additional details and references.)

Cameron's Visits

John Cameron visited Lisianski on the sloop Ebon in the 1890's to kill seals and turtles for meat and to fish for sharks. On a visit in the summer of 1893 he noted "miriads of mice" that overran the island but made little reference to other animal life (Farrell, 1928: 397-399). Since the account of Cameron's visit was written many years after his trips to the Hawaiian leewards, and since no other observer from that period reported "mice," we suspect that his observations of Lisianski were probably confused with those of another atoll.

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[4]This is the only reference to the visit of the San Diego.

Cameron revisited the island twice during the summer of 1894. On the second visit the crew fished for sharks for a few days and then spent the remainder of the visit killing turtles and seals (Farrell, 1928: 414).

## Lisianski and its Leases

On 29 March 1890 rights to remove phosphates and guano from Lisianski (and Laysan) were granted to Charles N. Spencer and George D. Freeth by the Hawaiian Kingdom.[5] These rights were subsequently signed over to the North Pacific Phosphate and Fertilizer Company which formally leased Laysan and Lisianski on 17 April 1893 for a period to extend until 29 March 1910. The island was visited in July 1890 by George D. Freeth on the schooner Kaalokai, presumably to investigate the status of guano deposits.[6] With him was A.B. Lyons, who, with Freeth, had just previously visited Laysan Island. Lyons (1890) later published an account of his visit to Laysan but no details of the visit to Lisianski are now available.

In March 1904 Max Schlemmer, the "King of Laysan," applied for a lease to Lisianski, Laysan, and French Frigate Shoals, but his plea was rejected. Shortly thereafter, 6 May 1904, the Pacific Guano and Fertilizer Company,[7] which had ceased to work Laysan for guano, made Schlemmer an agent who could represent it with the power to act in accordance with the terms of its contract and lease with the Hawaiian Government.

In late 1907 Schlemmer again applied to the Hawaiian Government for a lease to Laysan and Lisianski but did not obtain it until 8 February 1909. (This lease was later declared invalid since it postdated Theodore Roosevelt's Presidential Executive Order of 3 February that had placed these islands within the Hawaiian Islands Reservation.)

Schlemmer had previously visited Japan and there, on 22 December 1908, had concluded a contract with a Japanese, Genkichi Yamanouchi, in which he granted the Japanese whatever rights he held or would hold to the two islands. Genkichi was in the feather trade and later sent a crew of Japanese to Lisianski and Laysan to harvest feathers (for more details on this raid, see below).

Such rights as Schlemmer had accorded the Japanese were soon valueless since the Pacific Guano and Fertilizer Company surrendered its lease to the Hawaiian Government on 31 December 1908.

## Exploitation of Lisianski's Guano Deposits

Various authors--e.g., Bryan (1942: 192) and Hutchinson (1950: 207)--have recorded that guano was removed from Lisianski, but a reconsideration

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[5]For a more detailed account of this and other contracts dealing with Lisianski, see the historical account of Laysan in Ely and Clapp, 1973.

[6]Freeth visited Lisianski again during the summer of 1894 (Farrell, 1928: 414).

[7]The North Pacific Phosphate and Fertilizer Company had changed its name to the Pacific Guano and Fertilizer Company on 3 April 1894.

of the evidence indicates that no guano, other than small samples for chemical testing, was ever taken. Both Bryan's and Hutchinson's statements refer to a comment by Carl Elschner, who visited the Northwestern Hawaiian Islands, including Lisianski, in September 1914, long after the Pacific Guano and Fertilizer Company had ceased operations in that area. Elschner (1915: 56) stated that "at some time or other guano and phosphates were shipped...." However, the historical absence of structures such as wharfs used for loading guano, and the lack of any other physical evidence of guano operations, as well as the vagueness of Elschner's comment, strongly suggest that Elschner was only reporting hearsay and had no direct evidence of guano operations. In addition, an anonymous article in a Honolulu trade magazine, "The Sales Builder," states that the only island worked by the company for guano was Laysan (Anon., 1939: 19).[8]

Plumage Hunters on Lisianski - 1904

On 8 January 1904 a party of 38 Japanese landed on Lisianski from the schooner Yeiju Maru for the purpose of securing birds' feathers that eventually were to be used in the French millinery trade.[9] About 18 January the ship broke loose from her anchorage in a heavy gale and was evidently lost on the reef as much debris from this ship later washed ashore. In late February the Tiyo Maru put an additional 39 men ashore and departed for Tokyo with no cargo (Hamlet, ms.).[10]

On 11 April 1904 Captain A.P. Niblack of the U.S.S. Iroquois went ashore and warned the Japanese of their violation of customs and immigration

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[8] This article contains many details of the history of guano operations on Laysan that are to be found in no other account. The nature of the statements suggests that the author had access to the files of the guano company which are apparently no longer available.

[9] This was probably not the first time that Lisianski had been visited by feather hunters. The previous year, Hugh Rodman, then commander of the U.S.S. Iroquois, had ordered from Lisianski some Japanese that he had previously found killing birds on Midway (Hugh Rodman to the Assistant Secretary of the Navy, 1 July 1903, Rec. Group 126, U.S. Nat. Archives, Washington).

[10] This account of Japanese activities, derived from an interview conducted by Hamlet with the leader of the Japanese, Tsunetare Sugiye, has the ring of authenticity. When the Japanese reached Honolulu they presented a different story, reported by Bryan (1942: 194), who relates: "The leader of the bird poachers told Acting Governor Atkinson that the party has been stranded....when the schooner, Aju, sank. He said that they had put up a signal of distress, seen by the Tiyo Maru, which had spared them some provisions and removed one of their party."

laws.[11] This warning probably had little effect since Niblack spoke no Japanese and the Japanese spoke no English. Niblack reported their presence on Lisianski when he returned to Honolulu and the U.S. Revenue Cutter Thetis was dispatched to remove the Japanese from the island.

The Thetis anchored off Lisianski on 16 June and Captain O.C. Hamlet and a party, including an interpreter, went ashore to investigate. There they found a camp, consisting of four thatched-roof shacks, and a party of 77 Japanese. If anything, the Japanese were pleased at being apprehended. They had been short of food for some time prior to the arrival of the Thetis and were down to 600 pounds of rice, a few beans and some dried tern meat which they had been preparing against the day that their rice would be gone (Hamlet, ms.).

Hamlet's party also found great quantities of dead birds as well as many packages of dried birds and skins. The manager of the feather-gathering operation, Tsunetare Sugiye, stated that 110 sacks of wings, 100 crates of whole dried birds, and 116 cases of birds and wings had been gathered up to the time of the Thetis' arrival. His records indicated that these packages contained approximately 121,768 whole birds and 162,223 pairs of wings. Nearly all of the approximately 284,000 birds killed had been "black and white terns" [= Sooty Terns], but both Laysan and Black-footed Albatrosses, Gray-backed Terns, and Red-tailed Tropicbirds had also been killed. The most highly prized catch was the "all white tern" [= White Tern] which, however, was scarce on Lisianski. "Black terns [= Noddy sp.] were not killed as they had no practical use for ornament (Hamlet, ms.).

Hamlet brought all the Japanese and their personal effects, as well as some bird specimens,[12] on the Thetis the same day, and departed for Honolulu that evening. All the rest of the birds and plumage was left on Lisianski since Hamlet, in a discussion with the Japanese consul-general, had previously stated that another Japanese vessel would be allowed to remove the catch from Lisianski (Hamlet, ms.).

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[11] Log of the U.S.S. Iroquois, Rec. Group 24, U.S. Nat. Archives, Washington.

[12] Hamlet states that "Examples of black and white and gray and white Terns and one Boatswain Bird, as put up on the island, and heads and necks of white Gonies...and a bottle of coral sand...has been mailed to The Department today [23 June 1904]." Some of these birds (2 Laysan Albatross, a Red-tailed Tropicbird, 2 Gray-backed Terns, 4 Sooty Terns, and a White Tern) were subsequently donated to the U.S. National Museum.

## Feather Poachers Visit Lisianski Again

On 3 February 1909, probably partly as a result of pressure by conservation groups, Theodore Roosevelt issued Presidential Executive Order No. 1019 which included Lisianski in the Hawaiian Islands Reservation. This order stipulated that the islands were to be set aside as a preserve for the native birds. The Department of Agriculture received jurisdiction over the refuge.

Nonetheless, the Japanese raided Lisianski again that same year. Early in the year, probably in April, a party of 10 Japanese landed on Lisianski and began harvesting feathers. On or about 21 August the party was removed from the island by the schooner Tempou. A new party of eight Japanese, under the direction of Nichichi Odaka, went ashore to continue harvesting feathers. At that time about 50 bales of birds' wings were taken onto the schooner for shipment to Japan, most of them from petrels and terns (Jacobs, ms.).[13]

Rumors that Japanese poachers were again at work in the Northwestern Hawaiian Islands reached American ears in late 1909. As a result, the U.S. Revenue Cutter Thetis, commanded by W.V.E. Jacobs, was dispatched in January 1910 to investigate. After finding no poachers on the inner islands, and after apprehending the poachers on Laysan, the Thetis proceeded to Lisianski, arriving there on the morning of the 19th. An officer and armed boat's crew went ashore and arrested the Japanese.[14] The following day the plumage that had been harvested was brought aboard ship. It consisted of 19 bales of feathers, a box of stuffed birds, and 1 box and 65 bags of birds' wings. The feathers weighed about 1-1/4 tons and the number of wings was calculated at about 140,400 (Jacobs, ms.). The value of the birds' feathers collected on Lisianski in 1909 would have been about $97,000.[15]

While ashore the crew of the Thetis found four small buildings, probably constructed by the Japanese. These structures consisted of a frame building with a corrugated tin roof where the Japanese dwelt, a similar shed used as a cookhouse, and two huts built of bamboo and mats used for storing cured plumage.

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[13] At an estimated 1,830 wings to the bale (Jacobs, ms.), ca. 108,000 bird wings were harvested; judging from the present composition of the Lisianski avifauna, the species killed in greatest numbers were probably Bonin Petrels and Sooty Terns.

[14] The Japanese presented a document signed by Max Schlemmer which they believed gave them the right to harvest feathers. For details on this contract and ensuing legal action, see Ely and Clapp, 1973.

[15] The Japanese overseers stated that the lowest price for the plumage gathered was $.33 per wing and $6.00 per pound of feathers (Jacobs, ms.).

After investigating the rest of the islands of the chain, the Thetis returned to Honolulu on 2 February and delivered the Japanese into the custody of the U.S. Marshall (Jacobs, ms.).

## Subsequent Visits by the Thetis

In the years following the capture of the feather poachers, Lisianski was often visited by the Thetis which made regular tours of inspection of the Northwestern Hawaiian Islands. On several occasions scientists accompanied the Thetis on her voyages but most of their efforts were concentrated on Laysan and relatively little information on the fauna and flora of Lisianski was obtained. A short resume of these visits by the Thetis is given below.

On 1 September 1910 two boats were sent ashore from the Thetis to investigate conditions on Lisianski. No signs of habitation were found. The following spring, on 28 April, another investigation by the Thetis again revealed no evidence of habitation. The Thetis visited Lisianski next on 23 April 1912 and found no evidence that the island had been inhabited since the previous visit.

When the Thetis next visited the island, 12 March 1913, George Willett and Alfred M. Bailey, members of a party from the Bureau of Biological Survey that had recently completed a survey of Laysan, went ashore for about half a day. A number of Laysan Rails were introduced and a seal and a Brown Booby were collected. A few brief notes on the birds and seals were later published by Bailey (1952a: 13, 1952b: 7; 1956: 30) but no detailed account of their observations was ever made.

On 12 September 1914, the next visit by the Thetis, Carl Elschner, a chemical engineer, went ashore with the survey party and spent a few hours observing conditions on the island. He subsequently published a few notes on the island, including comments on the position of Lisianski, its surrounding reefs and currents, and a chemical analysis of some of the sand. He also reported that

> At the time of my visit there were two houses on the island which, as well as the phosphate deposits, lay in the former lagoon, that is, in a depression, which however does not contain water any more. Surrounding the houses are small patches of tobacco, which grow wild, having been brought by Captain Schlemmer. This is in fact the only vegetation on the island, and there hardly is a blade or stalk of any other plant to be seen with the exception of perhaps two poorly looking specimens of Ipomea, which I saw....The rabbits introduced have just exterminated the flora...now the rest of these rabbits (we found many dead but very few living ones) will have to submit to starvation. (Elschner, 1915: 56).

When the Thetis visited Lisianski again on 24 March 1915, Lieutenant William H. Munter landed on the island with a boat's crew at about 1400

and remained there until 1815. His observations on the wildlife were later published in a little known article in the Annual Report of the Coast Guard for 1915 (Munter, 1915: 134-136). Although not an ornithologist, Munter's account clearly indicates that he knew birds well. He reported 15 species of birds, including the Laysan Rail that had been introduced two years previously. Munter's paper was the first to give numerical estimates for the birds of Lisianski and contained more details on avian reproduction than any previous publications.

The Thetis paid her last visit to Lisianski on 5 February 1916 and a party went ashore for about two hours. Second Lieutenant Stanley Parker, by no means as discerning an observer as Munter, reported on his return that

> The principal kinds of birds noted were the Laysan Albatross, Black-footed Albatross, Frigate Bird, Hawaiian Tern, Blue-faced Booby, Common Booby, and one or two Laysan Rail. Every particle of vegetation, except an algae in a damp spot, has disappeared from the island, ...and the rabbits have entirely disappeared. The buildings are very dilapidated and show no signs of recent occupancy, and no signs of poaching could be found. A few Wedge-tailed Shearwaters were noted.[16]

This report is particularly valuable since it fixes the date of extinction of the rabbits as between March 1915 and February 1916 and establishes that the introduced Laysan Rail population survived for at least 4 years.

## The Tanager Expedition Visits Lisianski

In 1923 the U.S. Navy, Bernice P. Bishop Museum, and U.S. Biological Survey cooperated in formulating plans for a thorough survey of the Northwestern Hawaiian Islands. The following year the U.S.S. Tanager set sail on its second trip (Trip B) to the leeward islands. Lisianski was visited by a scientific party staffed primarily by personnel of the Bishop Museum but under the direction of Alexander Wetmore of the U.S. Biological Survey. The field party (see Appendix Table 1) arrived on 15 May and set up camp on the west side of the island. Part of the party left for Pearl and Hermes Reef the same day, but the rest surveyed the island until 20 May. During their stay a broad spectrum of organisms was collected, many of them subsequently reported in Bishop Museum publications (see Appendix Table 3). Many of the bird observations, hitherto unreported, are mentioned in this report through the courtesy of Dr. Wetmore.

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[16] Report by Parker to Captain Brown of the Thetis, dated 21 February 1916. Rec. Group 26, U.S. Nat. Archives, Washington.

## Visits to Lisianski - 1924-1943

At least one visit was made to Lisianski by the fishing schooner Lanikai under Captain William G. Anderson in the late 1920's. During that period a fishing base was established at nearby Pearl and Hermes Reef and the Lanikai often made one or more visits there a year. On several of these visits fishing operations were conducted off Lisianski or other of the Northwestern Hawaiian Islands, and in some instances visits were made to the islands. Few details of these visits are available.

Lisianski was visited by the Lanikai on 14 April 1928 and Anderson collected some fishes 3/4 miles from shore (Schindler, 1932: 4). Some of this material was later used in a study of sexually mature larval Hemiramphidae (Schindler, op. cit.). Other specimens presumably collected during this visit were polychaetes and one inshore fish.

In 1931 Lisianski was visited twice by the U.S. Coast and Geodetic ship Pioneer. During the first visit, 16 to 28 August, various aspects of the island were studied and buoys were set offshore. A number of Casuarina trees were planted by the party. Some of the trees planted during this visit are probably those still present.

More buoys were laid and soundings were made around the island during the second visit, 22 September to 10 October (Honolulu Star Bulletin, 10 Sept. 1931).[17]

In June 1934 the U.S. Coast Guard Cutter Itasca made a series of inspections of the Northwestern Hawaiian Islands. The Captain, John S. Baylis, and three others went ashore on Lisianski for about 5 hours on 25 June. Baylis (ms.) reported that they found no inhabitants and stated that the party saw about 25 large shedding seals and 25 large turtles on the beaches.

Two large turtles--one weighing 180 pounds--were captured by the party and brought back to the Itasca. On 26 June, on course 6 hours from Laysan to French Frigate Shoals, three turtles, presumably including these two, were marked with brass tags inscribed "U.S.S. ITASCA, 1934" and thrown overboard.

In late 1934 or January 1935 Captain Northrup H. Castle visited Lisianski on the schooner Lanikai. Castle was searching for traces of a missing plane, the Star of Australia, piloted by C.T.P. Ulm (Honolulu Star Bulletin, 30 Jan., 6 Feb., 29 Mar. 1935).

Lisianski was visited again on 14 October 1943 by the U.S.S. YMS-299 commanded by Captain E.H. Gentry. A demolition team spent a few hours

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[17]Log of the U.S.S. Pioneer. Rec. Group 27, U.S. Nat. Archives, Washington.

ashore achieving the objective of the visit--the disposal of a mine that had washed ashore on the southeastern corner of the island.[18]

## Visits to Lisianski During the 1950's

### Visits by Ships of the Pacific Ocean Fisheries Investigation Program (POFI)

Lisianski was visited three times in the early 1950's by Bureau of Commercial Fisheries vessels engaged in fish surveys of the north-central Pacific. The primary purpose of visits to Lisianski (and other Northwestern Hawaiian Islands) was to conduct fish-bait surveys. Sometimes brief observations were made of fauna and flora. Most such data may be found in the "Scientist's Logs" for a given vessel's cruise; other brief comments on the visits may be found in the Narrative Reports of each cruise.

The first of these visits was made by the Hugh M. Smith on 24 June 1950. Vernon E. Brock, Director of the Hawaii Division of Fish and Game, was along as a collaborator. He and several others spent about 7 hours on the island which was thoroughly scouted for bait fishes. Very little bait was found. An estimate was made of the number of seals seen and a count of turtles was taken. Seven species of birds were recorded in the notes of the "Scientist's Log" (POFI).

The Hugh M. Smith visited Lisianski a second time on 13 May 1951.[19] During the 9 hours ashore the survey party collected fish bait and scouted the entire shoreline of the island. A complete count was made of the seals and nine species of birds were recorded in the notes (POFI).

A third such visit was made by the John R. Manning on 8 May 1955. A bait scouting party spent about eight hours on the island and made a few brief notes on seals, turtles, and several species of birds (POFI).

### Other Surveys of Lisianski During the 1950's

On 26 March 1954 Frank Richardson of the University of Washington visited Lisianski for three and a half hours. During his brief visit he

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[18] Gentry, C.H. ms. Report of voyage to Lisianski with 16 accompanying photographs. Rec. Group 37, U.S. Nat. Archives, Washington.

[19] Svihla (1959: 227) stated that "Vernon Brock reported 407 seals while on a fishery cruise aboard the 'H.M. Smith' during June and July, 1951..." and listed a count or estimate of the number of seals on Lisianski, implying that the Hugh M. Smith was in the Northwestern Hawaiian Islands at this time. This report is erroneous. The Hugh M. Smith was conducting fish-bait surveys in the Line and Phoenix Islands in June and July 1951, and Brock was in the Line Islands on George Vanderbilt's schooner, the Pioneer.

noted 18 species of birds and estimated their numbers (Richardson, pers. comm.). Some of these observations were subsequently incorporated in a study of the breeding cycles of Hawaiian seabirds that was supported by a Yale-Bernice P. Bishop Museum fellowship (Richardson, 1957).

On 1 November 1954 an aerial survey was made by Philip A. Dumont and Johnson A. Neff of the Bureau of Sport Fisheries and Wildlife.

Dale W. Rice and Karl W. Kenyon of the Bureau of Sport Fisheries and Wildlife made a number of low-level aerial inspections of Lisianski and other Northwestern Hawaiian Islands in 1957 and 1958. Lisianski was flown over on 7 January, 15 April, and 28 December 1957, and 28 June 1958.

The prime purpose of these surveys was to determine albatross and Hawaiian monk seal populations. Results of this work were later reported by Kenyon and Rice (1959), Rice (1960), and Rice and Kenyon (1962).

## Surveys of Lisianski in the 1960's

On 9 and 10 March 1961 David H. Woodside and Raymond J. Kramer of the Hawaii Division of Fish and Game visited Lisianski from the U.S. Coast Guard vessel Planetree as part of an inspection trip of the Hawaiian Islands National Wildlife Refuge. A particular objective of their visit to Lisianski was to determine whether the island would afford suitable habitat for the introduction of the Laysan Teal.

The two biologists visited the island both days--for about three and a half hours on the 9th and for seven hours on the 10th. During this period they made observations of seals, turtles, and birds, erected refuge signs, and established photographic stations for the study of changes in the vegetation. In an unpublished report Woodside and Kramer reported ten species of seabirds and implied the presence of two others, and listed three species of shorebirds but gave no detailed information on them. As a result of their observations, they concluded that Lisianski was definitely not suited for teal and recommended that none be introduced.

Later in the month Lisianski was visited by the U.S.S. Duval County which was transporting a party that was establishing first order astronomic stations and HIRAN and azimuth marks in connection with the Hawaiian geodetic survey (Roach, ms.). The ship arrived on 16 March and debarked the survey party. The ship then departed for islands further up the chain, returning on the 24th to remove the party from the island.

Lisianski was visited subsequently one or more times by parties engaged in other aspects of the HIRAN operation, but we have no details of these visits.

On 18 July 1962 Harvey I. Fisher visited Lisianski from a naval vessel. During his visit, 1,697 nestling Laysan Albatross that had been captured on Sand Island, Midway Atoll, were banded and released on Lisianski. This was done to determine whether young albatross would return to their natal island or would return to the foster island from which they had fledged.

Surveys by the POBSP and Bureau of Sport Fisheries and Wildlife

From early 1963 through June 1969 Lisianski was frequently surveyed by personnel from the Smithsonian Institution's Pacific Ocean Biological Survey Program (POBSP) and by field parties under the direction of the Bureau of Sport Fisheries and Wildlife (BSFW) (Table 1). The latter organization assumed responsibility for inspection and patrol of the refuge in 1964 when a refuge manager was assigned to Hawaii.

Table 1. Recent surveys of Lisianski Island by the POBSP and BSFW*

| Month | Year 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | Total Days of Observation |
|---|---|---|---|---|---|---|---|---|
| Feb. | POBSP (.3) | | | | | | | .3 |
| Mar. | POBSP (.6) | BSFW POBSP (.9) | POBSP (2.1) | | BSFW POBSP (.3) | BSFW POBSP (1.2) | BSFW (.2) | 5.3 |
| June | | | | POBSP (3.2) | POBSP (4.3) | | BSFW (.4) | 7.9 |
| July | | | POBSP (2.7) | | | | | 2.7 |
| Aug. | | POBSP (1.9) | | | | | | 1.9 |
| Aug.-Sept. | | | | | POBSP (4.8) | | | 4.8 |
| Sept. | | BSFW POBSP (.4) | | BSFW (.2) | BSFW (1.2) | | | 1.8 |
| Oct. | | | | POBSP (1.9) | | | | 1.9 |
| Total Days of Observation | .9 | 3.2 | 4.8 | 5.3 | 10.6 | 1.2 | .6 | 26.6 |

*POBSP is listed under BSFW when POBSP personnel accompanied BSFW personnel on one of their regular inspection trips. Figures in parentheses are the approximate number of days spent on the island. Table is complete through 1969 but does not include visits during which no landing was made.

During these brief visits, refuge personnel were concerned primarily with administrative functions, and studies of seals, turtles and albatross. POBSP efforts were primarily directed towards surveys of the avifauna, bird-banding, and, to a lesser degree, other aspects of terrestrial ecology. Data obtained on these visits, and hitherto unpublished data from earlier visits, are the primary basis for the faunistic accounts presented in following sections of this report.

Lisianski, and the other islands in the Hawaiian Islands National Wildlife Refuge, were designated "natural areas" in February 1967. This means that refuge policy is to administer the refuge in such a manner that the island's ecology remains as undisturbed as possible. As a result, visits may be made to the island only by scientific parties that have obtained entry permits from the Bureau of Sport Fisheries and Wildlife in Kailua.

## VEGETATION

Early reports of the vegetation indicate that Lisianski was well covered with "scrub," "grass," and "creeping plants" prior to its defoliation by rabbits (Christophersen and Caum, 1931: 14). By September 1914, about 10 years after the introduction of rabbits, the only plants left were introduced tobacco and several specimens of an unidentified Ipomoea. By February 1916 no vegetation remained.

When the island was visited in 1923 "the vegetation was apparently slowly starting to come back..." but was "exceedingly poor, one patch of grass at the north end and a few other plants sparsely distributed being all that was to be found" (Christophersen and Caum, op. cit.). Wetmore (ms.) further noted "The only vegetation on the island is a narrow strip of grass, and a pigweed of perhaps two acres that extends along the ridge above the beach in a narrow line at the northwest point. Elsewhere the place is absolutely bare." The Tanager Expedition collected four species of plants, Eragrostis, Nama, Portulaca, and Sesuvium, found the seed of another (an unidentified Ipomoea), and introduced a tree (Barringtonia).

Comparison of two aerial photographs, one taken in May 1943 (Fig. 21) and the other in January 1966 (see Fig. 2) shows a progressive pronounced change in the amount of Scaevola present. Areas containing Scaevola in 1943 now contain much more, with the greatest increase on the southwestern, southeastern, and northwestern portions of the interior. Several areas on the eastern and southeastern edge of the island, beaches in 1943, have been colonized and thereby stabilized. There has also been a considerable increase in the amount of Scaevola in the center of the island. There seems no reason to believe that the process of expansion and colonization by Scaevola is not now continuing, nor to think that the revegetation process, begun in the 2nd decade of this century, is yet completed.

On recent visits in the mid- and late 1960's, the vegetation was thick and composed of three major associations. These were: Scaevola-Eragrostis, Ipomoea, Sicyos, Boerhavia, and Tribulus; Eragrostis-Boerhavia; and Nama. These associations formed concentric bands. The Nama was found

on the sandy periphery, but was absent on the west side due to a shift in substrate materials. The Scaevola association, dominant around the outer rim of the island, is replaced by the Eragrostis association in the center of the island. Within the latter area, a number of pure or nearly pure stands of several species were found (see Annotated List following).

In all, 13 of the 17 vascular plants known to have grown on Lisianski still occur there. Vascular plants have been collected by the following: G.P. Wilder, May 1923; F.C. Sibley, February 1963; A.L. Young, August 1964; C.R. Long, September 1964; P.C. Shelton, June 1966. These collections are housed in the herbariums of the National Museum of Natural History (USNM), the B.P. Bishop Museum (BPBM), and the University of Hawaii (UH).

The following annotated list gives all specimens known to have been collected on Lisianski. It lists all species known to have been found on the island except the not clearly identifiable "Potatoes, melons, and other fruits and vegetables" planted on the island in 1844 (Ward, 1967: 34).

Graminae

Cenchrus sp.

In March 1969 Kridler found a small stand of this plant growing about 100 yards south of the coconut palms.

Eragrostis variabilis (Gand.) Stend.

Wilder 5, 7 (BPBM), Young 132 (UH), Long 2316 (UH), Shelton 414 (UH). Found throughout the island, commonly with Boerhavia and Ipomoea in the central open area (Fig. 22). Often in pure local stands above the beach, particularly in the northwestern portion of the island and in open Scaevola thickets.

Palmae

Cocos nucifera L.

Eighty planted on the southeast point about December 1844. Sprouting trees found in May 1846 and transplanted further inland (Ward, 1967: 45, 55). Two found growing on the northeastern portion of the island in February 1963 (Fig. 23). In March 1969 the top of one of these trees was found blown off. A 3-foot tree growing on the east beach in March 1967 (BSFW), was not seen subsequently.

Casuarinaceae

Casuarina equisetifolia L.

Sibley 100 (USNM), Young 133 (UH), Shelton 411 (UH). Introduced in 1931. Some six or seven trees now living, three at the top of the north-

Figure 21. Aerial photograph of Lisianski Island, May 1943. Assembled from U.S. Air Force photographs.

Figure 22. Ipomoea indica and Boerhavia repens in association with Eragrostis, interior of island, looking south. 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 23. Cocos growing on northeastern portion of island, February 1963. POBSP photograph by W.O. Wirtz, II.

west beach crest (Fig. 24); a group of three near the coconut trees on the northeast portion of the island (Fig. 25); and a single tree on the southwestern portion. Near the latter is a smaller dead tree (Fig. 26) and south of these two is another, much larger dead tree much utilized as a roost by Red-footed Boobies.

Chenopodiaceae

Chenopodium oahuense (Meyen) Aellen.

In March 1967 the BSFW planted seeds at the northwest corner of the island, including under the Casuarina trees, and along a line between this area and the coconut trees. None had sprouted by the following September.

Twenty-five of these plants, evidently from a prior introduction by the BSFW, were found growing and fruiting under the Casuarina tree on the southwest portion of the island in March 1967. By March 1969 these plants had occupied all the area under the tree canopy, an area roughly 25 feet in diameter.

Nyctaginaceae

Boerhavia repens L.

Sibley 101 (USNM), Young 134 (UH), Long 2321, 2323, 2324, 2328, 2336, 2337, 2350, 2351, 2352a (UH), Shelton 402 (UH). Found over most of the island; as widespread as Eragrostis but less conspicuous. In Scaevola thickets the stems grow over the surface of the lower shrubs and form nearly pure stands in a few central openings in the north-central interior (Fig. 27). Often found in mixed stands with Ipomoea. This species appears to be a pioneer in sandy area. Flowers vary in color from a lavender-pink to white.

Aizoaceae

Sesuvium portulacastrum L.

Wilder 6 (BPBM). Only one collection exists. It is possible that during the denudation of the island the sites on which this common species is usually found were drifted with sand, thus closing the preferred ecological niche of a thin soil over a moist coralline hardpan.

Portulacaceae

Portulaca lutea Sol.

Wilder 9 (BPBM) as Portulaca oleracea, Young 138 (UH), Long 2333 (UH), Shelton 406 (UH). The Wilder collection was evidently misplaced since Christophersen and Caum mention only a field label. Not common at present. Plants were found well scattered in sandy peripheral area, particularly at the top of the storm beach (Fig. 28) along the margin of

Figure 24. Casuarina trees at top of northwest beach. Young Black-footed Albatross in foreground, 6 June 1967. POBSP photograph by R.L. DeLong.

Figure 25. Casuarina trees near palms on northeast portion of island, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 26. Live and dead Casuarina trees on southwest portion of island, 12 March 1964. By September 1967 many of the branches had fallen from the dead tree and it had become heavily overgrown with Ipomoea indica. FOBSP photograph by A.B. Amerson, Jr.

Figure 27. Almost pure stand of Boerhavia in Eragrostis association in the north central interior. Young Laysan Albatross in mid-ground. POBSP photograph, 19 June 1966, by P.C. Shelton.

Figure 28. Portulaca lutea and Eragrostis, top of west beach, 19 June 1966. POBSP photograph by P.C. Shelton.

the Scaevola association. Some seedlings were observed in these areas in September 1964. Plants were in bloom and had mature fruits developed in June 1966.

Leguminosae

Young 137 (UH). A sterile specimen that resembles Canavalia or Vigna.

Zygophyllaceae

Tribulus cistoides L.

Sibley 102 (USNM), Young 139 (UH), Long 2348 (UH), Shelton 401 (UH). Most common in sandy soil around outer rim of island on outer half of Scaevola association; decidedly less common in the interior. Found in association with Ipomoea, Eragrostis, Boerhavia, and Scaevola. Nearly pure stands found growing over dead or decadent Scaevola along the inner edge of the Scaevola association (Fig. 29) with occasional blackened dead patches in dead Scaevola. In flower and with green fruit in June 1966.

Lecythidaceae

Barringtonia asiatica (L.) Kurz.

Seeds sowed by Wilder in 1923 (Christophersen and Caum, 1931: 15). Not subsequently found.

Convolvulaceae

Ipomoea indica (Burm. f.) Merr.

Sibley 103 (USNM), Young 140 (UH), Long 2339, 2349 (UH), Shelton 408 (UH). Common as climber in Scaevola, often covering and choking it (Fig. 30). Widespread in the Eragrostis association, often forming pure stands on level, sandy areas in the interior (Fig. 31), and occasionally on the inward and seaward slopes, In full flower in June 1966.

Ipomoea pes-caprae (L.) Sw.

Shelton 404 (UH). A single seedling found near the top of the beach on the north shore in June 1966.

Ipomoea sp.

Two poor specimens of an unidentified Ipomoea were seen in 1914 by Elschner and a seed of Ipomoea was picked up inland by Ball in 1923 (Christophersen and Caum, 1931: 15).

Figure 29. Tribulus in decadent Scaevola near the north shore, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 30. Ipomoea indica growing over Scaevola, 19 June 1966. POBSP photograph by P.C. Shelton.

## Hydrophyllaceae

Nama sandwicensis var. Laysanicum Brand

Wilder 8 (BPBM), Young 136 (UH), Long 2325, 2331 (UH), Shelton 405 (UH). Rare in 1923, at present scarce; scattered in sand on the south, east, and particularly the northward facing shores. Occurs below outer fringe of Scaevola (Fig. 32), often in association with Boerhavia. Many seedlings seen in September 1964 and June 1966 and plants in flower on the latter visit.

## Solanaceae

Nicotiana tabacum L.

Reported to be growing in small patches on Lisianski in 1914 by Elschner who stated that it had been introduced by Captain [Max] Schlemmer (Christophersen and Caum, 1931: 14). Not found on any recent visit.

Solanum nigrum L.

Long 2318 (UH), Shelton 406, 407 (UH). Rare, several plants were found growing in gravel pockets in coral rock just above the high water-line on the east side in September 1964. In June 1966 three plants were found; two growing with Ipomoea at the inner edge of the Scaevola fringe on the east side and one near the center of the island (Fig. 33). Plants were in flower and with fruit on both visits.

## Cucurbitaceae

Sicyos lamoureauxii St. John

Young 135 (UH), Long 2314, 2317, 2356 (UH). The Sicyos occurring has been described recently as a new species by St. John (1970). Two additional specimens, Long 2315 (UH), Shelton 403 (UH), were not mentioned by St. John but are likely this species.

Common, but scattered; on the east and northwest sides of the island. Often found climbing on Scaevola (Fig. 34). Some patches of dead Sicyos found on dead Scaevola near the northeast shore in June 1966 (Fig. 35). In bloom and with well-developed fruits on that visit.

## Goodeniaceae

Scaevola taccada (Gaertn.) Roxb.

Young 131 (UH), Long 2322, 2326, 2330, 2334, 2340, 2341, 2342, 2343, 2344, 2345, 2352, 2353, 2354, 2355 (UH), Shelton 412, 413 (UH). Forms found in scattered patches in the interior. Thickest and tallest growth occurs on the southeast portion of the island (Fig. 36), an area relatively recently colonized.

Figure 31. Pure stand of Ipomoea indica within Eragrostis association in the interior of the island, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 32. Nama sandwicensis var. laysanicum below the fringe of Scaevola on the northeast shore, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 33. Solanum nigrum near center of island, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 34. Sicyos growing with Tribulus and in Scaevola, 19 June 1966. Young Laysan Albatross in foreground. POBSP photograph by P.C. Shelton.

Figure 35. Dead Sicyos and Scaevola near the northeast shore, 19 June 1966. POBSP photograph by P.C. Shelton.

Figure 36. Lush Scaevola on southeastern portion of island, 12 March 1964. Looking east-northeast from the southeast high point of the island. POBSP photograph by A.B. Amerson, Jr.

# FAUNA

## Introduction

Despite having large seabird populations, very little has been reported about the terrestrial vertebrate fauna of Lisianski Island. Most information prior to recent investigations has consisted of scattered comments in a variety of papers usually largely devoted to studies of nearby Laysan Island (Rothschild, 1893-1900; Bailey, 1956) or appearing in poorly known sources (Munro, 1941a et. seq.; Munter, 1915), or appearing in papers that considered aspects of the Northwestern Hawaiian Island fauna as a whole (Bailey, 1918, 1952a, 1952b; Wetmore, 1925; Richardson, 1957). Still other papers considered the status of individual species (Kenyon and Rice, 1959; Rice and Kenyon, 1962) but these papers were derived largely from aerial photographs and from the scanty pre-existing literature. Only the paper by Munter, who was not very familiar with the avifauna, attempted a complete list of the birds seen on the island.

Historically only the papers by Rothschild and Munro give data on the status of species prior to the time when the vegetation of the island was laid waste by introduced rabbits. Information in these sources is very scanty, so scanty in fact that it is impossible to adequately estimate what the total breeding avifauna may have been nor to obtain any substantial idea of what the populations may have been like. One wonders, for example, if the Sooty Storm Petrel may not have once occurred on Lisianski but the historical data is insufficient to tell.

The papers by both Munter and Wetmore, as well as Wetmore's unpublished field notes, taken in conjunction with several other unpublished manuscripts from the period ca. 1915-1923, at least allow some idea of the nature of the fauna during the period when the island was largely denuded of vegetation.

There have been a relatively greater number of papers reporting on the invertebrate fauna, particularly arthropods, largely as a result of the investigations by the Tanager expedition in 1923 (see Appendix Tables 2 and 3). Some information, no doubt faunistically incomplete, has also been reported on the fish fauna. Virtually all these papers have been largely distributional or taxonomic in nature. It is evident that much yet may be learned about the occurrence and distribution of these groups on Lisianski and certainly little or nothing is known of their biology or ecology as regards Lisianski Island.

This report deals primarily with the terrestrial vertebrate fauna and with the vascular flora, the areas toward which the POBSP devoted most of its efforts. Nonetheless, we have attempted to indicate the principal accomplishments of previous surveys, particularly with regard to faunal (and floral) groups with which this report is not concerned. Appendix Tables 1 and 2 list the itineraries and personnel of the more important biological surveys and the principal activities undertaken.

Appendix Table 3 summarizes papers dealing with all groups but birds and hopefully will prove useful to those interested in taxa not considered herein. The latter table lists 52 papers dealing with Protozoa (1); Aschelminthes (1); Annelida (3); Arthropoda (21); Echinodermata (2); Pisces (3) Reptilia (4); Mammalia (12); Flora (3); and geophysical phenomena (2). Although the information presented in a number of these papers is relatively trivial or only consists of a taxonomically revised list based on previously reported data, this listing should at least give a fairly representative picture of what is known of these faunal groups on Lisianski. We have attempted to search thoroughly at least the more obvious literature sources available to us, but can make no claims as to the completeness of this list, particularly as regards more recent papers.

## Mammals and Reptiles

Three species of mammals and one species of reptile are known to have occurred on Lisianski but two of these, the European Rabbit and an unidentified mouse or rat, were introductions that survived but a short while. The other mammal, the Hawaiian Monk Seal, and the reptile, the Green Turtle, are native species that have suffered greatly over the years as a result of predation by man. Where appropriate, the species accounts for these animals follow the format that is outlined for birds below.

## Birds

In all, 33 species of birds have been recorded from Lisianski (Table 2), but this total includes two birds (a duck and a sandpiper) whose specific identity is unknown. Also included are one species (Osprey) whose occurrence is unconfirmed and another (Laysan Rail) which was an unsuccessful introduction.

Of the remaining 29 species, 17 are seabirds, all of which, excepting the vagrant Jouanin's Petrel, formerly bred on the island. Fifteen species still breed on Lisianski but the present breeding status of a 16th (Bulwer's Petrel) still requires clarification. Indeed, more than one-third of all surveys of Lisianski that obtained some useful data on populations or breeding status took place in March. Nonetheless, recent observations suggest that there are some, for the most part, apparently rather slight, differences in breeding cycles from those observed on the nearest seabird colonies, those on Laysan Island (Table 3).

Of the 10 remaining species, 12 are shorebirds, but only 5 of these usually occur on Lisianski during migration. The two additional species are gulls that have relatively seldom been recorded from Lisianski as compared with its neighboring atolls.

The relative paucity of accidental species recorded from Lisianski, as compared with other nearby Northwestern Hawaiian Islands, probably reflects in part the greater homogeneity of habitat found on Lisianski, but likely also reflects the relative infrequency with which observations

have been made there. It seems likely that further observations during the spring and fall may considerably extend the list of birds known from the island.

As on Laysan Island, all breeding species have a distinct annual cycle, the precise timing of which may vary somewhat from year to year. Four species, Black-footed Albatross, Laysan Albatross, Bonin Petrel and Black Noddy, have peak breeding periods from the winter through the early (northern) summer. The remainder of the breeding species breed primarily from March or April through September or October (Table 3), although several of these species (e.g., Blue-faced Booby, Brown Noddy, White Tern) may occasionally or even regularly have at least a few individuals nesting in every month of the year. Most species breeding on Lisianski, however, have a period of at least one to several months when no birds are breeding and when populations are markedly reduced or entirely absent (e.g., the albatrosses, shearwaters, Bonin Petrel, Gray-backed and Sooty Terns).

Our data on the occurrence and population and breeding cycles for the birds of Lisianski are much more limited than for several of the other Northwestern Hawaiian Islands, since very few observations have been made in the period from October through February (Table 4).

Table 2. The avifauna of Lisianski Island

| Taxa | Current Status | Maximum Estimate since 1960 and when recorded |
|---|---|---|
| ORDER PROCELLARIIFORMES | | |
| FAMILY DIOMEDEIDAE | | |
| *Diomedea nigripes* Black-footed Albatross | Common breeder | 3,000-4,000* Mar. 1964 |
| *Diomedea immutabilis* Laysan Albatross | Common breeder | 8,000* June 1966 |
| FAMILY PROCELLARIIDAE | | |
| *Pterodroma hypoleuca* Bonin Petrel | Abundant breeder | 1,000,000 Mar. 1965 |
| *Bulweria bulwerii* Bulwer's Petrel | Uncertain, formerly bred | "a few" July 1965 |
| +*Bulweria fallax* Jouanin's Petrel | Accidental (one record) | 1 Sept. 1967 |
| *Puffinus pacificus* Wedge-tailed Shearwater | Abundant breeder | 500,000 June 1967 |

Table 2. (continued)

| Taxa | Current Status | Maximum Estimate since 1960 and when recorded |
|---|---|---|
| *Puffinus nativitatis* Christmas Shearwater | Common breeder | 2,000 June 1967 |
| ORDER PELECANIFORMES | | |
| FAMILY PHAETHONTIDAE | | |
| *Phaethon rubricauda* Red-tailed Tropicbird | Common breeder | 4,500 June 1967 |
| FAMILY SULIDAE | | |
| *Sula dactylatra* Blue-faced Booby | Common breeder | 1,200 Oct. 1966 |
| *Sula leucogaster* Brown Booby | Uncommon breeder | 200 Oct. 1966 |
| *Sula sula* Red-footed Booby | Common breeder | 3,000 June 1967 |
| FAMILY FREGATIDAE | | |
| *Fregata minor* Great Frigatebird | Common breeder | 2,000-3,000 Mar. 1965 |
| ORDER ANSERIFORMES | | |
| FAMILY ANATIDAE | | |
| Duck sp. | Extinct | Not present |
| ORDER FALCONIFORMES | | |
| FAMILY PANDIONIDAE | | |
| *Pandion haliaetus* Osprey | Hypothetical | Not recorded |
| FAMILY FALCONIDAE | | |
| +*Falco peregrinus* Peregrine Falcon | Accidental (one record) | 1 Mar. 1965 |
| ORDER GRUIFORMES | | |
| FAMILY RALLIDAE | | |
| *Porzanula palmeri* Laysan Rail | Introduced in 1913, now extinct | Not present |

Table 2. (continued)

| Taxa | Current Status | Maximum Estimate since 1960 and when recorded |
|---|---|---|
| ORDER CHARADRIIFORMES | | |
| FAMILY CHARADRIIDAE | | |
| +Charadrius semipalmatus<br>Semipalmated Plover | Accidental<br>(one record) | 1<br>Sept. 1967 |
| +Charadrius mongolus<br>Mongolian Plover | Accidental<br>(one record) | 1<br>Sept. 1967 |
| Pluvialis dominica<br>Golden Plover | Abundant migrant | 2,000<br>Mar. 1965 |
| +Squatarola squatarola<br>Black-bellied Plover | Rare visitor<br>(two records) | 2<br>Mar. 1965 |
| FAMILY SCOLOPACIDAE | | |
| Numenius tahitiensis<br>Bristle-thighed Curlew | Common migrant | 200<br>Feb. 1963 |
| +Limosa lapponica<br>Bar-tailed Godwit | Accidental<br>(one record) | 1<br>Mar. 1964 |
| Heteroscelus incanum<br>Wandering Tattler | Uncommon migrant | 25<br>Mar. 1968 |
| Arenaria interpres<br>Ruddy Turnstone | Abundant migrant | 1,000-2,000<br>Mar. 1965 |
| Crocethia alba<br>Sanderling | Uncommon migrant | 20<br>Feb. 1963,<br>Mar. 1964 |
| +Erolia melanotos or acuminata<br>Pectoral or Sharp-tailed Sandpiper | Accidental<br>(one record) | 1<br>Oct. 1966 |
| FAMILY LARIDAE | | |
| +Larus argentatus<br>Herring Gull | Accidental<br>(one record) | 1<br>Feb. 1963 |
| +Larus glaucescens<br>Glaucous-winged Gull | Rare visitor<br>(two records) | 1<br>Mar. 1965<br>Mar. 1968 |

Table 2. (continued)

| Taxa | Current Status | Maximum Estimate since 1960 and when recorded |
|---|---|---|
| *Sterna lunata* Gray-backed Tern | Common breeder | 15,000 June 1967 |
| *Sterna fuscata* Sooty Tern | Abundant breeder | 1,700,000 June 1967 |
| *Anous stolidus* Brown Noddy | Common breeder | 15,000 June 1967 |
| *Anous tenuirostris* Black Noddy | Common breeder | 5,000 June 1966 |
| *Gygis alba* White Tern | Uncommon breeder | 500 July 1965 |

*Estimate is of the breeding population. All other estimates are of the maximum number of flying birds present.

+Indicates species was unknown from Lisianski prior to POBSP investigations.

Table 3. Breeding cycles of seabirds on Lisianski Island compared with breeding cycles on Laysan Island.

| Species | Primary Breeding Period on Laysan Island* | Primary Breeding Period on Lisianski Island |
|---|---|---|
| Black-footed Albatross | mid-November to mid-July | Similar+ |
| Laysan Albatross | mid-November to early July | Similar |
| Bonin Petrel | mid-January to late June | Similar, possibly somewhat earlier. |
| Wedge-tailed Shearwater | June to November | Similar |
| Christmas Shearwater | mid-April to early October | Similar |
| Red-tailed Tropicbird | late April to early October | Similar, apparently slightly earlier (1966) or later (1967) in some seasons. |

Table 3. (continued)

| Species | Primary Breeding Period on Laysan Island* | Primary Breeding Period on Lisianski Island |
|---|---|---|
| Blue-faced Booby | late March to September | Initiation of peak breeding is consistently ca. 2-4 weeks earlier. |
| Brown Booby | late March to October | Similar, but initiation of laying may be earlier in some years (1965), later in others (1966). |
| Red-footed Booby | March to September | Similar, but initiation of laying may be slightly earlier in some years (1964, 1967, 1968), later in others (1965, 1966, 1969). |
| Great Frigatebird | March to October | Similar, with initiation of laying perhaps slightly later in some years (1965, 1966?, 1968). |
| Gray-backed Tern | March to early August | Similar, possibly cycle tends to be initiated somewhat earlier in some years (1965, possibly 1966). |
| Sooty Tern | early April to early September | Similar, but in some seasons (1965, 1966, possibly also 1964, 1968) is apparently slightly earlier. |
| Brown Noddy | March to September | Similar. May tend to later initiation of laying. |
| Black Noddy | November to July | Probably similar. Recent spring and summer observations suggest that Lisianski cycles during these periods are somewhat in advance of those on Laysan. |
| White Tern | April or May to August | Similar |

* Data from Ely and Clapp (1973). The timespan indicated is that period through which the majority of eggs and/or dependent, non-flying young are present.

\+ That the data do not show any clear difference in breeding cycles between Laysan and Lisianski does not necessarily mean that such differences may not exist.

Table 4. Months of occurrence of non-breeding birds on Lisianski Island*

| Species | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|
| Bulwer's Petrel** | | | | X | | X | | X | |
| Jouanin's Petrel | | | | | | | | X | |
| Duck sp.*** | | | X | | | | | | |
| Osprey+ | | | | | X | | | | |
| Peregrine Falcon | | X | | | | | | | |
| Laysan Rail++ | X | X | | | | | | | |
| Semipalmated Plover | | | | | | | | X | |
| Mongolian Plover | | | | | | | | X | |
| Golden Plover | X | X | | X | X | | X | X | X |
| Black-bellied Plover | | X | | | X | | | | |
| Bristle-thighed Curlew | X | X | X | X | X | X | X | X | X |
| Bar-tailed Godwit | | X | | | | | | | |
| Wandering Tattler | X | X | | X | X | | X | X | X |
| Ruddy Turnstone | X | X | | X | X | X | X | X | X |
| Sanderling | X | X | | X | X | | X | X | |
| Pectoral or Sharp-tailed Sandpiper | | | | | | | | | X |
| Herring Gull | X | | | | | | | | |
| Glaucous-winged Gull | | X | | | | | | | |

*This table only includes months during which observations were actually made on Lisianski. Data for the months of February, April, and October are based on but a single survey. It seems reasonable to assume that the more abundant migrants such as turnstones, tattlers, curlews and Golden Plovers are present in most, if not all, other months as well.

**May breed, but present breeding unconfirmed.

***No longer present. Undoubtedly occurred throughout the year if it was an endemic species or subspecies.

+Occurrence hypothetical.

++An introduction that, while present, undoubtedly occurred throughout the year.

## Species Accounts

In the following species accounts, the common names of seabirds follow King (1967). Names of species not included in that manual follow standard references such as the A.O.U. Checklist (1957). Taxonomic order follows that of Peter's (1931, 1934, 1937) Checklist of Birds of the World, volumes I, II, and III, with the exception of the Procellariiformes, which follow Alexander et al. (1965), the Charadriidae and Scolopacidae which follow Jehl (1968), and the Sulidae, which follow the A.O.U. Checklist (1957). The taxonomic order utilized for mammalian species follows Tomich (1969).

A standard format is used for each species as indicated below:

Status: Intended to provide a very brief summary of the occurrence and activity of each species while on Lisianski. Included are:

A. Relative abundance: For breeding seabirds the following scale is used: (1) abundant--peak populations in excess of 50,000 individuals; (2) common--peak populations of about 1,000-50,000 individuals (3) uncommon--peak populations of 500 individuals or less. These limits were chosen because estimated populations of all species for the most part fall readily within one of these categories. A different scale is used for transient shorebirds and vagrants because of the much smaller numbers involved: (1) abundant--peak populations in excess of 1,000 individuals; (2) common--peak populations of 100-1,000 individuals; (3) uncommon--regular in occurrence but peak populations less than 100 individuals; (4) rare--has occurred on Lisianski two times or more but numbers of individuals always very small; (5) accidental--has been recorded but once from Lisianski.

B. Status: Two categories are used for the species regularly occurring on Lisianski: (1) breeder--a species breeding on the island; varying numbers of non-breeding birds (of local origin, from other island, or both) may be present during the non-nesting season; (2) migrant --a species that visits the island primarily during non-reproductive periods; may visit the island only briefly while in transit elsewhere or may remain for a substantial period, usually during the winter months.

C. Maximum recent estimate: These are maximum estimates obtained during the 1960's. All extreme estimates have been evaluated and those that we believe are probably erroneous are enclosed in brackets in the appropriate table of observations or wherever mentioned in the text. These estimates and those in the observation tables are of the maximum number of flying birds present during any one survey unless otherwise indicated. Such an estimate includes both breeding and non-breeding adults as well as recently fledged young and flying immature and subadult birds. It does not include the number of unfledged, dependent young present on the island.

D. Period present: The inclusive period of usual presence on Lisianski is indicated. Period of absence, if known, is also noted.

E. Nesting period: Indicates that span of time when the majority of birds has eggs or dependent young.

F. Nesting area: A summary statement that includes both the usual nesting habitat and the areas most utilized on the island.

Populations: All available data (published and unpublished) on population size and breeding status of regularly occurring representatives of the avifauna are summarized in a chronological table. Where available, actual counts or numerical population estimates are presented; when unavailable, more qualitative data are given. Absence of data in these

tables is indicated by a question mark. If a given survey failed to mention the occurrence of a species, this survey is omitted from the chronological listing.

Where sufficient data exist, the variation in population estimates is discussed. Many of the estimates are quite subjective and thus may err to a greater or lesser degree. This is probably particularly true for species with very large populations and for species that are primarily nocturnal. In general, estimates are believed to be more trustworthy for surveys that handled large numbers or a large proportion of birds present or for surveys during which adequate counts or sample counts were made.

Estimates of breeding populations are clearly distinguished from total population estimates in both tables and text. Such estimates usually represent twice the number of nests with contents and/or the number of dependent, non-fledged young. Thus breeding populations, in a less restricted sense, may actually be larger than indicated, even if estimates are relatively highly accurate. Breeding population estimates would likely be low both at the beginning of the nesting season when the number of courting and paired pre-laying birds may be omitted from the estimate and at the end of the nesting season when the number of birds with fledged, yet dependent, young may be omitted.

Annual Cycle: A generalized annual cycle based chiefly on observational data is presented. Where actual observations are lacking, interpolations based on incubation and fledgling periods are often utilized. Variation in the nesting cycle is discussed as are such topics as breeding peaks and the broad outlines of the cycle.

Ecology: This includes such data as habitat preference.

A. Breeding: Both historical and recent data are presented and where possible, the two are compared. Details concerning preferred nesting areas and nest sites are included.

B. Non-breeding: Utilization of the island by non-breeding birds is discussed on the basis of available data.

Specimens: To our knowledge, the great majority of museum skins of the birds of Lisianski is housed in the National Museum of Natural History (USNM). We have included brief statements or tabulations indicating where all specimens of whose existence we are aware are currently located. Location of additional specimens (alcoholics and skeletons) is also briefly noted. Hopefully, this information may be useful to those who may be interested in studying those facets of bird biology that can be determined from such material. It should also indicate areas in which future collecting might prove most profitable.

Banding and Movements: From 1963 through 1968, 65,163 birds of 19 species were banded on Lisianski. Of this total, 98.5% were banded by the POBSP (Table 5). In each species account the number banded on each visit

during this period is briefly stated or tabulated by age class and sex when known. Interisland movements recorded from POBSP-banded birds and involving Lisianski Island are briefly summarized in each account with details of the banding and recapture listed in Appendix Tables. A summary of the overall number of interisland recaptures or recoveries is given in Table 6.

## Birds

### BLACK-FOOTED ALBATROSS — *Diomedea nigripes*

#### Status

Common breeder; maximum recent estimate of breeding population 3,000-4,000. Present from about late October through late July with breeding occurring almost throughout this period; absent remainder of year. Nests on ground, principally in open areas around the perimeter of the island.

#### Populations

Recent estimates (Table 7), although variable, suggest March to June breeding populations on the order of 2,000 to 4,000 birds. This figure is somewhat lower than the 5,400 derived by Rice and Kenyon from aerial surveys in 1957. In view of the differences in methods of estimation and in the periods during which various recent estimates were made, the figures are probably not significantly different. The three early estimates (1913, 1915, 1923) are not consistent, nor probably comparable *inter se*. Wetmore's May (1923) estimate, certainly the most accurate of the three, compares quite favorably with recent June (1966, 1967) estimates.

#### Annual Cycle

Observations on breeding status at different times of year are far less detailed and extensive than for nearby Laysan Island (Ely and Clapp, 1973), but what data are available indicate no differences in the breeding cycle. Birds presumably return to the island in late October or early November and eggs are probably present from the latter half of November through January. The earliest date on which young have been recorded is 9 March (1961), but the size of the young seen then and on other March visits makes it clear that young are probably present for at least one or two months previous to March. Young evidently fledge from June through July and perhaps early August.

#### Ecology

Breeding: Almost all observers who have noted the nesting area of this species have indicated that it nested primarily along the perimeter of the island. Munter (1915: 135) is the only exception. He reported that Black-footed Albatross "were found scattered all over the island, but were more thickly settled along the shores."

Table 5. Banding totals, by year, of birds banded on Lisianski by the POBSP and BSFW

| Species | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | Totals | Totals Banded by POBSP |
|---|---|---|---|---|---|---|---|---|
| Black-footed Albatross | | 200 | 2 | | 500 | | 702 | 502 |
| Laysan Albatross | | 301 | 2,383 | 31 | 500 | | 3,215 | 2,915 |
| Bonin Petrel | | 500 | 3,000 | | 200 | | 3,700 | 3,700 |
| Wedge-tailed Shearwater | 1 | 500 | | 199 | 779 | | 1,479* | 1,479 |
| Christmas Shearwater | 7 | | | | 9 | | 16 | 16 |
| Red-tailed Tropicbird | 1 | 65 | 18 | | 244 | | 328 | 326 |
| Blue-faced Booby | 238 | 189 | 263 | 165 | 374 | 18 | 1,247 | 1,247 |
| Brown Booby | 3 | 6 | 9 | 13 | 36 | | 67 | 61 |
| Red-footed Booby | 10 | 2 | 2 | 439 | 412 | | 865 | 863 |
| Great Frigatebird | 58 | 61 | | 152 | 151 | | 422 | 421 |
| Golden Plover | | 12 | | | 55 | 6 | 73 | 14 |
| Bristle-thighed Curlew | 3 | 7 | 1 | | 82 | 26 | 119 | 54 |
| Wandering Tattler | | 1 | | | 4 | 2 | 7 | 3 |
| Ruddy Turnstone | 28 | 77 | | | 206 | 174 | 485 | 178 |
| Gray-backed Tern | | | 374 | | | | 374 | 374 |
| Sooty Tern | | 6,900 | 7,000 | 30,000 | 6,197 | | 50,097 | 50,097 |
| Brown Noddy | | | | | 1,507 | | 1,507 | 1,507 |
| Black Noddy | | 110 | | | 196 | 34 | 340 | 340 |
| White Tern | | 30 | 10 | | 80 | | 120 | 95 |
| Totals | 349 | 8,961 | 13,062 | 30,999 | 11,532 | 260 | 65,163 | 64,192 |

*Total includes several birds that were double-banded.

Table 6. Interisland movements of banded birds involving Lisianski Island*

| To Lisianski from: | Black-footed Albatross | Blue-faced Booby | Brown Booby | Red-footed Booby | Great Frigatebird | Ruddy Turnstone | Sooty Tern | Brown Noddy | Black Noddy | Total (to) |
|---|---|---|---|---|---|---|---|---|---|---|
| French Frigate Shoals | | 8 | | 16 | 3 | | 2 | 1 | 2 | 32 |
| Laysan Island | | 18 | | 14 | | | 20 | | 1 | 53 |
| Pearl and Hermes Reef | | 2 | | 4 | 1 | | 2 | | 2 | 11 |
| Midway Atoll | | | | 4 | | | 6 | | 1 | 11 |
| Kure Atoll | 1 | 3 | | 8 | 3 | | | 1 | | 16 |
| Johnston Atoll | | 4 | 1 | 26 | | | 10 | | 1 | 42 |
| Wake Island | | | 1 | 2 | | | 1 | | | 4 |
| Phoenix Island | | | | | | | | | | |
| At Sea | | | | | | | | | | |
| Alaska | | | | | | 5 | | | | 5 |
| Japan | | | | | | | | | | |
| Totals | 1 (1)+ | 35 (35) | 2 (2) | 74 (70) | 7 (7) | 5 (5) | 41 (41) | 2 (2) | 7 (2) | 174 (169) |

Table 6. (continued)

| From Lisianski to: | Black-footed Albatross | Laysan Albatross | Bonin Petrel | Wedge-tailed Shearwater | Blue-faced Booby | Red-footed Booby | Great Frigatebird | Golden Plover | Sooty Tern | Black Noddy | Total (from) | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| French Frigate Shoals | | | | | 8 | 12 | 1 | | 1 | 5 | 27 | 59 |
| Laysan Island | | 1 | | 1 | 9 | 8 | | | 10 | | 29 | 82 |
| Pearl and Hermes Reef | | | | | | | | 1 | 1 | | 2 | 13 |
| Midway Atoll | | 1 | | | | | | | 1 | | 2 | 13 |
| Kure Atoll | | 1 | 3 | | 6 | 7 | 3 | 1 | | 1 | 22 | 38 |
| Johnston Atoll | | | | | 3 | 6 | | | 2 | 1 | 12 | 54 |
| Wake Island | | | | | | | | | | | | 4 |
| Phoenix Island | | | | | | | | | 1 | | 1 | 1 |
| At Sea | 1 | 1 | | | 1 | | | | 1 | | 4 | 4 |
| Alaska | | | | | | | | | | | | 5 |
| Japan | | 1 | | | | | | | 1 | | 2 | 2 |
| Totals | 1 (1) | 5 (5) | 3 (3) | 1 (1) | 27 (26) | 33 (32) | 4 (4) | 2 (1) | 18 (18) | 7 (7) | 101 (98) | 275 |

*Total numbers of movements may be greater than total number of birds moving since a number of birds were recaptured on more than two islands.

+Number in parentheses is the total number of bands involved in movements.

Recent observers emphasize that Black-footed Albatross nested primarily on the sandy beaches, usually at the top of the beach crest or occasionally in open sandy cuts running inward from the beach. On one survey (March, 1965) a very few young were found in Eragrostis some distance from the beach.

On several surveys distinct concentrations of nesting birds were noted. One area of open sand extending inward from the southeast corner of the island seemed particularly favored. Nesting concentrations were reported from this area on no less than three visits (February, 1963; June, 1967; March, 1968). Somewhat of a concentration was found in the northeast corner along the edge of the Scaevola in February 1963. In June 1967 observers found them considerably more common nesting on the west rather than on the east beach. Most individuals usually nest on the beaches of the southern third of the island, presumably because the larger, more open beaches afford more nest sites.

Non-breeding: Wandering young that have not yet bred and presumably non-breeding adults are often found in the breeding areas. Other non-breeding birds disperse widely at sea, primarily to the north of the Northwestern Hawaiian Islands.

## Specimens

Apparently only two specimens of Black-footed Albatrosses have been collected from Lisianski. Wetmore collected two adult males in 1923, one (USNM 300828) on 17 May and the other (USNM 300829) the following day. In addition, two hybrids of this species and the Laysan Albatross were also collected by the POBSP. Both were males, one of them collected 11 March 1963 (USNM 493918), the other 20 March 1968 (USNM 543343).

## Banding and Movements

A total of 702 young Black-footed Albatross have been banded on Lisianski, 200 by the BSFW and 502 by the POBSP (Table 8). A "local" (= large young) banded by the POBSP in June 1967 was recaptured at sea three months later. In addition an adult banded on Kure Atoll in January 1964 was recaptured on Lisianski in March 1965 (see Appendix Tables 4a, 4b).

Table 7. Observations of Black-footed Albatross on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1828 3 Apr. | common | Occurrence noted by Isenbeck (Rothschild 1893-1900: iii). |
| 1891 29 June-4 July | very scarce | (Palmer in Rothschild, 1893-1900: xi); large young present (Munro, 1942: 8). |
| 1913 12 Mar. | 600* | (Willett, ms.); apparently more numerous than Laysan Albatross (Bailey, 1952a: 13). |

Table 7. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1915 | 24 Mar. | 8,000 | Well grown young in pin-feathers (Munter, 1915: 135). |
| 1923 | 15-20 May | 2,000* | Some young well-fledged; others in juvenal breast plumage (Wetmore, ms.). |
| 1951 | 13 May | ? | Half-grown young (POFI). |
| 1954 | 26 Mar. | 4,000* | Ca. 2,000 young (Richardson, pers. comm.). |
| 1955 | 8 May | ? | Large young (POFI). |
| 1957 | 7 Jan. | ca. 5,500* | Estimate of 2,749 nests from aerial survey (Rice and Kenyon, 1962: 374). |
| | 28 Dec. | ca. 5,200* | Estimate of 2,618 nests from aerial survey (Rice and Kenyon, 1962: 374). |
| 1961 | 9 Mar. | ? | Mostly with young about one foot tall (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | thousands | Nesting (POBSP). |
| 1964 | 11-12 Mar. | 3,000-4,000* | 1,500-2,000 young (BSFW, POBSP). |
| | 21-23 Aug. | 0 | (POBSP). |
| | 18 Sept. | 0 | (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 2,000-3,600* | 1,000-1,800 young (POBSP). |
| | 14-17 July | ? | Ca. 200 young (POBSP). |
| 1966 | 16-19 June | ? | 993 young counted and an estimated 1,000 present (POBSP). |
| | 18-20 Oct. | 0 | (POBSP). |
| 1967 | 20 Mar. | 1,000-2,000*+ | 500-1,000 young (BSFW, POBSP). |
| | 2-6 June | 2,400* | 1,161 young counted and an estimated 1,200 present (POBSP). |

Table 7. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 0 | (POBSP). |
| 1968 20-21 Mar. | 1,500-2,000* | Downy young (BSFW, POBSP). |

*Estimate is of the breeding population.

+Estimate undoubtedly low; see number counted for June 1967 survey.

Table 8. Black-footed Albatross banded on Lisianski Island

| Period of Survey | Bander | Adults | Young | Totals |
|---|---|---|---|---|
| 1964 March | BSFW | 0 | 200 | 200 |
| 1965 July | POBSP | 0 | 2 | 2 |
| 1967 June | POBSP | 0 | 500 | 500 |
| Totals | | 0 | 702 | 702 |

LAYSAN ALBATROSS — *Diomedea immutabilis*

Status

Common breeder; maximum recent estimate of breeding population 8,000. Present from about late October through early August; absent remainder of year. Breeds primarily from November through July. Nests on ground over surface of island but more commonly along island perimeter.

Populations

Recent March and June estimates (Table 9) consistently suggest that the breeding population is far less than the 60,000 thought by Rice and Kenyon to be present in 1957. Even if the largest recent estimate of the number of young is doubled to allow for possible mortality since the inception of the breeding season, the total (16,000) is only about one-quarter that given by Rice and Kenyon. This does not mean that populations have declined since 1957; rather that Rice and Kenyon's estimate was excessively high. We think, moreover, that the present breeding population is usually on the order of 8 to 10 thousand birds rather than the 16,000 suggested above.

The earlier estimates (1913, 1915, 1923) are not highly consistent but the most reliable (1923) suggests that there has been at least a five-fold increase in the breeding population since then.

Annual Cycle

The various observations cover too short a portion of the breeding period completely to document a typical breeding season or to indicate differences in the breeding cycle from year to year. Available data indicate no difference in the cycle from other islands of the Northwestern Hawaiian Islands.

Birds presumably arrive in late October and have eggs from about November through January or early February with young being present thereafter. Fledging occurs primarily during June and July with a few perhaps fledging in August. Most of the very few young seen in late August or September (1964, 1967) were weak and starving and probably never fledged.

Various observations indicate that this species' breeding cycle is somewhat behind that of the Black-footed Albatross as on many other Northwestern Hawaiian Islands.

Ecology

Breeding: Nesting Laysan Albatross are found over the entire surface of the island but are distinctly more abundant in some areas than others. Almost all recent observers have indicated that a preponderance of nests or young was found around the island perimeter from about the top of the beach crest inland for at least 100 yards. Along this perimeter birds are most abundant in the barer, open, sandy areas among the bunch grass (Eragrostis) and are least abundant among the dense stands of Scaevola. Scattered nests are found throughout the interior but many areas of dead stands of Eragrostis are almost devoid of breeding birds. Within the interior maximum concentrations of nesting birds have been found in small areas largely bare of vegetation or in areas with a nearly pure growth of low-growing plants such as Ipomoea or Boerhavia. In such areas concentrations of as many as 50 to 100 nests may be found. Some birds also nest on the open sand itself, often in proximity to the Black-footed Albatross which dominate this nesting habitat.

Non-breeding: During the breeding season, many non-breeding birds, most of them young birds which have not yet bred, visit the island and may be found among the breeding birds. During the contranuptial season, albatross disperse widely at sea, primarily to the north.

Other

Albinism: Rothschild (1893-1900: 57) and later Munro (1942: 7) both reported that two young albino albatrosses were present during the midsummer 1891 visit.

Rothschild, who gave the better description of these albinos, stated that they were "white throughout, wing and tail of a delicate pearl-gray (the tail in one more brownish); the black pale gray; feet pale flesh color. The down, which, [was] still visible in some parts of the body,

[was] pure white." Both were collected and are evidently the downy specimens now present in the American Museum (see below under Specimens).

Specimens

We know of eight specimens from Lisianski (Table 10).

Banding and Movements

3,415 young have been banded on Lisianski, 300 by BSFW and 3,115 by the POBSP (Table 11). Five of these birds were subsequently recaptured elsewhere: 1 at Midway Atoll, 1 at Kure Atoll, 1 at Laysan Island, 1 in Japan, and 1 at sea (Appendix Table 5). No Laysan Albatross banded on other Northwestern Hawaiian Islands have yet been found at Lisianski.

Table 9. Observations of Laysan Albatross on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1828 3 Apr. | ? | Occurrence noted by Isenbeck (Rothschild, 1893-1900: iii). |
| 1891 29 June-4 July | thousands | (Palmer *in* Rothschild, 1893-1900: xi); large young (Munro, 1942: 8). |
| 1913 12 Mar. | 200* | (Willett, ms.). Apparently less numerous than Black-footed Albatross (Bailey, 1952a: 13). |
| 1915 4 Mar. | 10,000 | Well-grown young in pin-feathers fairly numerous (Munter, 1915: 135). |
| 1923 15-20 May | 1,600 | Young molting in juvenal breast plumage (Wetmore, ms.). |
| 1951 13 May | ? | Half-grown young (POFI). |
| 1954 26 Mar. | 4,000* | *Ca.* 2,000 young seen (Richardson, pers. comm.). |
| 1955 8 May | ? | Young; relatively few adults present (POFI). |
| 1957 7 Jan. | *ca.* 60,000* | Estimate of 29,141 nests from aerial survey (Rice and Kenyon, 1962: 374). |
| 28 Dec. | | |
| 1961 9 Mar. | ? | (Woodside and Kramer, ms.). |
| 1963 14 Feb. | thousands | Nesting (POBSP). |

Table 9. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1964 | 11-12 Mar. | 7,500-10,000 (5,200)* | Ca. 2,600 young (BSFW, POBSP). |
| | 21-23 Aug. | ? | Ca. 30 large young seen (POBSP). |
| | 18 Sept. | 0 | (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 5,000-6,000* | 2,200 young banded; ca. 2,500-3,000 present (POBSP). |
| | 14-17 July | ? | Ca. 2,000 young present (POBSP). |
| 1966 | 16-19 June | ? | 2,785 young counted and an estimated 4,000 present; most young with down still covering head, nape, and abdomen. A few had lost down from head and neck (POBSP). |
| | 18-20 Oct. | 0 | (POBSP). |
| 1967 | 20 Mar. | 4,000-6,000* | Ca. 2,000-3,000 young (BSFW, POBSP). |
| | 2-6 June | 8,000* | 2,858 young counted and an estimated 4,000 present. Very few adults seen (POBSP). |
| | 31 Aug.-5 Sept. | ? | Two starving young still present (POBSP). |
| 1968 | 20-21 Mar. | 4,000* | Only downy young present (BSFW, POBSP). |

*Estimate is of the breeding population.

Table 10. Specimens of Laysan Albatross from Lisianski Island

| Mus. | ♂♂ Mus. Nos. | ♀♀ Mus. Nos. | ??& yg. | Mus. Nos. | When Coll. | Coll. |
|---|---|---|---|---|---|---|
| AMNH | | | 2 | 526869-870 | 3 July 1891 | Palmer |
| USNM | | | 2 | 191497-498 | ?? | U.S. Treas. Dept. |
| USNM | 2 300850-851 | 1 300849 | | | 17,19 May 1923 | Wetmore |
| USNM | | | 1 | 495735 | 17 July 1965 | POBSP |

Table 11. Laysan Albatross banded on Lisianski Island

| Period of Survey | | Bander | Adults | Young | Totals |
|---|---|---|---|---|---|
| 1964 | March | BSFW | 0 | 300 | 300 |
| | August | POBSP | 0 | 1 | 1 |
| 1965 | March | POBSP | 0 | 2,200 | 2,200 |
| | July | POBSP | 0 | 183 | 183 |
| 1966 | June | POBSP | 0 | 31 | 31 |
| 1967 | June | POBSP | 0 | 500 | 500 |
| Totals | | | 0 | 3,215 | 3,215 |

BONIN PETREL — *Pterodroma hypoleuca*

Status

Abundant breeder; maximum recent estimate 1,000,000. At least a few birds present in all months but most numerous from late August through March or perhaps April. Breeding cycle poorly known but breeds from February, or perhaps January, through June or July. Nests in burrows.

Populations

Although undoubtedly inaccurate to some degree, estimates (Table 12) indicate that this species is extremely abundant.[20] The largest estimate

[20]Bonin Petrels are more abundant on Lisianski than on any other of the Hawaiian Islands. We believe it likely that this island supports a population as large as, or larger than, the combined populations for all other Northwestern Hawaiian Islands.

(March 1965) may seem extremely large, but it was based on more careful calculations than were made on most surveys. On two nights in March, intensive banding operations were conducted in one small area and, since this species occurs rather uniformly over the entire surface of the island, the resulting density figure was applied to the total acreage of the island. This estimate is crude but it probably represents peak population levels far better than many other estimates. We have no doubt that, at a minimum, the island supports 500,000 to 700,000 birds.

Diurnal estimates in March 1954 and September 1964, periods when these birds would be expected to be abundant, are very low. This does not mean that the birds were not abundant during these months but points up the remarkable difference between the numbers and conspicuousness of diurnal and nocturnal populations. Unlike the other procellariiforms occurring on the island, this species departs the island en masse early in the morning and returns in large numbers only at dusk. Thus, diurnal surveys may fail to indicate accurately the numbers present.

The low numbers reported for May 1923 strongly suggest that the population was considerably smaller then than in 1891 and at present. Wetmore (ms.) suggested that the reduction in numbers was caused by the near absence of vegetation that he felt these petrels needed in order to construct their burrows. Even recently many burrows were found caved in by the weight of the sand. In some instances, starving, but still living, birds were found half-buried in loose sand. Such caved-in burrows were typically found in areas of open sand near the island perimeter or in areas of the interior where vegetation was scanty. Presumably the root systems of the vegetation, particularly Eragrostis, reinforce the subsurface soil and make the burrows less vulnerable to destruction.

Annual Cycle

Little attention was paid to the breeding status of this species on many recent visits. Consequently, only the broad outlines of the nesting cycle are known.

The cycle is very similar to that found on Laysan.[21] Most of the population leaves the island when the young fledge (about June) and are absent for about two months. They begin to return to the island about mid-August and are apparently abundant within only a few weeks. (Note the remarkable difference between the size of the estimates for 21 to 23 August 1964 and ca. 31 August 1967.)

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[21] In July 1965 apparently new arrivals were present on Lisianski the 14th to 17th, but none was on Laysan the 17th to 21st. In June 1966 Crossin (POBSP) stated that this species was further along in its breeding cycle on Lisianski than on Laysan. Both sets of observations suggest that the Lisianski cycle is somewhat in advance of that on Laysan. Considerably more detailed work with sample nest counts is needed to determine whether the cycle is essentially the same on all the Northwestern Hawaiian Islands or whether there are regularly occurring, discrete differences between populations on different islands.

Large numbers are present for the next four or five months while birds court and dig burrows. Although observations are few from this time of year, those available, and those from nearby islands where the cycle is presumably similar, indicate that no eggs are laid until mid-winter. Egg laying begins at least by early or mid-February (1963, 1965) and eggs are present through at least late March. A few are possibly present in April, but the two sets of June observations (1966, 1967) suggest that most eggs have hatched by April since it is likely that this species takes at least two months to fledge. Most young probably hatch in late March and early April, and most young are fledged by late June with a few possibly present into July.

## Ecology

Breeding: Recent observers found burrows throughout the vegetated portion of the island. Burrow density was greatest under Eragrostis and lowest under the Scaevola on the perimeter of the island. Rarely, birds nest on the surface of the ground under dense vegetation (Figs. 37-38).

Non-breeding: Most birds are apparently absent from the island after nesting.

Mortality: On some surveys many dead Bonin Petrels were encountered. Aside from mortality caused by natural collapse of burrows as mentioned above, a considerable amount of burrow destruction probably was caused by parties visiting the island. The interior is honeycombed with burrows and it is almost impossible to traverse the island without stumbling into four or five of them. Probably no less than 1,500 burrows were so destroyed from February 1963 through March 1968. This does not mean that 1,500 nests were destroyed; many burrows are inactive and several recent visits were made at times of year when burrow destruction probably had little effect on nesting success. Since burrows are so numerous and since so many are unoccupied, we estimate that less than .2 percent of the nesting population was adversely affected by recent visitors.

On several occasions dead or starving birds were found entangled, usually by the wing, in vegetation, mostly Ipomoea. One was found so entangled in August 1964, several in July 1965, and one observer estimated that 1,000 birds were so found in March 1965.

## Specimens

Table 13 lists the present location of thirteen specimens known to have been collected on Lisianski.

## Banding and Movements

The POBSP banded 3,700 adult Bonin Petrels on Lisianski: 300 in March 1964, 200 in August 1964, 3,000 in March 1965, and 200 in September 1967. Three of these birds, all banded as adults in March 1965, were recaptured on Kure Atoll during the period from February through April 1969 (Appendix Table 6). None was recaptured on any other island, and none banded on other islands was recaptured on Lisianski.

Figure 37. Bonin Petrel resting on sand near burrow under Ipomoea, September 1967. POBSP photograph by R.B. Clapp.

Figure 38. Bonin Petrel nest and egg on surface of ground under dense Scaevola, 14 February 1963. POBSP photograph.

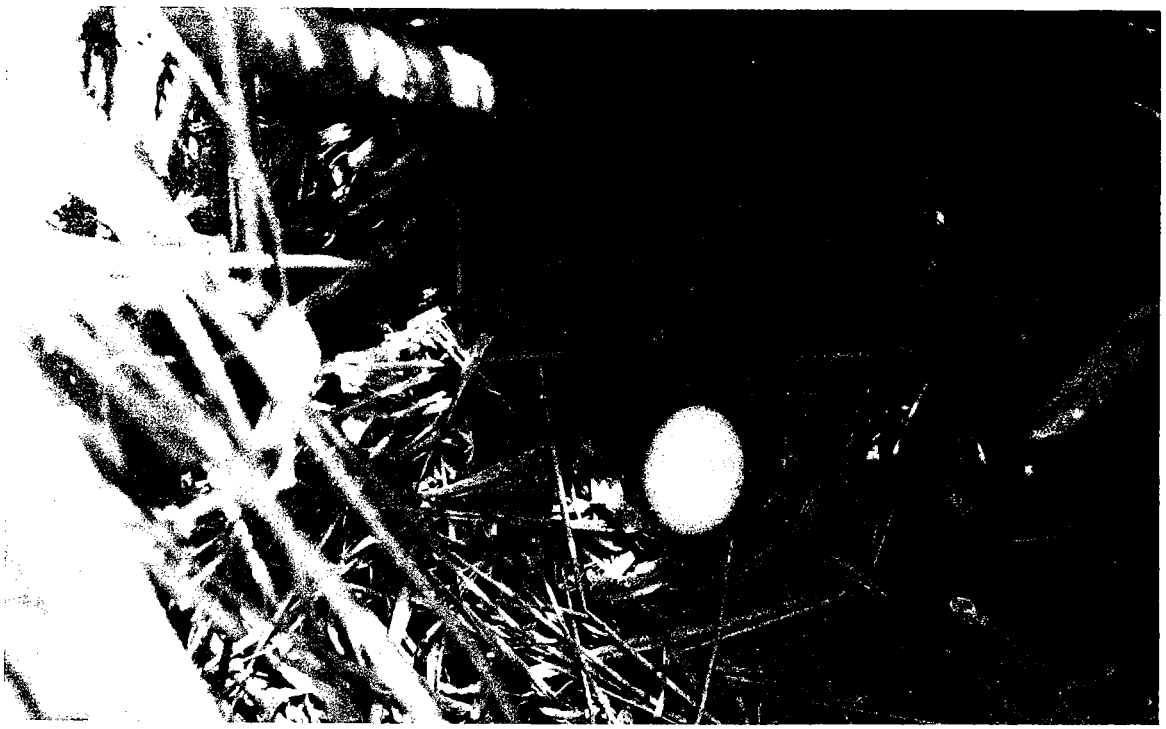

Table 12. Observations of Bonin Petrels on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | ? | Young birds, some alive and some dead (Munro, 1944: 28). |
| 1913 | 12 Mar. | 40,000 | (Willett, ms.). |
| 1923 | 15-20 May | 50 | No eggs or young found, specimens collected were sexually inactive (Wetmore, ms.). |
| 1954 | 26 Mar. | 500 | Overhead (Richardson, pers. comm.). |
| 1961 | 9 Mar. | 0 | Thought to be present (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | abundant | Egg-laying begun (Kramer, ms., POBSP). |
| 1964 | 11-12 Mar. | 100,000 | Numerous nests (BSFW, POBSP). |
| | 21-23 Aug. | 15,000 | Much calling but no other courtship behavior observed (POBSP). |
| | 18 Sept. | 30 | Seen flying in to island at dusk, no evidence of breeding; no nocturnal observations made (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 1,000,000 | Nests with eggs and small young, 1 egg opened contained a near-hatching young; more eggs than young found (POBSP). |
| | 14-17 July | 200 | No evidence of nesting (POBSP). |
| 1966 | 16-19 June | 500 | Ca. 500 young, some still being fed by parents, remaining on island; all had attained juvenal plumage and were near fledging (POBSP). |
| | 18-20 Oct. | 500,000 | Mostly engaged in courtship behavior; no burrow examined held either eggs or young (POBSP). |
| 1967 | 20 Mar. | hundreds offshore | None found in burrows during day; no eggs or young (BSFW, POBSP).* |
| | 2-6 June | 100 | No more than ca. 250 prefledging chicks still present; very few adults (POBSP). |

Table 12. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 500,000 | Burrows being excavated; no eggs or young (POBSP). |
| 1968 20-21 Mar. | 800,000 | Many burrows being excavated, none of very few burrows examined contained eggs or young (BSFW, POBSP). |

*Little effort made to discover nests.

Table 13. Specimens of Bonin Petrels from Lisianski Island*

| Mus. | ♂♂ | Mus. Nos. | ♀♀ | Mus. Nos. | ??& yg. | Mus. Nos. | Date Coll. | Coll. |
|---|---|---|---|---|---|---|---|---|
| AMNH | | | | | 1 | 528329 | 3 July 1891 | Palmer |
| USNM | 2 | 300663, 665 | 2 | 300662, 664 | | | 17 May 1923 | Wetmore |
| USNM | 1 | 494125 | 1 | 494126 | | | 13 March 1965 | POBSP |
| USNM | 1 | 496585 | 1 | 496586 | | | 18,19 June 1966 | POBSP |
| USNM | 1 | 545021 | 1 | 545020 | | | 4 September 1967 | POBSP |

*Not included are a skull (USNM 289187) collected by Wetmore 16 May 1923, and a skeleton (USNM 497951) collected by the POBSP 11 February 1963.

BULWER'S PETREL — Bulweria bulwerii

Status

Uncertain; maximum recent estimate "a few;" may no longer breed on Lisianski.

Observations

Bulwer's Petrels have been recorded from Lisianski four times. Munro (1941c: 2), the first to record the species, found birds incubating under grass in late June 1891. He also noted that large numbers flew in to the island at dusk. Wetmore (ms.) observed that they were fairly common at dusk 16 to 19 May 1923. Although his notes do not state whether they were breeding, the numbers seen and collected suggest that this may have been the case.

More recently, POBSP personnel saw a few flying over the island 14 to 17 July 1965 but found none on the ground and discovered no nests.

On 4 September 1967 Ely collected one as it sat alone on the narrow, sandy northeast beach. The area nearby, which contained a large log and a few rocks overgrown with Scaevola, was carefully searched for a nest burrow but none was found. The specimen (USNM 544002) is an adult female with a small ovary. The absence of other observations during many recent visits suggests that the breeding population, if extant, probably consists of no more than a very few pairs.

Specimens

We know of six study skins from Lisianski, the one mentioned above, and five adult females (USNM 300501-505) collected by Wetmore 17 May 1923. In addition, there is a skeleton (USNM 289201) of an adult female collected by Wetmore the same date.

Banding and Movements

None has been banded on Lisianski.

JOUANIN'S PETREL — Bulweria fallax

Status

Accidental; one record September 1967.

Observations

On 4 September 1967 Clapp collected a small dark petrel as it sat near some Bonin Petrels in an open, sandy area on the northwestern corner of the island (Clapp, 1971). The specimen (USNM 543185), identified as Jouanin's Petrel by G.E. Watson, W.R.P. Bourne and C. Jouanin, was a male that was molting the body feathers, had little fat, and had undeveloped testes.

Jouanin's Petrel, whose breeding area has not yet been found, occurs principally in the northwestern Indian Ocean (Bailey, 1966: 239). This specimen thus constitutes not only the first record for the Hawaiian Islands, but also for the entire Pacific area.

WEDGE-TAILED SHEARWATER — Puffinus pacificus

Status

Abundant breeder; maximum recent estimate [500,000]. Present from about March through at least October; probably absent from late November through February. Nests primarily in burrows but occasionally on the surface of the ground.

Populations

POBSP estimates (Table 14) varied considerably from survey to survey, even at the same time of year. This is almost surely because of the small proportion of any survey period spent studying the smaller Procellariiformes. Relatively few observations were made of these species and little effort was expended in banding them since other commitments were thought to be of greater importance. These birds' nocturnal habits and often inconspicuous nesting sites have undoubtedly contributed to miscalculations of numbers present. Consequently, population estimates for Wedge-tailed Shearwaters, and for other petrels and shearwaters occurring on Lisianski, are less accurate than for any other seabirds occurring on the island.

We do feel that, since most estimates made independently by different field parties agree rather well, maximum populations are tens of thousands rather than hundreds of thousands.

There were only three estimates of numbers prior to the 1960's. Both Richardson's (1957) and Wetmore's (1923) estimates agree with the majority of POBSP estimates. Munter's 1915 estimate, on the other hand, is 100 times larger than any other estimate made during March.

Annual Cycle

The annual cycle of Wedge-tailed Shearwaters on Lisianski appears to be very similar to, if not the same as, that found on Laysan. Most, if not all, of these shearwaters are probably absent during late fall and winter. They return to Lisianski in March and from then through May court and dig burrows. Egg-laying begins in June and probably reaches its peak late in the month. Young begin to hatch in late July or early August. Varying sizes of young have been seen on all visits during succeeding months. If, as seems likely, the cycle is as extended as on Kure Atoll (Woodward, 1972: 125), young will be on the island until early December.

Ecology

Breeding: Almost all visitors to Lisianski (Munter, Wetmore, many POBSP survey parties) noted that Wedge-tailed Shearwaters nested everywhere. Subterranean burrows were found beneath all sorts of vegetative cover, e.g., under Scaevola bushes, in Boerhavia-Eragrostis, or in sand-Eragrostis associations (Figs. 39, 40). POBSP observers Shelton and Crossin noted that densities of nests and numbers of breeding birds were decidedly lower in the lowest (southwest-central) portion of the interior.

Active nests are not infrequently found on the surface of the ground. Most such nests were beneath Scaevola bushes but others were found in more exposed situations such as beside a tuft of Eragrostis or beneath a Casuarina tree (Fig. 41).

Non-breeding: After breeding, the Wedge-tailed Shearwaters evidently leave the island for the winter.

Figure 40. Wedge-tailed Shearwaters near burrows in sand area at edge of Boerhavia-Eragrostis association, 19 June 1966. Young Laysan Albatross in mid-ground. POBSP photograph by P.C. Shelton.

Figure 39. Pair of Wedge-tailed Shearwaters near mouth of burrow, September 1967. POBSP photograph by R.B. Clapp.

Figure 41. Wedge-tailed Shearwater chick at base of southwestern Casuarina tree, September 1967. POBSP photograph by R.B. Clapp.

Other

Clubs: At night and during the morning hours, up to several hundred shearwaters roost in different parts of the island. In August 1964 two large clubs were observed on bare sand near the beach, one club at each end of the island. In September 1967 a club containing 75 to 100 birds was found in an open sand-Eragrostis-Boerhavia association above the northeast beach crest. The breeding status of birds found in such clubs is yet to be determined.

Color phases: The only reference we have found that gives proportions of different color morphs in the Lisianski population is Wetmore's (ms.) observation that "gray-breasted birds" comprised about 3 to 5 percent of the population. POBSP banding data indicate that at present the proportion of dark-phase morphs in the population is considerably less than indicated by Wetmore. Only 1 of 88 (1.1 percent) banded birds of known color phase was a dark-phase morph.

It should be noted here that all POBSP and other USNM specimens from Lisianski assessed as "dark-phase morphs" are the color phase described by Murphy (1951: 9-10) as "intermediate." None of the "dark-phase morphs" from the Northwestern Hawaiian Islands in the USNM collection is as dark as those from south-central Pacific Islands (e.g., the Phoenix Islands). Thus, the above banding data expresses the proportion of "dark-appearing" shearwaters (including both "dark" and "intermediate" phases) in the population.

Specimens

There are, in addition to the 12 study skins listed in Table 15, a skull (USNM 289186) and an alcoholic (USNM 289348) collected by Wetmore on 19 May 1923.

Banding and Movements

POBSP personnel banded 1,479[22] adult Wedge-tailed Shearwaters on Lisianski: 1 in March 1963, 500 in August 1964; 100 in June 1966; 99 in October 1966; 693 in June 1967; and 86 in August-September 1967. Fourteen of these birds were subsequently returned, 13 of them on Lisianski (1 in June 1966, 12 in June 1967). The 14th bird, banded on Lisianski in late August 1964, was recaptured and released on Laysan in early August 1965 (see Appendix Table 7).

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[22]Total includes several birds that were double-banded.

Table 14. Observations of Wedge-tailed Shearwaters on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1828 | 3 Apr. | ? | One of Isenbeck's descriptions (see below) may have referred to this species (Rothschild, 1893-1900: v).* |
| 1891 | 29 June-4 July | ? | Most birds on eggs in late June (Munro, 1942: 8). |
| 1915 | 24 Mar. | 15,000 | No eggs (Munter, 1915: 136). |
| 1923 | 15-20 May | 25,000** | Copulation and courting but no nests with eggs found (Wetmore, ms.). |
| 1954 | 26 Mar. | 10-15 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | ? | Evidently nesting (Woodside and Kramer, ms.). |
| 1964 | 11-12 Mar. | 25 | Courting pairs (BSFW, POBSP). |
| | 21-23 Aug. | 50,000 | Nesting (POBSP). |
| | 18 Sept. | 60,000 | Many downy young (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 100-200 | No burrows with eggs or young (POBSP). |
| | 14-17 July | 45,000 | All nests examined contained eggs in varying stages of incubation (POBSP). |
| 1966 | 16-19 June | 50,000 | Breeding cycle just beginning; digging, and fresh eggs found; ca. 1,000 nests with eggs (POBSP). |
| | 18-20 Oct. | [250,000] | Young birds molting in juvenal plumage; no eggs or young at other stages of development (POBSP). |
| 1967 | 20 Mar. | 0 | (BSFW, POBSP). |
| | 2-6 June | [500,000] | No data on stage of nesting obtained (POBSP). |
| | 31 Aug.-5 Sept. | 40,000 | Medium-sized to large downy young (POBSP). |

Table 14. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1968 20-21 Mar. | 0 | A few may have been present (BSFW, POBSP). |

*Rothschild's record, based on Isenbeck's description, may be erroneous. Rothschild's translation of the description reads "Another Petrel, a little larger [than about 9 inches]; breast, abdomen, and neck white; upper surface mixed white and brown; the forked tail only moderately emarginate." While most of these characters fit the Wedge-tailed Shearwater, the moderately emarginate tail most certainly does not.

**Noted as most abundant species on island.

Table 15. Specimens of Wedge-tailed Shearwaters from Lisianski Island

| Mus. | ♂♂ | Mus. Nos. | ♀♀ | Mus. Nos. | ??& yg. | Mus. Nos. | When Coll. | Coll. |
|---|---|---|---|---|---|---|---|---|
| USNM | 3 | 300730, 732,734 | 5 | 300727-729,733, 735 | 1 | 300731 | 16,17,19 May 1923 | Wetmore |
| USNM | | | 1 | 492959 | | | 12 March 1963 | POBSP |
| USNM | | | 2 | 495631-632 | | | 16 July 1965 | POBSP |

CHRISTMAS SHEARWATER — *Puffinus nativitatis*

Status

Common breeder; maximum recent estimate 2,000. Present from at least February through October, but most breeding occurs from April or May through October. Nests primarily on the surface of the ground in shallow depressions under dense vegetation.

Populations

Various numerical estimates (Table 16) consistently suggest only a few Christmas Shearwaters are found on Lisianski, probably no more than several thousand when largest numbers are present.

Of the two early estimates, Wetmore's (ms.) agrees well with the series of recent estimates made by POBSP, but Munter's (1915) is about 20 times as large as the largest estimate made recently at the same time

of year. With the notable exception of the Wedge-tailed Shearwater, most of Munter's estimates for species on this island agree with most recent estimates, both in numbers and in relative abundance of species. Therefore, we cannot dismiss the possibility that this species was once much more common on Lisianski than at present.

Annual Cycle

The Christmas Shearwater annual cycle on Lisianski appears to be quite similar to that of the Wedge-tailed Shearwater except for being about a month earlier. Detailed data on nesting status from various visits is scant, and the island has not been visited during several months from which data are needed to round out the schedule of the annual cycle. Nonetheless, the general schedule of events is about as follows:

Birds arrive at the island in February, or perhaps earlier, but eggs are not laid for one or two months. The earliest that eggs have been found is mid-May (1923), but observations on nearby islands such as Laysan suggest that at least a few eggs may be laid a month earlier. Eggs have been present through at least mid-June (1966).

The earliest that young have been recorded is late August (1964) but the size of the young indicates that it was probably hatched at least two months earlier.

Young are present until at least mid-October and a few are possibly present into November.

Ecology

Breeding: These shearwaters breed primarily under Scaevola bushes around the perimeter of the island. They are found to a much lesser extent under other vegetation in the interior. On almost half of all visits (particularly those from June through October), POBSP observers noted that Christmas Shearwaters were more abundant at the north and south ends of the island than on the eastern and western perimeters.

The few nests found have for the most part been above ground (Fig. 42). These nests have typically been shallow, partially leaf-filled depressions under densely leaved Scaevola bushes. In March 1965 several nests were found beneath pieces of corrugated tin in an Eragrostis-Ipomoea-Boerhavia association in the interior of the island. Wetmore (ms.) found an egg under a board "merely broad and deep enough to conceal the bird."

Non-breeding: Judging from their behavior on other Northwestern Hawaiian Islands, Christmas Shearwaters are probably absent from Lisianski during most of the winter months.

Specimens

We know of five study skins from Lisianski: a male and a female (USNM 300697-698) collected by Wetmore 17 May 1923, and two males and a

Figure 42. Christmas Shearwater chick in nest site under Scaevola along the northeast beach, September 1967. POBSP photograph by R.B. Clapp.

female (USNM 492967, 494123, 494122), collected by the POBSP 12 and 13 March 1965.

Banding and Movements

Only 16 Christmas Shearwaters, all of them adults, have been banded on Lisianski by the POBSP: 7 in March 1963 and 9 in August and September 1967. None have yet been recaptured.

Table 16. Observations of Christmas Shearwaters on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | less numerous on Lisianski than Laysan | (Munro, 1941d: 16). |
| 1913 | 12 Mar. | ? | 1 pair seen (Willett, ms.). |
| 1915 | 24 Mar. | 10,000 | No eggs found (Munter, 1915: 136). |
| 1923 | 15-20 May | 600 | Eggs, some fresh, but no young (Wetmore, ms.). |
| 1950 | 24 June | ? | Nesting (POFI). |
| 1963 | 14 Feb. | 15 | No nests (POBSP). |
| 1964 | 11-12 Mar. | very few | (BSFW). |
| | 21-23 Aug. | ? | 1 almost fledged (POBSP). |
| | 18 Sept. | 6 | No evidence of breeding (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 300-500 | Burrows contained pairs by day but no nests with eggs or young found (POBSP). |
| | 14-17 July | 400 | No burrows found (POBSP). |
| 1966 | 16-19 June | 1,000 | Birds courting and incubating eggs; 50 nests with eggs present (POBSP). |
| | 18-20 Oct. | 50 | Adults not seen; estimate based on number of near-fledging young (POBSP). |
| 1967 | 20 Mar. | 25 | No nests with eggs (BSFW, POBSP). |
| | 2-6 June | 2,000 | Only nests with eggs; an estimated 500 nests (POBSP). |

Table 16. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 250 | 3 large, near-fledging young; small number of adults scattered about the island (POBSP). |
| 1968 20-21 Mar. | 100 | No evidence of breeding activity (BSFW, POBSP). |

RED-TAILED TROPICBIRD — Phaethon rubricauda

Status

Common breeder; maximum recent estimate 4,500. A few birds probably present in all months but maximal numbers present from about May or June through August; probably few present from late September through February. Breeds from March through at least November but most nesting occurs from April through September or early October. Nests either solitarily or semi-colonially on the ground under dense vegetation.

Populations

Although estimates made during periods when few birds were present are rather consistent from visit to visit, those made during the periods of peak breeding activity are highly variable (Table 17). This variability perhaps does not indicate changes in population size from year to year but merely reflects the lack of accuracy in the estimates. The June 1967 estimate of 4,500 birds seems particularly large and is probably erroneous. Other estimates from the June to August period are variable but suggest maximal populations of 500 to 1,000 birds.

Although they were undoubtedly numerous in earlier years, Wetmore's observations, made at a time of year when the present population is large, indicate that the population had been extirpated by 1923.

We cannot explain why this species was not reported by Palmer and Munro in June 1891--before rabbits had been introduced, before the Japanese were known to poach on the island, and at a period when breeding populations should have been at a peak. The absence of other early observations is not surprising since all other early observations were made in March, when very few tropicbirds are present.

Annual Cycle

Population estimates and the composition of sample nest counts suggest that more than 90 percent of the population completes its breeding cycle between April and October. On only two of six recent March visits (1965, 1968) were nesting birds found. This, and the small size of population estimates in March, indicates that the birds have just begun

to arrive on the island at this time. Observations from both June 1966 and 1967 suggest that the egg peak occurred in May and early June. If this is true, most fledging probably occurs about 3 months later, or from August through early September. The nest count taken in August and September 1967 generally agrees with this conclusion, but indicates that a fair number of birds fledge throughout September. Small numbers fledge in October and through at least late November (if the nests begun late in the year are successful). No observations have been made on Lisianski from November through January but it seems likely that few birds are present and breeding then.

## Ecology

Breeding: Tropicbirds on Lisianski breed primarily around the perimeter of the island but scattered pairs nest inland. Birds nesting on the perimeter almost invariably choose to nest under the larger and denser Scaevola bushes (Fig. 43), but when maximum numbers are breeding, the lower Scaevola may be utilized as well. In this perimeter area the tropicbirds are semi-colonial, three or four pairs nesting under a single clump of Scaevola from 15 to 20 feet in diameter. Areas of denser growth which usually held greatest numbers of nesting birds were just behind the crests of the east and south beaches and behind the northeast and north beaches. Fewer nesting birds were found above the west beach where the Scaevola is considerably less luxuriant.

Tropicbirds nesting in the interior seem to prefer Ipomoea which had grown in mounds over stunted, dying, or dead Scaevola. Most of this Scaevola was less than 3 feet tall, considerably lower than much of that found about the perimeter of the island.

Non-breeding: The large decrease in numbers of tropicbirds during periods of non-breeding, or much reduced breeding, and the absence of observations of immatures flying over the island, indicates that most, if not all, adult and young tropicbirds leave the island shortly after completion of the nesting cycle.

## Specimens

To our knowledge, there are but two specimens of the Red-tailed Tropicbird: USNM 191499, lacking a collection date on the label, was confiscated from the Japanese 16 June 1904; a male (USNM 300983) was collected by Wetmore 17 May 1923.

## Banding and Movements

Table 18 gives the number of Red-tailed Tropicbirds banded on Lisianski by the POBSP and BSFW through 1969. None has yet been recaptured on other islands or at sea.

Figure 43. Red-tailed Tropicbird on nest under Scaevola, 6 June 1967. POBSP photograph by Robert L. DeLong.

Table 17. Observations of Red-tailed Tropicbirds on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1923 | 17 May | 2 | No nests found (Wetmore, ms.). |
| 1951 | 13 May | ? | (POFI). |
| 1954 | 26 Mar. | ca. 10 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | many | No eggs or young seen (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 0 | (Kramer, ms.; POBSP). |
| | 12-13 Mar. | a few | No nests found (POBSP). |
| 1964 | 11-12 Mar. | 100-150 | No nests found (BSFW, POBSP). |
| | 21-23 Aug. | 300 | Eggs to large young, but most nests with large young; estimated 10 nests with eggs, 140 with young (POBSP). |
| | 18 Sept. | 50-100 | 5 large immatures (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 20-30 | 1 nest with egg found; several more birds seen on ground (POBSP). |
| | 14-17 July | 1,000 | Partially incubated eggs to near-fledging young; estimated 200 nests with young. Sample count of 60 nests: 3 (5%) with eggs, 4 (7%) with small downy chicks, 25 (42%) with medium-sized to large downy chicks, and 28 (47%) with dependent immatures (POBSP). |
| 1966 | 16-19 June | 600 | Estimated 300 nests, half with eggs, half with young (POBSP). |
| | 18-20 Oct. | 25 | Ca. 10 near-fledging young, no nests with eggs or small young observed (POBSP). |
| 1967 | 20 Mar. | 25 | No nests found; 20 birds in flight but only 2 on ground, no special search made (BSFW, POBSP). |
| | 2-6 June | 4,500 | Eggs to medium-sized downy young; most nests with eggs; an estimated 1,500 nests on island. Sample count of 53 nests: 50 (94%) with eggs, 1 (2%) with a small downy young, and 2 (4%) with medium-sized downy young (POBSP). |

Table 17. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 800 | Recently hatched young to dependent immatures. Most nests with large downy young or dependent immatures. Sample count of 128 nests: 4 (3%) with recently hatched young, 16 (13%) with small downy young, 50 (39%) with medium-sized or large downy young, and 58 (45%) with dependent immatures (POBSP). |
| 1968 20-21 Mar. | 100 | Only 2 nests with eggs found (BSFW, POBSP). |

Table 18. Red-tailed Tropicbirds banded on Lisianski Island

| Period of Survey | Bander | Adults | Young | Totals |
|---|---|---|---|---|
| 1963 March | POBSP | 1 | 0 | 1 |
| 1964 March | BSFW | 2 | 0 | 2 |
| August | POBSP | 7 | 56 | 63 |
| 1965 March | POBSP | 18 | 0 | 18 |
| 1967 June | POBSP | 79 | 0 | 79 |
| August-September | POBSP | 58 | 106 | 165* |
| Totals | | 165 | 162 | 328* |

*Includes 1 bird of unknown age.

BLUE-FACED BOOBY — *Sula dactylatra*

Status

Common breeder; maximum recent estimate 1,200. Present with some birds probably breeding in all months but most nesting occurring from late February or early March through late August or early September. Nests on ground, primarily in open sandy areas among the vegetation rimming the island's perimeter.

Populations

Recent estimates of Blue-faced Boobies (Table 19) on Lisianski indicate that maximal populations are on the order of 1,000 to 1,200 birds,

but the larger estimates almost invariably include several hundred non-breeding birds found roosting in clubs (see below). Many of these birds are probably from other breeding populations in the Northwestern Hawaiian Islands. The number breeding each year is considerably smaller, probably seldom exceeding 450 to 500 birds at any one time. The total number that breed on the island or attempt to breed in any one year may be one to two hundred birds larger, since a large proportion of the 955 adults banded on the island are known to have bred in one year or another.

The present population is clearly two to three times larger than in 1923 when Wetmore visited Lisianski, but earlier numerical records are too vague for us to speculate on whether numbers were formerly greater.

Annual Cycle

Blue-faced Boobies on Lisianski have an extended breeding season that in some years may encompass all months. The population breeds on an annual cycle which in recent years has varied relatively little.

Egg laying may begin as early as November (1962), December (1967), or December to January (1964-65; 1966-68), but recent sample nest counts indicate that less than 1 percent of the number breeding yearly initiate nesting in November or December. Furthermore, relatively few birds begin laying in January but in some years they comprise a significant proportion of the March nesting population. Of the nesting birds present in March 1964, 1965, 1967, and 1968, perhaps as many as 25 percent, 20 percent, 10 percent, and 15 percent, respectively, had begun nesting in January.

Considerably larger numbers of birds begin nesting in February or March with the peak probably usually falling between late February and late April or even May. Many pre-breeding pairs were observed in March 1965 and 1967, indicating that laying would occur in the following months. On the latter survey, an estimated 47 percent of the nesting population had not yet laid. Laying continues at least into June and a few eggs possibly are laid as late as August. The nest count data from June through October suggest, however, that little laying occurs in July and that laying probably does not usually occur in August. (The egg observed in August 1964 may well have been an abandoned, sterile egg.)

Recently hatched young have been recorded as early as February but hatching has probably occurred as early as December (1962). Recently hatched young have been recorded as late as mid-July. Most hatching probably falls into the period from early April through early June.

Fledged or near-fledging young have twice been recorded in June (1891, 1966) and, if July nests are successful, could occur as late as November. Most young, however, probably fledge from early July through late August to mid-September.

Ecology

Breeding: In 1923, when there was little vegetation, the birds moved inland and nested near the remaining patch of grass. All the more recent

observations indicate that these birds nest primarily along the perimeter of the island, from the edge of the beach for a short distance inland (Figs. 44,45). Areas which have many bare areas of sand interspersed among thicker vegetation are particularly favored and few or no birds nest in the interior of the island which is densely covered with low vegetation (primarily clumps of Eragrostis). No nests were found in the central portion of the island on POBSP surveys from 1963 through 1968, but they were found as far as 50 yards inland in areas where bare sand extended between dense Scaevola growth. Most inland nests were found along the south and southeast perimeters.

The limited data on nest distribution suggest that these boobies nest uniformly around the island perimeter, except they are less abundant along the north perimeter and perhaps a little more abundant along the perimeter of the southern half of the island. There seems to be little tendency for distinct colonial concentrations except birds nest somewhat more densely in areas that afford more suitable habitat.

Non-breeding: Most non-breeding birds (and some breeding birds) are found in roosting aggregations (clubs) on beaches that are not used for breeding (Fig. 46). Data on the location and sizes of such clubs were not taken consistently but those available suggest that some areas were more favored than others (Table 20). The largest clubs were most frequently seen on the south and southwest beaches (which are considerably larger than most others), but large clubs also were seen consistently on the beaches at the north end of the island.

The proportion of birds in clubs in June 1966 is probably considerably larger than is usually found at that time of year. There were far fewer nests than in June 1967 which may indicate that 1966 was a particularly unfavorable year for nesting.[23] If this is true, it seems likely that many of the birds in clubs were ones whose nests failed earlier in the season.

## Specimens

To our knowledge only four Blue-faced Booby specimens have been collected on Lisianski. Wetmore collected an immature female (USNM 300942) and two adult males (USNM 300943-944) 17 and 18 May 1923, respectively. There is also a specimen in the Bishop Museum for which we know neither collector nor collection date.

## Banding and Movements

The POBSP has banded 1,247 Blue-faced Boobies on Lisianski (Table 21). Twenty-one have been subsequently found on other islands or at sea. Some

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[23] Woodward (pers. comm.) states that on Kure Atoll the 1966 Blue-faced Booby breeding cycle was different from any other during the 1963 to 1968 study period. The breeding population decreased by about 25 percent and the cycle was later than in any other year.

Figure 44. Typical Blue-faced Booby nest with egg and recently hatched young, 12 March 1964. POBSP photograph by A.B. Amerson, Jr.

Figure 45. Blue-faced Booby brooding young in nest at edge of vegetation, February 1963. POBSP photograph.

Figure 46. Club of roosting Blue-faced Boobies on the south point, September 1967. Brown Boobies (note fifth bird from right) occasionally roost in such clubs. POBSP photograph by R.B. Clapp.

have been recorded from more than one other island and some have been recaptured on Lisianski after having been previously recaptured on other islands. Eight have been recaptured at Laysan, 5 each at Kure Atoll and French Frigate Shoals, 3 at Johnston Atoll, and 1 at sea (Appendix Table 8a). In addition, 33 birds banded on other islands have been recaptured on Lisianski: 17 were banded on Laysan Island, 7 at French Frigate Shoals, 4 at Johnston Atoll, 3 at Kure Atoll, and 2 at Pearl and Hermes Reef (Appendix Table 8b).

Table 19. Observations of Blue-faced Boobies on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1828 3 Apr. | ? | Probably seen by Isenbeck but his observations do not clearly distinguish between this species and the Red-footed Booby (see Rothschild, 1893-1900: v). |
| 1891 29 June-4 July | ? | Palmer noted on 30 June that young "some ...being just able to fly" were found with the adults "all along the beach" (Rothschild, 1893: xi-xii). |
| 1913 12 Mar. | rather common | (Bailey, 1956: 74; Willett, ms.). |
| 1915 24 Mar. | fairly large numbers | Eggs and variously sized young; 3 or 4 near fledging young (Munter, 1915: 135). |
| 1923 15-20 May | 200 | Nest sites selected, large and fledged young (Wetmore, ms.). |
| 1951 13 May | ? | With half-grown young (POFI). |
| 1954 26 Mar. | 400 | (Richardson, pers. comm.). |
| 1955 8 May | ? | Ca. 50 on nests; a few nests with 2 eggs and some with an egg and a young bird (POFI). |
| 1961 9 Mar. | ? | (Woodside and Kramer, ms.). |
| 1963 14 Feb. | 500 | Mostly on eggs, but recently hatched young, small and large downy young, also present (POBSP; Kramer, ms.). |
| 1964 11-12 Mar. | 500-650<br>400-450* | Ca. 200 nests; most nests with eggs. Sample count of 134 nests: 95 (71%) with eggs, 14 (10%) with an egg and a young bird; 25 (19%) with young (BSFW, POBSP). |

Table 19. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1964 | 21-23 Aug. | 600 | 1 nest with egg, 1 with a half-grown chick; ca. 100 fledged immatures on island (POBSP). |
| | 18 Sept. | 250 | 54 flying immatures counted (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 750-1,000 | 90-110 nests with eggs and very small chicks; at least 2 chicks about 1 month old and many pre-nesting birds. Sample count of 71 nests: 53 (75%) with eggs, 10 (14%) with recently hatched young, 7 (10%) with small downy young, and 1 (1%) with a large downy young (POBSP). |
| | 14-17 July | 300 | Eggs to fledged young; ca. 100 young on island (POBSP). |
| 1966 | 16-19 June | 725 | Eggs to fledged young; most nests with 1/4- to 1/2-grown young. An estimated 85 nests present. Sample count of 55 nests: 3 (5%) with eggs, 5 (9%) with recently hatched young, 23 (42%) with small downy young, 14 (25%) with medium downy young, and 10 (18%) with large downy young. 1 fledged young seen (POBSP). |
| | 18-20 Oct. | 1,200 | Most of young fledged or fledging; no nests with eggs or small young (POBSP). |
| 1967 | 20 Mar. | 300 | Eggs to large downy young; most nests with eggs. Sample count of 64 nests: 52 (81%) with eggs, 7 (11%) with recently hatched young, 4 (6%) with small downy chicks; and 1 (2%) with a large downy chick (BSFW, POSSP). |
| | 2-6 June | 1,000 | Eggs to large downy young; most nests with downy young. Count of 165 nests: 32 (19%) with eggs, 28 (17%) with small downy young, and 105 (64%) with medium or large downy young (POBSP). |
| | 31 Aug.-5 Sept. | 800 | No nests with eggs or downy young; estimated 200 dependent immatures (POBSP). |

Table 19. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1968 20-21 Mar. | 430 | Eggs to medium downy young; most nests with eggs. Sample count of 98** nests: 76 (78%) with eggs, 6 (6%) with naked young, 15 (15%) with small downy young, and 1 (1%) with a medium downy young. An estimated 225 breeding birds (nearly 50% of the population) still in pre-nesting pairs (BSFW, POBSP). |
| 1969 30 Mar. | 194*** | Eggs to young; most nests with eggs. Sample count of 92 nests: 87 (95%) with eggs, 1 (1%) with an egg and young bird, 4 (4%) with young. 4 pairs of pre-laying birds also seen (BSFW). |

*Estimate by Walker.

**Count probably within 5 nests of total present

***Estimate of the number of nesting birds, estimate probably very close to actuality.

Table 20. Locations and sizes of Blue-faced Booby clubs on Lisianski Island

| Period of Observation | | Not given | SE beach | S beach | SW beach | N & NW beaches | Total #s birds in clubs | Approx % of free-flying population in clubs |
|---|---|---|---|---|---|---|---|---|
| 1964 | late Aug. | | | 100 | | "large flock" | ? | |
| 1965 | mid-Mar. | 100 | | | | | ? | |
| 1966 | mid-June | | | | 300 | 200-300 | 500-600 | 70-85 |
| | mid-Oct. | "many clubs" ca. 50-70 | | | | | | |
| 1967 | early June | | | >300 | | 100 | ca. 400 | 40 |
| | early Sept. | | 15-20 | 200 | 40 | ca. 100 | ca. 350 | 45 |
| 1968 | late Mar. | No clubs present | | | | | | 0 |

Table 21. Blue-faced Boobies banded on Lisianski Island

| Period of Survey | | Numbers of Each Age/Sex Class Banded | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Adult ♂♂ | Adult ♀♀ | Adult ?? | Subtotal Adults | Subadult ?? | Immature ?? | Nestling ?? | Age ?? | Totals |
| 1963 | Mar. | 0 | 0 | 235 | 235 | 0 | 0 | 3 | 0 | 238 |
| 1964 | Mar. | 41 | 46 | 0 | 87 | 0 | 0 | 13 | 0 | 100 |
| | Aug. | 15 | 8 | 1 | 24 | 1 | 63 | 1 | 0 | 89 |
| 1965 | Mar. | 9 | 13 | 230 | 252 | 0 | 0 | 0 | 0 | 252 |
| | July | 0 | 0 | 1 | 1 | 0 | 10 | 0 | 0 | 11 |
| 1966 | June | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 3 |
| | Oct. | 61 | 50 | 5 | 116 | 2 | 30 | 14 | 0 | 162 |
| 1967 | June | 52 | 50 | 29 | 131 | 5 | 2 | 21 | 1 | 160 |
| | Aug.-Sept. | 38 | 49 | 1 | 88 | 33 | 85 | 7 | 1 | 214 |
| 1968 | Mar. | 9 | 9 | 0 | 18 | 0 | 0 | 0 | 0 | 18 |
| Totals | | 225 | 225 | 505 | 955 | 41 | 190 | 59 | 2 | 1,247 |

BROWN BOOBY — *Sula leucogaster*

Status

Uncommon breeder; maximum recent estimate 200. Probably present all year but most nesting occurs from about April through late September. Builds nests on the ground in small openings in the perimeter of *Scaevola* above the beaches, and in areas covered with low vegetation near *Scaevola* in the interior of the island. Some nests rather isolated but most birds breed in small loose colonies of 6 to 14 birds.

Populations

Recent estimates consistently indicate populations reach a zenith of no more than 200 birds (Table 22). The more careful recent surveys of nesting populations (July 1965; June 1966; June, August- September 1967) give a maximal breeding population of no more than 40 birds (July 1965) for any one visit. The breeding population may be somewhat larger as nests are often hard to find and can be overlooked, and breeding may have occurred outside periods covered by our surveys. In 1967, however, two careful counts revealed a maximum nesting population for almost the entire year of no more than 50 birds. If, as seems likely, the 4 large downy young and 3 immatures seen in August and September[24] are from the nests seen in June, then no more than 38 birds bred in 1967. In any case we doubt whether the breeding population has exceeded 60 birds in any year since 1963. If this number bred and had 100 percent nesting success, then a maximum population of 100 flying birds seems not unreasonable. Two of the larger recent estimates (July 1965, October 1966) may be somewhat too large but could represent instances in which the island had been visited by a number of wandering birds from other colonies in the area, or when maximal numbers of young birds had returned to the island.

Early estimates by Munter and Wetmore compare favorably with recent estimates, giving no indication of population change in this century.

Annual Cycle

Too few Brown Booby nests have been found on Lisianski by POBSP personnel to enable us to do more than outline the general aspects of the breeding cycle. Most egg-laying apparently occurs from March through May or June.[25] Two nests with eggs were found outside this period (October

[24] In August and September 1967 a major effort was made to determine very accurately the Brown Boody population. We feel that we banded or returned all Brown Boobies on the island and are certain that the nest count is exact. Thus, we have a more firm basis for determining the 1967 breeding population than other years when nesting data were either not taken, or were subject to a greater probability of error.

[25] Two of the more detailed nest counts (June 1966, June 1967) both suggest that an egg-laying peak occurred in April or May.

1966, September 1967) but probably only the September 1967 eggs were viable.

Young are usually present from about May through September or October although a few young from late nests may be present later. The young Munter saw in March 1915 are the only ones seen that early in the year.

The absence of data from November through January precludes definite statements about nesting during that period, but March observations suggest that these birds breed only rarely during those months.

## Ecology

Breeding: About equal numbers nest in small openings in the Scaevola above the beach crests and in the interior. Nests were found most frequently above the west and northwest beaches (June 1966; June 1967). In the interior, nests were most numerous in two areas covered by Ipomoea and near low Scaevola on the south-central and southeastern portions.

In most instances, nesting "colonies" were composed of three or four pairs of birds. In mid-July 1965, however, about seven pairs nested together above the west shore.

Non-breeding: Non-breeding adults and immatures frequently roosted near breeding areas, but other scattered individual birds roosted on Scaevola around much of the beach perimeter. Occasionally individuals roosted in nocturnal aggregations of Red-footed Boobies, and an occasional bird roosted with the Blue-faced Boobies on the beaches. In October 1966 two small clubs of about 30 each were seen on the beaches.

Judging from the relatively low populations observed in spring, some of the population probably departs the island after the breeding season.

## Specimens

Present museum distribution of 17 study skins of Brown Boobies from Lisianski is given in Table 23.

## Banding and Movements

The POBSP and BSFW have banded 67 Brown Boobies on Lisianski (Table 24). None of these has yet been recaptured elsewhere but two adults banded on other islands, one at Wake Island, the other at Johnston Atoll, were recaptured on Lisianski (Appendix Table 9).

Table 22. Observations of Brown Boobies on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1891 29 June-4 July | least common of the three booby species | Only evidence of nesting found was 2 young, both of which were collected by Palmer (Rothschild, 1893-1900: xii). |

Table 22. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1913 | 12 Mar. | 12 | (Bailey, 1956: 59; Willett, ms.). |
| 1915 | 24 Mar. | 75-100 | Eggs and young; some of young well-developed (Munter, 1915: 135-136). |
| 1923 | 15-20 May | 80 | Eggs to about 2-week-old young; most nests apparently with eggs (Wetmore, ms.). |
| 1951 | 13 May | ? | No nest sites found (POFI). |
| 1954 | 26 Mar. | 2 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | ? | Several boobies seen building (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 30 | Flying immatures on beach, no nests found (POBSP). |
| | 12-13 Mar. | ? | (POBSP). |
| 1964 | 11-12 Mar. | 15-20 | No nests found (BSFW, POBSP). |
| | 21-23 Aug. | 50 | No nests found (POBSP). |
| | 18 Sept. | 25-30 | 1 immature, no nests found (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 20-30 | 1 nest with eggs (POBSP). |
| | 14-17 July | 100 | Colony with 6 pairs with nearly full-grown young; estimated 20 young on island (POBSP). |
| 1966 | 16-19 June | 90 | Eggs to small young; estimated 15 nests. Sample count of 11 nests: 3 (27%) with eggs, 8 (73%) with small young (POBSP). |
| | 18-20 Oct. | 200 | 1 nest with eggs, one of them a runt (POBSP). |
| 1967 | 20 Mar. | 15 | 15 adults; no nests found (BSFW, POBSP). |
| | 2-6 June | 75 | Eggs to medium-sized young; ca. half of the nests with eggs, ca. half with young. Count of 18 nests: 10 (56%) with eggs, 5 (28%) with small young, and 3 (17%) with medium-sized young (POBSP). |

Table 22. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 40 | Eggs to dependent immatures; mostly large downy young and immatures. Count of 5 nests: 1 with egg, 4 with large downy young. 2 dependent immatures seen (POBSP). |
| 1968 20-21 Mar. | 20 | Primary breeding areas not visited (BSFW, POBSP). |

Table 23. Specimen skins[x] of Brown Boobies from Lisianski Island.

| Mus. | ♂♂ | Mus. Num. | ♀♀ | Mus. Num. | ??& yg. | Mus. Num. | Date Coll. | Coll. |
|---|---|---|---|---|---|---|---|---|
| AMNH | 5 | 72 471-475 | 5 | 72 476-480 | 1 | 72 481, 482 | 3 June-3 July 1891 | Palmer |
| BPBM | | | | | 1 | ? | ? | ? |
| USNM | | | 1 | 240994 | | | 12 March 1913 | Willett |
| USNM | 1 | 300874 | 1 | 300873 | 1 | 300875 | 16,19 May 1923 | Wetmore |

[x] There is in addition an alcoholic specimen of a young bird (USNM 239249) collected by Wetmore 17 May 1923.

Table 24. Brown Boobies banded on Lisianski Island.

| Period of Survey | | Bander | Adult ♂♂ | Adult ♀♀ | Adult ?? | Subtotal Adults | Immatures | Nestlings | Totals |
|---|---|---|---|---|---|---|---|---|---|
| 1963 | March | POBSP | 0 | 0 | 3 | 3 | 0 | 0 | 3 |
| 1964 | March | BSFW | 0 | 3 | 3 | 6 | 0 | 0 | 6 |
| 1965 | July | POBSP | 0 | 0 | 5 | 5 | 4 | 0 | 9 |
| 1966 | June | POBSP | 0 | 0 | 8 | 8 | 0 | 0 | 8 |
| | October | POBSP | 2 | 3 | 0 | 5 | 0 | 0 | 5 |
| 1967 | August-September | POBSP | 9 | 19 | 1 | 29 | 3 | 4 | 36 |
| Totals | | | 11 | 25 | 20 | 56 | 7 | 4 | 67 |

RED-FOOTED BOOBY Sula sula

Status

Common breeder; maximum recent estimate 3,000. Present throughout year but most abundant from March through at least October. Breeds from at least February through October or November; most breeding occurs from March through September. Builds bulky nests in Scaevola bushes wherever they occur on the island.

Populations

Recent numerical estimates (Table 25), although not highly accurate, suggest that the number of Red-footed Boobies on Lisianski varies with the season, smaller numbers being present in late fall (?) and winter. There are no observations from November through January; we do not know how much populations decrease during that period. Moreover, when only a small proportion of the population is breeding (as in early spring and fall), most of the population is present only as nocturnal roosters. Since no nocturnal observations were made by the POBSP in February 1963 and March 1967, we cannot establish whether there was any real difference between estimates made then and on other March surveys. It seems likely, however, that the spring estimates are small enough so that they represent a real difference in population size from peak populations recorded during summer and fall.

Since the September 1964 survey was made during daylight hours, it is probably somewhat low. We also believe that the estimates from August 1964 and July 1965 are too low. However, data from other islands such as Johnston Atoll indicate that the size of the roosting population may vary greatly from night to night.

Comparisons of recent estimates with those made in 1913 and 1923 clearly indicate that present populations are much larger than during the earlier period. This increase is most likely attributable to the increase of nesting sites concomitant with the revegetation of the island.

Annual Cycle

Egg-laying evidently begins in late February or early March, but probably does not reach a peak until late March or April (see below). Young birds were present in March 1915, but no young were found on March visits between 1964 and 1969. The 1964 season evidently began earlier than subsequent seasons since about half the active nests had eggs by early March. Surveys in early March 1965, and late March 1967, 1968, and 1969, suggest that no more than a third of the active nests contained eggs.

The latest that eggs have been recorded is 19 June, and at least a few eggs are probably present until the end of the month. The single set of recent July observations (1965) indicates that no eggs were present past mid-June that year; the August-September 1967 observations also indicate no eggs past June. However, the large young observed in October 1966

were probably no more than three months from hatching, which shows that eggs could be present as late as July.

The POBSP made no visits to Lisianski in April or May so we cannot with certainty document the peak month or period of egg laying. The large proportion of empty, completed, or nearly completed nests present on various March surveys suggests that the egg peak probably occurred at least several weeks after the surveys were made. The two June nest counts (1966, 1967) indicate that some laying probably occurred in May, but the proportion of eggs to young suggests that most laying occurred from late March through April.

If most of the population lays between late March and late April, then most hatching probably occurs from early May through the first half of June. The relatively high proportion of recently hatched young in early June 1967 lends support to this contention. If the fledging period is taken to be 80 to 100 days, most young fledge from late July through mid-September. A few birds fledge later in the year, but they probably comprise a very small proportion of the total number fledging.

We found no evidence of winter nesting on any of the POBSP March visits, but the observations by Munter of well-grown young in March 1915 indicate that eggs had been laid from 3-1/2 to 4-1/2 months earlier, or sometime in November or December.

Ecology

Breeding: On Lisianski Red-footed Boobies nest exclusively in Scaevola (Fig. 47). They nest individually, in groups of about four to eight birds, or in small colonies. These boobies frequently nest in "pure" colonies but often are found in small numbers among frigatebirds, occasionally nesting in the same bushes with the latter.

In June 1967 detailed notes were taken on sites, nesting materials, and heights of 100 nests. All nests were in forks of Scaevola branches. A major portion of the nesting material, particularly the bases of the nests, consisted of branches and twigs of Scaevola. The upper portion of the nest consisted primarily of Tribulus and/or Sicyos stems and branches; occasionally Scaevola leaves were added. No Boerhavia vines were found in the nests examined in June, but observations made in March 1967 indicate that it is fairly frequently used.

Most nests examined were about four inches deep and over a foot in width; many appeared to have been built on sites utilized in previous years.

Half of the 100 nests examined were on the west side of the island; half were on the east side. In the 50 nests on the west side, Scaevola was used as nesting material in all nests, and Tribulus was used in all but two nests. Scaevola and Tribulus were used in all nests examined on the east side. Sicyos was much more prevalent in nests on the west side of the island (in 38 percent of the nests) than it was on the east side (in

Figure 47. Red-footed Boobies on nests in Scaevola, 12 March 1964. POBSP photograph by A.B. Amerson, Jr.

percent of the nests). This difference suggests the nesting material used may depend in part on the nesting material immediately available.

Difference in the heights of nests on the west and east sides of the island (Table 26) are almost certainly the results of differences in Scaevola height in the two areas. The Scaevola on the west side of the island is, on the whole, much larger than that found on the east side.

Non-breeding: Non-breeding birds roost in a wide variety of situations, both in active colonies and in areas where no nests are found. Most roost in Scaevola and there seems to be a tendency for birds to congregate in roosts in a particular area, but little information is available from most surveys. Casuarina trees, coconut palms, and dead trees are also utilized as roosting sites.

Specimens

We know of four specimens. Two were study skins of males (USNM [illegible]) collected by Wetmore 17 May 1923. He also collected two alcoholic specimens, an embryo (USNM 289[illegible], 16 May 1923) and a young bird (USNM 289295, 17 May 1923).

Banding and Movements

Table 27 summarizes banding of Red-footed Boobies on Lisianski by the POBSP and BSFW. Twenty-five of these birds were recaptured on other islands, some of them having been recaptured more than once and on more than one island. Nine of the birds captured elsewhere were recaptured on French Frigate Shoals; six were recaptured at Laysan Island and at Kure Atoll and five were recaptured on Johnston Atoll (Appendix Table 10a). Seventy that were banded on other islands had been recaptured at Lisianski through 1969: 23 at Johnston Atoll, 15 at French Frigate Shoals, 14 at Laysan Island, 6 at Kure Atoll, 4 each at Midway Atoll and Pearl and Hermes Reef, and 1 at Wake Island (Appendix Table 10b).

Table 25. Observations of Red-footed Boobies on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1828 3 Apr. | ? | Seen by Isenbeck but his observations do not clearly distinguish between breeding of this species and of the Blue-faced Booby (see Rothschild, 1893-1900: iv-v). |
| 1891 29 June-4 July | ? | Palmer noted these birds sitting on their nests on 30 June and indicated that young were seen on 1 July (Rothschild, 1893-1900: xii). |
| 1913 12 Mar. | 60* | 30 pairs nesting, some with fresh eggs (Willett, ms.). |

Table 25. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1915 | 24 Mar. | 10 | Eggs and young birds (Munter, 1915: 135). |
| 1923 | 15-20 May | 40 | Most not nesting, 2 nests with eggs (Wetmore, ms.). |
| 1954 | 26 Mar. | 40-60 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | comparatively rare** | Nesting (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 50 | Nesting (POBSP). |
| | 12-13 Mar. | ? | (POBSP). |
| 1964 | 11-12 Mar. | 500* | Ca. 250 nests, 50-60% with eggs, none with young (BSFW, POBSP). |
| | 21-23 Aug. | 300 | None found nesting*** (POBSP). |
| | 18 Sept. | 500 | 17 very large young, about 1/4 of population composed of flying immatures (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 500-750 | Many nests completed but only a few eggs laid (POBSP). |
| | 14-17 July | 500 | Ca. 200 young from about half-grown nestlings to fully feathered juveniles (POBSP). |
| 1966 | 16-19 June | 2,000 | Sample count of 56 nests showed: 23 (41%) with eggs, 33 (59%) with young; an estimate 50-60 nests with eggs and 65-85 nests with young on island (POBSP). |
| | 18-20 Oct. | 2,500 | Ca. 15 very large young and unfledged immatures; no new nests or nests with eggs (POBSP). |
| 1967 | 20 Mar. | 170* | 18 of 85 (21%) completed nests checked contained eggs; the rest were empty (BSFW, POBSP). |
| | 2-6 June | 3,000 | Eggs to large downy young, most nests with eggs or small young. Count of 516 nests: 236 (46%) with eggs, 88 (17%) with recently hatched young, 73 (14%) with small downy young, and 119 (23%) with medium-sized or large downy young (POBSP). |

Table 25. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 1,500-2,000 | Large downy young to fledged immatures. Most birds with dependent immatures. Ca. 14 large downy young and ca. 400 dependent immatures present. Ca. 3% of population consisting of fledged immatures (POBSP). |
| 1968 21-21 Mar. | 250 | Only eggs present. Sample count of 16 nests: 11 (69%) active but empty; 5 (31%) with eggs. An estimated 150-200 nesting birds present (BSFW, POBSP). |
| 1969 30 Mar. | >214* | 107 nests counted around shoreline; of 8 whose contents were investigated, 6 (75%) were empty but active and 2 (25%) contained eggs (BSFW). |

*Estimate of the number of breeding birds.

**Compared to Blue-faced Boobies.

***The September 1964 observations indicate that a number of nests were overlooked by the August survey

Table 26. Heights of Red-footed Booby nests on Lisianski Island.

| Height of Nests above Ground | Nests located on west side of Lisianski | | Nests located on east side of Lisianski | | All nests examined | |
|---|---|---|---|---|---|---|
| | No. | Pct. | No. | Pct. | No. | Pct. |
| 1 foot | 2 | 4 | 5 | 10 | 7 | 7 |
| 2 feet | 11 | 22 | 26 | 52 | 39 | 39 |
| 3 feet | 27 | 54 | 15 | 30 | 42 | 42 |
| 4 feet | 7 | 14 | 4 | 8 | 11 | 11 |
| 5 feet | 2 | 4 | 0 | -- | 2 | 2 |
| 6 feet | 1 | 2 | 0 | -- | 1 | 1 |
| Mean height | 3.0 | | 2.4 | | 2.7 | |

Table 27. Red-footed Boobies banded on Lisianski Island.

| Period of Survey | | Bander | Adults | Sub-adults | Immatures | Nestlings | Unknown | Totals |
|---|---|---|---|---|---|---|---|---|
| 1963 | March | POBSP | 10 | 0 | 0 | 0 | 0 | 10 |
| 1964 | March | BSFW | 2 | 0 | 0 | 0 | 0 | 2 |
| 1965 | July | POBSP | 0 | 0 | 2 | 0 | 0 | 2 |
| 1966 | June | POBSP | 26 | 0 | 1 | 0 | 0 | 27 |
| | October | POBSP | 350 | 45 | 8 | 2 | 7 | 412 |
| 1967 | June | POBSP | 16 | 0 | 0 | 0 | 0 | 16 |
| | August-September | POBSP | 262 | 66 | 47 | 21 | 0 | 396 |
| | Totals | | 666 | 111 | 58 | 23 | 7 | 865 |

GREAT FRIGATEBIRD — *Fregata minor*

Status

Common breeder; maximum recent estimate 2,000 to 3,000. Peak populations probably occur from March through September or October concurrent with breeding. Some breeding may occur in any month but little breeding probably occurs from late November through early February. Builds bulky nest in *Scaevola* anywhere on the island but with variable local concentrations.

Populations

Recent population estimates rather consistently suggest maximum populations on the order of 3,000 birds with maximal breeding populations of 900 to 1,000 birds. Present populations are about five times the size of that in 1923 (Table 28); presumably revegetation since then now affords the species many more nest sites. The single numerical estimate prior to 1923 (in 1915) suggests populations about equal to those now present. Populations were probably larger prior to 1915 (and to now) since the island had several times been visited by feather hunters prior to Munter's visit and since Munter's comments suggest that the island had been partially defoliated by rabbits by 1915.

Annual Cycle

As on Laysan Island, populations are probably considerably smaller in mid-winter but the absence of observations from November through January makes it impossible adequately to document the decrease in numbers when few birds are breeding.

Laying may begin as early as February (1963) and probably earlier, but the peak laying period apparently falls in March. The peak laying period evidently varies by as much as a week or more with birds laying earlier in some years (1964, 1965) and later in others (1967-69). The presence of eggs and recently hatched young in June 1966 and 1967 implies that eggs may be laid through at least late May. Young may hatch as early as early March (or earlier) and fledge as early as late August or early September. (Immatures seen from March through early August are almost all certainly birds from preceding breeding seasons.) Peak hatching and fledging periods usually fall between late May and June and from early October through early November, but late young may sometimes fledge as late as mid-November or even later.

Ecology

Breeding: Great Frigatebirds nest in Scaevola bushes (Fig. 48) wherever they occur, but the locations of the larger nesting concentrations apparently vary from year to year. In August 1964 most of the nesting birds were found on the southern half of the island whereas in June 1966 most were found on the northern half. In June 1967 the largest concentration of nests was found on the northeastern corner. In August this area still contained large numbers of young birds but an area in the southeastern corner contained almost as many.

Wetmore (ms.) found these birds nesting solely in the tops of clumps of grass (Eragrostis). Such sites are exceedingly unusual in colonies in the Northwestern Hawaiian Islands except at French Frigate Shoals (Amerson, 1971: 220) and were probably used in 1923 only because no other vegetation was available. Neither Munter (1915: 135), who recorded that this species nested in "bushlike growth," nor recent observers have found frigatebirds nesting in grass clumps.

In recent years, all nests found have been built in Scaevola. Most nests observed have been from one to three feet off the ground and the nests themselves ranged from about a foot to a foot and a half in diameter. Nests are usually constructed primarily of Tribulus and/or Scaevola but pieces of Portulaca, Boerhavia, Ipomoea, and Sicyos have also been found in the nests.

Non-breeding: Roosting birds occur in the same areas as breeding birds but often roost apart from them. We have noted on several occasions that non-breeding adults form sexually segregated roosting aggregations. A small group of 4 to 10 adult females will be found roosting together while 50 feet away will be found a similar small group of roosting males.

Fledged immatures and subadults are often found in these groups of males or females, and others roost either individually or in small groups throughout the Scaevola. Both adults and young occasionally use the Casuarina trees as roost sites. Recently fledged young apparently return to the nest site to roost.

Figure 48. Adult female and several young Great Frigatebirds on nests in Scaevola along the west side of the island, 19 June 1966. POBSP photograph by P.C. Shelton.

Specimens

We know of six specimens from Lisianski. Two, an adult male (USNM 464439) and an adult female (USNM 464438) are study skins of birds collected by Wetmore 18 and 17 May 1923, respectively. The other four (USNM 289288-291) collected by Wetmore on 18 May, are alcoholic specimens that were later sent to Leningrad.

Banding and Movements

In all, 422 Great Frigatebirds have been banded on Lisianski, one by the BSFW and the rest by the POBSP (Table 29). Four have been recaptured subsequently on other islands, three at Kure Atoll and one at French Frigate Shoals. In addition, seven banded on other atolls have been recaptured on Lisianski: three each from French Frigate Shoals and Kure Atoll, and one from Pearl and Hermes Reef.

Table 28. Observations of Great Frigatebirds on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1828 3 Apr. | ? | Many nests with eggs; immatures or subadults scarce (Isenbeck *in* Rothschild, 1893-1900: iii-iv). |
| 1891 29 June-4 July | in large numbers | Nesting (Palmer *in* Rothschild, 1893-1900: xii). |
| 1913 12 Mar. | ? | Nesting (Bailey, 1956: 79); substantial nesting colonies (Willett, ms.). |
| 1915 24 Mar. | 3,500 | Nesting in three colonies (Munter, 1915: 135). |
| 1923 15-20 May | 650 | *Ca*. 80 pairs nesting; eggs and young (Wetmore, ms.). |
| 1951 13 May | ? | Nesting (POFI) |
| 1954 26 Mar. | 400 | (Richardson, pers. comm.) |
| 1963 14 Feb. | 1,000 | Some eggs (POBSP). |
| 12-13 Mar. | ? | Nesting (POFI). |
| 1964 11-12 Mar. | 1,750 | *Ca*. 450 nests, *ca* 80% with eggs (BSFW, POBSP). |
| 21-23 Aug. | 10,000 | *Ca*. 100 nests with from 1/3 to 2/3 grown young (POBSP). |
| 18 Sept. | 1,600 | No eggs or nestlings (BSFW, POBSP). |

Table 28. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1965 | 12-14 Mar. | 2,000-3,000 | Ca. 300-400 nests, ca. 75% with eggs (mostly fresh), none with young (POBSP). |
| | 14-17 July | 1,200 | Ca. 400 nests with recently hatched to near-fledging young; immatures on the wing (POBSP). |
| 1966 | 16-19 June | 2,750 | Ca. 300 nests, ca. 25% with eggs, ca. 75% with recently hatched to half-grown young (POBSP). |
| | 18-20 Oct. | 1,500 | 324 near-fledging or fledged young, no nests with eggs or small young (POBSP). |
| 1967 | 20 Mar. | 1,000 | Ca. 200 active nests, 20 of 60 (33%) nests checked contained eggs, rest empty. Over 300 flying immatures (BSFW, POBSP). |
| | 2-6 June | 2,000 | Eggs to large downy young; most nests with eggs or small young. Count of 473 nests: 237 (50%) with eggs, 27 (6%) with recently hatched young, 93 (20%) with small downy young, and 116 (25%) with medium-sized or large downy young (POBSP). |
| | 31 Aug.-5 Sept. | 1,000 | Small downy young to dependent immatures, mostly large dependent young and dependent immatures; 1 small downy young and 11 medium or large downy young counted (POBSP). |
| 1968 | 20-21 Mar. | 1,000 | Fresh to very slightly incubated eggs and a few dependent immatures from the previous breeding season. Sample count of 36 nests: 23 (64%) empty but active and 13 (36%) with eggs (POBSP). |
| 1969 | 30 Mar. | >210 | 105 nests counted around shoreline; of 46 investigated, 14 (30%) were empty but active and 32 (70%) contained eggs (BSFW). |

Table 29. Great Frigatebirds banded on Lisianski Island

| Period of Survey | | Bander | Numbers of Each Age/Sex Class Banded: Adult ♂♂ | Adult ♀♀ | Sub-total Adults | Sub-adult ♂♂ | Sub-adult ?? | Immatures | Nestlings | Unknown | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | Mar. | POBSP | 17 | 25 | 42 | 0 | 16 | 0 | 0 | 0 | 58 |
| 1964 | Mar. | BSFW | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Aug. | POBSP | 28 | 5 | 33 | 0 | 1 | 19 | 7 | 0 | 60 |
| 1966 | June | POBSP | 11 | 15 | 26 | 0 | 0 | 4 | 0 | 1 | 31 |
| | October | POBSP | 10 | 8 | 18 | 3 | 0 | 0 | 100 | 0 | 121 |
| 1967 | Aug.-Sept. | POBSP | 26 | 95 | 123* | 0 | 26 | 2 | 0 | 0 | 151 |
| | Totals | | 93 | 148 | 243* | 3 | 43 | 25 | 107 | 1 | 422 |

*Includes 2 unsexed adults.

DUCK sp. — *Anas* (?) sp.

Status

Extinct. First recorded in 1828 and possibly present through about 1844.

Observations

"A species of Duck,[25] with no conspicuous plumage, [was found] living in small flocks on Moller [= Laysan] and Lisiansky, but not breeding" by Isenbeck in April 1828 (Rothschild, 1893-1900: v). A newspaper account of the wreck of the *Holder Borden* in 1844 (Ward, 1967: 34) stated that "...wild ducks...are plentiful....[and]....were readily tamed." The account also implied that these ducks were eaten by members of the crew. Another account (Ward, 1967: 42) stated that "The ducks seemed peculiarly inclined to renounce their wild and roving propensities and adopt the domestic habits of civilized life. A flock of 40 had attached themselves to the settlement."

[25] This duck, which Warner (1963: 6) and others thought might be the same as the endemic Laysan Teal (*Anas laysanensis*), could have been a distinct subspecies or species.

Although it is possible that the ducks were some other species, this does not seem too likely. Jabes Pell, Captain of the vessel and evidently the primary source for the accounts of the shipwreck (Ward, 1967: 38), was from New England and should have been able to distinguish ducks from curlews, the only other species occurring on Lisianski that is likely to have exhibited the habits ascribed to the ducks. We think it likely that the last of the endemic ducks on Lisianski were killed for food between 1844 and 1846 by the shipwrecked crews of the Holder Borden or Konohasset.

OSPREY — Pandion halieatus

Status

Hypothetical; one unconfirmed record June 1950.

Remarks

King (a) (1956: 42) remarked that in June 1950 he saw "an eagle-like bird on Lisiansky [sic] Island, which I decided later was most probably an osprey." This species has been sighted several times in the main Hawaiian Islands but has not been certainly identified from any of the Northwestern Hawaiian Islands.

PEREGRINE FALCON — Falco peregrinus

Status

Accidental; one sight record March 1965.

Observations

Wirtz saw a falcon, presumably the same bird seen subsequently on 13 and 14 March, flying offshore Lisianski on 12 March 1965 apparently in pursuit of a Bonin Petrel. Judging from the "reddish-brown" plumage, the bird was evidently either a female or an immature.

On 12 March Clapp found a hawk roost in a Casuarina tree near the center of the island. Beneath the tree were many carcasses of shorebirds and a few of terns. One of the carcasses (a Ruddy Turnstone) had been recently killed. In all, there were remnants of 3 Gray-backed Terns, 1 Black Noddy, at least 47 Ruddy Turnstones and 20 Golden Plovers. Most of the shorebirds had been either completely eaten with only disarticulated wings not ingested, or all parts of the body had been eaten except for the wings which were still attached to one another by bare bones. The terns, on the other hand, were only partially eaten, perhaps indicating that the falcon had found these birds less tasteful.

During the POBSP survey of the island, the roost was watched from dusk until dark on several evenings but the falcon was not seen. POBSP personnel searched beneath other Casuarina trees for evidence that they were being used as roosts but no other bird kills were found.

This record, a sight record from Midway, and a specimen from Kure, constitute the only records of Peregrines in the Northwestern Hawaiian Islands (Clapp and Woodward, 1968: 15-16).

LAYSAN RAIL — Porzanula palmeri

Status

Possibly present in 1828 and subsequently extinct; introduced in 1913 but disappeared from the island between February 1916 and May 1923.

Observations

On Laysan and Lisianski in March and April 1828, Isenbeck saw "A kind of Fowl, about as large as a Ptarmigan; mixed grey and brown; running on the ground, singly, but at the same time rather numerous...very rapid and rather shy" (translation from Kittlitz in Rothschild, 1893-1900: v). Rothschild (op. cit.), commenting on this description, stated that "Although the description is very different, nothing else can be meant but Porzanula palmeri...." In view of the vagueness of many of Isenbeck's descriptions, we doubt the accuracy of Rothschild's statement, particularly since the description might also fit the Bristle-thighed Curlew.

On 12 March 1913, 45 rails that had been brought from Laysan were released on Lisianski by George Willett and Alfred M. Bailey. Although no rails were noted by Elschner the following year, in March 1915 Munter (1915: 136) noted that several were seen and remarked that "One was seen breaking into a tern's egg and greedily eating of the contents...." In February of the following year, one or two birds were seen by the crew of the Thetis. At that time no vascular plants grew on the island and it seems doubtful if the last few rails survived much longer. In any case, none was found during the visit of the Tanager Expedition in May 1923.

SEMIPALMATED PLOVER — Charadrius semipalmatus

Status

Accidental; one record September 1967.

Observations

On 4 September 1967 Ely shot a Semipalmated Plover at the north end of Lisianski. When first seen, the plover was feeding along the flat, rocky shoreline. The specimen (USNM 544001) is a very fat immature female. It constitutes the first record for Lisianski. These plovers are regular visitors in small numbers to the main Hawaiian Islands and have been recorded from French Frigate Shoals (Amerson, 1971: 237), Laysan Island (Ely and Clapp, 1973 ) and Midway Atoll (Clapp, 1968: 76) in the Northwestern Hawaiian Islands.

MONGOLIAN PLOVER — *Charadrius mongolus*

Status

Accidental; one record September 1967.

Observations

At 0400, 4 September 1967, Clapp collected by hand a Mongolian Plover that was roosting solitarily on the wave-sculpted rocks along the northeast perimeter. The specimen (USNM 543063) is an immature female that had only light fat. On the basis of range and wing length (133 mm.), the specimen is tentatively assigned to the race *Charadrius mongolus stegmanni*. It constitutes the first record for Lisianski and for the entire Hawaiian area. The Mongolian Plover breeds from northeastern Siberia to western Alaska (A.O.U., 1957: 169) and has previously been recorded as far east in the tropical Pacific as Majuro Atoll in the Marshall Islands (Amerson, 1969: 100).

GOLDEN PLOVER — *Pluvialis dominica*

Status

Abundant migrant; maximum recent estimate 2,000. Probably occurs in all months but more abundant in spring and fall. Found primarily around perimeter of island.

Populations and Annual Cycle

The largest numbers have been present in February and March, and late August, September, and October (Table 30). Numbers present during these migratory periods were variable, suggesting rapid turnover in the population. Minimal numbers are apparently present June through August. Since scientific visits have not been made November through January, we do not know the size of the wintering population.

Ecology

Like most other shorebirds occurring on Lisianski, plovers are most common around the perimeter of the island. The largest flocks most often roost on the wider expanses of the south and southwest beaches. On the south beach in March 1965, a flock of about 950 was present, and in August and September 1967, a flock of about 200 was seen there. In March 1968, about 500 roosted on the southwest beach. During periods of peak abundance (March 1965, 1968), these birds were so numerous that they were found around the entire perimeter of the island.

Individuals and small flocks frequently feed in the interior of the island, but the preferred area is within several hundred yards of the beach crest. In March 1968, Kenyon noted that this species (and the turnstones and curlews) apparently preferred to forage in areas of low growth such as *Tribulus* and *Ipomoea*.

At night many plovers roost inland, usually solitarily. On several visits (August and September 1967, March 1968), they were found commonly in little clearings in the Scaevola and Eragrostis above the beach crests, and were commonest above the beach crests on the south, west, and north-northwest perimeter.

Specimens

We have found no records indicating that Golden Plovers have been collected on Lisianski.

Banding and Movements

In all, 73 Golden Plovers have been banded on Lisianski by the POBSP and BSFW. The BSFW banded 12 in March 1964, 41 in September 1967, and 6 in March 1968; the POBSP banded 14 in September 1967. One of these birds, banded in March 1964, was found subsequently on two other atolls, Kure Atoll and Pearl and Hermes Reef (Appendix Table 12).

Table 30. Observations of Golden Plovers on Lisianski Island

| Date of Survey | Population Estimate | Remarks and References |
|---|---|---|
| 1828 3 Apr. | ? | Some "Snipe" or "a species of Sandpiper" seen in flocks by Isenbeck; may have been this species (Rothschild, 1893-1900: v). |
| 1891 29 June-4 July | ? | Noted by Palmer 30 June (Rothschild, 1893-1900: xii). |
| 1913 12 Mar. | plentiful | (Willett, ms.). |
| 1923 15-20 May | 12 | 1 flock on 19 May (Wetmore, ms.). |
| 1950 24 June | abundant | (POFI). |
| 1954 26 Mar. | 50 | (Richardson, pers. comm.). |
| 1961 9 Mar. | a few | Circling island (Woodside and Kramer, ms.). |
| 1963 14 Feb. | 300-400 | Large flocks on eastern and southeastern beaches (POBSP). |
| 12-13 Mar. | ? | (POBSP). |
| 1964 11-12 Mar. | 600 | Count of 520 made 12 March (BSFW, POBSP). |
| 21-23 Aug. | 30 | 1 flock on SW shore (POBSP). |
| 18 Sept. | 75 | Count of 50 (BSFW, POBSP). |

Table 30. (continued)

| Date of Survey | Population Estimate | Remarks and References |
|---|---|---|
| 1965 12-14 Mar. | 2,000 | Flock of about 1,000 seen flying off the south beach 14 March; large flocks seen in complex aerial maneuvers offshore (POBSP). |
| 14-17 July | 0 | (POBSP). |
| 1966 16-19 June | 75 | Count of 56 on 18 June; most birds along beaches. 5-10% in full breeding plumage (POBSP). |
| 19 Sept. | 3 | Along shoreline (BSFW). |
| 18-20 Oct. | 300 | Count of 81 on 18 October; many seen singly in interior as well as with flocks of turnstones on beaches (POBSP). |
| 1967 20 Mar. | 75-100 | 35 counted along beaches; all seen in winter plumage (BSFW, POBSP). |
| 2-6 June | 200 | Ca. 80% in breeding plumage (POBSP). |
| 31 Aug.-5 Sept. | 450 | Estimate based on partial count around perimeter 31 August; more common on north, west, and south beaches than on east beach; many small flocks of 20-50 birds and a large flock of at least 200 on the south beach; none seen in full breeding plumage but many still retaining patches of black on the belly (POBSP). |
| 1968 20-21 Mar. | 600 | Most seen in 1 flock of ca. 500 birds on southwest beach; many coming into breeding plumage (BSFW, POBSP). |
| 1969 30 Mar. | ? | 5 along shoreline (BSFW). |

BLACK-BELLIED PLOVER — Squatarola squatarola

Status

Rare visitor; two records March 1965, June 1966.

Remarks

Three Black-bellied Plovers collected by POBSP personnel are the only records of this species from Lisianski. A male (USNM 494120) and

a female (USNM 494121) were collected by Clapp on the east beach 13 March 1965. They were first observed feeding among exposed rocky outcroppings in shallow water. A female (USNM 496779) was collected 18 June 1966 by Crossin as it fed along the shoreline of the southeast beach, occasionally in association with Golden Plovers.

Black-bellied Plovers are found infrequently in the Northwestern Hawaiian Islands, but have been recorded also from Kure, Midway, and Laysan (Clapp and Woodward, 1968: 16).

BRISTLE-THIGHED CURLEW — Numenius tahitiensis

Status

Common migrant; maximum recent estimate 200. A few are probably present in all months with larger numbers present February to March and August to September.

Populations and Annual Cycle

This species, like other shorebirds occurring on Lisianski, shows pronounced population fluctuations (Table 31). Lack of counts or estimates from November through January and from April make it impossible to determine exactly periods of peak numbers and numbers wintering on the island. Observations from June through October suggest that the fall peak of migration may occur from late August through early September. Two estimates prior to that period (July 1965, June 1966) and two thereafter (September 1964, October 1966) are no more than 50 percent of the two extimates from intervening periods.

Ecology

Unlike other species of shorebirds occurring on Lisianski, Bristle-thighed Curlews are often found in as large numbers in the vegetation on the beach crest as along the beaches. Moreover, this species seems to exhibit a preference for some areas of the island, although birds can usually be found in small numbers all around the perimeter. On four surveys[26] these shorebirds occurred most densely on the northwest beach and beach crest of the island and along the rocky northeastern beach. Large flocks were seen in the former area in February 1963 (ca. 20 birds); in September 1967 (ca. 30); and in March 1968 (21). In the latter area, large flocks were seen in March 1965 (ca. 30-40) and in September 1967 (ca. 10).

At night curlews were found individually or by twos in clearings in the vegetation of the beach crest, and even well into the center of the island. They were rarely seen on the beaches at night.

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[26] Although the largest flocks were recorded on a number of other visits (ca. 35 in August 1964, 17 in July 1965, 12 in June 1967), the area in which they were found was not noted.

## Specimens

We know of but two specimens, a female (USNM 301042) collected by Wetmore 19 May 1923 and a male (USNM 493202) collected by the POBSP 12 March 1963.

## Banding and Movements

In all, 119 Bristle-thighed Curlews have been banded on Lisianski, 54 by the POBSP and 65 by the BSFW (Table 32). None has yet been recaptured on any other island.

Table 31. Observations of Bristle-thighed Curlews on Lisianski Island

| Date of Survey | | Population Estimate | Remarks and References |
|---|---|---|---|
| 1828 | 3 Apr. | rather numerous | "A kind of fowl, about as large as a Ptarmigan: mixed gray and brown" seen by Isenbeck (Rothschild, 1893-1900: 4) was most likely this species. |
| 1891 | 29 June-4 July | a few | A few "in poor plumage" noted by Palmer on 29 June (Rothschild, 1893-1900: xiii). |
| 1913 | 12 Mar. | common | (Willett ms.). |
| 1915 | 24 Mar. | 1 | Along the shore (Munter, 1915: 136). |
| 1923 | 15-20 May | 4 | Feeding along beach 19 May (Wetmore, ms.). |
| 1950 | 24 June | abundant | (POFI). |
| 1954 | 26 Mar. | 35 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | ? | "Common in the interior grass land" (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 200 | 1 flock of ca. 20 on northwest beach (POBSP). |
| | 12-13 Mar. | ? | More than a dozen along shoreline (POBSP). |
| 1964 | 11-12 Mar. | 100 | Count of 67 on 12 March (BSFW, POBSP). |
| | 21-23 Aug. | 100 | 1 flock of ca. 35 on beach; on beaches and in interior (POBSP). |
| | 18 Sept. | 30-40 | Count of 24 (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 100-200 | Flocks of 30-40 on beaches, particularly the rocky northeastern beach (POBSP). |

Table 31. (continued)

| Date of Survey | Population Estimate | Remarks and References |
|---|---|---|
| 1965 14-17 July | 50 | (POBSP). |
| 1966 16-19 June | 40 | Count of 28 on 18 June, mostly of birds on outer beaches (POBSP). |
| 19 Sept. | 17 | Along shoreline (BSFW). |
| 18-20 Oct. | 40 | (POBSP) |
| 1967 20 Mar. | 15 | 15 seen on beaches and in interior on partial survey of island (BSFW, POBSP). |
| 2-6 June | 20 | (POBSP). |
| 31 Aug.- 5 Sept. | 100 | On beaches and in interior. Most commonly seen in partially open areas on the crests of northern beaches. Ca. 30 seen in largest flock. 49 banded (POBSP). |
| 25-26 Sept. | ? | 32 banded (BSFW). |
| 1968 20-21 Mar. | 100-125 | Most abundant along northern perimeter but scattered individuals seen around perimeter. Largest flock contained 21 birds (BSFW, POBSP). |

Table 32. Bristle-thighed Curlews banded on Lisianski Island

| Period | | Bander | Number Banded |
|---|---|---|---|
| 1963 | March | POBSP | 3 |
| 1964 | March | BSFW | 7 |
| 1965 | March | POBSP | 1 |
| 1967 | June | POBSP | 1 |
| | September | POBSP | 49 |
| | | BSFW | 32 |
| 1968 | March | BSFW | 26 |
| Total | | | 119 |

BAR-TAILED GODWIT — *Limosa lapponica baueri*

Status

Accidental; one record March 1964.

Remarks

A female collected by Wislocki 11 March 1964 constitutes the only record for Lisianski Island. The specimen (USNM 493478) had a minute ovary, very light fat, and worn plumage. These godwits, casual visitors to the Northwestern Hawaiian Islands, have also been recorded from Kure, Midway, and Laysan (Clapp and Woodward, 1968: 17).

WANDERING TATTLER — *Heteroscelus incanum*

Status

Uncommon migrant; maximum recent estimate 25. A few probably present in all months. Recorded solely from the shoreline of the island, particularly in more rocky areas.

Populations and Annual Cycle

Although frequently recorded from Lisianski, tattlers are not abundant there (Table 33). The largest estimates have been made in March and September, but differences in estimates from month to month are too slight to justify delineating peak periods of abundance.

Ecology

All observers who have noted locations where these birds were seen have indicated that they were found along the shoreline. A few tattlers were usually seen along stretches of sandy beach but most birds were typically found along the perimeter in areas where rocky outcroppings line the shore (from the northwest point to the northeast side of the island) and where low tides exposed rocky tide pools (most of the southern half of the eastern perimeter).

Specimens

We know of the location of five specimens of tattlers from Lisianski: two females (USNM 301020-21) collected by Wetmore in May 1923; and a male (USNM 544562), a female (USNM 496688) and an unsexed specimen (USNM 544561) collected by the POBSP on 17 and 18 June 1966.

Banding and Movements

Seven Wandering Tattlers have been banded by the POBSP and BSFW: 1 in March 1964 (BSFW), 4 in September 1967 (3 POBSP, 1 BSFW), and 2 in March 1968 (BSFW). One of the birds banded by the POBSP in September 1967 was recaptured on Lisianski the following March but none has been recaptured on other islands.

Table 33. Observations of Wandering Tattlers on Lisianski Island

| Date of Survey | | Population Estimate | Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | ? | Noted by Palmer on 29 June (Rothschild, 1893-1900: xii). |
| 1923 | 15-20 May | 4 | Seen on 19 May (Wetmore, ms.). |
| 1963 | 14 Feb. | 12 | Half seen along the rocky northeastern beach (POBSP). |
| 1964 | 11-12 Mar. | 10 | Count of 7 on 12 March (BSFW, POBSP). |
| | 21-23 Aug. | 10 | (POBSP). |
| | 18 Sept. | 20-25 | Count of 16 (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 25 | Most seen along rocks of northeastern beach (POBSP). |
| | 14-17 July | 0 | (POBSP). |
| 1966 | 16-19 June | 20 | Count of 15 made 18 June. Most seen along the edge of the water. At least 3 in breeding plumage (POBSP). |
| | 19 Sept. | 1 | Along shoreline (BSFW). |
| | 18-20 Oct. | 10 | Count of 7 made 18 October (POBSP) |
| 1967 | 20 Mar. | 2 | Seen during partial survey (BSFW, POBSP). |
| | 2-6 June | 15 | (POBSP). |
| | 31 Aug.-5 Sept. | 20 | Based on partial counts around perimeter; singly or in pairs along beach perimeter (POBSP). |
| 1968 | 20-21 Mar. | 25 | Seen sparsely around perimeter of island (BSFW, POBSP). |

RUDDY TURNSTONE — *Arenaria interpres*

Status

Abundant migrant; maximum recent estimate 1,000 to 2,000. Probably present all year. Most abundant in March and September on basis of available data. Occurs most abundantly on beaches around outer perimeter of the island.

## Populations and Annual Cycle

This species is usually the most abundant shorebird on Lisianski but occasionally is equalled in numbers by the Golden Plover. Peak numbers were recorded in March and September; typically fewest birds were present June to August (Table 34). The few observations made August to November indicate that September is the fall migratory peak; there are too few observations from February and April for us to be certain that the spring peak is March. Observations from February to April on Kure indicate March is the period of peak migration; it seems likely the same is true for Lisianski.

Some probably winter on Lisianski, but no data are available that would indicate the size of the population then.

## Ecology

Turnstones were usually found all around the beaches but on some visits were noted as more common in certain areas. Largest flocks observed were: on or near the rock ledge on the northeast side of the island (175 - August 1964, 82 - June 1966); in an area of low grass at the north end of the island (150 - September 1967); on the wide south beach (400 to 500 - September 1967); and on the broad point of the southwest beach (200 - September 1967). On some visits (March 1965, 1968), birds were so abundant that they almost covered all beaches. On such visits it was difficult if not impossible to pick out discrete flocks.

At night these birds roost under vegetation or in small clearings in the vegetation, and on rock outcroppings on the island perimeter. Most birds seen at night in the interior are widely scattered, usually roosting solitarily or by twos. In March 1965 birds were particularly common at night under dense Scaevola along the northeast perimeter.

Largest nocturnal roosting concentrations were twice noted on the wave-sculpted rocks along the north and northeast perimeters. In August and September 1967 and March 1968 up to several hundred birds roosted in this area, crouching down in the hollows of the rock.

## Specimens

Twenty-four Ruddy Turnstones, 11 males, 11 females, and 2 of undetermined sex, were collected by the POBSP (Table 35).

## Banding and Movements

Ruddy Turnstones totalling 485 have been banded on Lisianski, 178 by the POBSP and 307 by the BSFW (Table 36). On 20 March 1968, six of the birds banded the previous September were recaptured on Lisianski. None of the birds banded on Lisianski has been recaptured elsewhere.

In addition, five turnstones that were banded by the POBSP on St. George Island, Alaska, were subsequently collected or recaptured on Lisianski (Appendix Table 13).

Table 34. Observations of Ruddy Turnstones on Lisianski Island

| Date of Survey | | Population Estimate | Remarks and References |
|---|---|---|---|
| 1823 | 3 Apr. | ? | Some "Snipe" or a species of "Sandpiper" seen in flocks by Isenbeck (Rothschild, 1893-1900: 4). |
| 1891 | 29 June-4 July | ? | Noted by Palmer on 29 June (Rothschild, 1893-1900: xii). |
| 1915 | 24 Mar. | 12 | (Munter, 1915: 136). |
| 1923 | 15-20 May | 4 | Seen on 16 May (Wetmore, ms.). |
| 1954 | 26 Mar. | 200-300 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | ? | Flock of 100+ (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 200-300 | Large flocks on eastern and southern beaches (POBSP). |
| | 12-13 Mar. | ? | Flock of several hundred on rocks along east shore (POBSP). |
| 1964 | 11-12 Mar. | 1,000 | Count of 725 on 12 March (BSFW, POBSP). |
| | 21-23 Aug. | 200 | Flock of ca. 175 on rocks at northeast end (POBSP). |
| | 18 Sept. | 900-1,000 | Count of 868. Flocks of from 250-600 (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 1,000-2,000 | Large flocks (POBSP). |
| | 14-17 July | 200 | Flock of 100+ on rocks along shore (POBSP). |
| 1966 | 16-19 June | 150 | Count of 119 on 18 June; includes flock of 82 on rocky outcropping at northeast end of island. About 25% in or near full breeding plumage (POBSP). |
| | 19 Sept. | 150 | Along shoreline (BSFW). |
| | 18-20 Oct. | 700 | Count of 580 on 18 October. Most birds along beaches in flocks of 30-100+. Most in winter plumage (POBSP). |
| 1967 | 20 Mar. | 100 | Seen during partial survey of island (BSFW, POBSP). |
| | 2-6 June | 100-300 | (POBSP). |

Table 34. (continued)

| Date of Survey | Population Estimate | Remarks and References |
|---|---|---|
| 1967 31 Aug.-5 Sept. | 1,700 | Estimate based on partial counts around perimeter on 31 August. Considerably more common on north, west, and south beaches than on east beach. Largest flock contained 400-500 birds. Plumage ranged from drab winter plumage to full breeding plumage (POBSP). |
| 1968 20-21 Mar. | 1,000 | Abundant along beaches; commonly observed in interior (BSFW, POBSP). |

Table 35. Specimens of Ruddy Turnstones from Lisianski Island

| Mus. | ♂♂ | Mus. Nos. | ♀♀ | Mus. Nos. | ?? | Mus. Nos. | Date Coll. | Coll. |
|---|---|---|---|---|---|---|---|---|
| USNM | | | 1 | 494143 | | | 22 Aug. 1964 | POBSP |
| USNM | 11 | 497536, 537,539, 543332, 544447, 449,531, 532,548, 552,553 | 10 | 543331, 333, 544445, 448,450, 533,534, 549-551 | 2 | 497538 544445 | 17-18 June 1966 | POBSP |

Table 36. Ruddy Turnstones banded on Lisianski Island

| Period | Bander | Number Banded |
|---|---|---|
| 1963 Mar. | POBSP | 28 |
| 1964 Mar. | BSFW | 77 |
| 1967 Aug.-Sept. | POBSP | 150 |
| Sept. | BSFW | 56 |
| 1968 Mar. | BSFW | 174 |
| Total | | 485 |

SANDERLING *Crocethia alba*

Status

Uncommon migrant; maximum recent estimate 20. Recorded in February, March, May, June, August and September. Found primarily along the sandy beaches.

Populations and Annual Cycle

Table 37 lists all known observations of Sanderlings on Lisianski. Although only recently reported from the island (Clapp and Woodward, 1968: 22), this species probably occurs in small numbers every year.

Ecology

These birds have been seen all around the outer beaches of the island, most frequently along the sandy beaches on the south and west. Four were seen sitting on a rocky outcrop off the east shore in March 1965 where some may roost at night.

The only nocturnal observations were of two or three birds found roosting along the west beach above the waterline on 20 March 1968.

Specimens

A male that was captured by Clapp with a hand net along the west beach on 20 March 1968 is the only specimen that has been collected. This bird (USNM 543338) was very fat, weighing 52.8 grams, and was molting in the body feathers. The largest testis measured 2.5 x 1.5 mm.

Table 37. Observations of Sanderlings on Lisianski Island

| Date of Survey | Population Estimate | Remarks and References |
|---|---|---|
| 1913 12 Mar. | fairly common | (Willett, ms.). |
| 1923 15-20 May | 0 | (Wetmore, ms.). |
| 1954 26 Mar. | 25-30 | (Richardson, pers. comm.). |
| 1955 8 May | 10-15 | (POBSP). |
| 1963 14 Feb. | 20 | At numerous points around the beaches: 8-10 in mixed shorebird flock on southeast beach; 9 in one flock on north beach (POBSP). |
| 1964 11-12 Mar. | 20 | Count of 12 on outer beach on 12 March (BSFW, POBSP). |
| 21-23 Aug. | 0 | (POBSP). |
| 18 Sept. | 2 | (BSFW, POBSP). |
| 1965 12-14 Mar. | 4-6 | 4 sitting on reef off east shore; 2 flying in flocks of plovers and turnstones (POBSP). |

Table 37. (continued)

| Date of Survey | | Population Estimate | Remarks and References |
|---|---|---|---|
| 1965 | 14-17 July | 0 | (POBSP). |
| 1966 | 16-19 June | 0 | (POBSP). |
| | 18-20 Oct. | 0 | (POBSP). |
| 1967 | 20 Mar. | 8 | Seen on west beach during partial survey (BSFW, POBSP). |
| | 2-6 June | 3 | Birds in winter plumage on northwest beach (POBSP). |
| | 31 Aug.-5 Sept. | 3 | All in winter plumage. Occasionally seen along east beaches but usually along sandy margins of west and southwest beaches (POBSP). |
| 1968 | 20-21 Mar. | 6-8 | All in winter plumage; 4 seen at once along northwest beach but 1-3 birds most often seen along west beach (BSFW, POBSP). |

PECTORAL or SHARP-TAILED SANDPIPER — *Erolia melanotos* or *acuminata*

Status

Accidental; sight records October 1966.

Observations

Lewis reported a "Pectoral?" Sandpiper in the interior of Lisianski on 18 October 1966. On the same date Harrington noted "2 Sharp-tails (?)." No details were given in field notes but it seems likely that one or the other of the above species was seen since both species regularly occur in the Northwestern Hawaiian Islands. Their occurrence on Lisianski, which has no interior pool or lagoon, is undoubtedly considerably less frequent than on atolls (such as Midway and Laysan) that possess them.

HERRING GULL — *Larus argentatus vegae*

Status

Accidental; one record February 1963.

Observations

Wirtz saw and shot at a Herring Gull offshore Lisianski on 14 February 1963. Sibley collected it on the east beach later that day. This

gull (USNM 493353), a female in first nuptial plumage, is the only record of the Herring Gull from the island (Clapp and Woodward, 1968: 26).

GLAUCOUS-WINGED GULL — *Larus glaucescens*

Status

Rare visitor; two records March 1965, March 1968.

Remarks

A male in first nuptial plumage (USNM 494133) was collected by Clapp on 12 March 1965. It was shot near the southeast point of the island but was only wounded and swam out to sea. Late the same night, Stadel and Clapp captured it on the south beach about $\frac{1}{4}$ mile from where it had been shot.

A second gull was seen by Clapp on 20 March 1968 as it flew along the crest of the northeast beach. He collected the bird on the southwest beach the following day. The specimen (USNM 543339), not reported heretofore, is a very fat female in second winter plumage.

Glaucous-winged Gulls are frequent visitors to the main Hawaiian islands in winter and have been recorded previously from most of the Northwestern Hawaiian Islands (Clapp and Woodward. 1968: 27).

GRAY-BACKED TERN — *Sterna lunata*

Status

Common breeder; maximum recent estimate 15,000. Present from at least February through early September but most breeding occurs from mid-March through late July. Probably absent from the island when not breeding or forming breeding colonies. Nests in scattered colonies on the ground over much of the island surface.

Populations

Since several recent March surveys were diurnal only, and since numbers may be much greater at night during the inception of the breeding season, most of the differences between March estimates (Table 38) probably are not significant. The difference between the March 1964 and March 1965 estimates, when nocturnal surveys were made, may indicate a real difference in population levels--a difference that probably resulted from differences in the timing of the breeding cycle in these years.

Wetmore's estimate is significantly lower than recent estimates made in June. The present breeding population is evidently 10 to 30 times as large as in 1923, presumably because far more nesting habitat is now available.

## Annual Cycle

Lisianski Gray-backed Terns have an annual breeding cycle, which varies little from year to year. These terns arrive at the island a month or more before egg-laying begins and leave the island shortly after the breeding season is completed. On Lisianski, as on other Northwestern Hawaiian Islands, the breeding cycle of the Gray-backed Tern is several weeks earlier than that of the Sooty Tern. Initiation of laying usually occurs about mid-March but occasionally occurs earlier or later. The presence of a recently hatched young in mid-March 1965 indicates that at least some eggs were laid by mid-February that year. In the previous year none was known to be laid until the latter half of March. The small number of birds and nests with eggs seen in late March 1967 and 1968 suggests that in both these years laying began in March. In addition, the predominance of fledged young in mid-June 1966 suggests that a laying peak occurred about three months earlier, or in mid-March. The June 1967 observations, on the other hand, suggest a somewhat later laying peak, probably late April or early May. On the whole, the data suggest that the egg peak usually falls between mid- or late March and mid- or late April but laying probably continues at a reduced level through mid-May. If this is true, the hatching peak probably occurs from mid- or late April through mid- or late May. The single set of observations made during this period (1923), while not detailed, seems to fit this pattern.

Most fledging probably occurs about two months after the hatching peak, or from mid- or late June through mid- or late July. A few birds from eggs laid in May fledge in August, primarily during the first two weeks of the month.

## Ecology

Breeding: During POBSP surveys, Gray-backed Terns have nested over much of the island. Eggs were usually placed under vegetation--the thick Scaevola on the island perimeter, the more open, partially dead Scaevola in the interior, or the clumps of Eragrostis in the sandy areas. On at least one occasion (July 1965), most of the Gray-backed Terns were found nesting around the perimeter of the Sooty Tern colony.

Non-breeding: The decreasing numbers of Gray-backed Terns towards the end of the nesting season, and the relatively small numbers present at its beginning, suggest that these terns are absent from the island during non-breeding periods.

## Specimens

We have records of five study skins of Gray-backed Terns from Lisianski: two unsexed birds (USNM 191501-502) confiscated from the Japanese 16 June 1904 by the U.S. Treasury; a male (USNM 300627) collected by Wetmore 18 May 1923; and two birds collected by the POBSP, a male (USNM 494124) collected 13 March 1965 and an unsexed bird (USNM 545022) collected 3 September 1967. There is, in addition, a skull (USNM 289225) collected by Wetmore 17 May 1923.

Banding and Movements

In March 1965 POBSP personnel banded 374 adults, 200 of them on eggs. None has been recaptured.

Table 38. Observations of Gray-backed Terns on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1828 | 3 Apr. | ? | Probably seen by Isenbeck (see Rothschild, 1893-1900: v-vi). |
| 1891 | 29 June-4 July | ? | Palmer noted that a few Gray-backed Terns were on the island on 30 June (in Rothschild, 1893: xii). |
| 1913 | 12 Mar. | ? | Nesting in considerable numbers (Willett, ms.). |
| 1915 | 24 Mar. | 500 | 1 egg found (Munter, 1915: 136). |
| 1923 | 15-20 May | 500 | Eggs and young present, but mostly recently hatched to well-grown young (Wetmore, ms.). |
| 1951 | 13 May | ? | (POFI). |
| 1954 | 26 Mar. | 300 | (Richardson, pers. comm.). |
| 1961 | 9 Mar. | few seen | Usually on eggs (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 200 | No nests found (POBSP). |
| | 12-13 Mar. | ? | No nests found (POBSP). |
| 1964 | 11-12 Mar. | 500 | Ca. 50-100 on ground but no nests found (BSFW, POBSP). |
| | 21-23 Aug. | 3 | 2 immatures; not breeding (POBSP). |
| | 18 Sept. | 0 | (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 2,000-3,000 | At least 1,000 nests with eggs but only 1 recently hatched young seen (POBSP). |
| | 14-17 July | 300 | Only fledged or near-fledging immatures (ca. 100) present (POBSP). |
| 1966 | 16-19 June | 7,500 | Ca. 1,000 nests with eggs and 2,500 young; mostly fledged young but some small young (POBSP). |
| | 18-20 Oct. | 0 | (POBSP). |

Table 38. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 20 Mar. | low 100's | 26 nests with eggs, 1 at least slightly incubated (BSFW, POBSP). |
| 2-6 June | 15,000 | From eggs to half-grown young; most nests with eggs; estimated 5,000 nests (POBSP). |
| 31 Aug.-5 Sept. | 20 | Nesting season essentially completed; only a few large young found, most of them apparently abandoned and starving: very few adults (POBSP). |
| 1968 20-21 Mar. | 1,000 | Only eggs present (BSFW, POBSP). |

SOOTY TERN — *Sterna fuscata*

Status

Abundant breeder; maximum recent estimate 1,700,000. Present from mid-February through October but most nesting occurs from April through early September. Nests on the ground over much of the interior of the island.

Populations

Although the largest recent estimate, made in early June 1967, seems large compared with all other population estimates (excepting perhaps the June 1966 estimate), it was based on density counts applied to total nesting area and is perhaps more accurate than some of the other estimates. POBSP estimates for other islands where careful attempts have been made to determine population size have consistently shown that visual estimates often greatly underestimate numbers present. Thus we feel that peak populations on Lisianski reach a million birds and very possibly more.

Comparison of recent estimates (Table 39) with those made in 1923 clearly show that populations are much larger now than then. Like both the Great Frigatebird and White Tern, this species was abundant at the turn of the century; numbers decreased markedly as a result of feather gathering activities and devegetation of the island and have increased markedly with the return of the vegetation.

Annual Cycle

Sooty Terns usually return to Lisianski about February but for a month to six weeks swirl over the island in pre-breeding flocks. The various recent March observations indicate that although numbers may be fairly large, few birds may be on the ground. Judging from recent

observations, laying begins in April but the peak laying period is usually from mid-May through early June (probably 1891, and 1964 through 1967). A few young may hatch in late April but the peak hatching period usually falls from mid-June through early July. Birds may fledge from early July through September or October, but probably only a very small proportion fledge in the latter month.

Our data are not precise enough to allow any extended discussion of yearly variations in breeding cycles. The Sooty Tern cycle on Lisianski seems quite consistent from year to year. Data from 1964, 1966, and 1967 seem quite comparable. The July 1965 observations, on the other hand, perhaps indicate an earlier than usual termination of the breeding cycle.

## Ecology

Breeding: At least in recent years the population has been distributed among a number of colonies (about 8 in August 1964) marked by slight differences in nesting cycle. Nesting occurs chiefly in the Eragrostis association in the center of the island (Fig. 49). Smaller numbers nest under the edges of Scaevola clumps (occasionally in fairly dense Scaevola patches) and in open areas in Ipomoea. In June 1966 some birds nested in thicker Scaevola than is typical for this species in the Northwestern Hawaiian Islands.

Non-breeding: After breeding, most adults desert the colony or return only at night. Most nightly concentrations form in the vicinity of chicks or in open areas. Birds may form "roosting flocks" composed entirely of adults or of adults and flying immatures. In 1966 and 1967 a few non-incubating birds were observed resting on Scaevola bushes.

## Specimens

We have records of 24 study skins of specimens collected on Lisianski: 4 unsexed birds (USNM 191503-506) confiscated from the Japanese 16 June 1904 by the U.S. Treasury; an adult male (USNM 300584), an adult female (USNM 300585), and a juvenile female (USNM 300586) collected by Wetmore 16-19 May 1923; and 17 specimens collected by the POBSP: 1 adult female (USNM 495461) collected just offshore 16 July 1965, 9 adult males (USNM 542927, 543020, 544620, 544625, 544783, 544785-786, 544789, 544791), 6 adult females (USNM 542925-926, 544784 544787-788 544790) and 1 unsexed adult (USNM 544705). The latter 16 birds were all collected 19 June 1966.

## Banding and Movements

The POBSP banded 50,097 Sooty Terns on Lisianski (Table 40). Eighteen of these birds were subsequently recaptured on other islands or at sea: 10 on nearby Laysan Island, 2 on Johnston Atoll, and 1 each at Midway Atoll, at sea, in Japan, and at Phoenix Island (Appendix Table 14a).

In addition, 41 Sooty Terns banded on other islands were recaptured on Lisianski: 20 from Laysan Island, 10 from Johnston Atoll, 6 from Midway Atoll, 2 each from French Frigate Shoals and Pearl and Hermes Reef, and one from Wake Island (Appendix Table 14b).

Figure 49. Prebreeding Sooty Terns on ground among Eragrostis clumps near the north end of the island, 18 June 1966. FOBSP photograph by P.C. Shelton.

Table 39. Observations of Sooty Terns on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | "in great abundance... by far the most numerous bird" | "Young very small" (Palmer in Rothschild, 1893-1900: xi). |
| 1913 | 12 Mar. | plentiful | (Willett, ms.). |
| 1915 | 24 Mar. | 1,000 | Not yet nesting (Munter, 1915: 136). |
| 1923 | 15-20 May | 500 | Mostly on eggs, no young present (Wetmore, ms.). |
| 1954 | 26 Mar. | 2,000 | Richardson, pers. comm.). |
| 1955 | 8 May | ? | No eggs seen (POFI). |
| 1961 | 9 Mar. | large numbers | Flocks swirling overhead (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | ? | Flocks swirling overhead, none on ground (POBSP). |
| | 12-13 Mar. | large numbers | Flocks swirling overhead; only a few sitting on ground. No nests with eggs found (POBSP). |
| 1964 | 11-12 Mar. | 50,000-100,000 | Most swirling overhead; only about 800-1,000 on ground. No nests with eggs found (POBSP). |
| | 21-23 Aug. | 160,000 | Ca. 40,000 young from about 1/3 grown to near-fledging. Small numbers of fledged young (POBSP). |
| | 18 Sept. | 4,000-5,000 | Fledged and near-fledging young observed (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 3,500-4,600 | One flock of ca. 3,000-4,000 swirling over south end; one of 500-600 swirling over north end. Only terns from former group sitting on ground. No nests with eggs found (POBSP). |
| | 14-17 July | 300,000 | Ca. 50,000 young, most of them near fledging; a few nests with eggs. Population estimate includes ca. 50,000 fledged young (POBSP). |

Table 39. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1966 | 16-19 June | 1,000,000 | Ca. 250,000 nests wigh eggs (95%); ca. 10,000 young (5%). Almost all young recently hatched (POBSP). |
| | 18-20 Oct. | 40 | Non-breeding. Several flying immatures and crippled immatures present from preceding breeding season (POBSP). |
| 1967 | 20 Mar. | 5,000-8,000 | Swirling overhead; no nests found (BSFW, POBSP). |
| | 2-6 June | 1,700,000 | Most birds preparing to lay or with fresh eggs. Some moderate and heavily incubated eggs and a few small chicks present. An estimated 400,000 birds with nests (POBSP). |
| | 31 Aug.-5 Sept. | 15,000 | Large chicks to flying young. Most birds with large chicks (POBSP). |
| 1968 | 20-21 Mar. | 7,500 | On ground by day but no nests found (BSFW, POBSP). |

Table 40. Sooty Terns banded on Lisianski Island

| Period of Survey | | Adults | Young | Totals |
|---|---|---|---|---|
| 1964 | August | 5,400 | 1,500 | 6,900 |
| 1965 | July | 5,500 | 1,500 | 7,000 |
| 1966 | June | 30,000 | 0 | 30,000 |
| 1967 | June | 6,000 | 0 | 6,000 |
| | September | 197 | 0 | 197 |
| | Totals | 47,097 | 3,000 | 50,097 |

BROWN NODDY — *Anous stolidus*

Status

Common breeder; maximum recent estimate 15,000. Probably present throughout year but decidedly fewer present during early spring and presumably winter. Breeds primarily from March or April through September

or October. Nests in loose colonies or in widely scattered individual sites. Most nests built on the ground under Scaevola or other dense vegetation, but some built off the ground in Scaevola.

Populations

Although variable, the population estimates are consistent enough from year to year to show that numbers of birds present in March are far fewer than in June through October (Table 41). The large difference between the February and March estimates suggests that much, if not most, of the population is absent from the island during periods of non- or reduced breeding.

One of the two early estimates (1915) does not very significantly from recent estimates made at the same time of year. Wetmore's late May (1923) estimate of 1,000 birds, however, seems significantly lower than either of the recent June estimates. Presumably the population suffered some reduction in numbers as did most other species when the island was nearly bare of vegetation.

Annual Cycle

The Lisianski Brown Noddy population apparently breeds on an annual basis, although the beginning and end of the nesting season may not coincide from year to year. Laying evidently begins in March or April, but some birds have laid as early as February (1965). On many March visits (1915, 1964, 1967) no nests were found, which suggests that the laying peak occurs in subsequent months. The observations from June 1966 and 1967 suggest a May to June laying peak, and the July 1965 observations, while not as complete, appear to fit this schedule.

Relatively few eggs were seen on August and September visits, and none was found on the single October visit. This suggests that laying was largely completed by July.

If, as we suspect, the normal laying peak is in May and June, it follows that the hatching peak occurs from June through July, and that most fledging occurs about two months later in August and September.

Most of the observations fit well into this proposed scheme of breeding. The observations from August 1964, which indicate no breeding, are obviously erroneous in view of observations made a month later.

Ecology

Breeding: During the peak of the nesting season in mid-summer, Brown Noddies nest over the entire vegetated portion of the island. They seem to prefer nesting under fairly dense vegetation, such as Scaevola, Ipomoea-covered Scaevola, or thick clumps of Eragrostis (Fig. 50). An occasional nest is built one to three feet off the ground in Scaevola, but well over 90 percent are built on the ground. Greater nesting densities are found in areas which have more luxuriant Scaevola (i.e. the outer perimeter of the

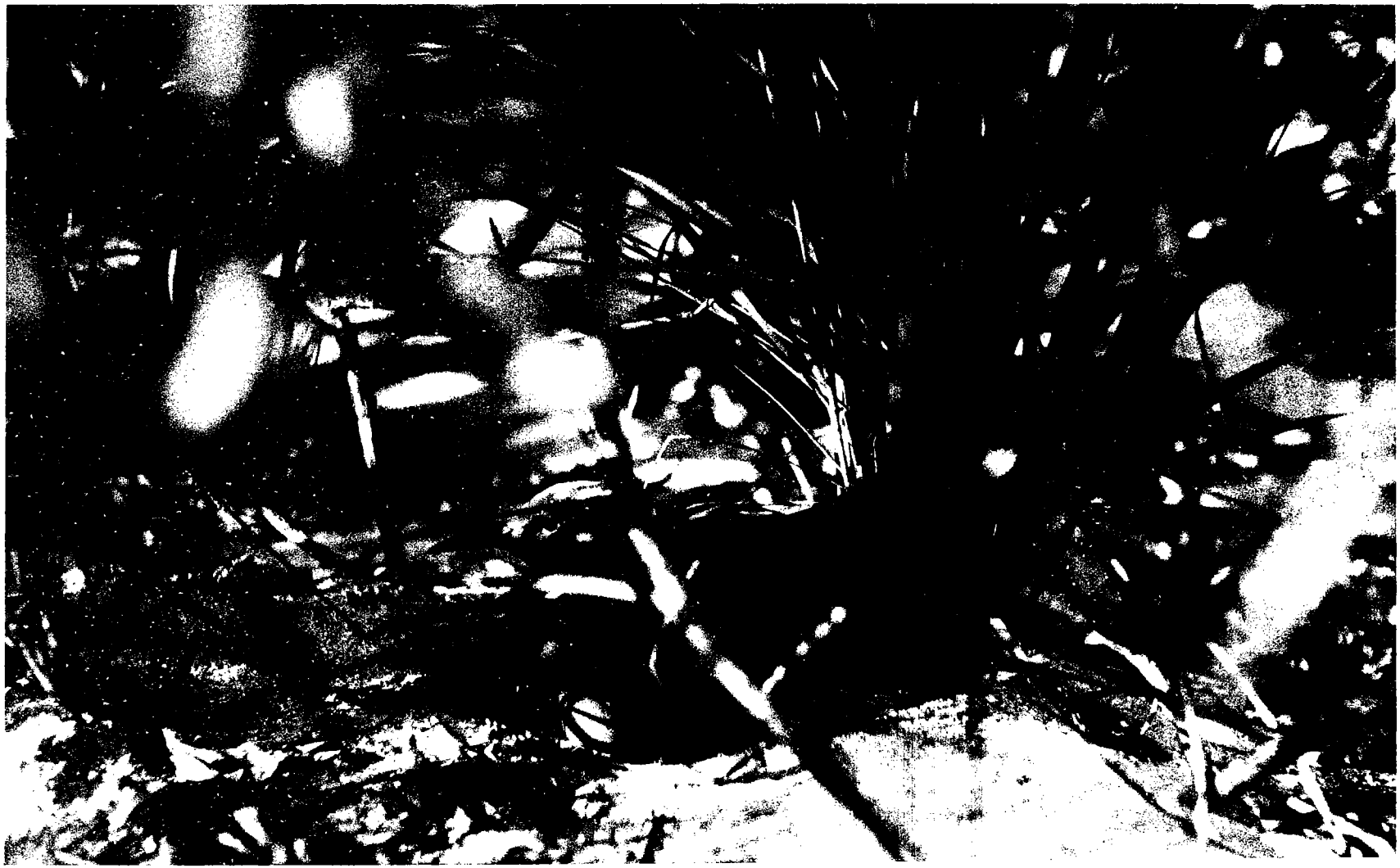

Figure 50. Brown Noddy incubating egg in nest under Scaevola, 19 June 1966. HOBSP photograph by P.C. Shelton.

island). Of 26 nests tabulated in June 1967, 16 (62 percent) were under Scaevola; 4 (15 percent) were under Scaevola and Ipomoea; 4 (15 percent) were under Eragrostis; 1 (4 percent) was under Scaevola and Eragrostis; and 1 (4 percent) was found beneath Ipomoea.

In 1923 Wetmore (ms.) found these noddies nesting principally in the interior and along the eastern shore. At that time they preferred to nest in little depressions in the sand, often at the entrance to an old shearwater burrow.

The nests themselves are often bulky constructions of vegetation and debris. Thirty nests were examined to determine what nesting materials were used: 28 (93 percent) contained Eragrostis; 26 (87 percent) contained Scaevola; 5 (17 percent) contained bones; and 1 (3 percent) contained Tribulus. Most of the nests (28) contained more than one material in varying proportions, but two were built solely of Eragrostis leaves and stems.

Wetmore (ms.) noted that nest depressions were "filled with a varied collection of small bones and feathers in lieu of other nesting material."

Non-breeding: Non-breeding Brown Noddies commonly occurred in several areas. During the day, flocks of from 10 to 50 birds roosted on the beaches. At night many roosted solitarily or in small flocks in the Scaevola in the interior of the island. During both day and night, scattered individual adults and immatures roosted under Scaevola or overhanging tufts of Eragrostis. Occasionally Brown Noddies roosted in Casuarina trees, but, proportionately, this species utilized these trees for roosting far less than did the Black Noddies.

## Specimens

We know of 20 Brown Noddy specimens from Lisianski, all of which are in the USNM. Two males (USNM 300518-519) were collected by Wetmore 17 May 1923. Eighteen, 7 males (USNM 496602, 604, 606, 608, 611, 613, 615) and 11 females (USNM 495541, 496601, 603, 605, 607, 609-610, 612, 614, 616-617) were collected by the POBSP 17 to 19 June 1966.

## Banding and Movements

POBSP personnel banded Brown Noddies only during the August and September 1967 survey. At this time, 1,507 were banded: 1,330 adults, 107 immatures, 20 nestlings, and 50 whose age was unrecorded.

Two returns have been made of birds banded on other islands. A nestling banded on Kure Atoll in July 1964 was found roosting on Lisianski in September 1967, and a local young banded on Whale-Skate Island, French Frigate Shoals, in June 1963, was recaptured on Lisianski in August 1964 (Appendix Table 15).

Table 41. Observations of Brown Noddies on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | ? | Evidently present and nesting (Munro, 1941e: 2). |
| 1913 | 12 Mar. | ? | Nesting in moderate numbers (Willett, ms.). |
| 1915 | 24 Mar. | 300 | No breeding (Munter, 1915: 136). |
| 1923 | 15-20 May | 1,000 | Most nests empty but a few contained eggs (Wetmore, ms.). |
| 1950 | 24 June | ? | Nesting on the ground (POFI). |
| 1951 | 13 May | ? | (POFI). |
| 1954 | 26 Mar. | 10-20 | (Richardson, pers. comm.). |
| 1963 | 14 Feb. | 200 | (POBSP). |
| 1964 | 11-12 Mar. | 25 | Not breeding (BSFW, POBSP) |
| | | 100-200 | (Walker, ms.). |
| | 21-23 Aug. | 2,000 | No evidence of breeding; 20% of population composed of fledged immatures (POBSP) |
| | 18 Sept. | 3,000 | Eggs to flying young (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 200-500 | Eggs and small chicks (POBSP). |
| | 14-17 July | 10,000 | Ca. 3,000 young; partly incubated eggs to near-fledging young (POBSP). |
| 1966 | 16-19 June | 15,000 | Ca. 5,000 nests with eggs; ca. 100 with recently hatched young; no large young seen (POBSP). |
| | 18-20 Oct. | 4,000 | Not breeding; estimate includes flying immatures (POBSP). |
| 1967 | 20 Mar. | 75 | No evidence of breeding (BSFW, POBSP). |
| | 2-6 June | 15,000 | Eggs to medium-sized young; more than 90% of nests with eggs; estimated 5,000 nests (POBSP). |

Table 41. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1967 31 Aug.- 5 Sept. | 10,000 | Eggs to flying young; mostly large young and dependent immatures. many recently fledged; estimated 100 small downy young: 1,000 large chicks. and ca. 2,000 dependent immatures (POBSP). |
| 1968 20-21 Mar. | 100 | Few eggs (BSFW, POBSP) |

BLACK NODDY — Anous tenuirostris

Status

Common breeder; maximum recent estimate 5,000. Breeding has occurred from late December through early August but most breeding probably occurs from late January through late July. Nests in Scaevola bushes and Casuarina trees.

Populations

Maximal populations on Lisianski are in the low thousands (Table 42) but we do not know whether most of the birds present on a given visit are part of the breeding population. When not breeding, this species is often found in large numbers both in the Northwestern Hawaiian Islands and on islands to the south, sometimes in large roosting flocks on islands on which it does not breed. In addition, band return data suggest that for central Pacific seabirds these terns are among the most frequent inter-island visitors.

It is likely that large fall populations, such as that seen in October 1966, may contain many birds whose nesting island is not Lisianski. The extreme range of the few estimates from late August through October (100 to 1,500) suggests that Lisianski Black Noddies frequently move in large numbers out to sea or to other islands.

Comparisons of recent numerical estimates with those made in 1915 and 1923 do not indicate any clearcut change in populations since that time.

Annual Cycle

Too little data are available on nesting in winter months to determine adequately when nesting is usually initiated. Interpolation from available observations indicates that laying often occurs in January (1915, 1965. 1967 1968) and once occurred in late December (1963). On nearby Laysan, a few birds have laid as early as November and it seems likely that similar early laying may occur on Lisianski. Laying continues through April and May and eggs are present into June. The absence of young on two

August visits suggests either that no eggs are laid in June or that no nests initiated in June are successful. The various sample counts do not indicate an egg peak but rather suggest that laying occurs continually over a fairly long period from at least early February through late April.

The earliest and latest that hatching is known to have occurred is late January (1964) and mid-June (1966 and probably 1967). The earliest and latest times of fledging that are indicated by our data are mid-March (1964) and late July or early August (1965, probably 1967).

## Ecology

Breeding: Black Noddies nest both in Scaevola bushes and Casuarina trees on Lisianski but seem to prefer the taller, somewhat more open Casuarina (Fig. 51). POBSP field notes do not indicate that any specific Scaevola area is favored for nesting over any other.

Nests in the Casuarina trees are on the whole situated further off the ground than the nests found in Scaevola. Heights of 12 nests in one Casuarina tree measured in March 1967 ranged from 21 inches to 10 feet off the ground and had a mean height of 4.5 feet. Nests in Scaevola during the same survey were all at heights between 18 and 32 inches.

Nests in the Casuarina trees were usually saddled on forks of limbs, but one nest was placed on a number of small branches. The 12 nests mentioned above had maximum widths varying from 6 to 13 inches and a mean maximum width of 7.4 inches. Their maximum depths ranged from 2.5 to 6 inches with a mean of 4.4 inches.

Nest materials in the nests in the Casuarina trees appeared to be more varied than in nests in Scaevola, at least in March 1967. All nests in Scaevola that were examined were built solely of grass and morning glory (Ipomoea). Nests in the Casuarina tree were built of Scaevola, Portulaca, Boerhavia, Tribulus, Eragrostis, leaves of Ipomoea, and several kinds of seaweed. One nest contained five small Portuguese men-of-war.

Non-breeding: Non-breeding Black Noddies roost primarily in Scaevola and Casuarina. Small numbers, usually individual birds or small groups of up to 10 birds, occasionally roost with Brown Noddies on the beaches or rocks of the island perimeter. Certain areas of Scaevola appear to be preferred for roosting. Larger flocks and greater numbers of roosting birds were usually found in the higher Scaevola at the southeast end of the island and above the west shore, than in the Scaevola above the east beach and in the interior.

## Specimens

We know of 15 study skins: 2 males (USNM 300454-455) collected by Wetmore 17 and 19 May 1923 respectively; 9 males (USNM 544112, 113, 115-117, 120-123), 3 females (USNM 544114, 118, 119), and an unsexed bird (USNM 544124) collected by the POBSP 19 June 1966.

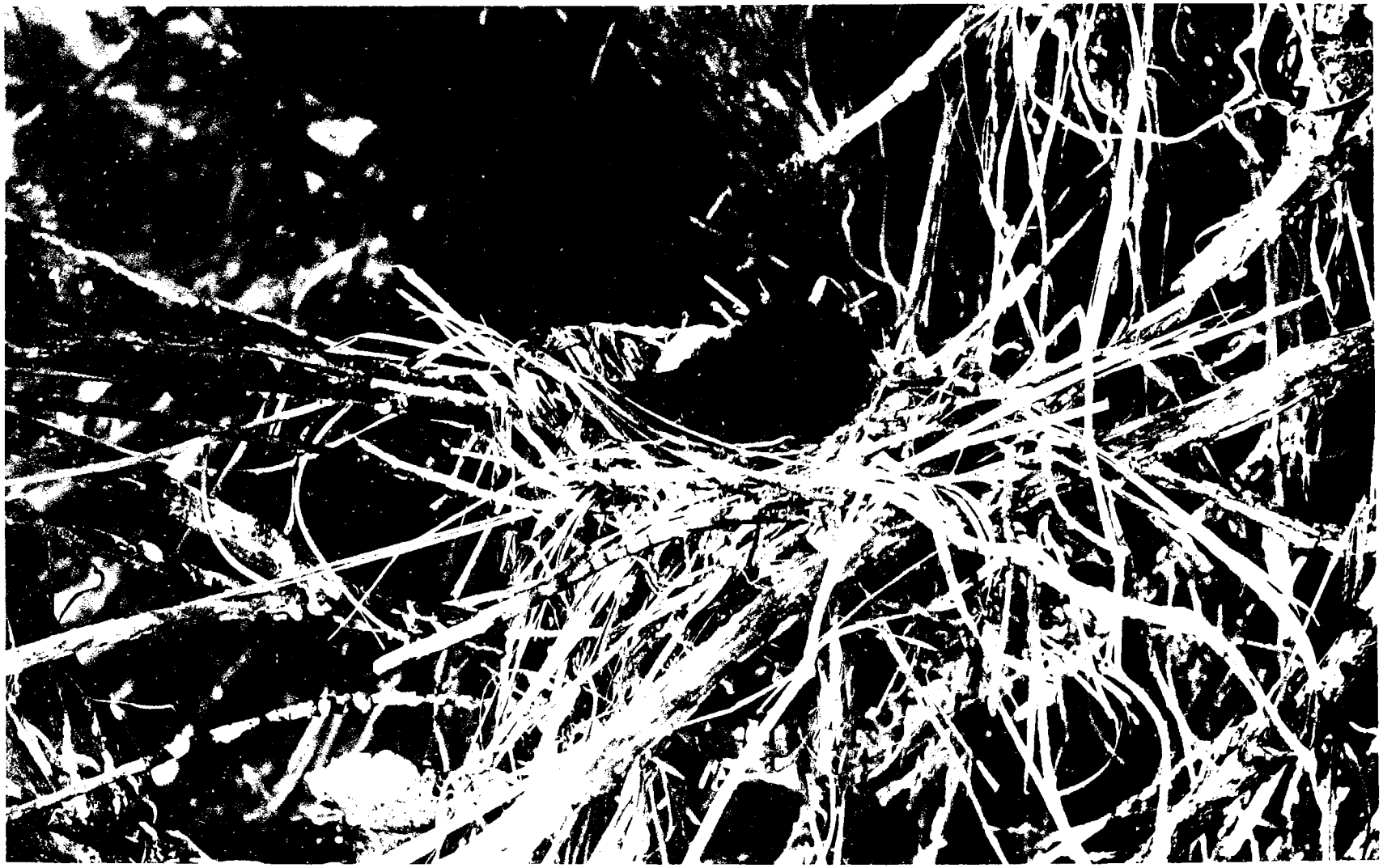

Figure 51. Recently hatched Black Noddy chick in nest in Casuarina, 12 March 1964. POBSP photograph by A.B. Amerson, Jr.

Banding and Movements

POBSP personnel banded 340 Black Noddies on Lisianski (Table 43). Seven have been recaptured subsequently on other islands: 5 at French Frigate Shoals, and 1 each at Kure Atoll and Johnston Atoll (Appendix Table 16a). Seven Black Noddies banded on other islands have been recaptured on Lisianski: 2 each from French Frigate Shoals and Pearl and Hermes Reef, and 1 each from Johnston Atoll, Laysan Island, and Midway Atoll (Appendix Table 16b).

Table 42. Observations of Black Noddies on Lisianski Island

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1891 | 29 June-4 July | ? | Stated to breed on Lisianski by Rothschild (1893-1900: 43) evidently as a result of Palmer's observations. |
| 1913 | 12 Mar. | ? | (Willett, ms.) |
| 1915 | 24 Mar. | 1,000 | Eggs and young in 2 colonies (Munter, 1915: 136). |
| 1923 | 15-20 May | 1,000 | None found nesting (Wetmore, ms.) |
| 1950 | 24 June | ? | Nesting in Casuarina (POFI). |
| 1951 | 13 May | ? | (POFI). |
| 1954 | 26 Mar. | 60-80 | (Richardson, pers. comm.) |
| 1963 | 14 Feb. | 300 | Many building nests but no eggs (Kramer, ms.). |
| | 12-13 Mar. | ? | Nesting (POBSP). |
| 1964 | 11-12 Mar. | 1,000<br>400-500+ | Ca. 200 nests present; ca. 50% with eggs, ca. 50% with young: young from recently hatched to fledglings (BSFW, POBSP). |
| | 21-23 Aug. | 400 | Not breeding (POBSP). |
| | 18 Sept. | 100 | Not breeding (BSFW, POBSP). |
| 1965 | 12-14 Mar. | 1,000-5,000 | Ca. 400 nests, most with pre-laying birds or eggs (some fresh); a few with small young (POBSP). |
| | 14-17 July | 1,500 | Ca. 300 young from half-grown to flying immatures (POBSP). |

Table 42. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1966 16-19 June | 5,000 | A few dozen nests with young from a few days old to near-fledging; ca. 20% of population composed of fledged immatures (POBSP). |
| 18-20 Oct. | 1,500 | Not breeding (POBSP). |
| 1967 30 Mar. | 350-500 | Nest construction to nearly fledged young. Of a sample 45 nests with contents, 30 (67%) contained eggs, 5 (11%) contained small downy young, and 10 (22%) contained near-fledging young. |
| 2-6 June | 3,000 | Eggs to large young; most nests with eggs; 355 nests counted. Sample count of 290 nests: 212 (73%) with eggs, 60 (21%) with small young, and 18 (6%) with medium-sized or large young (POBSP). |
| 31 Aug.- 5 Sept. | 1,000 | No nests with eggs or young present (POBSP). |
| 1968 20-21 Mar. | 500 | Fresh eggs to large young; most eggs (ca. 75%) moderately to heavily incubated. Sample nest count of 156 nests with contents: 105 (67%) with eggs, 30 (19%) with small downy young, 10 (6%) with medium-sized young, and 11 (7%) with large downy young (BSFW, POBSP). |
| 1969 30 Mar. | >520 | 260 nests counted. Ca. half of nests with eggs, half with young. |

Table 43. Black Noddies banded on Lisianski

| Period of Survey | Adults | Young | Totals |
|---|---|---|---|
| 1964 Mar. | 0 | 100 | 100 |
| Aug. | 10 | 0 | 10 |
| 1967 Sept. | 196 | 0 | 196 |
| 1968 Mar. | 20 | 14 | 34 |
| Totals | 226 | 114 | 340 |

WHITE TERN — *Gygis alba*

## Status

Uncommon breeder; maximum recent estimate 500. Probably present throughout year but most breeding occurs from March or April through August. Single egg is laid on limbs of *Casuarina* trees or in *Scaevola* bushes.

## Populations

Recent population estimates (Table 44) are too variable to assess accurately variation in numbers throughout the year, but they seem to indicate that maximal numbers are present in summer and fall with smaller numbers present in spring. The August and September 1964 estimates are inexplicably lower than other estimates for about that time of year.

Judging from the trend of estimates, the maximal population present at any one time is less than a thousand birds--probably 250 or more. It is evident that the population has increased considerably since 1923 when Wetmore saw these birds only twice--one bird on 15 May and two hovering over the camp on the evening of the 17th. In less than 70 years this species went from "great abundance" (1891) to near extirpation (1923) to once again fairly abundant (1960's)

## Annual Cycle

The available data on White Tern breeding activities on Lisianski suggest that breeding can occur from late January or early February (1964) through October (1967). Observations on nearby Laysan indicate that some individuals breed November to January; it seems likely that some winter breeding occasionally occurs here.

Data from most surveys are too sparse adequately to document yearly peaks of breeding, but the few summer observations suggest that a breeding peak is reached in June and July, with most of the population breeding from March or April through July and August. Most eggs are laid from late March through about late June. The egg peak probably occurs about April or May.

## Ecology

Breeding: White Tern nests have been found only in *Casuarina* trees and in *Scaevola* bushes. By far the larger proportion of nests found was in *Casuarina* trees (Fig. 52) probably because these nests are more readily observed than those in *Scaevola*. POBSP field notes indicate that nests of White Terns were found in *Scaevola* wherever it occurs on the island. They do not indicate any preference for one height of *Scaevola* nor for one area of the island.

All nests found were above the substrate but in some instances they were but a few inches above ground. An egg observed in *Casuarina* in March

Figure 52. Recently hatched White Tern chick on nest site in Casuarina, 12 March 1964. FOBSP photograph by A.B. Amerson, Jr.

1965 was no more than 6 inches above the ground; another observed in a Casuarina in March 1967 was 11 inches above the ground.

Non-breeding: The smaller population estimates made at the beginning and end of the breeding season suggest that at least some non-breeding birds leave the island. Data from banding activities, however, suggest that at least some birds present during the breeding season are non-breeding birds. Most of these birds roost in the areas used for nesting.

## Specimens

We know of only one specimen from Lisianski, an unsexed bird (USNM 191500) confiscated by the U.S. Treasury Department 16 June 1904.

## Banding and Movements

Table 45 lists the numbers of White Terns banded on various surveys by the POBSP and BSFW.

Four POBSP-banded birds have been recaptured on Lisianski, one of them twice. Although the returns were made in years other than the year of banding, returns on two terns banded as adults suggest that these birds remain on the island for much of the year. One bird (682-46193) banded in mid-March 1965 was present in both early June and early September 1967. Another (682-46226), probably banded in mid-March 1965, was present in mid-October 1966.

None has been recaptured on other islands and none banded on other islands has been recaptured on Lisianski.

Table 44. Observations of White Terns on Lisianski Island

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1891 29 June-4 July | in great abundance | Presence of eggs suggested by Rothschild (1893-1900: 36). Occurrence also noted by Munro (1941b: 2). |
| 1923 15-20 May | 1-2 | None found nesting (Wetmore, ms.) |
| 1950 24 June | ? | Nesting in Casuarina (POFI). |
| 1954 26 Mar. | 20-30 | (Richardson, pers. comm.). |
| 1963 14 Feb. | 50 | No evidence of breeding (POBSP). |
| 1964 11-12 Mar. | 150-200 | Ca. 10-15 nests, mostly with eggs. 5 young (BSFW, POBSP). |
| 21-23 Aug. | 50 | No nests found but an adult seen carrying a small fish in its bill (POBSP). |

Table 44. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1964 | 18 Sept. | 15-25 | Several immatures capable of flight (BSFW, POBSP) |
| 1965 | 12-14 Mar. | 100-150 | Ca. 15 nests with eggs: no young (POBSP). |
| | 14-17 July | 500 | Young, from recently hatched to fledged: no eggs (POBSP). |
| 1966 | 16-19 June | 250 | 3 nests with eggs and 1 with a week-old nestling (POBSP) |
| | 18-20 Oct. | 350 | None breeding (POBSP). |
| 1967 | 20 Mar. | 40* | 1 nest with egg and 1 with a half-grown young (POBSP). |
| | 2-6 June | 500 | Eggs to half-grown young: most nests with eggs. Estimated 200 nests (BSFW, POBSP). |
| | 31 Aug.-5 Sept. | 250 | 5 nests, 1 with an egg, others with young from large downy to stub-tailed immatures; at least 5 other dependent flying immatures (POBSP). |
| 1968 | 20-21 Mar. | 100 | No nests (BSFW, POBSP). |
| 1969 | 30 Mar. | 13* | No nests seen (BSFW). |

*Counted along the beach rim.

Table 45. White Terns banded on Lisianski Island

| Period of Survey | | Bander | Adults | Immatures | Nestlings | Totals |
|---|---|---|---|---|---|---|
| 1964 | March | BSFW | 25 | - | - | 25 |
| | August | POBSP | 5 | - | - | 5 |
| 1965 | March | POBSP | 10 | - | - | 10 |
| 1967 | August-September | POBSP | 71 | 5 | 4 | 80 |
| Totals | | | 111 | 5 | 4 | 120 |

Mammals

EUROPEAN RABBIT — *Oryctolagus cuniculus*

Status

Introduced, probably from Laysan after 1904. Extinct between March 1915 and February 1916.

Observations

The exact date when rabbits were introduced to Lisianski is unknown Bryan (1942: 192) quite accurately stated that "At some time prior to Elschner's visit [in 1914] . rabbits had been introduced. probably from Laysan. whence they had been brought by Max Schlemmer." Subsequent authors have apparently taken this comment and others about rabbits on Laysan and have given more specific (but apparently fictitious) dates for their introduction to Lisianski. Warner (1963: 7) has the rabbits as being introduced "about 1903 by the same individuals responsible for the introduction on Laysan." Tomich (1969: 30) has the "rabbits introduced here [Laysan and Lisianski] in 1902 and 1903...." So far as we can determine, rabbits could have well as been introduced by Japanese feather gatherers as by Schlemmer and at almost any time between 1904 and 1909.[27]

In any case, the earliest record of rabbits on Lisianski that we have been able to discover is Jacob's (ms.) observation that a few rabbits were present in January 1910.

By March 1913. rabbits were abundant but according to Salisbury[28] had not harmed the vegetation very much. Bailey (1956: 30), on the other hand, stated that Lisianski "...was a barren waste of sand. due to the destruction of the vegetation by the rabbits..." By September of the following fall there was no question of the harm done to the vegetation

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[27]Hamlet's (ms.) report of the apprehension of feather hunters in June 1904 fails to mention the occurrence of any rabbits on Lisianski despite the fact that he notes the diet of the Japanese in detail and remarks that the Japanese had been preparing dried tern meat against the eventuality of running out of food. Although this absence of mention of rabbits is not conclusive evidence that none was there, we strongly suspect that no rabbits were present and that it is most likely that they were subsequently introduced from Laysan.

[28]Letter from G.R. Salisbury to T.S. Palmer. dated 20 March 1913. Record Group 22. U.S. National Archives.

as Elschner (1915: 56) reported that the only vegetation left was a few small patches of tobacco. The rabbit population had evidently already overeaten its food supply and had suffered a sharp decrease in numbers since Elschner saw many dead rabbits but very few living ones.

Much the same situation prevailed six months later when W.H. Munter of the Thetis visited the island on 24 March 1915. He was "...struck with the lack of vegetation growing. What little was found was not in a very flourishing condition" (Munter, 1915: 135). The party that landed saw but seven rabbits, all of which were captured and removed from the island.

If these were not all the rabbits remaining, the last rabbit died sometime during the ensuing year as none (nor any living vegetation) was found when Lisianski was again visited by the Thetis in February 1916.

RODENT sp. — Mus. or Rattus sp.?

Status

Extinct; possibly introduced one or more times in the 1800's.

Observations

Two accounts, neither probably highly reliable, report the presence of rodents on Lisianski.

One newspaper account of the wreck of the Konohasset in 1846 (Ward, 1967: 60) indicated that many mice were present. Possibly these "mice" (which could have equally likely been the small Polynesian Rat, Rattus exulans) were introduced during the wreck of the Holder Borden, two years earlier.

John Cameron, who visited Lisianski during the summer of 1893, reported great numbers of mice were present and that hundreds were killed (Farrell, 1928: 397-399). We think it possible, if not likely, that this report was erroneous. George Munro, who visited Lisianski two years earlier, makes no mention of mice in notes subsequently published by him in the Elepaio.

HAWAIIAN MONK SEAL — Monachus schauinslandi

Status

Common breeder, present throughout the year. Maximum recent estimates 281 for an aerial count (1957); 187 for a ground count (1964).

Observations

Observations on populations and breeding status are summarized in Table 46. Clearly the seal was much less common in the late 1800's and early 1900's due primarily to the activities of sealers in the Northwestern Hawaiian Islands. The most useful of recent counts (March 1963-1969) might suggest that the population has declined somewhat in recent years

(from an average of 184 for 1964-1965 to an average of 131 for 1967-1969). How significant this decline may be is not certainly revealed by the data since during much of this period the BSFW has been conducting an intensive tagging program (See Appendix Table 2). Consequently the lower recent counts may only reflect that the present population is more sensitive to disturbance and less easily counted than previously.

Kenyon (1972) has recently suggested that the decline of populations of this seal on Midway and Kure Atolls was probably due to excessive disturbance by man. The level of harassment to which those seals were regularly subjected is much greater than that experienced by the Lisianski seals. A comparison of the number of pups counted on March visits from 1963 to 1969, while variable, does not suggest that there has necessarily been any decrease in the productivity of the population. (An average of 12 pups was counted March 1963-1965 as opposed to an average of 13 pups March 1967-1969.) Certainly it would seem worthwhile to conduct another series of aerial surveys such as those made in 1957 and 1958 so as to better assess the degree to which the Lisianski seal populations may have changed.

Variations in age-class terminologies used by different observers make it impossible to accurately determine annual production of young but it appears that on the order of 30-40 young are produced yearly. "Pups," presumably indicating young less than a month old, have been recorded from as early as 14 February (1963) through 20 October (1966) but the peak pupping season appears to be from about March through May or June. Other facets of the biology of this seal on Lisianski are likely very similar to those recorded by Kenyon and Rice (1959, q.v.).

Details of the tagging program and its results, as well as more detailed information on the life history of the seal, are to be presented at a later date by the BSFW.

Table 46. Observations of Hawaiian Monk Seals on Lisianski Island*

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1805 15-18 Oct. | none made | Four large seals killed with handspikes (Lisiansky, 1844). |
| 1891 29 June-4 July | [evidently few] | Three seals killed (Palmer in Rothschild, 1893-1900: xii. cf. Munro, 1942). |
| 1913 12 Mar. | 2 | A male and female found asleep on the beach. The latter (USNM 181252) was collected by Willett (Bailey, 1952b: 7). |
| 1923 15-19 May | ? | Ten specimens (USNM 243847-56) collected (Bailey, 1952b: 11). |

Table 46. (continued)

| Date of Survey | | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|---|
| 1950 | 24 June | "at least 100" | (POFI). |
| | | 70 | Estimate by Brock (in Bailey, 1952b: 25). |
| 1951 | 13 May | 195 | Counted. Total includes about a half-dozen recently born pups (POFI). |
| 1954 | 26 Mar. | 115 | Counted by Frank Richardson (Svihla, 1959: 227). |
| 1955 | 8 May | ca. 100 | Counted. 5 recently born pups included in total (POFI). |
| 1957 | spring | 256 | Based on aerial counts. Total includes 15 pups (Kenyon and Rice, 1959: 221). |
| 1958 | spring | 281 | Based on aerial counts. Total includes 34 pups (Rice, 1960: 377) |
| 1961 | 9-10 Mar. | 172 | Counted on 9 March. Total includes 19 pups and 36 yearlings** (Woodside and Kramer, ms.). |
| 1963 | 14 Feb. | 144 | Counted. Total includes 3 pups, one of which was dead (POBSP). |
| | 12-13 Mar. | 210 | Count of 82 adults and subadults and 13 pups (2 dead) on 12 March (POBSP). |
| 1964 | 11-13 Mar. | 180 | Counted on 12 March. Total includes 7 pups (BSFW). |
| | 21-23 Aug. | 144 | Counted on 21 August. Total includes 1 pup (POBSP). |
| | 18 Sept. | 121 | Count includes 33 yearlings (BSFW). |
| 1965 | 12-14 Mar. | 187 | Counted on 12 March. Total includes 15 pups and 1 dead adult (POBSP). |
| | 14-17 July | 161 | Counted on 14 July (POBSP). |
| 1966 | 16-19 June | 157 | Counted on 19 June. Total includes 33 yearlings and 3 pups (POBSP). |
| | 19 Sept. | 139 | Count includes 17 pups (BSFW). |

Table 46. (continued)

| Date of Survey | Population Estimate | Breeding Status, Remarks and References |
|---|---|---|
| 1966 18-20 Oct. | 111 | Counted on 18 October. Total includes 9 pups. An unspecified number of yearling seals were also present (POBSP). |
| 1967 20 Mar. | 139 | Count includes 10 pups and 17 yearlings (BSFW). |
| 2-6 June | 128 | Counted on 6 June. Total includes 12 pups and 11 yearlings (POBSP). |
| 31 Aug.- 5 Sept. | 141 | Counted on 2 September. Total includes 10 pups (POBSP). |
| 25-26 Sept. | 181 | Counted on 25 September. Total includes 28 yearlings (BSFW). |
| 1968 20-21 Mar. | 123 | Counted on 20 March. Total includes 10 pups and 19 yearlings (BSFW). |
| 1969 30 Mar. | 130 | Count includes 18 pups and 17 juveniles [= yearlings] (BSFW). 12 pups born recently (Laycock, 1970: 59). |
| 4 June | 127 | Count includes 26 pups and 2 yearlings (BSFW). |

*Table does not include several mentions of seals on Lisianski in the 1800's that add nothing to our knowledge other than the fact that they occurred there.

**Seals aged as yearlings in March are young from the preceding breeding season, while many, if not most, of those aged as yearlings on summer and fall surveys are young born that year.

## Reptiles

### GREEN TURTLE — *Chelonia mydas*

#### Status

Formerly a common to abundant breeder; now uncommon and not known to breed; maximum recent count 15.

Observations

Comments by early observers (Table 47) clearly indicate that Green Turtles were once a conspicuous and numerous element in the Lisianski fauna. Although hundreds were present in 1923, the population was almost certainly even then much reduced in abundance.

More recent observations, primarily by the BSFW, show a great reduction in numbers since 1923. Much of this decrease is probably attributable to poaching by fishermen in the decade after the Tanager Expedition.

The number currently utilizing Lisianski is undoubtedly higher than the maximal count but it seems doubtful that the breeding population, if in fact there is one, consists of more than a very few turtles.

No nests or hatchlings have been seen by any recent observer. This fact, and the preponderance of rather small turtles seen on most recent visits, suggests that many of the turtles are probably visitors from other islands in the chain, particularly from French Frigate Shoals, the primary breeding area; and possibly to some extent from Pearl and Hermes Reef, the only other atoll in the chain where fairly large numbers of turtles may still be found. Hopefully, the intensive tagging program being conducted by the BSFW will show to what extent the current "Lisianski population" consists of turtles from other islands.

Table 47. Observations of Green Turtles on Lisianski Island

| Date of Survey | | Number Seen | Remarks and References |
|---|---|---|---|
| 1805 | 15-18 Oct. | many | (Lisiansky, 1814). |
| 1825 | 6 July | in abundance | (Morrell, 1841: 216). |
| 1857 | 10 May | plentiful | (Paty, 1857: 40) |
| 1882 | 24 Jan. | ? | 13 captured by crew of the Ada (Hornell, 1934: 432-433). |
| | early May | | 107 captured by the crew of the Ada (Hornell, 1934: 432-433). |
| 1894 | summer | ? | Many turtles undoubtedly killed by the crew of the Ebon (Farrell, 1928: 414). |
| 1923 | 15-20 May | large numbers | 80 from 15" to 4' long counted in one 300-yard stretch of beach (Wetmore, 1925: 97). 25-50 frequently seen at one time; some females killed contained eggs ready to be laid (Wetmore, in Mellen, 1925: 181). |

Table 47. (continued)

| Date of Survey | Number Seen | Remarks and References |
|---|---|---|
| 1934 25 June | >400 | (Ball, ms.). |
| | ca. 25 | Large turtles (Baylis, ms.). |
| 1950 24 June | 6 | Count (POFI). |
| 1951 13 May | 0 | (POFI). |
| 1961 9 Mar. | 11 | Counted along shoreline 9 March; several fairly small individuals seen (Woodside and Kramer, ms.). |
| 1963 14 Feb. | ca. 30 | Seen on the beach and offshore. Several small individuals weighing less than 15 pounds seen (POBSP; Kramer, ms.). |
| 1964 11-12 Mar. | 13 | Counted by BSFW; 6 males and 7 females, 3 platter-sized (BSFW, POBSP). |
| 21-23 Aug. | ? | A few seen (POBSP). |
| 18 Sept. | 5 | Counted by BSFW: 2 ca. 30" and 3 ca. 18" (BSFW, POBSP). |
| 1965 12-14 Mar. | 6 | 5, 2-3' in length counted on 12 March, a smaller individual seen on 14 March (POBSP). |
| 14-17 July | 13 | Counted on 13 July (POBSP). |
| 1966 16-19 June | 4 | Count (POBSP). |
| 19 Sept. | 4 | Counted by BSFW; 1 large and 3 small (ca. 18") (BSFW). |
| 18-20 Oct. | 15 | Counted on 18th; 5 large (3 males, 2 females) and 10 small (ca. 15") (POBSP). |
| 1967 20 Mar. | 10 | Counted by BSFW; 6 large and 4 small; 2 males and 8 females (BSFW, POBSP). |
| 25-26 Sept. | ? | At least 6 seen (BSFW). |
| 1968 20-21 Mar. | 13 | Counted by BSFW (BSFW, POBSP). |
| 1969 30 Mar. | 11 | All tagged or recaptures (BSFW). |
| 4 June | 13 | Counted; 3 ca. 150 lbs., and the rest small (BSFW). |

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Appendix Table 1. Scientific visits to Lisianski Island, 1828-1969

| Date | | Personnel | Vessel |
|---|---|---|---|
| 1828 | 3 Apr. | C. Isenbeck<br>Crew | Moller |
| 1891 | 25 June-<br>4 July | Rothschild Expedition<br>Henry C. Palmer<br>George C. Munro | Kaalakai |
| 1904 | 16-17<br>June | Crew | Thetis |
| 1913 | 12 Mar. | Alfred M Bailey (BBS)<br>George Willett (BBS) | Thetis |
| 1914 | 12 Sept. | Carl Elschner | Thetis |
| 1915 | 24 Mar. | William H. Munter (USCG)<br>Crew members | Thetis |
| 1923 | 15-19<br>May | Tanager Expedition<br>Alexander Wetmore (BBS, ornithologist)<br>John Baker (collector)<br>Stanley C. Ball (BPBM, biologist)<br>T. Dranga (collector)<br>Chapman Grant (naturalist)<br>G. Higgs (cook)<br>F.R. Lawrence (naturalist, photographer)<br>F.C. Reno (BBS, rabbit killing expert)<br>Eric L. Schlemmer (asst. to Wetmore)<br>Ditlev Thaanum (conchologist)<br>L.A. Thurston (HA, conchologist)<br>Gerrit P. Wilder (botanist) | USS Tanager |
| 1928 | 14 Apr.* | Capt. William G. Anderson | Lanikai |
| 1950 | 24 June | Joseph E. King (POFI)<br>Vernon E. Brock (HDFG)<br>Other POFI personnel | USFWS M/V<br>Hugh M. Smith |
| 1951 | 13 May | POFI personnel | USFWS M/V<br>Hugh M. Smith |
| 1954 | 26 Mar. | Frank Richardson (UW) | USCGC Buttonwood |

*Lisianski apparently visited offshore only.

Appendix Table 1. (continued)

| Date | Personnel | Vessel |
|---|---|---|
| 1954 1 Nov. | Philip A. Dumont (BSFW)<br>Johnson A. Neff (BSFW) | Aerial survey* |
| 1955 8 May | POFI personnel | USFWS M/V<br>John R. Manning |
| 1957 7 Jan. | Karl W. Kenyon (BSFW)<br>Dale W. Rice (BSFW) | Aerial survey |
| 15 Apr. | Karl W. Kenyon (BSFW)<br>Dale W. Rice (BSFW) | Aerial survey |
| 28 Dec. | Dale W. Rice (BSFW) | Aerial survey |
| 1958 28 June | Dale W. Rice (BSFW) | Aerial survey |
| 1961 9-10 Mar.**<br>(1330-1700:9th)<br>(0800-1500:10th) | Raymond J. Kramer (HDFG)<br>David H. Woodside (HDFG) | USCGC Planetree |
| 1962 18 July | Harvey I. Fisher (SIU) | Naval vessel |
| 1963 14 Feb.<br>(1000-1630) | William O Wirtz, II (POBSP)<br>A. Binion Amerson, Jr. (POBSP)<br>F. Allen Blagden (POBSP)<br>Raymond J. Kramer (HDFG)<br>Robert W. McFarlane (POBSP)<br>Fred C. Sibley (POBSP) | USS Mobile |
| 12-13 Mar.<br>(1830-0830) | William O. Wirtz, II (POBSP)<br>A. Binion Amerson, Jr. (POBSP)<br>Robert W. McFarlane (POBSP) | USS Mobile |
| 1964 11-13 Mar.<br>(2000-1700) | Eugene Kridler (BSFW)<br>A. Binion Amerson, Jr. (POBSP)<br>Loren Kroenke (UH)<br>Edward O'Neill (BSFW)<br>Ronald L. Walker (HDFG)<br>George S. Wislocki (POBSP) | USCGC Planetree |

*An aerial survey may also have been made on 5 December.

**Time of arrival and departure, where known, is listed under the dates of visit for surveys made during the 1960's.

Appendix Table 1. (continued)

| Date | Personnel | Vessel |
|---|---|---|
| 1964 21-23 Aug. (0900-0600) | Kenneth E. Amerman (POBSP)<br>Alan H. Anderson (POBSP)<br>Robert Banner (UH)<br>Richard W. Merrill (POBSP)<br>J. Douglas Whitman (POBSP)<br>Paul W. Woodward (POBSP)<br>Alan Lee Young (UH) | USNS Shearwater |
| 18 Sept. (1050-1800) | Eugene Kridler (BSFW)<br>John W. Beardsley (UH)<br>Robert R. Fleet (POBSP)<br>Charles R. Long (POBSP)<br>Ronald L. Walker (HDFG) | USCGC Basswood |
| 1965 12-14 Mar. (1100-1500) | William O. Wirtz, II (POBSP)<br>Kenneth E. Amerman (POBSP)<br>Roger B. Clapp (POBSP)<br>J. Vincent Hoeman (POBSP)<br>Dennis L. Stadel (POBSP)<br>Charles Williams, Jr. (USN) | USNS Shearwater |
| 14-17 July (1130-0500) | Richard S. Crossin (POBSP)<br>Brian A. Harrington (POBSP)<br>Dayle N. Husted (POBSP)<br>Jeffrey P. Tordoff (POBSP) | USNS Shearwater |
| 1966 16-19 June (1630-2130) | Richard S. Crossin (POBSP)<br>Kenneth C. Balcomb (POBSP)<br>Richard D. Chandler (POBSP)<br>David I. Hoff (POBSP)<br>David L. Pearson (POBSP)<br>Philip C. Shelton (POBSP)<br>Frank H. Smith (POBSP) | USNS Shearwater |
| 19 Sept. (1030-1510) | Eugene Kridler (BSFW)<br>Sherwin Carlquist (CC)<br>Karl W. Kenyon (BSFW)<br>Warren Roll (HSB)<br>Ronald L. Walker (HDFG) | USCGC Ironwood |
| 18-20 Oct. (1945-0800) | Kenneth C. Balcomb (POBSP)<br>Patrick J. Gould (POBSP)<br>Brian A. Harrington (POBSP)<br>T. James Lewis (POBSP) | USS Tawakoni |
| 1967 20 Mar. (0900-1630) | Eugene Kridler (BSFW)<br>C. Douglas Hackman (POBSP)<br>Ernest Kosaka (HDFG)<br>John Maciolek (BSFW)<br>Richard Wass (UH) | USCGC Basswood |

Appendix Table 1. (continued)

| Date | Personnel | Vessel |
|---|---|---|
| 1967 2-6 June (1000-1800) | Robert L. DeLong (POBSP)<br>Ronald R. Amerson (USN)<br>David L. Burckhalter (POBSP)<br>Dennis L. Stadel (POBSP)<br>F. Christian Thompson (POBSP)<br>Robert Tuxson (POBSP) | USN light tugs 2081,2086,2087 |
| 31 Aug.- 5 Sept. (1130-1030) | Charles A. Fly (POBSP)<br>Roger B. Clapp (POBSP)<br>David I. Hoff (POBSP)<br>Ronald R. Amerson (USN) | USN light tugs 2081.2086.2087 |
| 25-26 Sept. (1000-1430) | Eugene Kridler (BSFW)<br>Robert Ballou (BSFW)<br>John L. Sincock (BSFW)<br>Ronald L. Walker (HDFG) | USCGC Buttonwood |
| 1968 20-21 Mar. (1100-1500) | Eugene Kridler (BSFW)<br>Roger B. Clapp (POBSP)<br>Karl W. Kenyon (BSFW)<br>Ernest Kosaka (HDFG)<br>John L. Sincock (BSFW) | USCGC Ironwood |
| 1969 30 Mar. (0915-1500) | Eugene Kridler (BSFW)<br>Karl W. Kenyon (BSFW)<br>George Laycock (NAS)<br>David L. Olsen (BSFW)<br>John L. Sincock (BSFW) | USCGC Buttonwood |
| 1969 4 June (0630-1530) | David L. Olsen (BSFW)<br>Karl Bathen (UH)<br>Tom Clark (UH)<br>Ronald Kent<br>Ernest Kosaka (HDFG)<br>James McVay (UH)<br>William Patzert (UH)<br>John L. Sincock (BSFW) | USFWS M/V Mahi |

Appendix Table 2. Results of scientific visits to Lisianski Island, 1828-1969.+

| Date | | Results |
|---|---|---|
| 1828 | 24 Mar. | 12 species of birds described, but some records of doubtful validity; turtles and seals noted. |
| 1891 | 29 June-4 July | Bird observations (Rothschild, 1893-1900; Munro 1941a, 1941b, 1941c, 1941d, 1941e, 1942). 16 bird specimens of 3 species collected; seals seen and killed. |
| 1904 | 16-17 June | 10 specimens of 5 bird species, seized by the Treasury Department, were later deposited in the USNM. |
| 1913 | 12 Mar. | Brief observations of birds (Bailey, 1952a, 1956); 45 Laysan Rails released. Seals observed and one collected. |
| 1914 | 12 Sept. | Description of island; analysis of phosphates. |
| 1915 | 24 Mar. | Observations on birds and their breeding status (Munter, 1915). Rabbits removed from island. |
| 1923 | 15-19 May | Collections of: fish, hippoboscid and other flies and insects, crustacea, echinoderms, polychaetous annelids, nematode, foraminifera, algae and vascular plants. 10 seal specimens and ca. 43 bird specimens of 15 species collected. Seeds of Barringtonia trees planted by Wilder. Turtles observed. |
| 1928 | 14 Apr. | Collected: offshore fishes, polychaete. |
| 1950 | 24 June | Shoreline scouted for fishbait; seals estimated; turtles counted; brief notes made on birdlife. |
| 1951 | 13 May | Shoreline scouted for fishbait; seals censused; brief notes made on birdlife. |
| 1954 | 26 Mar. | Brief notes made on birds and their breeding status (Richardson, 1957); census of seals. |
| | 1 Nov. | Aerial seal count. |
| 1955 | 8 May | Island scouted for bait; brief notes made on turtles, seals, and several species of birds. |
| 1957 | 7 Jan. | Aerial census of seals and nesting albatross. |
| | 15 Apr. | Aerial census of seals and nesting albatross. |
| | 28 Dec. | Aerial census: seals; albatross (Rice and Kenyon, 1962). |
| 1958 | 28 June | Aerial census of seals and seabirds. |

Appendix Table 2. (continued)

| Date | | Results |
|---|---|---|
| 1961 | 9-10 Mar. | Brief observations on wildlife: seals and turtles censused; refuge signs posted; photographic stations established. |
| 1962 | 18 July | Laysan Albatross nestlings, captured on Midway Atoll, transported to Lisianski, banded and released. |
| 1963 | 14 Feb. | Observations of birds;* examination of island for degree of disturbance caused by HIRAN project; 5 turtles and 35 seals tagged; 2 bird specimens of 2 species collected. |
| | 12-13 Mar. | Observations of birds;* 349 birds of 9 species banded. Collected: 4 bird specimens of 3 species and one hybrid, 1 new species of chigger, 2 new species of mites, ticks. |
| 1964 | 11-13 Mar. | Survey of numbers and breeding status of birds; census of seals and turtles; 1 Bar-tailed Godwit collected;* several Mallophaga collected; 1,133 birds of 14 species banded; gravity observations made. |
| | 21-23 Aug. | Survey of numbers and breeding status of birds; census of turtles and seals; 7,828 birds of 9 species banded. Collected: 1 bird specimen, algae. |
| | 18 Sept. | Observations of birds;* census of seals and turtles. Collected: algae, arachnids, insects. |
| 1965 | 12-14 Mar. | Census of turtles; observations of birds;* 5,855 birds of 7 species banded. Collected: 66 Berlese samples from 56 nests of 9 bird species and 10 samples of litter; 8 bird specimens of 5 species. |
| | 14-17 July | Survey of numbers and breeding status of birds; turtles and seals censused; ectoparasites studied; 7,207 birds of 6 species banded; 5 bird specimens of 4 species collected. |
| 1966 | 16-19 June | Survey of numbers and breeding status of birds;* census of seals, turtles; refuge signs erected; 30,200 birds of 7 species banded. Collected: ectoparasites, Berlese samples, plants, 75 bird specimens of 7 species. |
| | 19 Sept. | A few scanty observations of birds; census of turtles and seals; 15 seals and 2 turtles tagged. |

Appendix Table 2. (continued)

| Date | | Results |
|---|---|---|
| 1966 | 18-20 Oct. | Survey of numbers and breeding status of birds; census of turtles, seals, and shore birds; collections made for nasal-parasite studies; 799 birds of 5 species banded. |
| 1967 | 20 Mar. | Observations of birds,* census of seals and turtles; 27 seals and 9 turtles tagged; Chenopodium seeds planted. |
| | 2-6 June | Survey of numbers and breeding status of birds; census of seals; 7 seals tagged; 7,949 birds of 8 species banded. |
| | 31 Aug.-5 Sept. | Survey of numbers and breeding status of birds; census of seals; 3,453 birds of 16 species banded. Collected: hippoboscid flies, ticks, 7 bird specimens of 6 species.** |
| | 25-26 Sept. | Scanty observations of birdlife; census of turtles and seals; 5 turtles, 19 seals tagged; vegetation photostation photographs obtained and a new station established: 130 birds of 4 species banded. |
| 1968 | 20-21 Mar. | Observations of birds; census of turtles and seals; 9 turtles and 24 seals tagged; canvas resolution target laid out on beach; 260 birds of 6 species banded; 3 bird specimens of 2 species and 1 hybrid collected. |
| 1969 | 30 Mar. | A few observations of birds; census of turtles and seals; 9 turtles and 18 seals tagged; vegetation photostation photographs obtained. |
| | 4 June | Turtles and seals censused; 14 seals tagged. |

+Number of specimens listed as collected may represent something less than the total number collected in the field as some birds were subsequently discarded or destroyed before they entered the collections of the National Museum of Natural History. Totals given herein represent known number of bird specimens in the collection through March 1974.

*A new bird distribution record from these visits was reported by Clapp and Woodward (1968).

**A new bird distribution record from this visit was reported by Clapp (1971).

Appendix Table 3. Publications on collections and studies (with the exception of birds) made on Lisianski Island, 1828-1969*

| | |
|---|---|
| **Protozoa** | |
| Cushman in Edmondson et al., 1925 | Records 22 species of Foraminifera collected offshore by the Tanager Expedition. |
| **Aschelminthes** | |
| Chapin, 1925 | Describes a nematode from a Black Noddy collected by the Tanager Expedition. |
| **Annelida** | |
| Treadwell in Edmondson et al., 1925 | Reports 2 species of polychaetes collected by the Tanager Expedition. |
| Holly, 1935 | Records 4 species of polychaetes from Pietschmann's 1928 collection. |
| Hartman, 1966 | Summarizes earlier records and gives current taxonomy of 4 species of polychaetes. |
| **Arthropoda** | |
| **Arachnomorpha - Arachnida** | |
| Bryan et al., 1926 | States that a species of bird tick was found abundantly. |
| Munro, 1942 | Reports biting of humans by bird ticks in 1891 and that several species of spiders were present. |
| Brennan, 1965 | Describes a chigger (Acarina Trombiculidae) from POBSP collections in March 1963 |
| Beardsley, 1966 | Records 3 species of spiders collected in September 1964. |
| Amerson, 1968 | Reports the distribution and hosts of ticks collected by the POBSP. |
| Fain and Amerson, 1968 | Describes 2 new heteromorphic deutonymphs (Hypoderidae, Acarina) from a Great Frigatebird collected in March 1963. |

*Authors listed in chronological order.

Appendix Table 3. (continued)

| | |
|---|---|
| Crustacea | |
| Edmondson in Edmondson et al., 1925 | Reports 31 species of decapods collected by the Tanager Expedition. |
| Bryan et al., 1926 | States that isopods were collected by the Tanager Expedition. |
| Labiata - Hexopoda - Insecta | |
| Bryan, 1926 | Records an ephydrid fly from collections by the Tanager Expedition. |
| Bryan et al., 1926 | Records ca. 14 species of insects collected by the Tanager Expedition. |
| Bequaert, 1941 | Records a Hippoboscid fly collected by the Tanager Expedition. |
| Usinger, 1942 | Records a new species of Nysius (Lygaeidae. Hemiptera) from collections made by the Tanager Expedition. |
| Zimmerman, 1948a* | Lists a termite not reported in Bryan et al., 1926. |
| Zimmerman, 1948b | Lists 2 species of Hemiptera (1 Lygaeid. 1 Nabid). |
| Zimmerman, 1958 | Lists a noctuid moth. |
| Maa, 1962 | Reports specimens of hippoboscids collected by the Tanager Expedition. |
| Hardy, 1964 | Lists a dolichopodid fly. |
| Hardwick, 1965 | Describes an apparently endemic species of noctuid moth from specimens apparently collected prior to the Tanager Expedition. |
| Beardsley, 1966 | Lists 32 species of insects, 18 of them new distributional records, collected in September 1964 and summarizes earlier records excluding Mallophaga. |

*Zimmerman's series "Insects of Hawaii" primarily lists distributional data based on the Tanager collections and listed in Bryan et al. (1926), but there are a number of re-identifications, nomenclatural changes, and several previously unpublished records not included in the earlier paper.

Appendix Table 3. (continued)

| | |
|---|---|
| Maa, 1968 | Reports hippoboscid flies from POBSP collections. |
| Amerson and Emerson, 1971 | Reports 2 species of Mallophaga from a Bar-tailed Godwit collected on Lisianski in March 1964. |
| Echinodermata | |
| Clark in Edmondson et al., 1925 | Reports 1 ophiuroidean and 1 holuthurian collected by the Tanager Expedition. |
| Clark, 1949 | Summarizes earlier reports on echinoderms. listing a holothurian and ophiuroidean. |
| Chordata | |
| Vertebrata | |
| Pisces | |
| Fowler and Ball, 1925 | Reports 40 species of fish collected by the Tanager Expedition. |
| Schindler, 1932 | Discusses hemirhampids collected in 1928 at or offshore Lisianski. |
| Pietschmann. 1938 | Reports fish collected in 1928. |
| Reptilia | |
| Lisiansky, 1814 | Gives first mention of occurrence of turtles. |
| Wetmore, 1925 | Gives brief comment on abundance of green turtles during the Tanager visit. |
| Mellen, 1925 | Gives some observations of green turtles made by the Tanager Expedition. |
| Hornell, 1934 | Reports the killing of 120 turtles in January and May 1882. |
| Mammalia | |
| Lisiansky, 1814 | Gives first mention of occurrence of seals. |
| Bailey, 1918 | Reports observations of 2 seals and the shooting of one of them by the Biological Survey party of 1913. |
| Wetmore, 1925 | Mentions effect of rabbits on vegetation. |

Appendix Table 3. (continued)

| | |
|---|---|
| Farrell, 1928 | Reports, probably erroneously, the presence of mice in the late 1800's. |
| Munro, 1942 | Details killing of seals by the Rothschild Expedition. |
| Bailey, 1952b | Summarizes earlier information on the monk seal with liberal quotations from earlier publications. |
| King (b), 1956 | Gives a detailed summary of previous information on the Hawaiian monk seal. |
| Kenyon and Rice, 1959 | Records results of aerial surveys of Hawaiian monk seals made 7 January and 15 April 1957. |
| Svihla, 1959 | Lists some earlier estimates of seal numbers and adds counts or estimates from visits made in May 1951, March and November 1954, and May 1955. |
| Rice, 1960 | Records results of aerial surveys of the Hawaiian monk seal made 28 December 1957 and 28 June 1958. |
| Tomich, 1969 | A recent summary and bibliography of the mammals of Hawaii that mentions the occurrence of mammals on Lisianski. |
| Laycock, 1970 | Gives result of seal count made in March 1969. |
| Flora | |
| Christophersen and Caum, 1931 | Reports 4 species of vascular plants observed and collected by the Tanager Expedition, and summarizes earlier botanical information. |
| Tsuda, 1966 | Reports 14 species of marine benthic algae collected by the Tanager Expedition and in August and September 1964. |
| St. John, 1970 | Reports a new species of Sicyos from material collected in August and September 1964. |
| Geophysical | |
| Elschner, 1915 | Describes island and gives analysis of phosphate from visit in September 1914. |
| Kroenke and Woolard, 1965 | Gives gravity observations made in March 1964. |

Appendix Table 4a. Movements of Black-footed Albatross from Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex* | Where Recaptured | Date | Age Sex |
| 757-30919 | 06-05-67 | L | U | At sea, 42°50'N, 166°50'W | 09-05-67 | U - U |

Appendix Table 4b. Movements of Black-footed Albatross to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| Kure Atoll | | | | | | |
| 737-91997 | 01-04-64 | A | U | Lisianski | 03-13 65 | A - U |

Appendix Table 5. Movements of Laysan Albatross from Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-88153 | 03-11-64** | L | U | Eastern I., Midway Atoll | 02-28-69+ | U - U |
| 757-88911** | 03-11-64 | L | U | At sea, 32°34'N, 142°37'E | 02-14-69 | U - U |
| 757-15001 | 03-12-65 | N | U | Shionomisaki, Japan 33°30'N 135°40'E | -?-02-67 | U - U |
| 757-15082 | 03-12-65 | N | U | Kure Atoll | 03-31-69 | A - U |
| 757-16905 | 03-13-65 | N | U | Laysan I. | 07-19-69 | U - U (found dead) |

*A = adult; I = immature; L = local; N = nestling; S = subadult; U = unknown.

**Banded by BSFW.

+Captured by H.I. Fisher.

++Entangled in fish gear.

Appendix Table 6. Movements of Bonin Petrels from Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 843-70237 | 03-12-65 | A - U | Kure Atoll | 02-25-69 | A - U |
| 843-70685 | 03-12-65 | A - U | Kure Atoll | 03-13-69 | A - U |
| 843-71475 | 03-13-65 | A - U | Kure Atoll | 04-23-69 | A - U |

Appendix Table 7. Movements of Wedge-tailed Shearwaters from Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 615-18119 | 08-22-64 | A - U | Laysan I. | 08-08-65 | A - U |

Appendix Table 8a. Movements of Blue-faced Boobies from Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 757-89039 | 03-12-64 | A - F (with 2 eggs) | Lisianski I. | 06-04-67 | A - F (with large downy chick) |
| | | | Kure Atoll | 07-25-68 | A - F |
| 757-89061 | 03-12-64 | A - F (with 1/4-grown young) | Lisianski I. | 03-14-65 | A - F |
| | | | Laysan I. | 08-09-65 | A - U |
| 587-80221 | 08-21-64 | I - U | Whale-Skate I., French Frigate Shoals | 06-21-68 | A - F |
| 587-80236 | 08-21-64 | I - U | Sand I., Johnston Atoll | 03-29-65 | S - U* |
| 587-80277 | 08-22-64 | I - U | East I., French Frigate Shoals | 08-05-65 | A - U |
| | | | East I., French Frigate Shoals | 06-10-66 | A - U |

Appendix Table 8a. (continued)

| Original Banding Data | | | | Recapture Data | | | |
|---|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age | Sex |
| | | | | Lisianski I. | 09-04-67 | A | M (in roosting club) |
| 767-41556 | 03-12-65 | A | U | Laysan I. | 06-09-67 | A | F |
| | | | | Lisianski I. | 03-20-68 | A | F |
| 757-27725 | 10-19-66 | I | U | Laysan I. | 09-06-67 | S | U |
| 757-30112 | 06-02-67 | A | U (in roosting club) | Laysan I. | 09-06-67 | A | F |
| 757-30151 | 06-03-67 | A | M | Laysan I | 09-06-67 | A | U |
| 757-30172 | 06-03-67 | N | U | Kure Atoll | 07-23-68 | S | U (found dead) |
| 757-30181 | 06-03-67 | A | F | Laysan I | 09-06-67 | A | F |
| 757-30313 | 06-05-67 | N | U | Lisianski I | 09-01-67 | I | U |
| | | | | Johnston Atoll | 04-04-68 | S | U (found dead) |
| 587-90010 | 09-01-67 | N | U | Kure Atoll | 10-31-68 | S | U |
| | | | | East I., French Frigate Shoals | 06-05-69 | A | U |
| 587-90044 | 09-01-67 | I | U | East I., French Frigate Shoals | 06-05-69 | A | F |
| 587-90052 | 09-01-67 | A | M | Laysan I. | 09-10-67 | A | M |
| 587-90068 | 09-01-67 | A | M | Laysan I. | 03-18-68 | A | M |
| 587-90097 | 09-01-67 | I | U | Johnston Atoll | 03-30-68+ | S | U (found dead) |
| 757-28804 | 09-02-67 | I | U | Kure Atoll | 06-05-68 | S | U |
| 757-28820 | 09-02-67 | I | U | Whale-Skate I., French Frigate Shoals | 06-22-68 | S | U |

Appendix Table 8a. (continued)

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 757-28827 | 09-02-67 | I - U | Kure Atoll | 07-18-68 | S - U |
| 757-28897 | 09-02-67 | L - U | At sea ca. 23°10'N 163°10'W | 09-13-68 | U - U |

*Injured by flying into transmitter guy wire, subsequently collected.

+Found dead, specimen collected.

Appendix Table 8b. Movements of Blue-faced Boobies to Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| French Frigate Shoals, East I. | | | | | |
| 757-26183 | 06-11-66 | S - U | Lisianski I. | 09-04-67 | A - F (in roosting club) |
| 568-70101 | 06-20-66 | N - U | Lisianski I | 06-04-67 | S - U |
| | | | East I., French Frigate Shoals | 06-14-68 | A - F |
| | | | Whale-Skate I., French Frigate Shoals | 06-17-69 | A - F |
| 757-36011 | 06-10-67 | S - U | Lisianski I. | 08-31-67 | S - U |
| French Frigate Shoals, Gin I. | | | | | |
| 568-72328 | 08-25-65 | L - U | Lisianski I | 09-01-67 | A - F |
| French Frigate Shoals, Trig I. | | | | | |
| 558-83427 | 06-15-63 | A - U | Lisianski I. | 03-12-65 | A - F |
| | | | Trig I. | 06-08-67 | A - F (with chick) |
| | | | Trig I. | 06-24-68 | A - F (with large downy chick) |

Appendix Table 8b. (continued)

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| | | | Trig I | 06-24-69 | A - F |
| French Frigate Shoals, Whale-Skate I. | | | | | |
| 568-70109 | 06-26-66 | N - U | Lisianski I. | 09-01-67 | S - U |
| | | | Whale-Skate I., French Frigate Shoals | 06-17-69 | A - U |
| 568-70137 | 06-26-66 | N - U | Lisianski I. | 09-01-67 | A - M |
| Johnston Atoll | | | | | |
| 737-44167 | 04-08-64 | A - F | Johnston Atoll | 02-27-65 | A -(M)? |
| | | | Lisianski I. | 09-04-67 | A - F (in roosting club) |
| 737-44169 | 04-09-64 | S - U | Lisianski I. | 06-04-67 | A - M |
| 737-44195 | 02-26-65 | A - U | Lisianski I. | 06-04-67 | A - U |
| 737-44564 | 03-19-65 | A - U | Lisianski I. | 10-19-66 | A - U (in roosting club) |
| Kure Atoll | | | | | |
| 737-92947 | 06-02-65 | L - U | Kure Atoll | 09-10-66 | S - U |
| | | | Lisianski I. | 06-04-67 | A -(F)* |
| | | | Kure Atoll | 03-28-68 | A - M |
| | | | Kure Atoll | 02-12-69 | A - M |
| 737-92973 | 06-23-65 | N - U | Kure Atoll | 06-20-66 | S - U |
| | | | Lisianski I. | 09-01-67 | A - F |
| | | | Lisianski I. | 09-04-67 | A - F (in roosting club) |
| 737-99626 | 07-23-66 | L - U | Lisianski I. | 09-01-67 | S - U |

*Parentheses around an age or sex designation indicate that there may be some doubt as to the validity of the determination, or that, as is evident in some cases of multiple returns, on at least one occasion a bird was improperly aged or sexed.

Appendix Table 8b. (continued)

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| Laysan I. | | | | | |
| 767-41289 | 03-08-65 | A - U | Lisianski I. | 06-04-67 -06-05-67 | A - M |
| 767-41291 | 03-08-65 | A - U | Laysan I. | 06-12-66 | A - F |
| | | | Lisianski I. | 06-04-67 -06-05-67 | A - M(?) (with chick) |
| | | | Laysan I. | 03-13-68 | A - F |
| 767-41179 | 03-09-65 | A - U | Lisianski I. | 06-04-67 | A - M |
| 767-41200 | 03-09-65 | A - U | Lisianski I. | 03-13-65 | A - U |
| 767-41298 | 03-09-65 | A - U | Laysan I | 10-21-66 | A -(M) |
| | | | Lisianski I. | 06-04-67 | A -(F) |
| 767-41322 | 03-10-65 | A - U | Laysan I. | 10-20-66 | A - M |
| | | | Lisianski I. | 09-02-67 | A - M (with immature) |
| 767-41326 | 03-10-65 | A - U | Lisianski I. | 09-01-67 | S - U |
| 757-23007 | 07-19-65+ | U - U | Lisianski I. | 09-04-67 | A - F (in roosting club) |
| 757-23101 | 07-19-65+ | U - U | Lisianski I. | 06-04-67 -06-05-67 | A - M (with 1 egg) |
| 757-23103 | 07-19-65+ | U - U | Lisianski I. | 06-05-67 | A - M (with 1 egg) |
| 757-23145 | 07-19-65+ | U - U | Lisianski I. | 03-20-68 | A - M |
| 757-23166 | 07-19-65+ | U - U | Lisianski I. | 09-01-67 | A - M |
| 757-23171 | 07-19-65+ | U - U | Lisianski I. | 06-04-67 | A - F |
| 757-23239 | 07-19-65+ | U - U | Lisianski I. | 06-04-67 | A - M |

Appendix Table 8b. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-23438 | 07-19-65+ | U | U | Lisianski I. | 06-04-67 | A - F |
| 757-23462 | 07-19-65+ | U | U | Lisianski I. | 06-05-67 | A - M |
| 757-23474 | 07-19-65+ | U | U | Lisianski I. | 09-01 67 | A - F |
| Pearl and Hermes Reef, North I. | | | | | | |
| 558-83100 | 06-23-63 | A | U | Lisianski I. | 03-13-65 | A - F |
| 558-83580 | 06-24-63 | N | U | Lisianski I. | 09-02-67 | A - F (in roosting club) |

Appendix Table 9. Movements of Brown Boobies to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| Wake I. | | | | | | |
| 757-89726 | 04-27-65 | A | U | Lisianski I. | 10-19-66 | A - U |
| Johnston Atoll | | | | | | |
| 587-90429 | 04-26-67 | A (breeding) | M | Lisianski I. | 09-01-67* | A - M |

Appendix Table 10a. Movements of Red-footed Boobies from Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-27781 | 10-18-66 | A | U | Lisianski I. | 09-02-67 | A - U |
| | | | | Johnston Atoll | 01-04-69 | A - U |
| 757-27938 | 10-19-66 | S | U | Whale-Skate I., French Frigate Shoals | 06-16-67 | S - U |

+Listed on banding schedules as a Laysan Albatross.

*Marked on leg with orange streamer

Appendix Table 10a. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-27939 | 10-19-66 | S | U | Laysan I. | 09-07-67 | S - U |
| 757-27961 | 10-19-66 | S | U | Kure Atoll | 06-30-67 | S - U |
| | | | | Kure Atoll | 05-31-68 | A - U |
| 757-27962 | 10-19-66 | A | U | Laysan I. | 09-10-67 | A - U |
| 757-27968 | 10-19-66 | S | U | East I., French Frigate Shoals | 06-10-67 | A - U |
| 757-27984 | 10-19-66 | S | U | Laysan I. | 09-08-67 | S - U |
| 757-28266 | 10-19-66 | I | U | Johnston Atoll | 04-12-67 | I - U |
| | | | | Whale-Skate I., French Frigate Shoals | 06-04-67* | S - U |
| 757-28341 | 10-19-66 | S | U | Kure Atoll | 06-04-67 | S - U |
| | | | | Kure Atoll | 05-31-68 | A - U |
| 757-28344 | 10-19-66 | A | U | Johnston Atoll | 02-15-69 | A - U (dead) |
| 757-28457 | 10-19-66 | A | U | Laysan I. | 09-10-67 | A - U |
| 757-28495 | 10-19-66 | S | U | Kure Atoll | 06-27-68 | S - U |
| 757-28499 | 10-19-66 | U | U | Laysan I. | 09-10-67 | A - U |
| 587-84327 | 08-31-67 | S | U | Kure Atoll | 07-18-68 | S - U |
| 587-84329 | 08-31-67 | I | U | Johnston Atoll | 06-21-69 | S - U |
| 587-84330 | 08-31-67 | I | U | East I., French Frigate Shoals | 06-06-68 | I - U |
| 587-91162 | 08-31-67 | A | U | Whale-Skate I., French Frigate Shoals | 06-22-69 | U - U |
| 587-90235 | 09-01-67 | I | U | Kure Atoll | 07-22-68 | S - U |
| 587-90237 | 09-01-67 | N | U | Kure Atoll | 07-22-68 | S - U |
| 587-90247 | 09-01-67 | L | U | Whale-Skate I., French Frigate Shoals | 06-16-69 | S - U |

Appendix Table 10a. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 587-90249 | 09-01-67 | N | U | Johnston Atoll | 08-26-68 | S - U |
| 587-90250 | 09-01-67 | N | U | Whale-Skate I., French Frigate Shoals | 06-17-68 | I - U |
| | | | | Trig I., French Frigate Shoals | 06-23-69 | S - U |
| 587-90936 | 09-02-67 | A | U | Trig I., French Frigate Shoals | 06-23-69 | A - U |
| 757-28705 | 09-02-67 | (S) | U | Laysan I. | 09-06-67 | (A)- U |
| 757-28757 | 09-03-67 | I | U | Whale-Skate I., French Frigate Shoals | 06-17-68 | S - U |

*Marked on leg with orange streamer.

Appendix Table 10b. Movements of Red-footed Boobies to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| French Frigate Shoals, East I. | | | | | | |
| 767-43028 | 08-06-65 | N | U | Lisianski I. | 10-19-66 | S - U |
| | | | | East I., French Frigate Shoals | 06-06-68 | A - U |
| 767-43050 | 08-05-65 | S | U | Lisianski I. | 10-19-66 | S - U |
| 767-43056 | 08-05-65 | S | U | Lisianski I. | 09-04-67 | A - U |
| 767-43057 | 08-05-65 | S | U | Lisianski I. | 09-01-67 | A - U |
| 767-43085 | 08-05-65 | S | U | Johnston Atoll | 04-15-66 | S - U |
| | | | | Lisianski I. | 10-19-66* | S - U |
| 767-43103 | 08-05-65 | S | U | Lisianski I. | 10-19-66 | S - U |
| | | | | East I., French Frigate Shoals | | |

Appendix Table 10b. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-26028 | 06-10-66 | S | U | Lisianski I. | 10-19-66 | S - U |
| 757-26192 | 06-11-66 | S | U | Lisianski I. | 09-02-67 | S - U |
| 757-26413 | 06-12-66 | S | U | Lisianski I. | 09-03-67 | S - U |
| 757-26786 | 06-16-66 | A | U | Lisianski I. | 10-19-66 | A - U |
| | | | | East I., French Frigate Shoals | 05-26-67 | A - U |
| 757-26848 | 06-18-66 | S | U | Lisianski I. | 08-31-67 | S - U |
| French Frigate Shoals, Trig Island | | | | | | |
| 757-27502 | 07-03-66 | S | U | Lisianski I. | 10-19-66 | S - U |
| | | | | East I., French Frigate Shoals | 06-10-67 | S - U |
| French Frigate Shoals, Whale-Skate Island | | | | | | |
| 767-43982 | 08-31-65 | S | U | Lisianski I. | 10-19-66 | A - U |
| | | | | Lisianski I. | 08-31-67 | A - U |
| 757-27146 | 06-23-66 | S | U | Lisianski I. | 08-31-67 | S - U |
| 757-35767 | 06-06-67 | S | U | Lisianski I. | 09-03-67 | S - U |
| Johnston Atoll, Sand I. | | | | | | |
| 737-44110 | 07-15-63 | I | U | Lisianski I. | 08-31-67 | A - U |
| 737-44189 | 02-24-65 | I | U | Lisianski I | 10-19-66 | S - U |
| 737-44746 | 05-04-65 | I | U | Lisianski I. | 10-19-66 | A - U |
| 737-44829 | 06-11-65 | I | U | Lisianski I. | 09-01-67 | A - U |
| 737-43516 | 02-13-66 | I | U | Lisianski I | 09-03-67 | S - U |
| 737-43517 | 02-15-66 | A | M | Lisianski I. | 09-02-67 | A - U |
| 737-43533 | 02-19-66 | A | F | Lisianski I. | 10-19-66 | A - U |

Appendix Table 10b. (continued)

| Original Banding Data | | | | Recapture Data | | | |
|---|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age | Sex |
| 737-43536 | 02-19-66 | S | - U | Lisianski I | 08-31-67 | S | - U |
| 737-43583 | 02-22-66 | A | - M | Lisianski I. | 09-03-67 | A | - U |
| 737-43599 | 02-22-66 | I | - U | Lisianski I. | 10-19-66* | S | - U |
| 737-44686 | 02-23-66 | A | - M | Lisianski I. | 06-13-66 | U | - U |
| | | | | Laysan I. | 10-20-66 | A | - U |
| 737-44698 | 02-23-66 | S | - U | Lisianski I. | 10-19-66* | A | - U |
| 737-43666 | 03-24-66 | I | - U | Lisianski I. | 10-19-66* | S | - U |
| 737-43682 | 04-01-66 | I | - U | Lisianski I. | 10-19-66* | S | - U |
| 737-43742 | 04-15-66 | A | - M | Lisianski I. | 10-19-66* | A | - U |
| 737-43779 | 04-22-66 | S | - U | Lisianski I. | 09-03-67 | S | - U |
| 737-43862 | 05-11-66 | I | - U | Lisianski I. | 10-19-66* | S | - U |
| 737-43879 | 05-13-66 | I | - U | Lisianski I. | 09-02-67 | A | - U |
| 737-43884 | 05-19-66 | S | - U | Lisianski I. | 10-19-66* | S | - U |
| 737-43895 | 05-25-66 | I | - U | Lisianski I. | 09-03-67 | S | - U |
| 737-43897 | 05-25-66 | I | - U | Lisianski I. | 09-05-67 | S | - U |
| 587-90406 | 12-20-66 | A | - U | Lisianski I. | 06-04-67* | A | - U (with fresh egg) |
| 587-90389 | 04-03-67 | S | - U | Lisianski I. | 09-03-67 | S | - U |
| Kure Atoll | | | | | | | |
| 737-45370 | 10-14-63 | I | - U | Lisianski I. | 09-02-67 | A | - U |
| 737-98489 | 09-07-64 | I | - U | Lisianski I. | 10-19-66 | S | - U |
| | | | | Lisianski I. | 09-01-67 | A | - U |
| 767-45567 | 06-12-66 | S | - U | Lisianski I. | 09-03-67 | S | - U |
| | | | | Kure Atoll | 01-07-69 | A | - U |

Appendix Table 10b. (continued)

| Original Banding Data | | | | Recapture Data | | | |
|---|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age | Sex |
| 767-45802 | 07-15-66 | A | U | Lisianski I. | 10-19-66 | A | U |
| 767-45847 | 07-22-66 | S | U | Lisianski I. | 09-03-67 | S | U |
| 767-45868 | 08-08-66 | S | U | Lisianski I. | 09-01-67 | S | U |
| 737-99688 | 08-28-66 | N | U | Lisianski I. | 08-31-67 | S | U |
| 737-99760 | 09-03-66 | N | U | Lisianski I. | 08-31-67 | S | U |
| Laysan I. | | | | | | | |
| 587-80507 | 09-17-64 | A | U | Laysan I. | 08-09-65 | A | U |
| | | | | Lisianski I. | 09-02-67 | A | U |
| 587-80595 | 09-17-64 | I | U | Lisianski I. | 08-31-67 | A | U |
| 587-80625 | 09-17-64 | I | U | Johnston Atoll | 02-22-66 | S | U |
| | | | | Lisianski I. | 10-19-66* | S | U |
| 587-80663 | 09-17-64 | I | U | Lisianski I. | 10-19-66 | A | U |
| 767-41069 | 03-07-65 | A | U | Lisianski I. | 10-19-66 | A | U |
| 757-25643 | 08-09-65 | I | U | Lisianski I. | 06-04-67 | S | U |
| 757-25652 | 08-09-65 | I | U | Lisianski I. | 09-03-67 | S | U |
| 757-25656 | 08-09-65 | I | U | Lisianski I. | 10-19-66 | S | U |
| | | | | Lisianski I. | 09-03-67 | S | U |
| 757-25751 | 08-09-65 | I | U | Lisianski I. | 10-19-66 | S | U |
| 757-25754 | 08-09-65 | I | U | East I., French Frigate Shoals | 06-10-66 | S | U |
| | | | | Lisianski I. | 10-19-66 | S | U |
| | | | | Johnston Atoll | 04-03-67 | S | U |
| 757-25841 | 08-09-65 | I | U | Lisianski I. | 10-19-66 | S | U |
| 757-25798 | 08-10-65 | I | U | Lisianski I | 10-19-66 | S | U |

Appendix Table 10b. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-28517 | 10-22-66 | A | U | Lisianski I. | 09-04-67 | A - U |
| 587-85244 | 06-09-67 | A | U | Lisianski I. | 09-03-67 | A - U |
| Midway Atoll, Eastern I. | | | | | | |
| 767-40268 | 07-22-65 | N | U | Lisianski I. | 10-19-66 | S - U |
| 767-40183 | 07-24-65 | N | U | Lisianski I. | 09-04-67 | S - U |
| 767-40315 | 07-24-65 | N | U | Lisianski I. | 09-03-67 | S - U |
| 767-40340 | 07-24-65 | N | U | Lisianski I. | 10-19-66 | S - U |
| Pearl and Hermes Reef, Southeast I. | | | | | | |
| 737-38050 | 06-19-63 | N | U | Lisianski I. | 06-17-66 | U - U |
| 737-38051 | 06-19-63 | N | U | Johnston Atoll | 03-26-65 | I - U |
| | | | | Lisianski I. | 09-01-67 | A - U |
| 757-89390 | 08-17-64 | A | U | Lisianski I | 03-12-65 | A - U |
| 757-43066 | 09-25-66 | S | U | Lisianski I. | 09-04-67 | S - U |
| Wake I. | | | | | | |
| 767-48126 | 06-17-66 | S | U | Lisianski I | 08-31-67 | S - U |
| 587-84492 | 12-31-66 | A | U | Lisianski I. | 09-04-67 | A - U |

*Marked on leg with orange streamer.

Appendix Table 11a. Movements of Great Frigatebirds from Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 757-32604 | 06-17-66 | A | M | Kure Atoll | 09-27-68 | A - M |
| 757-32644 | 06-17-66 | A | M | Kure Atoll | 10-03-66 | A - M |

Appendix Table 11a. (continued)

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 757-28005 | 10-19-66 | N - U | Kure Atoll | 06-10-69 | S - U |
| 757-28096 | 10-19-66 | L - U | East I., French Frigate Shoals | 06-07-69 | S - F |

Appendix Table 11b. Movements of Great Frigatebirds to Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| French Frigate Shoals East I. | | | | | |
| 767-43767 | 08-24-65 | A - F | Lisianski I. | 09-02-67 | A - F |
| 757-26854 | 06-18-66 | A - F | Lisianski I. | 09-02-67 | S - U(?) |
| French Frigate Shoals. Whale-Skate I. | | | | | |
| 737-37466 | 06-14-63 | S - U | East I., French Frigate Shoals | 06-12-67 | S - F |
| | | | Lisianski I. | 08-31-67 | S - U |
| Kure Atoll | | | | | |
| 737-97595 | 12-15-65 | S - U | Kure Atoll | 05-16-66 | A - F |
| | | | Lisianski I. | 08-31-67 | A - F |
| 767-45442 | 04-23-66 | A - F | Lisianski I. | 09-01-67 | A - F |
| 767-46519 | 07-08-66 | S - U | Lisianski I. | 10-19-66 | S - U |
| Pearl and Hermes Reef, Southeast I. | | | | | |
| 757-43056 | 09-25-66 | N - U | Lisianski I. | 09-02-67 | S - U |

Appendix Table 12. Movements of Golden Plovers from Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 662-06097* | 03-11-64 | A - U | Kure Atoll | 09-01-64 | A - U |
| | | | Southeast I., Pearl and Hermes Reef | 03-15-65 | A - U (found dead) |

*Banded by BSFW.

Appendix Table 13. Movements of Ruddy Turnstones to Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| Alaska, Pribilof Is., St. George | | | | | |
| 712-08013 | 08-07-65 | A - U | Lisianski I. | 06-18-66* | A - U |
| 722-15262 | 08-23-66 | I - U | Lisianski I. | 09-01-67 | A - U |
| 722-16178 | 08-25-66 | I - U | Lisianski I. | 03-20-68 | A - U |
| 1103-00939 | 08-08-67 | A - U | Lisianski I. | 09-04-67 | A - U |
| 1103-03235 | 08-25-67 | I - U | Lisianski I. | 03-20-68 | A - U |

*Collected.

Appendix Table 14a. Movements of Sooty Terns from Lisianski

| Original Banding Data | | | Recapture Data | | |
|---|---|---|---|---|---|
| Band No. | Date | Age Sex | Where Recaptured | Date | Age Sex |
| 753-45170 | 08-21-64 | A - U | Midway Atoll, Easter I. | 06-12-66 | U - U (dead) |
| 793-80794 | 08-22-64 | A - U | Phoenix I., Phoenix Is. | 01-26-67 | A - U |
| 823-19014 | 07-16-65 | A - U | Laysan I. | 06-12-66 | A - U |

Appendix Table 14a. (continued)

| Original Banding Data | | | | Recapture Data | | | |
|---|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age | Sex |
| 823-19043 | 07-16-65 | A | U | Laysan I. | 06-07-67 | A | U |
| | | | | Laysan I. | 06-10-67 | A | U |
| 823-19068 | 07-16-65 | A | U | Laysan I. | 06-12-66 | A | U |
| 823-19072 | 07-16-65 | A | U | Laysan I. | 06-11-66 | A | U |
| | | | | Laysan I. | 06-13-66 | A | U |
| 823-19254 | 07-16-65 | I | U | Johnston Atoll | 07-21-67 | A | U |
| 903-90422 | 06-16-66 | A | U | Laysan I. | 06-10-67 | A | U (nesting) |
| 903-92438 | 06-16-66 | A | U | At sea, ca. 22°20'N 178°22'W | 04-06-68 | A | U |
| 903-96566 | 06-16-66 | A | U | Laysan I. | 06-10-67 | A | U |
| 903-98068 | 06-16-66 | A | U | Laysan I. | 06-10-67 | A | U |
| 903-98505 | 06-17-66 | A | U | Johnston Atoll | 08-15-67 | A | U |
| 943-04396 | 06-17-66 | A | U | Southeast I., Pearl and Hermes Reef | 05-29-69* | A | U |
| 943-07017 | 06-17-66 | A | U | Shizuoka Prefecture Japan, 35°00'N 138°20'E | 09-25-66+ | A | U |
| 943-14501 | 06-18-66 | A | U | Laysan I. | 06-11-67 | A | U (incubating) |
| 943-17848 | 06-18-66 | A | U | Laysan I. | 06-11-67 | A | U |
| 943-18114 | 06-18-66 | A | U | Laysan I. | 06-11-67 | A | U (breeding) |
| 923-58868 | 09-01-67-09-05-67 | A | U | East I., French Frigate Shoals | 06-10-68 | A | U |

*Returned by BSFW.

+Blown by typhoon, subsequently died.

Appendix Table 14b. Movements of Sooty Terns to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| French Frigate Shoals, East I. | | | | | | |
| 863-23219 | 08-15-65 | A | U | Lisianski I. | 06-04-67 | A - U (with egg) |
| 923-26436 | 08-02-66 | A | U | Lisianski I. | 06-04-67 | A - U (with egg) |
| Johnston Atoll | | | | | | |
| 753-15469 | 08-03-63 | A | U | Lisianski I. | 06-18-66 | U - U |
| 753-22396 | 09-04-63 | A | U | Lisianski I. | 06-19-66 | U - U |
| 753-22662 | 09-05-63 | A | U | Lisianski I. | 06-17-66 | U - U |
| 753-23261 | 09-06-63 | A | U | Lisianski I. | 06-17-66* | U - U |
| 753-23764 | 09-10-63 | A | U | Lisianski I. | 08-21-64 | U - U |
| 753-94491 | 02-04-64 | A | U | Lisianski I. | 06-04-67 | A - U (nesting) |
| 823-04010 | 05-09-65 | L | U | Lisianski I. | 06-04-67 | A - U |
| 823-07386 | 05-14-65 | L | U | Lisianski I. | 06-04-67 | U - U |
| 843-82437 | 07-22-65 | A | U | Lisianski I. | 06-18-66 | U - U |
| 843-94012 | 08-12-65 | A | U | Lisianski I. | 09-03-67 | A - U |
| Laysan I. | | | | | | |
| 793-82159 | 09-17-64 | A | U | Lisianski I. | 06-16-66 | A - U |
| 793-82184 | 09-17-64 | A | U | Lisianski I. | 06-04-67 | A - U |
| 823-01108 | 09-17-64 | A | U | Lisianski I. | 06-18-66 | A - U |
| 823-18811 | 07-17-65 | A | U | Lisianski I. | 06-04-67 | A - U |
| 893-01179 | 08-05-65 | A | U | Lisianski I. | 06-17-66 | A - U |
| 893-01681 | 08-05-65 | A | U | Lisianski I. | 06-17-66 | A - U |
| 893-07386 | 08-05-65 | A | U | Lisianski I | 06-04-67 | A - U |

Appendix Table 14b. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 893-09402 | 08-06-65 | A | U | Lisianski I. | 06-18-66 | A - U |
| 893-11955 | 08-06-65 | A | U | Lisianski I. | 09-03-67 | A - U |
| 863-62311 | 08-07-65 | A | U | Lisianski I. | 06-19-66 | A - U |
| 863-67412 | 08-08-65 | A | U | Lisianski I. | 06-18-66 | A - U |
| 863-67615 | 08-08-65 | A | U | Lisianski I. | 06-18-66 | A - U |
| 863-71956 | 08-09-65 | A | U | Lisianski I. | 06-04-67 | A - U |
| 903-41890 | 06-11-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| 903-43528 | 06-12-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| 903-43923 | 06-12-66 | A | U | Lisianski I. | 09-03-67 | A - U |
| 903-60540 | 06-13-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| 903-61808 | 06-13-66 | A | U | Lisianski I. | 06-17-66 | A - U |
| 903-63810 | 06-13-66 | A | U | Lisianski I. | 06-03-67 | A - U |
| 903-52322 | 06-14-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| Midway Atoll, Eastern I. | | | | | | |
| 713-70211 | 08-01-62+ | L | U | Lisianski I. | 06-19-66 | A - U |
| 793-83954 | 08-15-64 | N | U | Lisianski I. | 06-04-67 | A - U (nesting) |
| 793-89441 | 08-19-64 | N | U | Lisianski I. | 06-04-67 | U - U |
| 863-09402 | 07-23-65 | A | U | Lisianski I. | 06-18-66 | A - U |
| 913-77624 | 06-15-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| 913-42473 | 06-21-66 | A | U | Lisianski I. | 06-04-67 | A - U |
| Pearl and Hermes Reef, Southeast I. | | | | | | |
| 753-43868 | 08-17-64 | A | U | Lisianski I. | 06-18-66 | A - U |
| 753-44797 | 08-18-64 | A | U | Lisianski I. | 05-30-67 | A - U |

Appendix Table 14b. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| Wake I. | | | | | | |
| 743-49717 | 07-24-63 | A | - U | Lisianski I. | 06-04-67 | A - U |

*Marked with orange streamer on leg.

+Banded by BSFW.

Appendix Table 15. Movements of Brown Noddies to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| Kure Atoll | | | | | | |
| 773-18942 | 07-21-64 | N | - U | Lisianski I. | 09-23-67 | A - U |
| French Frigate Shoals, Whale-Skate I. | | | | | | |
| 723-60758 | 06-13-63 | L | - U | Lisianski I. | 08-21-64 | A - U |

Appendix Table 16a. Movements of Black Noddies from Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 773-40836 | 03-12-64 | N | - U | Johnston Atoll | 02-20-65 | S - U |
| 773-40847 | 03-12-64 | N | - U | Whale-Skate I., French Frigate Shoals | 08-16-66 | A - U |
| 773-40867 | 03-12-64 | N | - U | Whale-Skate I., French Frigate Shoals | 08-30-65 | A - U |
| 773-40868 | 03-12-64 | N | - U | Whale-Skate I., French Frigate Shoals | 08-11-65 | A - U |
| 773-40880 | 03-12-64 | N | - U | Whale-Skate I., French Frigate Shoals | 06-05-67 | A - U |

Appendix Table 16a. (continued)

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| 773-40883 | 03-12-64 | N | U | Whale Skate I., French Frigate Shoals | 08-30-65 | A - U |
| 712-50043 | 09-03-67 | A | U | Kure Atoll | 06-28-68 | A - U |

Appendix Table 16b. Movements of Black Noddies to Lisianski

| Original Banding Data | | | | Recapture Data | | |
|---|---|---|---|---|---|---|
| Band No. | Date | Age | Sex | Where Recaptured | Date | Age Sex |
| French Frigate Shoals, Whale-Skate I. | | | | | | |
| 863-28352 | 08-31-65 | U | U | Lisianski I. | 10-19-66 | U - U |
| 923-19192 | 08-16-66 | A | U | Lisianski I. | 09-03-67 | A - U |
| Johnston Atoll | | | | | | |
| 642-03038 | 04-16-67 | A | U | Lisianski I. | 09-04-67 | A - U |
| Laysan I. | | | | | | |
| 712-00697 | 10-22-66 | U | U | Lisianski I. | 09-02-67 | A - U |
| Midway Atoll, Eastern I. | | | | | | |
| 662-05417 | 02-16-64* | A | U | Lisianski I. | 09-03-67 | A - U |
| Pearl and Hermes Reef, Southeast I. | | | | | | |
| 632-20573 | 06-18-63 | A | U | Lisianski I. | 09-03-67 | A - U |
| 632-20761 | 06-21-63 | A | U | Lisianski I. | 09-04-67 | A - U |

*Banded by BSFW.

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