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ATOLL RESEARCH BULLETIN

171. THE NATURAL HISTORY OF LAYSAN ISLAND, NORTHWESTERN HAWAIIAN ISLANDS

By Charles A. Ely and Roger B. Clapp

Issued by
THE SMITHSONIAN INSTITUTION
Washington, D.C., U.S.A.

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TABLE OF CONTENTS

Page

LIST OF FIGURES....iii
LIST OF TABLES....vi
LIST OF APPENDIX TABLES....ix
INTRODUCTION....1
DESCRIPTION....3
HISTORY....19
HISTORY SECTION FOOTNOTES....59
VEGETATION....64
LAYSAN ISLAND FAUNA....87
Introduction....87
Birds....88
Mammals....92
Reptiles....93
Species Accounts....93
Birds....93
Diomedea nigripes....95
Diomedea immutabilis....101
Pterodroma hypoleuca....109
Bulweria bulwerii....115
Puffinus griseus....120
Puffinus pacificus....120
Puffinus nativitatus....127
Oceanodroma tristrami....132
Phaethon rubricauda....135
Sula dactylatra....141
Sula leucogaster....149
Sula sula....154
Phalacrocorax pelagicus....161
Fregata minor....161
Philacte canagica....169
Anas platyrhynchos....169
Anas laysanensis....170
Anas acuta....178
Anas crecca....179
Anas querquedula....180
Mareca americana....180
Spatula clypeata....181
Bucephala albeola....182
Histrionicus histrionicus....182
Porzanula palmeri....182
Charadrius semipalmatus....187
Pluvialis dominica....187
Squatarola squatarola....192
Arenaria interpres....192
Numenius phaeopus....197
Numenius tahitiensis....197
Heteroscelus incanum....202
Totanus melanoleucus....206

Page

Totanus flavipes....206
Erolia acuminata....207
Erolia melanotos....207
Erolia bairdii....207
Erolia alpina....208
Sandpiper spp. 208
Limnodromus sp. 210
Limosa fedoa....210
Limosa lapponica....210
Crocethia alba....211
Phalaropus fulicarius....213
Lobipes lobatus....214
Larus glaucescens....214
Larus hyperboreus....215
Larus argentatus....215
Larus philadelphia....215
Rissa tridactylus....216
Sterna fuscata....216
Sterna lunata....223
Procelsterna cerulea....228
Anous stolidus....228
Anous tenuirostris....233
Gygis alba....241
Fratercula corniculata....247
Acrocephalus f. familiaris....247
Himatione sanguinea fraithii....250
Psittirostra c. cantans....253
Mammals....263
Orytylagus cuniculus....263
Cavia porcellus....266
Tursiops truncatus....267
Monachus schauinslandi....267
Equus caballus....274
Equus asinus....274
Equus asinus X Equus caballus....274
Sus scrofa....275
Bos taurus....275
Reptiles....275
Chelonia mydas....275
Hemidactylus garnotii....279
Ablepharus boutonii....279
ACKNOWLEDGMENTS....280
LITERATURE CITED....282
APPENDIX TABLES....299

LIST OF FIGURES

Page

1. The Hawaiian Islands. 2

2. Aerial photograph of Laysan Island, 5 August 1939. Official U.S. Navy photograph. 4

3. Aerial photograph of Laysan Island, 28 May 1943. Official U.S. Navy photograph. 5

4. Aerial photograph of Laysan Island, January 1966. Official U.S. Navy photograph. 6

5. Map of Laysan Island in 1915 showing location of guano deposits. Redrawn from Elschner (1915). 10

6. Looking northwest along remnants of former tram line in sandy blowout on southwestern portion of Island, 14 June 1966. POBSP photograph by P.C. Shelton. 11

7. Coral shelf at southwest end of Laysan, June 1967. POBSP photograph by D.L. Burkhalter. 13

8. Looking toward north and northeast beach from point just northeast of lagoon, March 1967. North coconut grove is at mid-right. POBSP photograph by C.D. Hackman. 14

9. Looking southeast from concrete pillar near Casuarina tree on northwest perimeter of island. Dominant vegetation is Eragrostis variabilis with scattered patches of Boerhavia diffusa and (in immediate foreground) Fimbristylis cymosa. POBSP photograph by P.C. Shelton, 21 June 1966. 16

10. Looking southeast toward northern portion of lagoon, 21 June 1966. North Cocos grove in mid-foreground. POBSP photograph by P.C. Shelton. 17

11. Guano loading area on Laysan about May 1902. Photograph by F.M. Chamberlain during cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11. 27

12. Base of guano operations on Laysan in 1902. Photograph by F.M. Chamberlain during cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11. 28

13. Looking toward northern end of lagoon, about May 1902, evidently from tower on northwestern rim of island shown in preceding figure. Photograph by F.M. Chamberlain during 29

Page

cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11. 29

14. Guano digging on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu. 30

15. Guano digging on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu. 31

16. Guano shed and loading area on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu. 32

17. Guano operation headquarters. Undated photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu. 33

18. General view of inner basin of Laysan completely denuded of vegetation except for the dark patch of Sesuvium and Portulaca in background, 11 April 1923. 49

19. Camp on Laysan showing two surviving Cocos trees, 13 April 1923. 49

20. Laysan Albatross and Wedge-tailed Shearwaters in patch of Sesuvium, 5 May 1923. 49

21. Red-footed Booby colony in single Casuarina tree with two surviving Cocos in background, 5 May 1923. 49

22. Tobacco patch and associated birds, 10 May 1923. 49

23. Wedge-tailed Shearwaters near nesting burrow, 12 April 1923. 49

24. HIRAN camp on Laysan. Photograph by D.B. Marshall, 18 June 1962. Official U.S. Fish and Wildlife Service photograph. 56

25. Looking southeast toward the lagoon, dense stand of Cynodon dactylon much infiltrated by Ipomoea pes-caprae in foreground; Eragrostis variabilis and Cocos nucifera beyond. POBSP photograph by P.C. Shelton, 21 June 1966. 67

26. Sesuvium portulacastrum (left), Cyperus laevigatus (center) and Heliotropium curassavicum (center and right) along west shore of lagoon. POBSP photograph by P.C. Shelton, 21 June 1966. 67

Page

27. Stand of Cyperus pennatiformis near south end of lagoon. POBSP photograph by P.C. Shelton, 14 June 1966. 69

28. Casuarina tree inland from campsite on northwest shore of island. POBSP photograph by P.C. Shelton, 21 June 1966. 69

29. Cyperus, Sesuvium portulacastrum, and Tribulus cistoides along southeastern side of lagoon. POBSP photograph by P.J. Gould, October 1966. 75

30. Black-footed Albatross chick in dense growth of Ipomoea pes-caprae. POBSP photograph by A.B. Amerson, Jr., 10 March 1964. 78

31. Nama sandwicensis near north end of island. North Cocos grove in mid-background. POBSP photograph by P.C. Shelton, 21 June 1966. 78

32. Cyperus laevigatus and Heliotropium curassavicum near northwestern corner of lagoon. POBSP photograph by P.C. Shelton, 21 June 1966. 80

33. Small Tournefortia at top of west beach south of northwest campsite. POBSP photograph by P.C. Shelton, 15 June 1966. 80

34. Nicotiana tabacum (left foreground) and Conyza bonariensis (right foreground) at top of west seaward slope. POBSP photograph by P.C. Shelton, 14 June 1966. 82

35. Scaevola taccada, Cyperus laevigatus, and Ipomoea pes-caprae along small slough near southeast corner of lagoon. South Cocos grove in mid-background. POBSP photograph by R.B. Clapp, 18 March 1968. 82

36. Stand of Pluchea indica north of lagoon. North Cocos grove in background. POBSP photograph by P.C. Shelton, 21 June 1966. 86

37. Downy young Wedge-tailed Shearwater at nest site under rock on southwest beach, September 1967. Photo by D.I. Hoff. 122

38. Wedge-tailed Shearwater club near northwest corner of lagoon, September 1967. Photo by R.B. Clapp. 122

39. Red-footed Booby at nest in low Scaevola, June 1966. Photo by P.C. Shelton. 156

40. Young Great Frigatebirds in low Scaevola above the west beach, September 1967. Photo by R.B. Clapp. 163

Page

41. Black Noddy at nest with downy young, March 1965. Photo by R.B. Clapp. 235

42. Laysan Finches feeding on remains of albatross egg, March 1965. Photo by R.B. Clapp. 255

LIST OF TABLES

1. Recent surveys of Laysan Island by the POBSP and BSFW. 58

FI-1. Present status of breeding seabirds on Laysan. 89

FI-2. Status of endemic Laysan birds. 90

FI-3. Status of regular shorebird species on Laysan. 90

FI-4. Months of occurrence of accidental and vagrant species on Laysan. 91

BFA-1. Locations of Black-footed Albatross skins from Laysan. 97

BFA-2. Black-footed Albatross banded on Laysan. 97

BFA-3. Observations of Black-footed Albatross on Laysan. 98

LA-1. Locations of Laysan Albatross skins from Laysan. 104

LA-2. Laysan Albatross banded on Laysan. 105

LA-3. Observations of Laysan Albatross on Laysan. 105

BP-1. Locations of Bonin Petrel skins from Laysan. 112

BP-2. Observations of Bonin Petrels on Laysan. 112

BuP-1. Locations of Bulwer's Petrel skins from Laysan. 117

BuP-2. Bulwer's Petrels banded on Laysan. 117

BuP-3. Observations of Bulwer's Petrels on Laysan. 117

WTS-1. Locations of Wedge-tailed Shearwater skins from Laysan. 123

WTS-2. Wedge-tailed Shearwaters banded on Laysan by the POBSP. 124

Page

WTS-3. Observations of Wedge-tailed Shearwaters on Laysan. 124

CS-1. Locations of Christmas Shearwater skins from Laysan. 129

CS-2. Christmas Shearwaters banded on Laysan. 129

CS-3. Observations of Christmas Shearwaters on Laysan. 129

SSP-1. Locations of Sooty Storm Petrel skins from Laysan. 133

SSP-2. Observations of Sooty Storm Petrels on Laysan. 133

RTTB-1. Locations of Red-tailed Tropicbird skins from Laysan. 137

RTTB-2. Red-tailed Tropicbirds banded on Laysan. 138

RTTB-3. Observations of Red-tailed Tropicbirds on Laysan. 138

BFB-1. Locations of Blue-faced Booby skins from Laysan. 144

BFB-2. Blue-faced Boobies banded on Laysan. 145

BFB-3. Observations of Blue-faced Boobies on Laysan. 146

BB-1. Brown Boobies banded on Laysan. 151

BB-2. Observations of Brown Boobies on Laysan. 152

RFB-1. Locations of Red-footed Booby skins from Laysan. 157

RFB-2. Red-footed Boobies banded on Laysan by the POBSP. 157

RFB-3. Observations of Red-footed Boobies on Laysan. 157

GF-1. Locations of Great Frigatebird skins from Laysan. 164

GF-2. Great Frigatebirds banded on Laysan by the POBSP. 165

GF-3. Observations of Great Frigatebirds on Laysan. 165

LT-1. Locations of Laysan Teal skins from Laysan. 174

LT-2. Laysan Teal banded on Laysan. 174

LT-3. Observations of Laysan Teal on Laysan. 175

P-1. Observations of Pintails on Laysan. 178

Sh-1. Observations of Shovelers on Laysan. 181

	Page
LR-1. Locations of Laysan Rail skins from Laysan.	185
LR-2. Observations of Laysan Rails on Laysan.	185
GP-1. Locations of Golden Plover skins from Laysan.	188
GP-2. Golden Plovers banded on Laysan.	188
GP-3. Observations of Golden Plovers on Laysan.	189
RT-1. Locations of Ruddy Turnstone skins from Laysan.	193
RT-2. Ruddy Turnstones banded on Laysan.	194
RT-3. Observations of Ruddy Turnstones on Laysan.	194
BTC-1. Locations of Bristle-thighed Curlew skins from Laysan.	199
BTC-2. Bristle-thighed Curlews banded on Laysan.	199
BTC-3. Observations of Bristle-thighed Curlews on Laysan.	199
WT-1. Locations of Wandering Tattler skins from Laysan.	203
WT-2. Observations of Wandering Tattlers on Laysan.	203
Ss-1. Observations of small Sandpiper Spp. on Laysan.	209
BTG-1. Observations of Bar-tailed Godwits on Laysan.	211
S-1. Observations of Sanderlings on Laysan.	212
ST-1. Locations of Sooty Tern skins from Laysan.	219
ST-2. Sooty Terns banded on Laysan by the POBSP.	219
ST-3. Observations of Sooty Terns on Laysan.	220
GBT-1. Locations of Gray-backed Tern skins from Laysan.	225
GBT-2. Observations of Gray-backed Terns on Laysan.	226
BrN-1. Locations of Brown Noddy skins from Laysan.	230
BrN-2. Observations of Brown Noddies on Laysan.	230
BlN-1. Locations of Black Noddy skins from Laysan.	236
BlN-2. Black Noddies banded on Laysan.	236
BlN-3. Observations of Black Noddies on Laysan.	237

Page

WhT-1. Locations of White Tern skins from Laysan. 243

WhT-2. White Terns banded on Laysan. 243

WhT-3. Observations of White Terns on Laysan. 243

LM-1. Locations of Laysan Miller-bird skins. 249

LM-2. Observations of Laysan Miller-birds on Laysan. 249

LH-1. Locations of Laysan Honey-eater skins. 252

LH-2. Observations of Laysan Honey-eaters on Laysan. 252

LF-1. Locations of Laysan Finch skins. 259

LF-2. Laysan Finches banded on Laysan by the BSFW. 259

LF-3. Observations of Laysan Finches on Laysan. 259

R-1. Observations of rabbits on Laysan. 264

HMS-1. Observations of Hawaiian Monk Seals on Laysan prior to 1951. 268

HMS-2. Recent population counts and observations of Hawaiian Monk Seals on Laysan. 269

GT-1. Observations of Green Turtles on Laysan. 276

LIST OF APPENDIX TABLES

1. Scientific visits to Laysan Island, 1828-1969. 299

2. Results of scientific visits to Laysan Island, 1828-1969, with emphasis on bird observations. 307

3. Publications on collections and studies (with the exception of birds) made on Laysan Island. 313

4-1. Yearly banding totals of birds banded on Laysan by various agencies. 325

4-2. Interisland movement of banded birds involving Laysan Island. 326

		Page
4-3a.	Movements of Black-footed Albatross from Laysan.	328
4-3b.	Movements of Black-footed Albatross to Laysan.	328
4-4a.	Movements of Laysan Albatross from Laysan.	328
4-4b.	Movements of Laysan Albatross to Laysan.	330
4-5a.	Movements of Blue-faced Boobies from Laysan.	330
4-5b.	Movements of Blue-faced Boobies to Laysan.	332
4-6a.	Movements of Red-footed Boobies from Laysan.	334
4-6b.	Movements of Red-footed Boobies to Laysan.	340
4-7a.	Movements of Great Frigatebirds from Laysan.	342
4-7b.	Movements of Great Frigatebirds to Laysan.	343
4-8a.	Movements of Sooty Terns from Laysan.	344
4-8b.	Movements of Sooty Terns to Laysan.	346
4-9a.	Movements of Black Noddies from Laysan.	349
4-9b.	Movements of Black Noddies to Laysan.	349
5.	Distribution of Laysan bird skins and mounts.	350
5-1.	Laysan specimens in major museums.	351
5-2.	Laysan specimens at the American Museum of Natural History (includes mounts).	352
5-3.	Laysan specimens at the Bernice P. Bishop Museum (includes mounts).	353
5-4.	Laysan specimens at the Chicago Museum of Natural History (includes mounts).	354
5-5.	Laysan specimens at the Denver Museum of Natural History (includes mounts).	355
5-6.	Laysan specimens at the Museum of Comparative Zoology.	356
5-7.	Laysan specimens at the State University of Iowa (includes 106 mounts).	356
5-8.	Laysan specimens at the University of Michigan Museum of Zoology.	357

Page

5-9. Laysan specimens at the United States National Museum (includes mounts). 358

5-10. Minor Laysan holdings. 359

5-11. Present deposition of specimens from major expeditions. 360

5-12. Laysan specimens by expedition. 360

THE NATURAL HISTORY OF LAYSAN ISLAND, NORTHWESTERN HAWAIIAN ISLANDS

by Charles A. Ely[2] and Roger B. Clapp[3]

INTRODUCTION

Laysan Island, the largest of the Northwestern Hawaiian Islands, is located in the central Pacific at latitude 25°42'41"N, longitude 171°44'06"W. It is approximately 115 nautical miles east of Lisianski, 202 miles northwest of Gardner Pinnacles and 709 miles northwest of Honolulu, Oahu, Hawaii (Figure 1). Laysan is almost due south of the Pribilof Islands and roughly equivalent in latitude to Monterrey, Mexico and Miami, Florida. It is roughly rectangular in shape and about 1.4 square miles in area with a lagoon occupying about one-fifth of the island interior. Laysan is a coral island ringed on its periphery by sand dunes; the beach crest and inland slopes are well vegetated.

Laysan has the most remarkable biota of any island in the Northwestern Hawaiian Islands. It remained relatively undisturbed until the late 19th century and even the first decade of human occupancy had little apparent effect on island life. Introduction of rabbits (about 1903), however, proved very nearly disastrous--more so than the famous raids by Japanese feather poachers a decade later. Attempts to exterminate the rabbits in 1912-1913 failed and only the timely arrival of the Tanager Expedition in 1923 saved the island from complete devegetation. Even the extermination of the rabbits and replanting of vegetation were too late to save three of the five endemic birds. Today the vegetation and most animal populations have regained levels similar to those recorded early in the 20th century.

Laysan was declared a part of the Hawaiian Islands Bird Reservation by presidential executive order in 1909 and is now known as the Hawaiian

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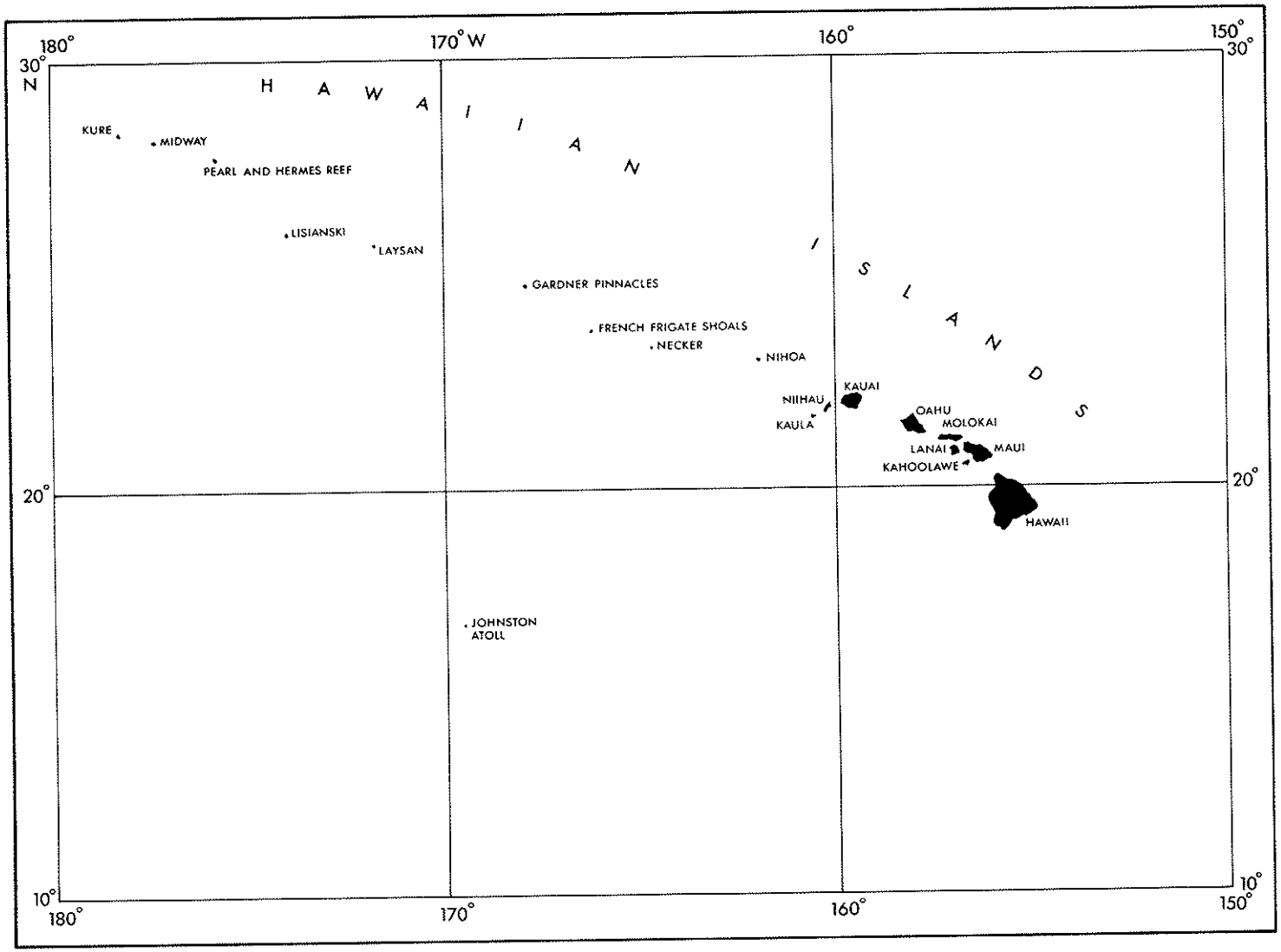

Figure 1. The Hawaiian Islands.

Islands National Wildlife Refuge. During the 1950's and 1960's Laysan was visited primarily by biologists from the State of Hawaii Division of Fish and Game under contract to the Bureau of Sport Fisheries and Wildlife of the U.S. Department of Interior. In 1964 a federal refuge manager was assigned to Hawaii and direct responsibility for inspection, patrol and management of the refuge was assumed by the Bureau. In February 1967 Laysan was declared a "natural area" to be maintained as free from outside or non-natural disturbance as possible and island visits are restricted to official or scientific business.

The Pacific Ocean Biological Survey Program (hereafter referred to as POBSP) of the Smithsonian Institution, Washington, D.C., made 13 trips to Laysan during the period 1963 to 1968. A number of these visits were made in conjunction with regular inspection trips by the Bureau of Sport Fisheries and Wildlife. These visits, together with additional surveys made by personnel of the Hawaii Division of Fish and Game and the Bureau of Sport Fisheries and Wildlife, form the basis of this paper, which summarizes biological information concerning Laysan Island.

DESCRIPTION

General Nature

Laysan is roughly rectangular in shape with the long axis slightly east of North. The Tanager Expedition survey (by Major Chapman Grant) determined maximum dimensions of one and four-fifths mile long (9,375 feet) by just over one mile wide (5,580 feet). Warner (ms.: 5) used this map to calculate a total area (including the lagoon) of almost 913 acres (about 1.43 square miles). Bryan (1954: 4) had previously given the area as 1.56 square miles.

Although island dimensions have been variously reported by different writers (e.g., Brooks, 1859: 500 [3 miles long, 2 1/2 miles wide]; Fisher, 1903a: 772 [3 miles long, 1 1/2 miles wide]), an appreciable change in size during historical times is unlikely. Aerial photographs taken in 1939, 1943 and 1966 (Figs. 2-4) agree in most particulars with the outline map prepared by the Tanager Expedition in 1923.

Laysan is a coral island capped by large sand accumulations and with a large salt water lagoon in its central depression. The island is probably the flattened top of a once massive volcanic peak formed perhaps during the Miocene, since eroded far below the present sea level, and subsequently built up by the action of coral, other marine invertebrates and calcareous algae. The depth of the coral deposits capping Laysan has not been determined but is probably considerable. (Borings on Eniwetok and Bikini reached the volcanic bedrock at 4,222 and 4,610, and 2,556 feet, respectively [Weins, 1962: 92].)

Relatively shallow water extends some distance in all directions from the present island surface and then drops off rapidly to an average depth

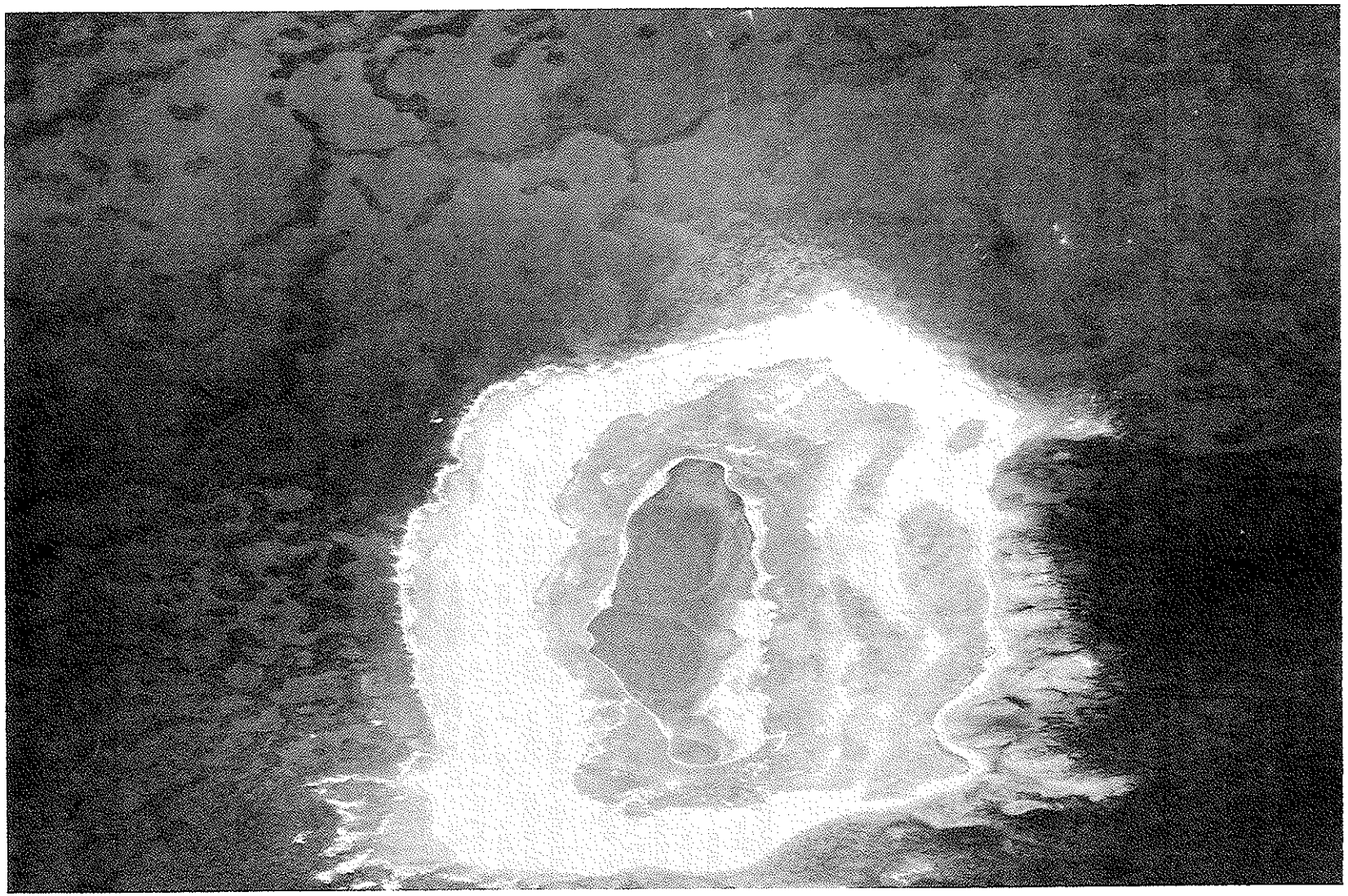

Figure 2. Aerial photograph of Laysan Island, 5 August 1939. Official U.S. Navy photograph.

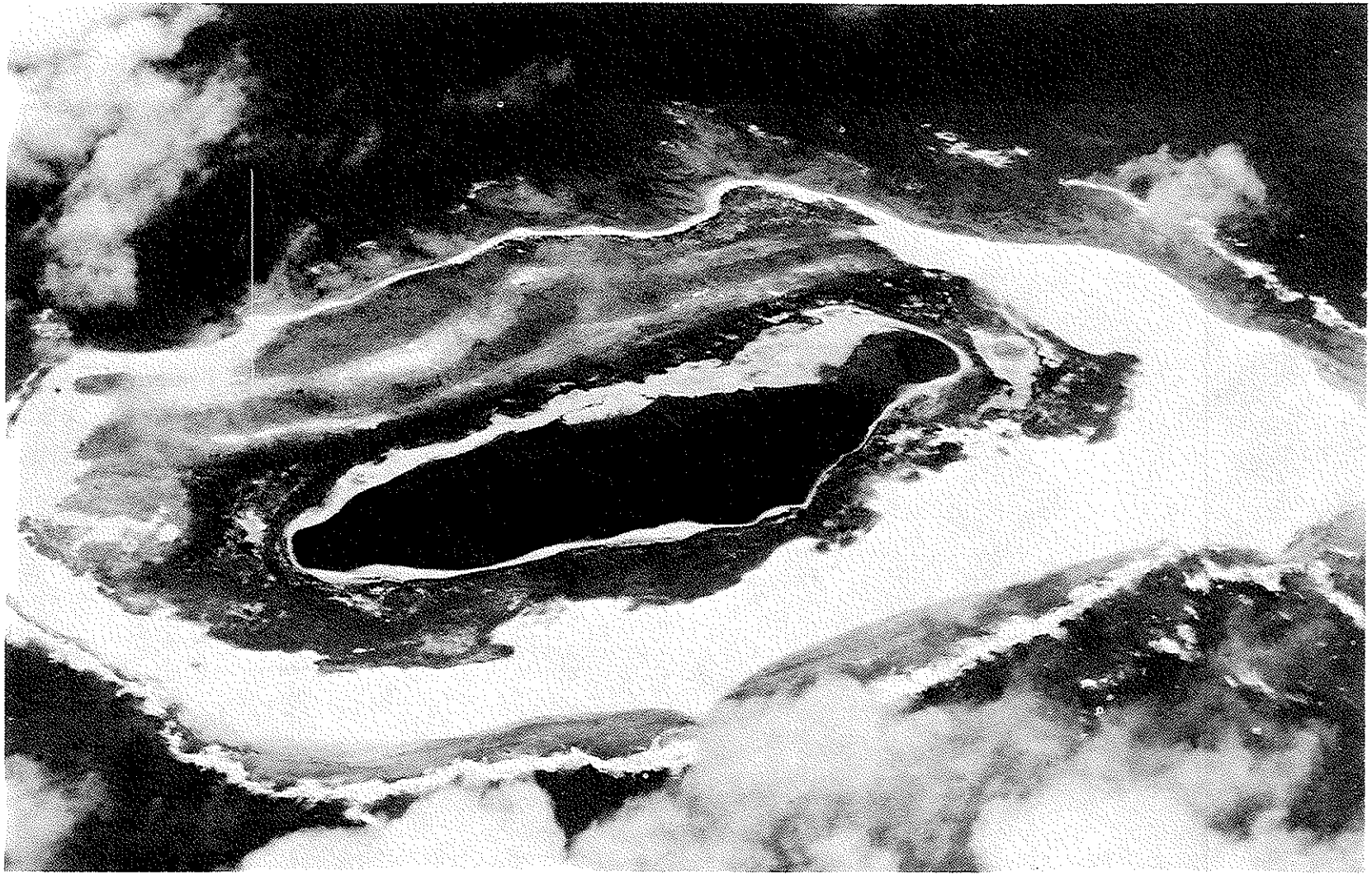

Figure 3. Aerial photograph of Laysan Island, 28 May 1943. Official U.S. Navy photograph.

Figure 4. Aerial photograph of Laysan Island, January 1966. Official U.S. Navy photograph.

of 1,800 fathoms between Laysan and neighboring islands. The 100-fathom line encloses an area of approximately 210 square miles (Warner, 1963).

As Warner (loc. cit.) pointed out, "the topography of Laysan suggests that the island was at one time a small atoll with a central lagoon which is now nearly filled with sand and coral fragments." He described its present configuration as "a great ringed sand dune... heaped upon the coralline rock base whose subsurface is approximately five feet above mean high water mark."

The island rises abruptly to a height of 15 to 18 feet (Bryan, 1942: 185), then rises more gradually to a crest of 30 to 40 feet. The maximum crest elevations (just over 40 feet) occur in the sand dune area at the north end of the island with crests of 30 feet elsewhere; lowest on the south. The beach crest varies in width from a narrow strip on the northwest and east to a width of about one-eighth mile on the southwest and west. Inside the beach crest the island slopes gradually (more steeply on the east) to the lagoon--the major physical feature of the island interior. The lagoon lacks an opening to the sea, is just above sea level and varies considerably in shape and area with water level.

The island is presently well-vegetated except for coastal dunes, most of which are stabilized, and two "blow-out" areas inland from the beach crest on the west side. The original flora was the most varied in the Northwestern Hawaiian Islands chain. Destruction of the vegetation by man and introduced rabbits resulted, by 1923, in near desert conditions, the extinction of several species, and the movement of sand which altered some physical features of the island interior and partially filled the lagoon. At present the vegetative cover has returned to something approaching the original condition. Vegetation extends generally from the beach crest to a narrow, vegetation-free zone near the lagoon which apparently marks the zone of maximum salt impregnation. In some areas, particularly the north, sand dunes extend over the crest and part way down the inward slope.

The fresh water pond once located near the southwest end of the lagoon has not been reported since 1915 and presently even brackish water exists only after periods of heavy rainfall. A few remnants of the guano period remain (several piles of phosphate rock, the rusting tram line), as do scattered debris from later visits. A HIRAN team which surveyed the island in 1961 left a tall concrete bench mark above the campsite near the northwest landing. The island has been uninhabited since 1906 except for brief periods by feather poachers in 1909 to 1910 and 1914 to 1915 and by the Schlemmers from 12 July to 2 December 1915.

Physical Features

Offshore structures and reef plate

The fringing reef surrounding the island varies from 100 to 500 yards in width and is most extensive at the northwest end of the island.

Inside the reef is a narrow, shallow channel nearly encircling the island except for the south and southeast sides. A small boat can navigate most of this channel at high tide. A natural opening on the northwest reef provides a safe boat entrance during most weather and other less satisfactory breaks in the reef are present near the southwest and northeast corners of the island. Outside the reef the depth increases gradually, with generally under 20 fathoms at least five miles from the reef.

The reef consists of coral, calcareous algae and the remains of shelled marine invertebrates. On the east side the rocks and stones are cemented together but with a dislocation or fracture extending across the bottom of the lagoon and crossing the reef near the southeast corner (Elschner, 1915: 30).

Elschner (1915) described the reef plate or plate rock in some detail. It formed the bottom of the lagoon depression and extended seven to ten inches deeper than the water level of the lagoon and probably a foot lower than the average ocean level. It was strongly phosphatized and formed by the caking and cementing together of disintegrated coral substances through the influence of guano solutions. The result was a fine conglomerate with the pores closed and clogged to such a degree that it was nearly impenetrable to water. In areas this plate was on the surface but in others partly covered by a more or less phosphatized sand or soil. Both the plate and the remainder of the lagoon basin were penetrated with horizontal stripes of brown phosphate between layers of white undecomposed carbonate.

Soil, fresh water, and guano

The island surface consists primarily of more or less phosphatized coral sand. The phosphatized sand consists of round oolitic grains, which are covered with a layer of brown phosphate and contain in such cases undecomposed centers of carbonate. Between these grains there are larger pieces of limestone and splinters of bone. The thickness of the phosphate coating varies considerably. When phosphatization is nearly complete (high percentage of phosphate), the phosphate is frequently a very fine brown powder (Elschner, 1915).

Schauinsland (1899: 89) reported the finding of a "peat" deposit as follows: "In the north part of the island just below its highest elevation on a deeply situated spot where Scirpus laevigatus was abundantly growing, I excavated because there was presumably a 'coal deposit' there. Underneath a layer of humus I first found sand, then a hard substance like marl, and finally peat (somewhat mixed up with the sand) consisting of the remains of long plants (Scirpus?) situated rather uniformly together in significant amounts." In 1961, Woodside (ms. c) reported that members of his party dug small, shallow holes to water level near the lagoon to examine the underlying layers. No peat was found but what appeared to be a dark-colored soil was noted.

Laysan has had no permanent fresh water supply since at least the late 19th century. Paty (1857: 42) reported finding, on 1 May 1857, an abundance of "tolerable good fresh water" by digging two feet "not a 100 yards from the salt"(on shore of the lagoon). Two years later, also in May, Brooks (1860: 500-501) dug a well and found "very good water."

Either the tastes of the individuals involved were different or potable fresh water was no longer present in quantity by 1896. Schauinsland (1899: 72) stated that the water on the island itself was "briny" and that they relied solely on rain water collected from the roofs. Wilder (1905: 392) made similar observations in September 1905. At that time a well sunk inland provided water (presumably somewhat brackish) for washing while drinking water was collected from roofs and stored in cement cisterns. In 1911, Dill and Bryan (1912: 9) observed that the pump was rusted out and the well partly filled with sand. All 20th century visitors have relied on imported water supplies or on frequent, usually brief, rain showers.

It seems likely that the fresh water lens described by Warner (1963: 9) may have been more prevalent during the period of early island exploration. In recent years this fresh water lens, developing on occasion as a result of high rainfall, has provided the only fresh or brackish water on the island. McKernan (in Warner, 1963) indicated that the fresh water lens might occur also above the hypersaline water of the lagoon when rainfall and ground seepage are sufficiently high.

The exposure of the fresh water lens in low depressions was undoubtedly the source of small fresh water ponds or puddles noted by several observers up to the present time. The largest of these was a small pond of slightly brackish to fresh water (Fisher, 1903a: 773) near the southwest corner of the lagoon. This pond was permanent in nature through at least 1915. By the arrival of the 1923 Tanager Expedition, however, it had filled with wind-blown sand and disappeared. Warner (1963: 9) noted a number of brackish water depressions and small ponds during wet seasons. These were highly favored by Laysan Teal. Similar observations were made by the POBSP, usually at the southeast edge of the lagoon.

Schauinsland (1899: 19) described the guano observed by him in 1896 as clean and odorless. It was present "partly as a more or less dusty or sandy, rather thick form under the surface (brown or white guano) and partly as solid rock several meters deep which must be broken with pick and shovel (the so-called 'rock guano')." He also reported finding whole granules of beautiful pure crystal. Elschner (1913) reported that Laysan guano occurred as a fine phosphatized coral sand or as a soft, loose phosphate sandstone of low grade.

Elschner (1913, 1915) described the processes of guano formation on Pacific islands and described in some detail the deposits on Laysan about the turn of the century. These deposits were formed under conditions of moderate rainfall and resulted in a guano intermediate in nature between

excrement and mineral. Due to the great amount of leaching and chemical changes, most of the nitrogen was lost and phosphorization occurred, resulting in a phosphate guano, as contrasted with the nitrogeneous guano of arid regions.

His map (Fig. 5) showed the greatest guano deposits at the south end of the lagoon with smaller deposits northwest, north, and northeast of the lagoon. A "tram" line ran to the south digging with a spur to the north end of the lagoon. Part of the former was still present though partly covered with sand in 1967 (Fig. 6).

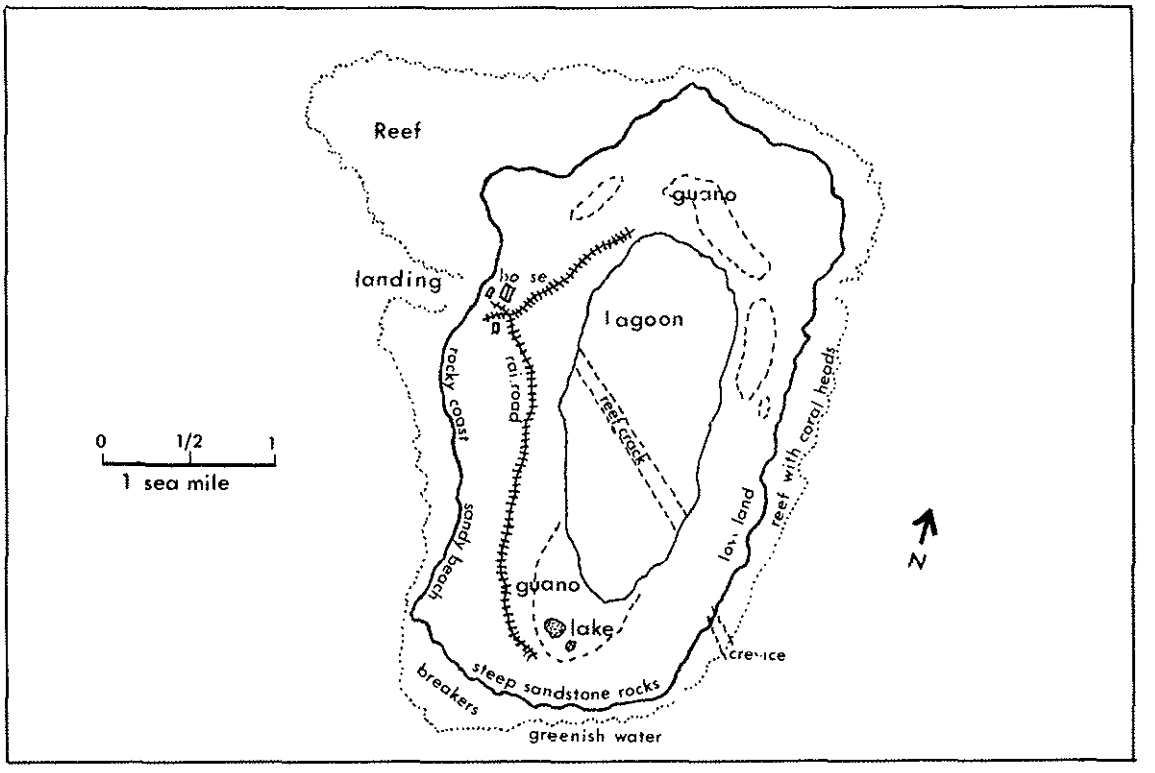

Figure 5. Map of Laysan Island in 1915 showing location of guano deposits. Redrawn from Elschner (1915).

Various accounts indicate that the greatest amount of digging was at the south end of the lagoon and the large flat mined area is a conspicuous landmark today. Also remaining are several piles of broken phosphatic rock some six feet in height. Sahcuinsland (1899: 33) stated that the guano level extended to below sea level and on the east side of the island extended into the ocean. Bones and "petrified" eggs occurred in this layer and some of the latter are now in the Bernice P. Bishop Museum collections.

Elschner further stated (1913) that the high grade qualities contained up to 75%, in small areas even 80%, phosphoric lime (based on dry substance) and up to 1.25% nitrogen. All grades containing more than

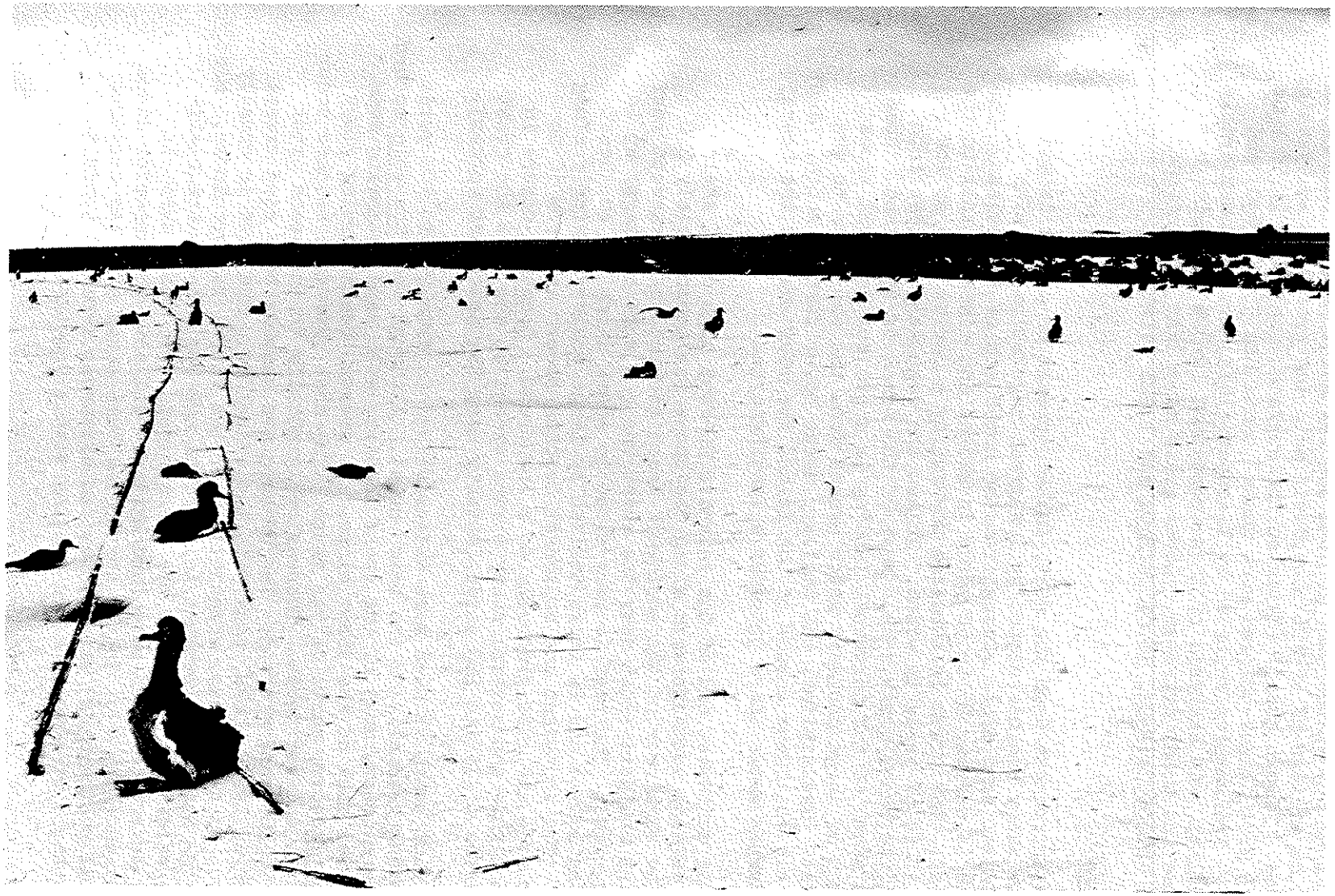

Figure 6. Looking northwest along remnants of former tram line in sandy blowout on southwestern portion of Island, 14 June 1966. POBSP photograph by P.C. Shelton.

60% phosphoric lime had been completely exhausted by 1917 so that only lower-quality types of 40-50% $Ca_3P_2O_8$ remained on the island. Schauinsland (1899: 89) stated that in 1896 the raw guano shipped from Laysan contained an average of 25-30% phosphoric acid and presented analyses of two samples. "Brown guano" (lying on the surface) contained 11.5% P_2O_5 and 48.64% CaO; "light-colored rock guano" contained 36.99% P_2O_5 and 33.3% CaO. Two samples reported by Elschner (1913) are of considerably higher quality. An analysis of these contained 72-80% tribasic phosphoric lime and 0.82% nitrogen. Lower grade materials (soft stone) contained 48.20% $Ca_3P_2O_8$, 38.0% $Ca_3P_2O_8$ and 1.02% nitrogen.

The beaches

When approached from the west, Laysan appears as a flat island with white sandy beaches capped by low green vegetation and with conspicuous white sand dunes rising from the north end of the island. The west beach is narrow, 25 to 50 yards in width, and rises rapidly to the beach crest. The crest is bordered seaward by a narrow band of low Scaevola 10 to 60 yards in width. Inland the vegetation grades into the extensive bunch-grass zone. Most of the beach is open sand. Some 600 yards south of the northwest landing is a projecting coral block and a group of large boulders which extend from the shoreline to the beach crest. Two similar, but smaller, areas occur farther south. Just north of the southwest corner of the island the reef reaches the beach and the deeper water there provides a landing area.

At the southwest end of the island a 20-foot high coral shelf (Fig. 7) extends southeastward along the shore for approximately 250 yards. The remainder of the southwest beach consists of waveswept reef and massive boulders--most near the waterline but some scattered up to the beach crest. The reef is very close to shore along the southeast part of the island and is characterized by large boulders chiefly along the reef. The southwest and southeast beaches proper are from 50 to 100 yards wide and rise gradually to a low crest. Scaevola occurs in scattered clumps and several sandy strips extend up and over the crest for distances of 150 to 200 yards (notably near the southwest corner).

The east beach is much more extensive and is from 250 to 400 yards wide, sloping gradually to the beach crest. Although some Scaevola occurs on the beach crest, most of the crest is bare, with sand extending some distance over much of the inner slope. In season, beach morning glory and Boerhavia cover parts of the slope. The most extensive beaches occur on the north and northeast. These slope gradually to the beach crest some 150 to 200 yards inland. The beaches are usually bare sand except for scattered large rocks, mostly on the shoreline. The sand is usually compact but in some areas, especially near the shore, is more loose. Most of the large sand dunes present inland from the north beach are stabilized, especially those inside the beach crest. The beach crest is generally unvegetated and bare sand extends well down the interior slope of the island (Fig. 8). In the north, the bare sandy area (as measured from aerial photographs) extends various distances from 250 yards to about one-third of a mile before meeting stable vegetation.

Figure 7. Coral shelf at southwest end of Laysan, June 1967. POBSP photograph by D.L. Burkhalter.

Figure 8. Looking toward north and northeast beach from point just northeast of lagoon, March 1967. North coconut grove is at mid-right. POBSP photograph by C.D. Hackman.

The island interior

Visitors to Laysan usually camp at the site of the former guano headquarters on the northwestern part of the island where a large ironwood tree now marks the natural passage through the reef. Most of the few conspicuous landmarks can be seen from the beach crest near this point. The general impression is of an expanse of tall, coarse bunch grass in the foreground sloping gently to a long flat plain containing a shallow lake (Fig. 9). The inner slopes are generally covered with clumps of grass and capped with scrubby Scaevola except where bare sand extends over the beach crest. Scaevola forms a continuous zone along the west beach crest. The lagoon varies in size and shape with season and water level and is usually bordered by bare saline mud flats, particularly on the west and northwest sides. A ring of prostrate vegetation and sedges occurs between the mud flat and the bunch grass zone. On the east side of the lagoon the mud flat is much more narrow and the island rises rapidly to the beach crest.

A small group of coconut trees is present a few hundred yards seaward from the northwest end of the lagoon (Fig. 10). A smaller grove at the southeast end of the lagoon is barely visible from the campsite. Also barely visible are several patches of Pluchea bushes at the northeast and south ends of the lagoon. Two large areas of bare sand ("blow-outs") are present on the inner slopes west of the lagoon. During dry periods the lagoon is separated by a narrow strip of vegetation from a small, shallow "pond" to the northeast. A sand bar (its size varying with water level) crosses the lagoon at about its northern third. During periods of high water, generally in winter, the lagoon floods and water may extend over the low vegetation surrounding the lagoon and even extend to the northwest coconut grove. During major winter storms, heavy waves may also break over the low southern beach crest and drain inward to the lagoon. Winter storms also shift sand and destroy vegetation inland and near the lagoon.

Available aerial photographs from 1939 through 1966 show two very distinct bands of light (less dense) vegetation west of the lagoon and extending the entire length of the island, roughly parallel to the island contours. These bands average about 75 yards in width and alternate with three bands of dark (denser) vegetation. These bands are within the bunch grass zone and are not easily seen from the ground. Lamoureux (1963: 12) determined that the less dense areas were due to more widely spaced Eragrostis clumps in nearly pure stands. The relationship of these bands to soil conditions, moisture, or other factors has not yet been determined. Perhaps these zones were associated with sand dunes while the island was denuded or perhaps they date far back into the island's history. These bands of vegetation were not mentioned by early visitors but could have been easily overlooked from the ground.

Two "blow-out" areas of unconsolidated sand are the most prominent landmarks on the western side of the island. These areas, in the southwestern and south-central portions of the island, are clearly visible on

Figure 9. Looking southeast from concrete pillar near Casuarina tree on northwest perimeter of island. Dominant vegetation is Eragrostis variabilis with scattered patches of Boerhavia diffusa and (in immediate foreground) Fimbristylis cymosa. POBSP photograph by P.C. Shelton, 21 June 1966.

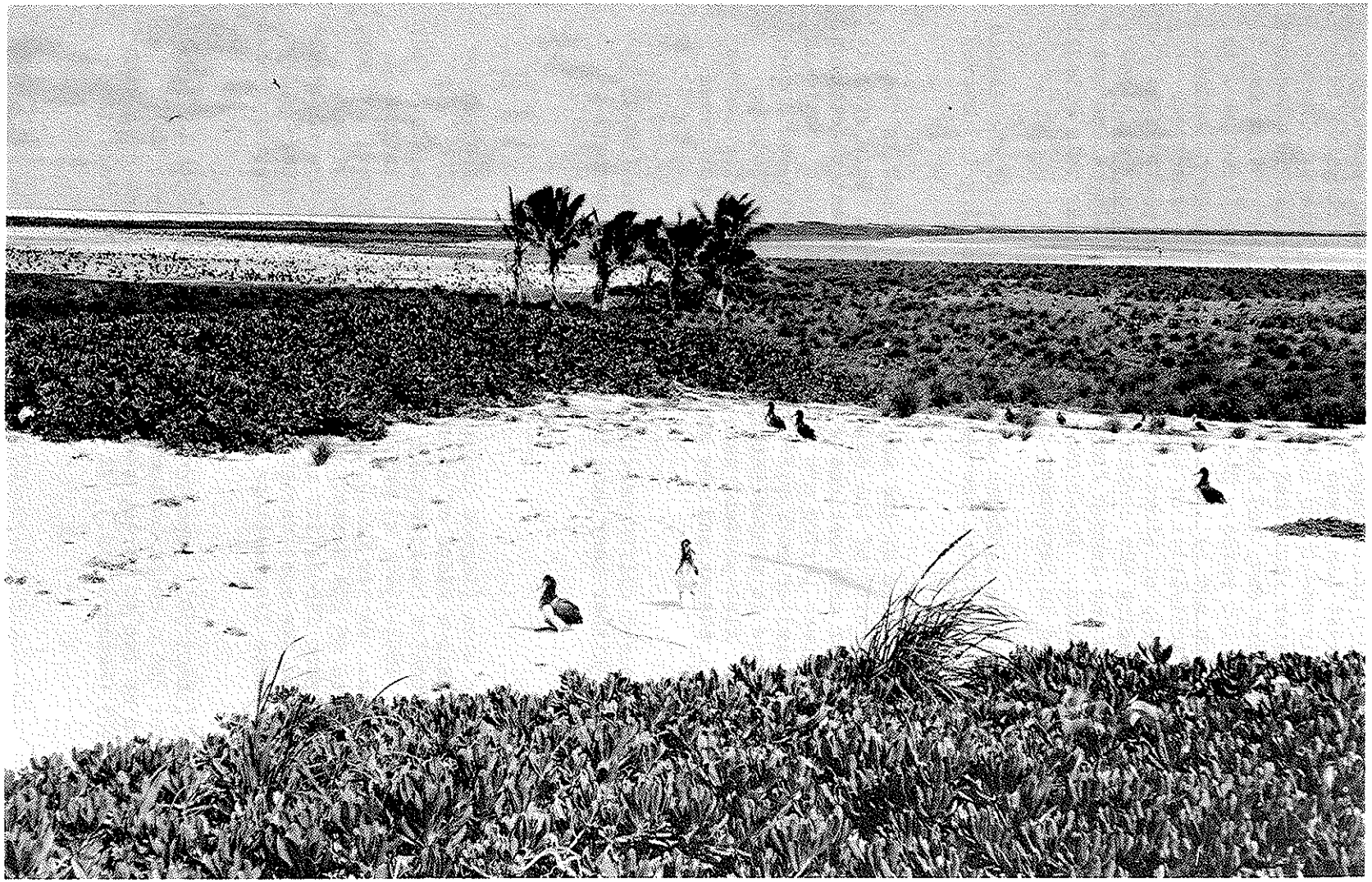

Figure 10. Looking southeast toward northern portion of lagoon, 21 June 1966. North Cocos grove in mid-foreground. POBSP photograph by P.C. Shelton.

aerial photographs taken in 1939, 1943 and 1966. They vary considerably in size and shape but are always centered in the zones of less dense vegetation. In the May 1939 photographs, one such blow-out is nearly continuous with the southwest beach and extends inland (northward) for about 1,000 yards or nearly one-third the length of the island. Photographs taken four years later show that most of this area has revegetated, particularly at the southern end, and the area of bare sand covers an area of only about 200 by 100 yards. The extent of unstabilized sand is probably affected by season and by local rainfall and consequent condition of the vegetation. Activities of nesting birds also affect the vegetation rather drastically at times. The January 1966 photographs show a large blow-out crossing the center strip of dense Eragrostis and extending inland almost to the lagoon flat. Its largest dimensions are approximately 560 by 300 yards. The blow-out did not appear this extensive when viewed from the ground in September 1967.

The only other noticeable landmark on the western side of the island is the remains of the old tram line now badly rusted and largely covered with sand.

The most prominent feature of the south end of the island is the very flat, almost circular site of the main guano diggings. This area is about 300 yards in diameter and portions still lack permanent vegetation. Also remaining from the guano period are one large "rock" pile about six feet in height, several smaller rock piles and numerous scattered loose rocks. The vegetation here is predominately Sesuvium and heliotrope rather than bunch grass. Also present near the south end of the lagoon are the clumps of Pluchea bushes and the small grove of coconut trees mentioned earlier.

The 20-foot high inland cliffs mentioned by Schauinsland (1899: 33) are no longer present. Either they have been destroyed or perhaps covered by sand dunes.

The lagoon

The central lagoon area (lagoon proper and bare shore) is about one mile long with a maximum width of about one-third of a mile. The actual water area fluctuates considerably with season and rainfall. Both Palmer (in Rothschild, 1893-1900: x) and Fisher (1903a: 773) estimated the lagoon at 100 acres. Warner (ms.), using the Tanager Expedition map, calculated a lagoon area of 204 acres. During at least some winters (e.g., 1961-62) the lagoon floods its shores and extends to the northwest coconut grove. Contours are most variable on the shallow western side and on the north end where fluctuations in rainfall cause temporary ponds and sand bars.

In 1859 Brooks (1860: 501) reported a maximum lagoon depth of five fathoms in the center and a coral bottom. Schauinsland (1899: 20) described the lagoon as two to three, sometimes five, fathoms deep with clear water. By 1923 (Wetmore, ms.), it was "generally 3-5 feet deep

with a maximum depth of 15 feet." A similar depth was noted by Warner (1963: 4) near the eastern shore. He also noted that the sand bottom and changes in contours of the eastern shore were evidence of appreciable encroachment by shifting sand dunes, probably during the denuded period of the early 1920's.

The reef plate mentioned earlier greatly reduces the percolation of lagoon waters as shown by the lack of any apparent tidal fluctuation and by the high salinity of the lagoon water. Salinities of 12 to 15% were found by Schauinsland (1899: 20) in 1896 and by Elschner (1915: 33) in 1914. Warner (1963: 6) reported similar concentrations ranging from 12% (June 1958) to 14% (July 1959). Samples taken by Walker from the surface over flooded vegetation and mud flats in December 1963 after a period of heavy rainfall varied from 5.9 to 8% while two samples taken from "flooded springs" were 4.3 to 5.3%. These lower values are probably typical during periods of high rainfall and flooded conditions.

Some amount of flooding probably occurs during most winters. In some years (e.g., 1961-62), heavy rainfall after the Laysan Albatrosses have laid results in heavy egg mortality. Large amounts of vegetation bordering the lagoon may also be killed. Warner (1963: 4) also noted that during winter storms, waves sometimes wash over the east slopes of the island as evidenced by debris deposited on the lake flats.

HISTORY

Laysan in the early 1800's

It is generally agreed that Laysan was originally discovered and named by an American ship, but no details are presently available concerning the actual discovery. The visit of the Russian ship, the Moller, in 1828 is usually listed as the earliest visit but we know of at least two that undoubtedly occurred prior to that.

In the summer of 1828 J.N. Reynolds, who had been delegated this task by the Navy, visited New England whaling ports and gathered from various whaling masters ships' logs, etc., information on the location of islands in the south seas (Stackpole, 1953: 461). His report, submitted September 1828, but not published until 1835 (Reynolds, 1835), contained several entries which bear on the history of early visits to Laysan. Since whalers were normally in the Pacific for over a year, and since his information was compiled in mid-1828, it is likely that all entries pertaining to Laysan were the result of visits made no later than 1827.

On page 7 of his report Reynolds places "Laysan's island" at 25°50'N and 171°51'W. The position currently listed for Laysan is 25°46'N, 171°44'W (Office of Geography, 1956: 46).

On page 23 Reynolds related that "Captain Briggs discovered an island west and north of Sandwich Islands, in 25°47' north, longitude

172° west. The island is low, with not more than 60 feet in any part from the water, 3 miles long and 2 across it." This island was almost certainly Laysan.

Examination of the tables in Starbuck (1878) reveals that the only ship listed as whaling in the Pacific prior to 1828, and with a captain named (John) Briggs, was the Wilmington and Liverpool Packet of New Bedford which made two voyages, on either of which Laysan may have been discovered. On the first voyage the ship left New Bedford on 12 April 1821 and returned on 27 December 1823. On her second voyage the ship left on 1 December 1824 and returned on 8 March 1827. On a third voyage under the same captain the ship left on 25 August 1827 and did not return until 24 June 1830. Since Briggs must have been absent when Reynolds compiled his report, Reynold's information must have been obtained from some other individual. Briggs' discovery of Laysan must have occurred no later than 1826 and possibly as early as 1821 or 1822.

Stackpole (1953: 304) relates that "The Lyra...[a new Bedford whaler] discovered a reef and an island which was probably the island of Lysan [sic], northwest of Oahu, but was wrecked not many miles distant from it a few years later (in August 1830)."[1]*

Capt. Stanikowitch of the Russian vessel Moller visited Laysan on 24 March 1828 and, not knowing of its previous discovery, named it Moller after his vessel. C. Isenbeck, the ship's surgeon, made a few observations of the island and its biota which were passed to and later published by F.H. von Kittlitz (1834). Unfortunately, either the original notes were unclear or their translation was incorrect concerning several bird species. An English translation of parts of the Kittlitz paper was published by Rothschild (1893-1900). The description of Laysan in 1828 (Rothschild translation) follows:

> On March 12 (24) Herr Isenbeck landed on Moller (Laysan) which was originally a coral-island with a long reef round it. It seems that it was raised higher and became a real island from the accumulations of the birds' excrements. It is covered with a strong bushy kind of grass and partly with low shrubs, between which a few pigmy palms had grown up. Although there was no fresh water on the island, there were not only sea-birds but also several land-birds, as the following list will show. Most of the larger birds were already breeding, or had paired at least.

1850-1874

In 1857 Captain John Paty explored much of the leeward chain in the Hawaiian schooner Manuokawai. On 1 May he landed on Laysan and annexed it to the Hawaiian Kingdom. An account of this visit was published by Paty (1857: 40) with the following description:

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*Footnotes to the history section, numbered consecutively, begin on page 59.

> Laysan Island--W. by N. 3/4 N. from Honolulu 808 miles. This is a low sand island, 25 to 30 feet high; 3 miles long and 1-1/2 broad. The surface is covered with beach grass, and half a dozen small palm trees were seen. It has a lagoon in the centre (salt) 1 mile long and half a mile wide, of salt water, and not a hundred yards from the lagoon, abundance of tolerable good fresh water can be had by digging two feet, and near the lagoon was found a deposit of guano. The island is "literally covered" with birds; there is, at a low estimate, 800,000. Seal and turtle were numerous on the beach, and might be easily taken. They were evidently unaccustomed to the sight of man, as they would scarcely move at our approach, and the birds were so tame and plentiful, that it was difficult to walk about the island without stepping upon them. The gulls lay enormous large eggs, of which I have a specimen. A bank of rocks and sand extends off to the South and West 6 or 8 miles or more. Good anchorage can be found on the West side of the island in from 4 to 20 fathoms, by selecting a sandy spot to anchor upon, half to 2 miles from the beach. The best landing is about one-third of the distance from the Northern to the Southern point of the island, where there is a very smooth sand beach.

Lt. J.M. Brooke, commanding officer of the U.S. Schooner Fenimore Cooper, visited Laysan on 14 January 1859 and took soundings, positions, and physiographic data which were later incorporated into Hydrographic Office charts. Three hours were spent on Laysan and "six small turtles and a variety of sea birds were taken."[2]

Captain N.C. Brooks of the U.S.S. Gambia visited Laysan in May 1859 and described the island as follows:

> Laysan Island.--Laysan Island is in lat. 25°46'N., long. 171°49' W., is 3 miles long and 2-1/2 broad, and covered with a luxuriant growth of shrubs. It is surrounded by a reef about half a mile from the land. Outside of this reef there is a bank five miles wide, on which I found from fourteen to nineteen fathoms water. There is a boat passage inside the reef nearly the whole way round the island. Good landing can be found anywhere, excepting on the South and S.E. sides; good anchorage anywhere on the West side,--the best, however, is about half a mile from the S.W. point, in from eight to twelve fathoms water. It can be approached from any point of the compass, no dangers existing within half a mile of the reef. On the east end of the island I found the remains of a wreck, but saw no signs of a camp.

> There is a lagoon on the island about one mile long and half a mile wide, with five fathoms water in the centre, and coral bottom. On the shores of this lagoon I found salt of good quality.
>
> There are five palm-trees on the island, and I collected twenty-five varieties of plants, some of them splendid flowering shrubs, very fragrant, resembling plants I have seen in gardens in Honolulu. I saw on the beach trunks of immense trees. The island contains about fifty acres of good soil. It is covered with a variety of land and sea birds; some of the land varieties are small and of beautiful plumage. Bird's eggs were abundant.
>
> Near the N.W. point of the island I found a stick about two feet long, and at the foot of it a bottle containing a paper, but could not decipher the writing. From the East point, where the wreck lies, to a decayed palm-tree on the shore of the lagoon, in a direct line, I planted potatoes, onions, and pumpkins. The soil on which I planted them embraces every variety, and appears to be adapted to vegetation. There is a very small deposit of guano on this island, but not of sufficient quantity to warrant any attempts to get it. Dug a well and found very good water. The reefs here abound in fish and turtle (Brooks, 1860: 500-501; see also Brooks, 1859).

Material from this log was quoted in nearly the same form by Rothschild (1893-1900: i-11).

Some Visits to Laysan in the 1880's and 1890's

Laysan was visited twice in 1882 by the fishing schooner Ada sailing from Nagasaki, Japan. During the first visit, 26 to 30 January, 104 turtles were taken, 61 of them from beaches during the course of one day. Two hundred and seven beche-de-mer were also collected, but shark-fishing was a failure. During this visit the crew found a board on which "was an appeal to voyagers not to take the turtle away" (Mansbridge in Hornell, 1934: 432). The board was repainted to express the same sentiments.

The ship returned to Laysan on 3 May and captured another 26 turtles (Hornell, 1934: 432-433).

The schooner General Siegel (which wrecked shortly thereafter on Midway) visited Laysan while on a sharking expedition about late September 1886. A fair haul of sharks was made, some turtles and a few seals were killed; the crew spent a week ashore (Farrell, 1928: 253-254).

John Cameron visited Laysan about fall of 1893 while on a shark-fishing voyage on the sloop Ebon. He noted the presence of two pigs and

indicated that albatross had begun to return to the island, an event which suggests the visit was made no earlier than October (Farrell, 1928: 399).

Cameron revisited Laysan during the summer of 1894. His stay of about a month was broken by a visit to nearby Lisianski (Farrell, 1928: 414).

Laysan Becomes a "Guano Island"

In 1890 George D. Freeth, an Englishman who had visited Laysan as early as 1864, and George N. Wilcox, who had previously managed a guano operation on Jarvis Island, inveigled a Honolulu firm, Hackfeld and Company, into financing the North Pacific Phosphate and Fertilizer Company, which was to work guano deposits on Laysan (Anon., 1939: 9-10).

Previously Freeth had captained the vessel Akamai to Laysan where he had taken possession of the island, hoisted the Hawaiian flag, and left two men on the island in February 1890 to hold possession. On 13 March he returned to Honolulu with "reports [of] good guano deposits on Lycan [sic] Island." (The Friend, April 1890: 29; see also Lyons, 1890: 90). On 29 March Freeth and Charles N. Spencer got the Hawaiian Kingdom to grant them[3] the right to mine phosphate deposits on Laysan and Lisianski Islands for a period of 20 years with a royalty of 50 cents per ton to be paid to the Hawaiian Government. These rights were later transferred to the guano company which was incorporated on 23 May 1890.[4]

On 10 July Freeth departed for Laysan for the purpose of systematically examining the guano deposits. With him on the schooner Kaalokai was Captain Rosehill, who was to become a foreman of the laborers on Laysan, and A.B. Lyons. The party arrived at Laysan on 16 July after a six-day run from Honolulu.

Lyons later published some notes taken on this visit which consisted primarily of observations of birds, but which also included an interesting description of the island.

> July 16. Here we are at Laysan Island we have brought the schooner inside the reef under the lea of the island, and are laying in quiet water within two hundred yards of the shore. The only indication of land this morning at day break was the flocks of sea birds which we could see in every direction, although we were in reality only twenty miles from the island. The land lies so low that it can be seen from the deck of a vessel only a few miles....
>
> There was nothing indeed, particularly inviting in the land itself. A beach of white shell sand, a steep bank, also of sand, with little vegetation--beyond a strip of nearly level land scantily covered with coarse bunch grass and low shrubberry,--that was all we could

> see as we approached the shore. Not quite all, for there rests over the land perpetually a cloud of sea fowl, and these you can see at a glance hold undisputed possession of the island....
>
> The island is quite small, barely two miles long by a mile and a quarter wide, of the familiar ring form, with a small closed lagoon. In its highest part the land may be as much as 35 or possibly 40 feet above high tide mark. Although the island is surrounded with reefs, there is very little rock to be seen above the water level, except on the south-east coast where there is a rampart of sandstone rising ten feet or more perpendicularly from the water. The rock is all a shell sandstone containing a very little coral, and even on the reefs little living coral is to be seen. The soil of the island consists of a peculiar kind of white sand, made up partly of fragments of sea shells, but largely of bits of egg shells and the bones of sea birds....
>
> A rough calculation puts the bird population of the island at about 800,000; it may reach 1,000,000. They have not yet learned to fear man excessively, and are in fact no more shy than barn door fowl, so that it is very easy to study their habits.
>
> The flora of the island I find interesting, although somewhat disappointing. I gathered only twenty-one species of flowering plants, nearly all of them Hawaiian or cosmopolitan plants. The seeds of most if not all of them have floated to the island in sea-water. Among them should be mentioned the loulu palm, the maia pilo (caper) and Koali (convolvulus) and a stunted species of sandalwood (Lyons, 1899: 90-91).

At the first meeting of the North Pacific Phosphate and Fertilizer Company in October 1890, Wilcox was elected president and Spencer vice-president. One of the Hackfeld family was elected treasurer, no doubt to protect their investment; Freeth was appointed resident superintendent for Laysan (Anon., 1939: 10).

Freeth thereupon hired a chemist, a foreman, and eight laborers and chartered the Inter Island Steam Navigation Company's S.S. Pele to transport them and their supplies to Laysan. When they reached the island, about November 1890, all but the railway equipment was landed before the party was driven from the island by one of the Northwestern Hawaiian Islands' notorious winter storms. All returned to Honolulu, arriving there on 9 December (Anon., 1939: 10).

From 1891 through 1903 guano operations were conducted directly under the aegis of the North Pacific Phosphate and Fertilizer Company, and much guano was removed by a series of ships, some of Hawaiian registration and others of American or German registration (Bryan, 1942: 186).

On 25 June 1892 the fertilizer company renegotiated its agreement with the Hawaiian Government. In the Memorandum of Agreement drawn up between C.N. Spencer (then Minister of the Interior of the Hawaiian Kingdom) and the company, the government agreed not to raise royalties on the guano, and gave permission for the phosphate to be made into fertilizer in processing plants other than those on the Hawaiian Islands.

On 31 March 1893, Sanford B. Dole, President of the Provisional Government of Hawaii, signed an act, effective on publication, which confirmed the earlier Spencer-Freeth franchise and which authorized the lease of Laysan and Lisianski to the guano company.[5] On 17 April that year the lease was executed by the Minister of the Interior, J.A. King.[6] By terms of this lease these islands were rented to the guano company at a dollar a year until 29 March 1910. (The lease was eventually surrendered to the Hawaiian Government on 31 December 1908.[7])

On 15 February 1894 the fertilizer company leased, for a period of 25 years at a rental of a dollar a year, other islands of the Northwestern Hawaiian group (Morrell [sic], Ocean [sic], Pearl and Hermes Reef, Midway, and French Frigate Shoals). The company was also granted the exclusive right to mine the phosphate deposits thereon, provided a royalty of 50 cents a ton was paid to the Hawaiian Government. A clause within this contract stated that operations had to begin within five years of the signing of the contract or the right to the deposits would be withdrawn. Since no guano was mined on any of these islands, the right must have been automatically withdrawn on or about 15 February 1899.

On 3 April 1894 the North Pacific Phosphate and Fertilizer Company changed its name to the Pacific Guano and Fertilizer Company, and in 1896 Max Schlemmer became superintendent of operations on Laysan.[8]

In April 1891 the first shipment of guano, 80 tons that sold at $15 a ton, was removed from Laysan by the chartered schooner Mary E. Foster, Captain Berry commanding; 90 tons were taken from the island by the same ship in May.[9] More guano cargos were shipped later in the year via the Foster and the clipper Elizabeth Nicholson. By 30 November, 1,017 tons (valued at $1,975.20) had been removed (Anon., 1939: 12-13).

Thomas (ms.) gives the most detailed picture of guano operations when they were at or near their peak of productivity. Laborers mined the guano, consisting mostly of a hard, conglomerated, phosphate of lime, with picks, crowbars, shovels, and sledges. This material was placed on cars on the narrow guage railway and pulled by mules to storage sheds where the guano was kept until a ship arrived. A small amount of brown guano (bird droppings and soil) was also collected and sifted, but it was a small proportion of the total amount of guano shipped from the island.

When ships came in the guano was carried from the storage sheds in barrows holding about a ton out onto the wharf that extended from the west side of the island. At the end of the wharf the guano was dumped into a chute which deposited the material in lighters. These lighters in

turn transferred their cargo to the clipper ships that were anchored between two buoys offshore. As much as 100 to 125 tons per day could be loaded under favorable conditions (cf. Bailey, 1956: 24)

Guano was shipped only from April through September but a caretaker remained on the island throughout the winter. Schauinsland (1899: 32) related that the caretaker left on the island one winter was found dead when the island was revisited seven months later.[10] He was found sitting at the table where he had been working on his journal and was subsequently buried on the west beach. On the few occasions when ships arrived at Laysan during periods of high surf,[11] landings were made at the "winter landing" on the north coast of the island. Figures 11-17 are from the guano period.

Scientific Work on Laysan in the 1890's

The Rothschild Expedition

The first intensive scientific collecting expedition in the Northwestern leeward Hawaiian Islands was sponsored by Walter Rothschild (Tring Museum) in 1891. Henry C. Palmer and his assistant, George C. Munro, arrived on Laysan 16 June aboard the schooner Kaalokai (Capt. F.D. Walker) and stayed with Captain Freeth, then manager of the guano operation. They departed 27 June. Ornithological results of this visit, a portion of Palmer's diary, and a summary of earlier observations were published by Rothschild (1893-1900); more popular accounts of the visit were written by Munro (1930, 1941-43, 1946) and Walker (1909). Island conditions were described, a biological survey made and numerous birds collected, including four species new to science (see Appendix Table 2).

Visit by J.J. Williams

Between mid-November 1892 and late January 1893, J.J. Williams, a Honolulu photographer, spent about a month on Laysan taking photographs and collecting birds. He collected "several barrels of stuffed birds" and took about 300 photographs (Pacific Commercial Advertiser, 3 February 1893).

Collection of birds in 1895

In September 1895 a small collection of birds was made on Laysan by W.H. Hall who collected birds for the Bernice P. Bishop Museum (Bryan, 1901: 259). None of his specimens has specific dates on the labels and we have been unable to discover anything else about his visit.

Schauinsland's visit in 1896

Dr. and Mrs. H.H. Schauinsland spent the summer of 1896 with the guano company on Laysan. They arrived on the barque H. Hackfeld at the beginning of the guano season, anticipating a short visit, but when the magnitude of their planned survey became obvious, they decided to remain

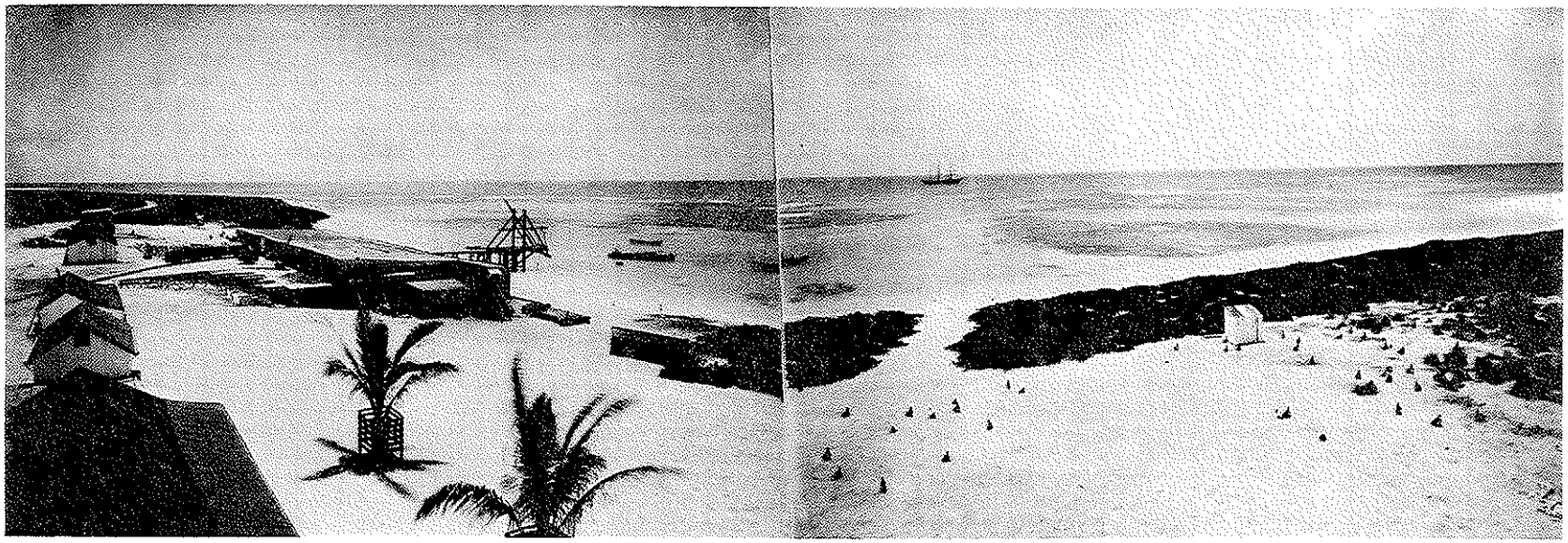


Figure 11. Guano loading area on Laysan about May 1902. Photograph by F.M. Chamberlain during cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11.

Figure 12. Base of guano operations on Laysan in 1902. Photograph by F.M. Chamberlain during cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11.

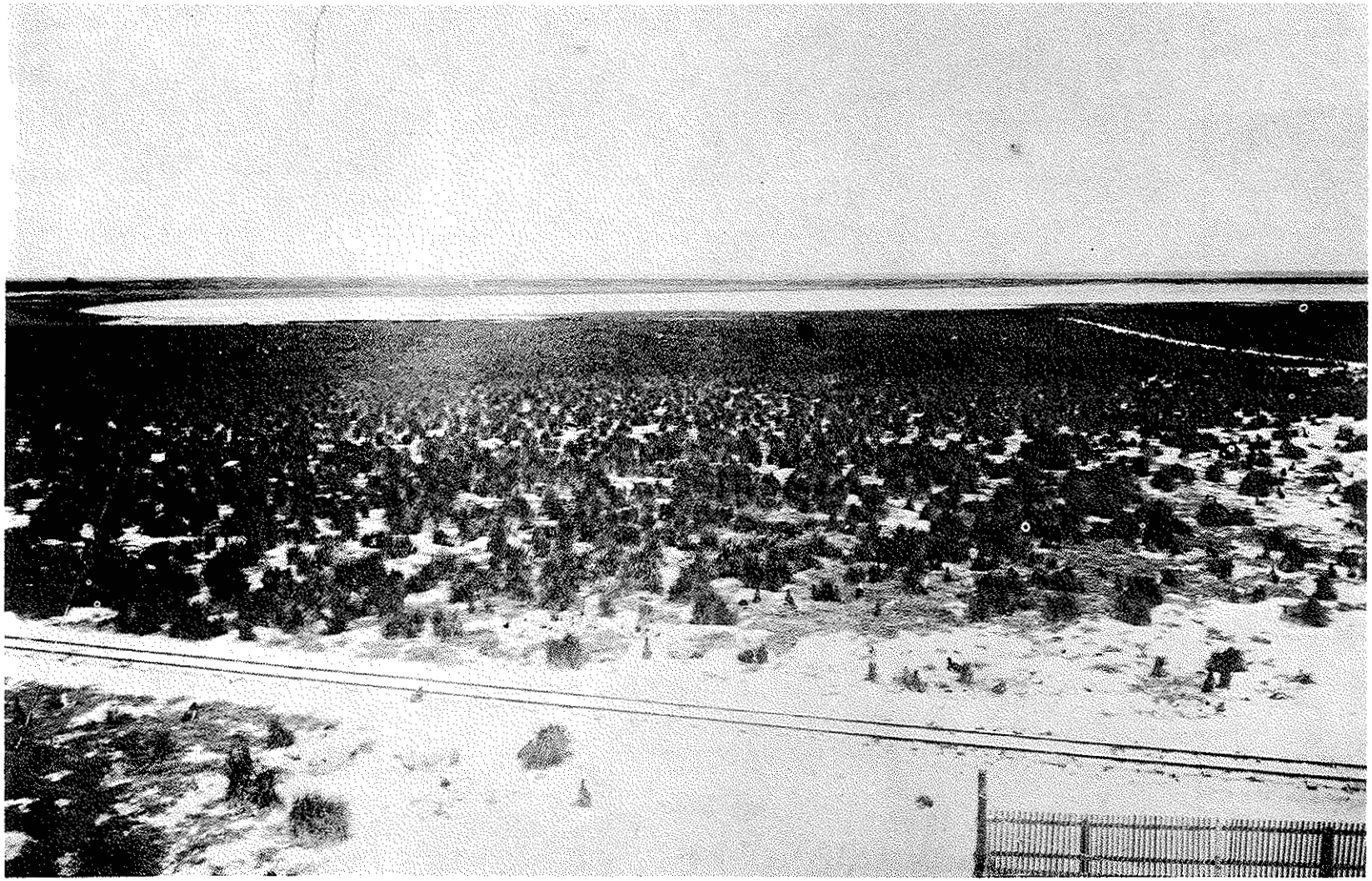


Figure 13. Looking toward northern end of lagoon, about May 1902, evidently from tower on northwestern rim of island shown in preceding figure. Photograph by F.M. Chamberlain during cruise of U.S. Fisheries Commission Steamer Albatross. U.S. Fish and Wildlife Service photograph, National Archives Record Group 22, Series 11.

Figure 14. Guano digging on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu.

Figure 15. Guano digging on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu.

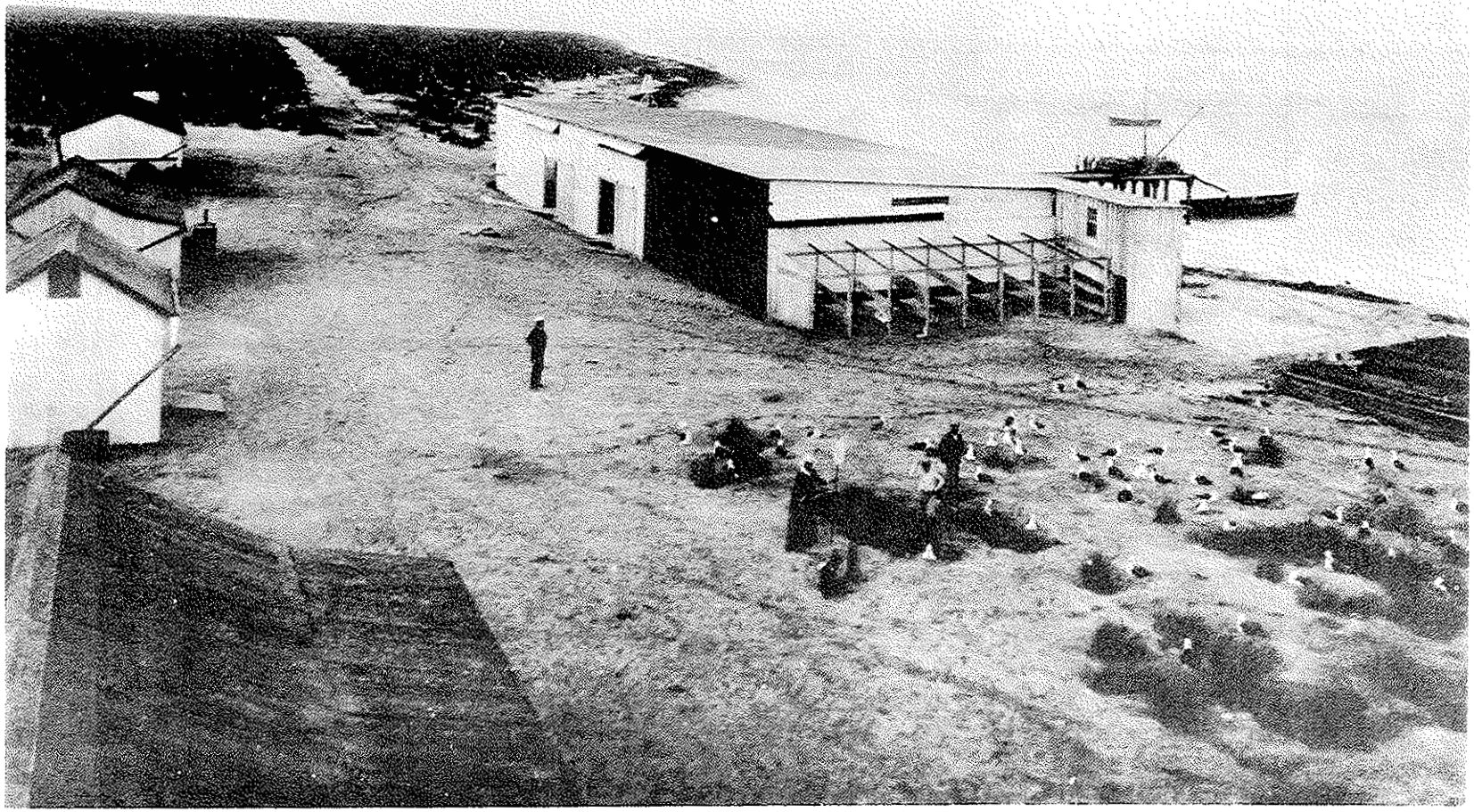


Figure 16. Guano shed and loading area on Laysan, probably during early 1890's. Photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu.

Figure 17. .Guano operation headquarters. Undated photograph by unknown photographer, courtesy Bernice P. Bishop Museum, Honolulu.

until the departure of the last guano vessel on 24 September. Schauinsland's report (1899) is wonderfully detailed and includes data on geology, meteorology, and biology. Extensive collections were made of many biological taxa and were subsequently sent to Germany. Correspondents on Laysan apparently sent bird specimens to the Bremen Museum for several years afterward. Many of these collections were subsequently reported by various German collaborators (see Appendix Table 3).

Homicide on Laysan[12]

Life on Laysan during the guano mining era was not always peaceful as is attested by a case of homicide that occurred in 1900. On the evening of Saturday, 11 August, forty Japanese laborers became involved in a fracas with the overseers of the guano mining operation. We give below an extract of the original story of the shooting reported under the banner headline "Laysan Island's Story of Blood."

> War has been declared, waged, and ended on Laysan Island...four against forty--those were the odds, four white men fighting desperately against forty infuriated Japanese. And the white men conquered. [On the evening of Saturday, 11 August 1900]...the forty Japanese rose in a body, determined to annihilate all the white people and run things to suit themselves. Captain Spencer [the manager of the guano-mining operation]...called his son and Captain Spilner, late of the Honolulu mounted patrol and the engineer, Luhrs...and together they went out to talk to the mob which had gathered between the white men's house and the Japanese quarters. [Captain Spencer asked what the trouble was whereupon]...the leaders of the mob answered defiantly, cursing...and shouting.... They threatened the white men's lives..., were carrying flags and waving them excitedly and were armed with knives, clubs, stones, and cutlasses made of hoop iron sharpened. They made a movement towards the platform.... Old Captain Spencer...raised a six shooter in either hand. "The first man who steps upon this platform shall die!" shouted Captain Spencer. "Shoot away!" cried the mob and at a signal from the leader, charged all together for the platform. Though they moved quickly, Captain Spencer's trigger fingers moved quicker. Eight times his revolvers spoke and they spoke to the point. Pistols in the hands of the other white men also had something to say. Two... Japanese dropped dead...[who] were the leaders...[and] three others fell helpless, sorely wounded. (Pacific Commercial Advertiser, 8 September 1900).

How much of this lurid account was true? Subsequent testimony given at a pre-trial hearing varied considerably according to various witnesses, and the excited yellow journalism with which the case was reported tends to obscure the facts. Events following the shooting seem fairly clear, however.

Events following the killings

After the fusillade, the Japanese dispersed to their quarters and the white men returned to their house, where, according to later testimony by Spencer, the whites awaited a further attack. The following day the surviving 39[13] Japanese were rounded up at gunpoint and incarcerated aboard the barque Ceylon which had recently arrived at Laysan. Subsequently the two dead Japanese were buried and on 16 August the Ceylon sailed for Honolulu with all concerned except Spencer's son and the engineer. After an uneventful passage the Ceylon arrived in Honolulu on 7 September. After being questioned by the police, Spencer and Spilner were arrested.[14]

The pre-trial examination followed shortly thereafter. Spencer was formally charged with murder and Spilner was held as a witness for the prosecution.

On the 11th testimony for the prosecution was begun with statements by two of the Japanese, Higuchi Shiro, and Oguma, who cooked for the Japanese. Their testimony was followed by that of Kinoshita who had been standing near Goto when Goto was shot. His testimony was largely corroborated by witnesses the next day.

Thursday, 14 September, Tanaka, the luna (foreman) of the Japanese, and Captain Spilner testified for the prosecution. Spilner's testimony was particularly damaging to Spencer's case. Although avowing himself a good friend, Spilner implied that Spencer fired on the Japanese without warning. Letters, however, entered as evidence for the defense, written at an earlier date by Spilner to Dr. Averdam, manager of the Pacific Guano and Fertilizer Company in Honolulu, rather clearly established the extent of Spilner's friendship. Therein Spilner implied that Spencer was a drunkard and an incompetent, wasteful manager, and that he, Spilner, would be a fit replacement.

Spilner concluded his testimony on the 17th and the last of the prosecution witnesses, a carpenter named Wahlers, told his story.[15]

The defense then began to introduce its witnesses. The first to testify were five sailors from the Ceylon who served primarily as character witnesses for Captain Spencer. Three of them, though, had recently spent six weeks on Laysan when they had been stranded there by the wreck of the barque McNear,[16] and presumably knew something of conditions on the island preceding the uprising. Captain Spencer then took the stand and gave what appears to be a fairly credible version of the incidents.

On the 18th the defense briefly interrogated its last witness, Dr. Averdam, who repeated some hearsay evidence concerning a conversation with the carpenter and who strongly rebutted Spilner's assertions about Spencer. After the summing up by the attorneys on 21 September, all charges against Spencer were dropped.

What really happened on 11 August 1900?

The facts of the case are hard to ascertain in spite of, or perhaps because of, all the evidence offered at the trial. The following account, derived primarily from testimony by Shiro, Wahlers, and Spencer, is probably as close to the truth as one can get this many years after the event.

On the 9th of August, Spencer, his wife, and 12 new laborers arrived at Laysan on the Ceylon. During Spencer's absence Spilner had been in charge, with Tanaka acting as luna. With Spencer's arrival Spilner was demoted to luna and Tanaka to common laborer, a tremendous loss of face for the latter.

On the morning of the day the incident occurred, part of the labor force went to dig guano and the others went to the wharf. Those on the wharf did not work, however, and first Spencer's son and then Spencer himself, talked to them, telling them that they must go home if they would not work. It should be noted here that apparently only Tanaka spoke both English and Japanese. Thus, one can only speculate as to the actual degree of communication between the two parties on the day of the shooting.

Either then or shortly thereafter according to Shiro, Tanaka and a delegation went to Spencer to ask him about alternating work ashore with work afloat. Testimony by Wahlers, Spencer, and Spilner indicates that Tanaka warned them that the Japanese were going to "pull down the house and make us all sore." It seems clear that Spencer had thrown a number of Japanese out of Tanaka's house earlier in the day and that he had taken a bottle of gin from Goto.

When Spencer refused the original request and another to increase wages, it seems evident that the Japanese on the wharf brought in those from the guano fields.

We suspect that much of the following may have been fomented by fear of collective and individual "loss of face" by the various Japanese concerned. Using the excuse that they had not received their day's ration and were "weak with hunger,"[17] the Japanese moved at dusk en masse for a confrontation with Spencer. Few if any bore arms.

Spencer, aware that trouble was afoot, took the two revolvers that he had received from the Captain of the Ceylon and with the three others went to meet them. Shortly after they mounted the platform, they were joined by the unarmed carpenter.

When the Japanese arrived, demands were made for more food and for higher pay. Since Tanaka was doing the translating, it is not clear whether the laborers actually expressed the demands or whether the demands were Tanaka's idea. In any case, four or five of the Japanese who stood on the steps of the platform began to press forward.

Spencer told them to stop or he would shoot. The Japanese pressed on and Spencer then fired three shots, one into the air and two into the crowd, and told the others to shoot.[18] Spilner fired two shots and each of the others fired at least one. All testimony considered, it is not actually known who killed the Japanese. We suspect that Spilner, who held some animosity toward the Japanese, may well be the real villain. In his testimony he stated that he had fired one shot in the air and one into the house. Spencer, however, later testified that Spilner had told him after the shooting that, "My two shots counted all right--they got their men."

Schlemmer's Attempts to Lease Laysan

In 1904, with guano deposits nearly depleted and with little profit to be gained from continued operations, the Pacific Guano and Fertilizer Company relinquished its rights to guano operations, and on 27 April sold "everything on Laysan...excepting houses...to Max Schlemmer...for $1750" (Anon., 1939: 19). On 6 May Max Schlemmer received an agent's commission from the Pacific Guano and Fertilizer Company.[19]

Schlemmer evidently believed that this document and the bill of sale conferred on him full rights to Laysan (see below), but since he wanted to make a coconut plantation of the island, he wished further to confirm his legal title. Thus, on 25 March he had applied to the Hawaiian Land Commissioner for lease to Laysan, Lisianski, and French Frigate Shoals for a period of 99 years.[20]

No action was taken on Schlemmer's proposal at the time, presumably because Schlemmer had left for Laysan about the end of April, possibly aboard the schooner Robert Lewers.[21]

On his return to Honolulu Schlemmer pressed the issue. In his proposal to the governor Schlemmer had agreed, in addition to the limitation on bird killing, to:

(1) pay a royalty of 50 cents per ton for all guano shipped,

(2) maintain his residence on Laysan and keep a caretaker there should it be necessary for him to leave the island,

(3) maintain a schooner of not less than fifty tons which could be used to bring shipwrecked persons to Honolulu from the Northwestern Hawaiian Islands, and

(4) plant not less than one thousand coconut trees a year for a period of ten years.

In the same letter he proposed that he kill the following numbers and kinds of birds on Laysan and that he turn over the skins to the Territorial Government which would sell them and retain 10 percent of the proceeds as a royalty:

	Variety	Could be killed as follows:
Number 1.	Black Widacks [Wideawakes = Sooty Terns]	5,000 a season
Number 2.	Blue Widacks [= Gray-backed Terns]	2,000 a season
Number 3.	Large Black Birds [= Brown Noddies]	200 a season
Number 4.	Small Black Birds [= Black Noddies]	200 a season
Number 5.	Tropical Birds [= Red-tailed Tropicbirds]	200 a season
Number 6.	Love Birds [= White Terns]	None
Number 7.	Four large kinds of Mutton birds [= Bonin Petrels, Christmas Shearwaters, and presumably the two color phases of the Wedge-tailed Shearwater]	5,000 a season
Number 8.	Two small kinds of Mutton birds [= Sooty Storm Petrels and Bulwer's Petrels]	500 a season
Number 9.	White Albatrosses [= Laysan Albatrosses]	5,000 a season
Number 10.	Black Gunies [= Black-footed Albatrosses]	1,000 a season
Number 11.	Frigate Birds [= Great Frigatebirds]	All there could be killed
Number 12.	Large Bubbies [= presumably Blue-faced Boobies]	100 a season
Number 13.	Small Bubbies [= presumably Red-footed Boobies]	500 a season
Number 14.	Wingless Birds [= Laysan Rails]	1,000 a season
Number 15.	Canary Birds [= Laysan Finches]	1,000 a season
Number 16.	Red Birds [= Laysan Honeyeaters]	100 a season
Number 17.	Miller Birds or insect killer [= Laysan Millerbirds]	100 a season

Schlemmer also asked that no rent be required for the first ten years since the coconuts would not yet have begun to produce, but proposed to pay an annual rent thereafter of 50 dollars a year.[22]

This proposition was apparently not accepted but Schlemmer went ahead with his plans anyway.[23] Schlemmer visited the island regularly from 1904 through 1908 and on several occasions thereafter; some shipments of guano were made during this period.

Despite the comments of Munro (1946: 67) that guano was last taken from the island about 1906, guano is known to have been removed from Laysan

as late as 1910. The schooner Concord arrived at Laysan in late July 1910 and spent 9 days removing 75 tons of guano. The surviving mule of the two left on the island when Schlemmer discontinued working the guano fields was taken aboard and returned to Honolulu. During the visit of the Concord, a Japanese vessel, with a crew intent on gathering feathers, arrived at the island (see below) (Honolulu Evening Bulletin, 6 August 1910).

Feather Gathering on Laysan 1908 to 1910

Schlemmer became involved with the Japanese in feather gathering on Laysan in December 1910. The Japanese, however, were probably involved in feather harvesting in the Hawaiian Islands prior to this. In April 1909 the American vice-consul in Japan reported an article in a Japanese newspaper which stated that a number of Japanese vessels (seven listed) had visited Laysan between October 1908 and January 1909.[24] It was noted that these vessels had left Japan on the pretense of deep-sea fishing, but that their real object was gathering bird skins and feathers on the uninhabited islands of the Hawaiian group.[25] The vice-consul's letter of 3 April 1909 also reported the Niigata Maru was planning to sail again for the Northwestern Hawaiian Islands.[26]

In 1908 Schlemmer must have been in poor financial condition: there was little or no guano left to export and he had lost his schooner the C. Kennedy shortly after its construction.[27] On 22 December 1908 he concluded a contract in Tokyo with Genkichi Yamanouchi by which terms he was to receive $150 in gold monthly in Honolulu for giving the Japanese the rights, inherent in his Agent's Commission, to remove and sell freely "phosphate, Guano, and products of whatever nature in and from the islands of Laysan and Lisianski."[28] In this contract, which was to run for 15 years, Schlemmer promised to use his police authority to prevent others from infringing on the Japanese's privileges.[29]

About six weeks later, on 8 February 1909, Schlemmer finally received a lease to Laysan and Lisianski from the Hawaiian government. Provisions of the lease stipulated that the government might reclaim the islands at any time for any public purpose; that Schlemmer was to plant 500 coconuts per year and that Schlemmer might not use explosives for capturing fish nor allow destruction or capture of birds. Further, he was to pay a royalty of fifty cents a ton for each ton of guano removed.[30] The islands were leased for 15 years at an annual rental of $25.[31]

On 17 April 1909 a party of 15 Japanese, under the direction of Masayeshi Houme, landed on the island and began harvesting feathers. By August an estimated 30 bales (or about 1 ton) of feathers, and 70 bales of wings had been collected (Jacobs, ms.). At ca. 1,830 wings to the bale, 70 bales would amount to ca. 128,100 wings. Wings and feathers were removed from the island on or about 10 August when the Japanese schooner Tempou Maru visited the island. At that time nine of the original party were replaced by nine other laborers (Jacobs, ms.).

During late 1909 rumors reached Honolulu that poachers were again raiding the Northwestern Hawaiian Islands. Since most of these islands had been set aside as the Hawaiian Islands Bird Reservation by the presidential executive order of 3 February 1909 (Bryan 1942: 187), the U.S. Revenue Cutter Thetis, captained by W.V.E. Jacobs, was sent to investigate.

The Thetis arrived at Laysan on the afternoon of 16 January 1910 and an armed crew was sent ashore. Fifteen Japanese were found on the island, using the 13 buildings that had been erected by the Pacific Guano and Fertilizer Company.

> One of the buildings was full of the breast feathers of birds in bulk, another was two-thirds full of loose bird's wings, and two other buildings were partly filled with bales of feathers and wings, and a number of stuffed birds of various species. On the sand adjacent to the buildings were about two hundred mats held down by rocks, under which were laid out masses of birds' wings in various stages of curing. Stretched along the beach and over the island were bodies of dead birds in large numbers from which emanated obnoxious odors (Jacobs, ms.).

The following day a boat's crew was again sent ashore, this time to arrest the Japanese and to seize all plumage and bring it to the ship. By the 18th these operations were completed. Sixty-five bales of birds' wings, 28 large and 3 small bags of feathers, 13 bales of feathers, and 2 boxes of stuffed birds were seized. This amounted to about a ton of feathers and an estimated 119,000 birds' wings.

Approximately 800 pounds of feathers and 63,500 wings were insufficiently cured for transportation. They were destroyed by removing the mats under which the wings were drying and by knocking in the sides of the buildings in which the feathers were stored so that wind and weather would render the plumage valueless.

Thus, from 13 April 1909 through 16 January 1910 the Japanese had gathered ca. 2 1/4 tons of feathers and 310,600 birds' wings. The lowest price for these materials, as stated by overseers of the two laboring parties (one party operating on Lisianski) was $.33 per wing and $6.00 a pound for feathers (Jacobs, ms.). The value of the materials gathered on Laysan, therefore, would have been about $131,300.[32]

A number of documents were offered by the Japanese overseer as evidence that he had a right to be on the island: the Agent's Commission to Max Schlemmer from the Pacific Guano and Fertilizer Company, Schlemmer's Police Constable's Commission, the agreement between Schlemmer and Genkichi Yamanouchi concerning the conditions of rental of Laysan and Lisianski, and a contract between Schlemmer and Yamanouchi in which Schlemmer stated that he recognized the capture of birds by Yamanouchi.[33] These documents were seized by Jacobs for use in prosecution of the Japanese.

The Japanese were returned to Honolulu where they were held pending trial and the plumage was turned over to the government.

Trial of the Japanese and Max Schlemmer

During February legal procedures were instigated against Schlemmer and the Japanese. On 21 March Schlemmer was indicted on charges of poaching on a federal bird reservation and on two counts of illegally importing contract laborers (Pacific Commerical Advertiser, 22 March 1910). Suits were also filed against one of the Japanese. This case was apparently a test case, which, if successful, would have been the basis for action against the other Japanese. The test case, however, was unsuccessful; as a result it was decided that the Japanese were entitled to free passage back to Japan. The judge also dismissed the charges against Schlemmer.[34]

The government appealed the judge's decision, dropped the charge of poaching, reworded the other charges slightly and in late June Schlemmer was again indicted on two counts of bringing aliens into the country unlawfully (Honolulu Evening Bulletin, 1 July 1910).

Schlemmer pleaded not guilty; the case was continued until October so that Schlemmer could visit Laysan before the trial. In late October Schlemmer finally went to trial and was found not guilty.[35]

Other visits to Laysan in 1910

In late July 1910 a Japanese two-masted schooner arrived at Laysan, evidently to pick up the feathers gathered earlier, and to exchange work crews, as it had aboard a party of 30 men. Since the vessel had left Tokyo in early January, there seems to be no question but that the Japanese were unaware of the Thetis' visit and the arrest of the feather gatherers (Honolulu Evening Bulletin, 6 August 1910).

The Thetis visited the islands of the Hawaiian Bird Reservation many times during the following six years to discover whether further depredations had been made. On occasion it transported scientific parties to and from the islands. In 1910, alone, it visited Laysan twice again.

The first visit occurred 19 May 1910 when several of the crew were sent ashore for about two hours to observe conditions; the officer in charge reported that conditions were practically unchanged from those seen the preceding January.[36]

The Thetis landed a party on the island again on 2 September 1910 which, like the previous party, spent about two hours on the island. No signs of human disturbance were discovered.

Scientific Work on Laysan, 1900-1914

The Albatross Expedition

During the summer of 1902 a scientific party headed by Charles Henry Gilbert, aboard the U.S. Fish Commission Steamer Albatross, engaged in

deep-sea explorations off the Hawaiian Islands. Walter K. Fisher and John O. Snyder spent 16 to 23 May on Laysan as guests of Schlemmer, then manager of the guano operation. They made a general biological survey of the island and collected a variety of biological specimens. A formal report by Fisher (1903a) contains a description of the island and of island conditions and is especially valuable for detailed notes on all bird species present. Careful population estimates, which are of special value since they were made under relatively "natural" conditions, were made of most bird species then present. They provide a basis for comparison with the drastic population changes that occurred during the next 20 years as a result of decimation by feather hunters and habitat destruction by rabbits.

W.A. Bryan's visit in 1903

In April and May 1903 Laysan was visited by William Alanson Bryan of the Bernice P. Bishop Museum, Honolulu. During this visit, about which little is known, Bryan made one of the largest bird collections ever made on Laysan; he also collected plants. Bryan never published any report of his observations and little mention is made of this visit in the literature.

The Director's Report for the Bishop Museum for 1904 lists Bryan's collection as "669 specimens of bird skins, eggs, etc., from Laysan." E.H. Bryan, Jr. (pers. corres.) informs us that accession records break this down as "189 skins, 102 sets of eggs, 6 mounted birds, 22 skeletons, and 8 bodies in alcohol." The skins that we have seen indicate that Bryan was on Laysan from at least 3 through 30 April; E.H. Bryan, Jr. writes that other specimens are labeled May 1903.

Gerrit P. Wilder's visit in 1905

Gerrit P. Wilder, aboard the U.S.S. Iroquois, visited Laysan for a few hours on 19 September 1905.[37] He made a few general observations on biology and island conditions (Wilder, 1905), collected a few insects, and introduced some plants (see Appendix Tables 2 and 3). He considered the vegetation to be in good condition despite the presence of one donkey and a few cows. Rabbits were not mentioned. The guano deposits were said to "be rapidly being exhausted." Birds were "very plentiful" but only two species were specifically mentioned.

Collections by residents of Laysan

Paul E.H. Bompke was employed by Schlemmer on Laysan from 1904 to 1906 (Bailey, 1956: 15). He collected birds, several of which were new distributional records, for the Bernice P. Bishop Museum between 26 January and 6 June 1906.

During the years that Schlemmer lived on Laysan as an agent for the guano company, he collected a small number of birds. We have found records of 39 specimens of 9 species, all collected in April or May in the years 1904 to 1908. All but two of these specimens are now housed in the Museum of Comparative Zoology, Harvard. Schlemmer also made a small collection of fish (Jordan and Snyder, 1904).

Visit by the State University of Iowa Expedition

In 1909 Charles C. Nutting, head of the Department of Zoology of the State University of Iowa, began organizing an expedition to Laysan to ascertain the condition of the bird rookeries and to collect a series of birds for a museum exhibit (Dill and Bryan, 1912: 8). The expedition was to have visited Laysan in the spring of 1910, but the trip was delayed for a year because of difficulties in obtaining transportation and because Nutting did not want to disturb the birdlife so soon after the Japanese depredations of 1909-1910.[38]

After much correspondence between Nutting and the Bureau of Biological Survey, the field party, selected by Nutting, was finally determined: Homer R. Dill, Professor, State University of Iowa, in charge; Horace C. Young, assistant; Clarence J. Albrecht, photographer and assistant; Charles A. Corwin, artist; and William A. Bryan, Oahu College, representing the Bureau of Biological Survey. All members of the field party were commissioned as Game Wardens or Assistant Game Wardens in case Japanese poachers were found on the island or visited it during the party's stay.

The field party arrived at Laysan aboard the Thetis on 24 April 1911. Bryan left the island on 30 April when the Thetis stopped on her return from Midway; the remainder of the party stayed until the next visit of the Thetis on 5 June.

Some friction occurred between personnel of the Biological Survey Bureau and of the State University of Iowa following this trip. Fewer bird specimens were sent to the Department of Agriculture than H.W. Henshaw, head of the Biological Survey, felt were due it. Nutting, on the other hand, felt that a larger share of the collection should go to the University since their visit had been reduced from the agreed upon three months to five weeks. Henshaw pointed out that "Under the terms of this arrangement [about the allotment of specimens] you were given a permit to collect 1,030 specimens, of which you were to retain 665 and we were to have 365, or a little more than one-third of the total. You actually collected 398 specimens of which you allot us 45, or about one-ninth of the number secured."[39] Henshaw requested another 51 specimens.

Nutting replied to Henshaw telling him that their proposed museum exhibit would be ruined if the college were to give the Bureau more specimens. Henshaw thereupon agreed to an adjustment by which the Biological Survey would receive 29 more skins.[40]

A second point of contention arose between the two parties when Henshaw added Bryan's section to the expedition report (Dill and Bryan, 1912), without consulting Dill. Dill strongly objected to co-authoring the report with Bryan, partly because "Mr. Bryan was not a member of our party and did no scientific work during the few days he was on the island."[41]

Henshaw answered that he had added Bryan's section as an afterthought since "it occurred to me that inasmuch as the Bureau had sent a representative

with your party it was absolutely necessary for official reasons that the report furnished by Bryan should be included...."[42]

Visit by the Thetis in 1912

On 22 April 1912 the Thetis revisited Laysan to determine whether any poaching had occurred subsequent to the visit by the Iowa party. The party that went ashore found no evidence that Laysan had been visited since the preceding year (Cochran, ms. a). Conditions were the same as on the June 1911 visit but "owing to the early part of the season the number and variety of birds [was] less;" there was no material increase in the number of rabbits.

Visit by Biological Survey Expedition of 1912-1913

Towards the end of 1912, the Bureau of Biological Survey, acting on Bryan's recommendations (Dill and Bryan, 1912: 25), sent a party to exterminate rabbits, determine the condition of the bird colonies, introduce coconuts, and conduct an experimental transfer of Laysan Rails from Laysan to Lisianski.[43] The party consisted of Commodore G.R. Salisbury (USN), William Seward Wallace (Stanford University), George Willett (Bureau of Biological Survey), and Alfred M. Bailey.

Prior to leaving Honolulu for Laysan, the party destroyed the bird plumage confiscated in 1910 by the Thetis. Eleven wagon-loads of wings and feathers were hauled to the dumping ground and burned (Bailey, 1956: 22).

The field party departed Honolulu on the Thetis on 15 December and arrived off Laysan on the 21st.[44] The following afternoon Willett, Bailey, Wallace, and D.T. Fullaway of Honolulu, who accompanied the party to Laysan to collect insects, landed on Laysan. Commodore Salisbury continued on to Midway and Pearl and Hermes Reef, returning with the Thetis on 29 December. Heavy seas prevented his landing that day and it was not until 31 December that he finally came ashore. The same day Fullaway returned to the Thetis and sailed for Honolulu (Cochran, ms. b).

The four-man Biological Survey party remained on Laysan until 11 March 1913 when the Thetis returned. During its stay the party killed 5,024 rabbits but were not successful in exterminating them (Salisbury, ms.). Salisbury estimated that less than one-third of the total still remained.[45] Willett subsequently made a full report to the Bureau of Biological Survey but it was never published and its present location is unknown (Bailey, 1956: 7). Bailey borrowed Willett's field notes from Mrs. Willett and incorporated many of Willett's observations in his popular account that appeared years later (Bailey, 1956). Several subsequent reports by Bailey (1952a, 1956) dealt principally with birds; other papers dealing with Laysan that resulted from this trip are summarized and listed in Appendix Table 3.

Another visit by the Thetis

In 1914 the Thetis again checked the Northwestern Hawaiian Islands for the presence of poachers and landed a party on Laysan on 11 September.[46]

Carl Elschner, a passenger on this cruise, made a brief study of the island, particularly its geology, guano deposits and vegetation (Elschner, 1915).

Another raid by feather poachers

In 1915 the Thetis arrived at Laysan on 23 March but no landing could be made because of rough seas. The ship departed the same day and continued her survey of the Northwestern Hawaiian Islands. On her return from islands to the westward, the Thetis stopped at Laysan and landed a survey party there on 3 April. The shore party, under the direction of 1st Lt. William H. Munter, spent about 5 hours surveying the island (Brown, ms. a).

Munter reported that the island had been visited by poachers. Judging from the incubation stage of eggs left in deserted nests, he estimated that the poachers had been there two to two-and-a-half months earlier--about January.

In his detailed report of bird life on the island, Munter (1915: 138-140) stated that:

> Dead birds were seen in piles of 10 and 15 and sometimes as many as 40 or 50 in a pile....Only the breast and belly feathers had been taken....The...Laysan Albatross was the chief sufferer, next the Black-footed Albatross with the Frigate Bird and Blue-faced Booby following in order of number found killed. Between one hundred and fifty and two hundred thousand birds were found lying in heaps in all parts of the island. All of them were found on their backs with only the breast feathers missing. In the majority of cases the feathers had been pulled out, but in some instances knives had been used and the breast had been cut away from the bodies.... As a consequence there were very few young Albatrosses and Boobies....The western half of the island [has] only a very few young Albatrosses but there [are] hundreds of eggs with young chicks in them that never hatched....Along the southern and southeastern part of the island quite a number of the young of the Black-footed Albatross were found... [but]...here as elsewhere hundreds of grown birds had been slain...no portion of the island was spared....
>
> Arriving at the buildings on the western part of the island we found a great pile of dead birds...in one of the sheds....Decaying turtle meat was discovered in one of the pantries....Around the buildings skinned birds were found, also the wings of Terns and Albatrosses....About two thousand [frigatebirds]...were killed by the poachers ....A hundred or more [Blue-faced Boobies] were found dead....About fifteen [rabbits] were found dead near one of the buildings.

The Return of Max Schlemmer[47]

Despite his earlier financial and legal difficulties over Laysan, Max Schlemmer had by no means given up his desire to live there. Early in 1915 he applied for a position as permanent warden of the Hawaiian Islands Reservation, stipulating that he wished to reside on Laysan with his two sons, a daughter, and two assistants, and that he would visit other islands when necessary on his recently purchased yacht the Helene. The Bureau of Biological Survey took his request seriously enough to make inquiries as to whether enough guano remained so that a warden could support himself by mining it.[48]

Nothing came of this application but Schlemmer, nonetheless, sailed on the Helene from Honolulu bound for Laysan on 25 June. With him were his sons, Otto and Eric, his daughter, Marie, and a young sailor, Harold Brandt.

Otto and Marie were put ashore on Kauai on account of sickness on the 30th; the remaining three sailed to Laysan, arriving on 12 July. They landed the following day and spent the next few months cleaning up, patching the buildings, making water containers, digging wells, and otherwise trying to repair the ravages of wind and weather. During their stay they killed 3 seals and 15 turtles for food and oil, and pickled 350 albatross eggs.

Their life on the island continued uneventfully until 28 September when a small boat was sighted in the late afternoon on the southwest point of the island. The boat contained Captain Charles A. Lunn, his wife, and nine crew members (including Julia Lunn as stewardess) of the schooner O.M. Kellogg. The schooner, bound for San Francisco from Apia, had stranded on Maro Reef on the night of 25 September.

Schlemmer immediately offered Lunn the use of the Helene to reach Honolulu but Lunn felt he had not enough provisions to make the voyage. The party remained on Laysan until 4 October, when Lunn, who had decided to sail to Midway, departed on the Helene with all hands, leaving Schlemmer and the two boys alone on the island with no means of transport.

Schlemmer and the boys patiently awaited the return of the Helene or the arrival of other transport but weeks passed and provisions began to run low. Diary entries made towards the end of their stay on the island attest to their difficulties and anxiety over their plight.

> Nov. 4 - This day we had great hopes of seeing the U.S. Coast Guard Cutter Thetis arrive but all in vain. We have a pretty hard time of it and we have to live on water and flour only for the last two weeks. This is pretty tough on the boys, but as for myself, I keep up good courage and hope for the best. We have done lots of work which any one who has been here recently can see but now we have to do only a little each day as we soon feel weak.

> Nov. 13 - This is to certify that we have had nothing to eat for the last 3 weeks but flour and water and we therefore took one Gooney [=Black-footed Albatross] egg today, the first of the year, [which was made into a pancake]. [signed] Harold Brandt, Eric Schlemmer.
>
> Nov. 15 - I sent Eric Schlemmer and Harold Brandt along the beach to look for wreckage. To my surprise they came home with a tin of dried potatoes which had washed ashore. It had some salt water in it, but was mostly dry in the center. I must say that it came like a God send to us as we have nothing else to eat. We have not had a potato for the past 4 weeks....This day we also ate our last grain of sugar.
>
> Dec. 1 - This day we all kept a sharp lookout for a ship, but there was not one to be seen. It is becoming very hard on the boys' nerves as they are not used to this kind of living we have had for the past three months. It takes all I can do to keep up their courage. I told them however, not to be discouraged and that they should pray to God....So they said their prayers.

On the following day, the U.S.S. Nereus arrived at Laysan to pick them up, having been sent at the request of the Department of Agriculture. By 6 December all three had returned to Honolulu.[49] The Helene, however, had wrecked on Sand Island, Midway Atoll, during a northwest storm (Hadden, 1941: 6).

Surveys in 1916 and 1918

When the Thetis revisited Laysan in 1916 the crew again encountered difficulties in landing a survey party. The ship anchored offshore on the evening of 30 January but, as the seas were becoming increasingly rough, departed the next morning for Lisianski. The ship returned to Laysan on the evening of 6 February but was not able to land a party until the morning of 9 February (Brown, ms. b).[50]

In an unpublished report, Munter (ms.) made observations on birds and other matters of interest on the island. He noted that the rabbits were multiplying rapidly and strongly recommended that they be killed before Laysan became "but a sand spit like Lisianski Island." He set his crew to work catching rabbits but they could only catch 20 as the animals were difficult to capture.

Munter also reported finding a barrel of about 350 Black-footed Albatross eggs that had been left by Schlemmer the previous year. The crew decided to cook some of these eggs and found them "fresh and also very palatible, if allowed to remain in boiling water for twenty-five minutes. In fact, they had a much better flavor that the similar product from the hen...."

Figure 18. General view of inner basin of Laysan completely denuded of vegetation except for the dark patch of Sesuvium and Portulaca in background, 11 April 1923.

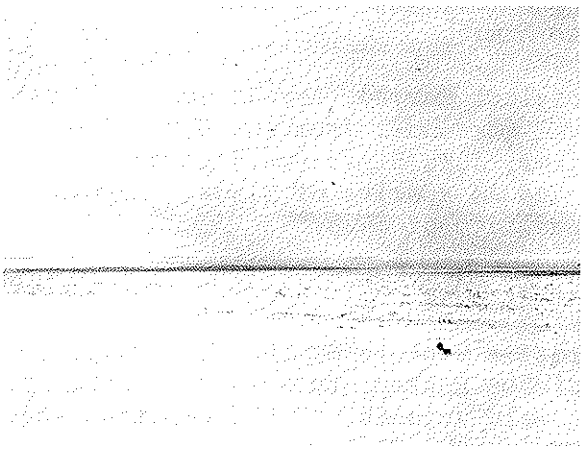
Figure 19. Camp on Laysan showing two surviving Cocos trees, 13 April 1923.

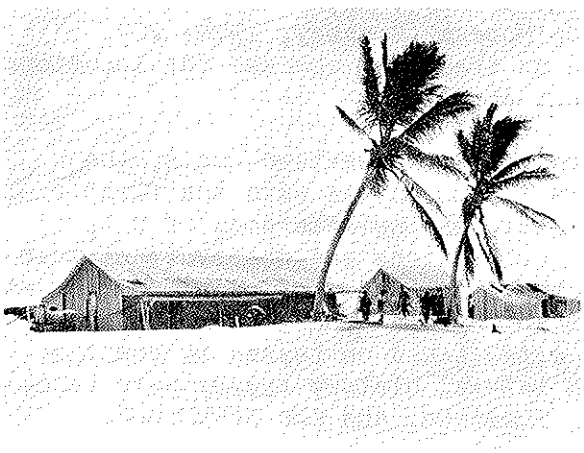
Figure 20. Laysan Albatross and Wedge-tailed Shearwaters in patch of Sesuvium, 5 May 1923.

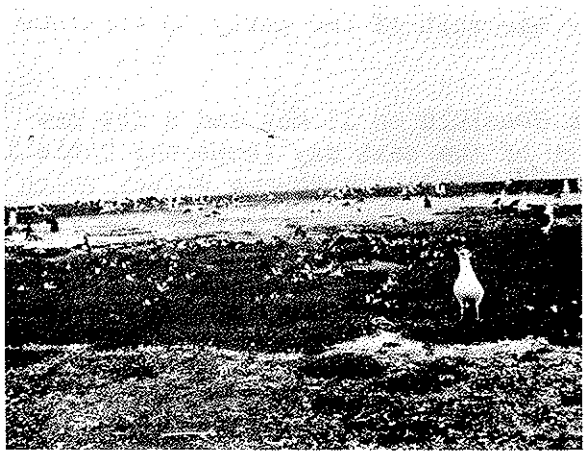
Figure 21. Red-footed Booby colony in single Casuarina tree with two surviving Cocos in background, 5 May 1923.

Figure 22. Tobacco patch and associated birds, 10 May 1923.

Figure 23. Wedge-tailed Shearwaters near nesting burrow, 12 April 1923.







During their stay the survey party also made measurements to determine precisely the island's location, they collected "beach sand, shells, and shell fish" for W.A. Bryan, and they gathered some of Schlemmer's personal effects to return to him.

At the behest of the Bureau of Biological Survey, Laysan was visited on 8 and 9 September 1918 by naval personnel from the U.S.S. Hermes. A report by the commanding officer, J.T. Diggs (ms.) gives information on turtles, rabbits, seals, and 18 species of birds. Laysan was then neglected until the Tanager Expedition of 1923.

The Tanager Expedition, 1923

The Tanager Expedition was a cooperative venture by the U.S. Navy, U.S. Biological Survey, and Bernice P. Bishop Museum, to survey thoroughly the Northwestern Hawaiian, Johnston, and Wake Islands. Transportation and hydrographic work was conducted by the Navy. The Biological Survey was represented by an ornithologist (Alexander Wetmore, the field party leader), an expert in small mammal control (E.C. Reno), and a scientist and nature photographer of Pasadena, California (D.R. Dickey). Other scientists and field workers were supplied by the Bishop Museum (Gregory, 1924: 20). Officers on the naval vessel that served as transport checked the locations of the various islands as given on current charts.

On the first of several voyages along the northwestern chain, the minesweeper U.S.S. Tanager proceeded directly to Laysan with the first field party (Appendix Table 1). Laysan was sighted on the afternoon of 7 April and the party landed the following day. Collections and observations were made offshore and on the island through the 13th. The following morning at 0730 Wetmore with most of the party left to explore other outer islands of the Reservation. Remaining in the camp established on Laysan to continue the rabbit extermination program and the natural history survey were Reno, Dickey, Schlemmer, Stanley C. Ball, J.W. Thompson, and the Navy cook, George Higgs.

On the afternoon of the 29th the Tanager returned. Late in the afternoon of the 30th Thompson, Dickey, Edward L. Caum, and David T. Fullaway departed aboard it for Honolulu, leaving the rest of the party to continue the island work.

The Tanager returned to Laysan from Honolulu on 13 May and a few new members of the expedition landed for part of the next day (Appendix Table 1). All departed the island on the 14th, thus concluding a 38-day survey which yielded far more information on the biota of Laysan than any previous or subsequent visit (Appendix Tables 2 and 3 and Figures 18-23).

Visits to Laysan from 1924 through the early 1940's

Laysan was visited fairly regularly during this period but few of the visits are known in much detail.

On 6 May 1924 Wilder, then a warden for the Hawaiian Bird Reservation, visited the island from the U.S.S. Pelican.[51] Wetmore (1925: 103), presumably referring to this visit, stated that "a party sent to Laysan a year after our visit reported no sign of a single [surviving rabbit]." The only other information we have been able to find on this visit consists of a few notes copied from a letter received by the Biological Survey (Wilder, ms. a). Therein, Wilder noted the presence of five species of birds.[52]

The next three visits of which we found record occurred in 1928.[53] On 1 March Dr. Victor Pietschmann, a Bishop Museum fellow from Vienna, Austria (Bryan, 1942: 198), visited the island briefly through the courtesy of William G. Anderson, master of the schooner Lanikai, which often cruised to Pearl and Hermes during the late 1920's. He collected various marine specimens.

On 6 May, Anderson again briefly visited the island and collected marine organisms, most, if not all, from offshore. We cannot be certain whether Anderson actually landed.

In between these two visits, Laysan was briefly visited on 24 April by the U.S.S. Marblehead, commanded by H.K. Cage, apparently to search for the wreck of a ship. An aerial survey of the island was made by a plane catapulted from the ship; no trace of a wreck was found.[54]

In August 1930 Wilder again visited Laysan. He was transported to the island by the Coast and Geodetic Survey ship Pioneer and spent 16 days there

> to ascertain how the planting of vegetation in 1923 had progressed and to introduce plants that might grow on the island and give shelter to birds. Native grasses and vines were found to have been most successful. Ironwood trees, kamani, Coccoloba, Pritchardia, Scaevola frutescens, and coconuts were planted. Collections of plants, birds' eggs, insects, marine organisms, and artifacts were made. (Gregory, 1931: 16).

Although some of Wilder's collections were subsequently described (Appendix Table 3), few other details of this survey are available.[55] The survey party from the Pioneer made astronomical and magnetic observations (Honolulu Star Bulletin, 28 July 1930).

The Pioneer revisited Laysan between 14 and 17 September to continue the survey work begun on the previous visit.[56]

In the summer of 1934 the U.S. Coast Guard vessel Itasca, under the command of J.S. Baylis, visited most of the Northwestern Hawaiian Islands to survey the islands and to see if there were any inhabitants on them. Laysan was visited on 26 June; the captain and seven others went ashore for about three hours in the morning. The party reported finding "numerous birds and a few large turtles." The old guano sheds were tumbling in and

filled with sand; quite a number of boatswain birds [=Red-tailed Tropicbirds] were nesting in the sheds (Baylis, ms.).

Laysan was visited in December 1934 and January 1935 by Captain Northrup H. Castle of the schooner Lanikai. Castle was searching for traces of a missing plane, the Star of Australia (Honolulu Star Bulletin, 30 January, 6 February, 29 March 1935).

Laysan was visited twice in 1936. The first visit occurred in March when the island was visited for two days by the U.S. Coast Guard Patrol Boat Reliance, commanded by Boatswain B.L. Bassham. The purpose of the visit was to investigate the bird life to determine if the island had been visited since the last survey (Bassham, ms.). On board was Alfred D. Trempe, a co-operator for the Bureau of Biological Survey.[57]

The ship arrived at Laysan on 7 March and a surf boat put seven men ashore for three or four hours. The following day Trempe and nine others spent three hours on the island.[58] During this visit photographs were taken and a few birds were banded with blue celluloid rings and with brass rings that had been made in the engine room of the Reliance. Subsequently Trempe (ms.) made a brief report of his observations and activities.

In early December 1936 William F. Coultas and Tashio Asaeda visited Laysan from the yacht Zaca as part of the C. Templeton Crocker Expedition. They were collecting specimens for the Whitney Memorial Hall in the American Museum of Natural History (Bailey, 1956: 16). Little is known of this visit but a few notes on birds are in the files of the Bureau of Sport Fisheries and Wildlife and the B.P. Bishop Museum in Honolulu (Coultas, ms.).

Laysan was evidently visited very little during the 1940's, probably because of World War II. The island apparently played little part in this struggle.

Visits to Laysan in the 1950's

Laysan was visited often in the 1950's. Most of the early visits were made by personnel of the Pacific Ocean Fisheries Investigations (POFI) or by individuals cooperating with them, such as the Hawaii Division of Fish and Game (HDFG) and the Bureau of Sport Fisheries and Wildlife (BSFW).[59]

The first POFI vessel to visit Laysan was the Hugh M. Smith which arrived early on the morning of 23 June 1950. A party from the ship went ashore during the day to scout for fish bait and to do some fish collecting. With the party was Vernon E. Brock (HDFG), who went ashore "to tag turtles and observe reef fishes and sea birds" (Brock, 1951a: 371). Eighteen species of birds were recorded during the visit and very brief notes were made on the breeding stage of nesting species (POFI). Brock (1951a) later reported his observations on the Laysan Teal.

Another visit was made by the Hugh M. Smith on 12 May 1951. The island was again scouted for fish bait, a count was made of Hawaiian monk seals (see Svihla, 1959: 227), and very brief notes were made on 15 species of birds (POFI).

The George Vanderbilt Pacific Equatorial Expedition sailed to Laysan on the 172-foot auxiliary schooner Pioneer, owned by Vanderbilt and captained by T. Ivar Vatland, in June and July 1951. The field party included two scientists--Vernon Brock and Robert R. Harry, Stanford University--Vanderbilt, his wife and daughter, and members of the Pioneer's crew. Nine days were spent at Laysan. Most of the effort was devoted to collecting fishes. Over 6,000 specimens were collected from 21 different stations (Harry, 1953; Herald, 1952). Only a single day was spent on the bird census that was later reported by Brock (1951a).

Laysan was again visited by POFI personnel on 3 November 1954. About six hours were spent on the island by a party from the Charles H. Gilbert. Only a few brief notes were made on the fauna (POFI).

Laysan was visited again by the Hugh M. Smith on 10 February 1955.[60] Donald L. McKernan went ashore and made a special effort to evaluate the status of the Laysan Teal population (Warner, 1963: 13). Brief notes were made on 13 species of birds. Laysan was scouted for fish bait, and two U.S. Fish and Wildlife Refuge signs were erected (POFI).

Two visits were made to Laysan in 1957. David H. Woodside and Richard E. Warner visited the island 25 June to 3 July and made biological observations on the Laysan Teal, many of which were later reported by Warner (1963). During this visit three males and five females were captured and subsequently delivered to the Honolulu Zoo (Woodside, ms. a).

Shortly thereafter (8 to 12 July), Laysan was visited by two amateur naturalists, Al Labrecque and Al Stoops. They had been transported to Laysan by a Honolulu fishing sampan, the 75-foot Koyu Maru. They published two brief accounts about their experiences (Labrecque, 1957; Stoops, 1958).

During 1957 and 1958 a series of aerial inspections was made of Laysan and other Northwestern Hawaiian Islands by Dale W. Rice and Karl W. Kenyon of the Bureau of Sport Fisheries and Wildlife. Laysan was surveyed on 7 January, 15 April, and 28 December 1957, and 28 June 1958. The primary purpose of these flights was to estimate albatross and Hawaiian monk seal populations. The results of these investigations are summarized in Kenyon and Rice (1959), Rice (1960b), and Rice and Kenyon (1962).

Between 27 May and 4 June 1958 Rice and Warner (a temporary BSFW employee) and others studied the seabird populations on Laysan, banded over 3,000 birds, and made other biological observations. This survey was followed by a series of inspection trips to the refuge, usually by members of the Hawaii Division of Fish and Game under contract to the Bureau of Sport Fisheries and Wildlife, and often accompanied by a Bureau representative (Appendix Table 1). Transportation was afforded by the U.S. Coast Guard

and visits were necessarily brief because of other Coast Guard commitments. Many visits were of but a few hours' duration while the support vessel waited offshore. On several occasions, however, it was possible to land from a vessel going west to relieve the ship at Ocean Station Victor and to board the relieved vessel on its return trip a week or so later.

Two survey parties visited Laysan in 1959. The first survey party--Raymond J. Kramer, a biologist; Hubert Caspars, a hydrobiologist from Hamburg University; George D. Butler, Jr., an entomologist from the University of Arizona; and William R. Smythe, a zoologist employed by the Hawaii Sugar Planters Association--visited the island 28 April to 1 May. Insects were collected by Butler and notes and observations on the fauna were made by Kramer (ms.). Evidently greatest emphasis was placed on observation of species (albatross, teal, seals) that were of particular interest to the Division of Fish and Game.

The second survey party--Miklos D.F. Udvardy, Charles W. Daniel, Butler, Warner, and C.H. Danforth--visited the island 20 to 27 July. The party surveyed the vegetation, made entomological and botanical collections, and studied birds and the Hawaiian monk seal (Udvardy, 1961b: 43). Observations made on this visit were reported in a number of different papers (Butler, 1961a, 1961b; Lamoureux, 1963; Warner, 1963, Butler and Udvardy, 1966), but we have been unable to discover any general account of this survey.

Visits to Laysan During the 1960's

A visit to Laysan was made by the Charles H. Gilbert on 23 August 1960. During a brief survey of the island a count was made of Hawaiian monk seals but no notes were taken on birdlife (POFI).

Three visits to Laysan occurred in 1961. Woodside and Kramer (HDFG) spent about one day on the island 7 to 8 March as part of a general survey of the Northwestern Hawaiian Islands. Some general observations were made on birdlife but most effort was spent on surveying seals and teal (Woodside and Kramer, ms., Kramer and Woodside, ms.). The only observations published were notes on the teal that were incorporated in Warner's (1963) paper. Four days after Woodside and Kramer left the island, the U.S.S. Duval County arrived offshore. This, the first of several visits to Laysan by military personnel, was part of Phase I of the HIRAN operation during which first order astronomic stations and HIRAN and azimuth marks were to be established on the Northwestern Hawaiian Islands. An Army survey team and its equipment were sent ashore on the 12th and remained there until the 20th when the Duval County returned to pick them up (Roach, ms.).

The Harold J. Coolidge Expedition visited Laysan in September 1961. This expedition was conceived by members of the July 1959 expedition who decided that information from another season would greatly expand scientific knowledge. Harold J. Coolidge, General Secretary of the 10th Pacific Science Congress, arranged for transportation by airplane to French Frigate Shoals, and thence to Laysan by the U.S. Coast Guard vessel Ironwood.

Warner, then associated with the University of California, was designated leader of the party since he had participated in four earlier visits (Udvardy, 1961: 43). The party consisted of scientists from a wide range of disciplines and was one of the largest field parties ever to visit the island (Appendix Tables 1 and 2).

The party landed and set up camp on 4 September and remained on the island until the morning of 10 September when it returned to the Ironwood which had remained offshore. Data were collected on subjects ranging from geophysical observations to rectal temperatures of seals (see Appendix Tables 2 and 3). Originally the party had intended to produce a monograph on the ecology of Laysan but it was never written. Some, but not all, of the observations were reported in a number of short papers by various individuals (Udvardy, 1961b, 1963; Lamoureux, 1963; Warner, 1963; Tsuda, 1965).

Another survey of the Hawaiian Islands National Wildlife Refuge was conducted by personnel from the Hawaii Division of Fish and Game and the U.S. Bureau of Sport Fisheries and Wildlife during the summer of 1962. The field party, consisting of Woodside, Kramer, David B. Marshall, and John W. Beardsley, an entomologist from the Hawaii Sugar Planters' Association, visited Laysan 14 to 19 June. The scientists were accompanied by five air force and army personnel with the HIRAN II project who came to re-establish their camp (Fig. 24). The camp consisted of four large tents and about 30 fuel and water barrels which were placed near a five-foot concrete block which had been installed for engineering purposes just northeast of the ironwood tree on the west side of the island. The party intended to spend about two weeks on the island (Kramer and Beardsley, ms.; Marshall, ms.).

One of the purposes of the visit by the wildlife personnel was to determine the effect on biota of the previous occupation of the island by HIRAN personnel. They found potatoes and onions growing near one of the larger garbage dumps and subsequently destroyed all that could be found on the theory that these "introduced" plants might crowd out "native" plants. However, they planted seeds of Chenopodium, Solanum, and Sicyos microcarpa that had been procured on Nihoa. They surveyed seal, albatross, and Laysan Teal populations (Kramer and Beardsley, ms.). Kramer made a few brief observations on the birdlife. The only published observations concerned a few collections, primarily of insects (see Appendix Table 3). Marshall (1964) wrote a popular account of the trip.

Five HIRAN personnel returned to Laysan in late January 1963 for about three weeks to conduct further studies (A.B. Amerson, Jr., pers. comm., 25 February 1970).

On 15 May 1966 the Gilbert conducted another fish bait survey. No notes were kept on the status of wildlife.

Since 1963 Pacific Ocean Biological Survey Program personnel (POBSP) have made thirteen visits to Laysan, a number of them in conjunction with

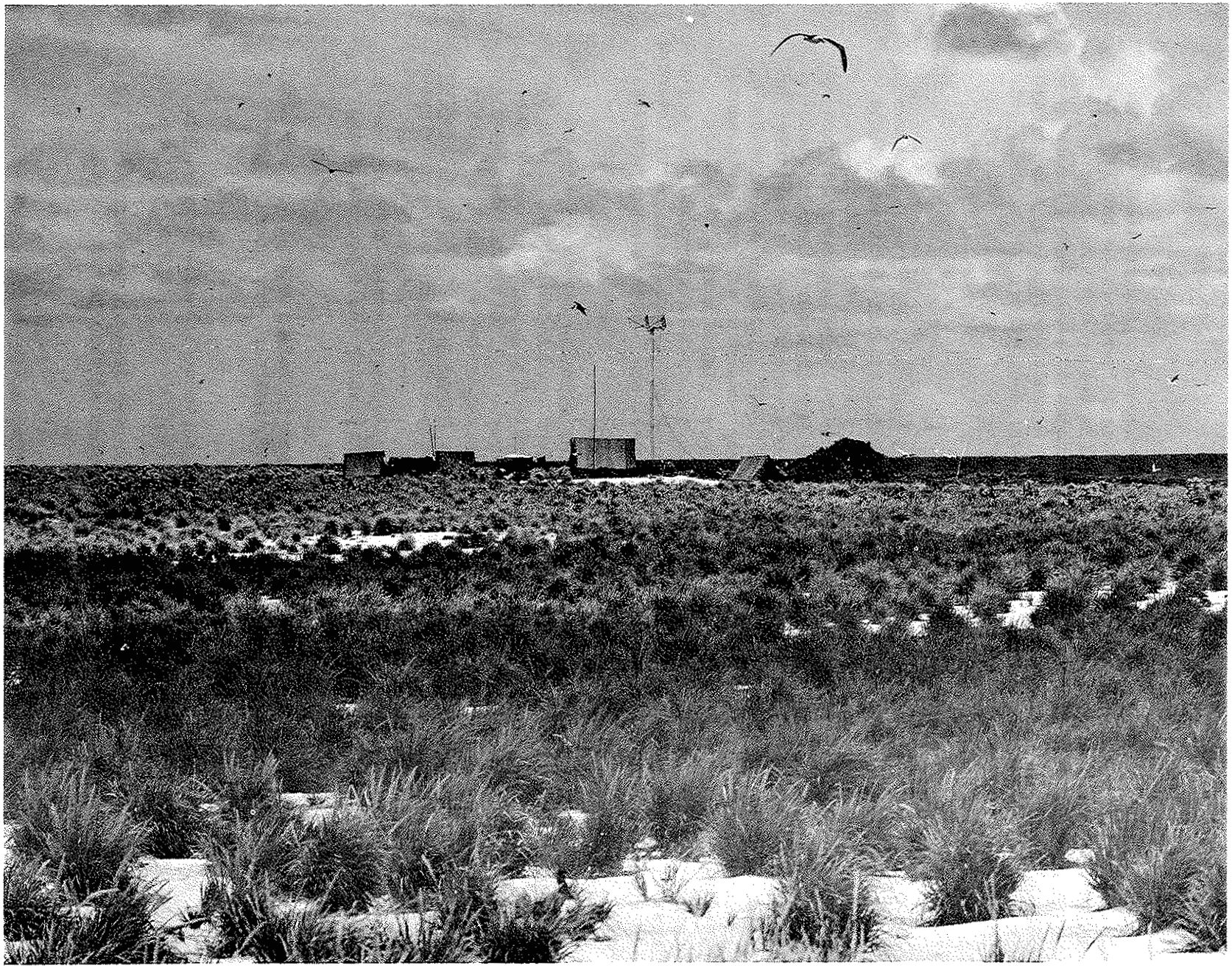


Figure 24. HIRAN camp on Laysan. Photograph by D.B. Marshall, 18 June 1962. Official U.S. Fish and Wildlife Service photograph.

regular inspection trips made by the Bureau of Sport Fisheries and Wildlife (BSFW).[61] In addition, there have been six surveys made solely by Bureau personnel. A summary of the personnel involved and results of the surveys are presented in Appendix Tables 1, 2 and 3. The temporal distribution of these visits and their duration are presented in Table 1.

In February 1967, Laysan and the other islands comprising the Hawaiian Islands National Wildlife Refuge were designated "natural areas" by the Bureau of Sport Fisheries and Wildlife. Refuge policy is to maintain the islands' ecology as free from outside, or non-natural, disturbance as possible. Landings may be made only by permit from the Bureau and visits may be made only by persons involved in scientific studies.

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

Month	1963	1964	1965	1966	1967	1968	1969	Total
February	POBSP(1.9)							(1.9)
March		BSFW(.9) POBSP	POBSP(4.2)	BSFW(4.7)	BSFW(1.0) POBSP	BSFW(2.0) POBSP	BSFW(3.3)	(16.1)
June				POBSP(7.1)	POBSP(5.0)		BSFW(1.4)	(13.5)
July			POBSP(3.6)					(3.6)
August			POBSP(7.2)					(7.2)
September		POBSP(3.9) BSFW(1.5) POBSP			POBSP(5.5) BSFW(3.2)	BSFW** (ca. 1.0)	BSFW(.3)	(ca. 15.4)
October				POBSP(2.5)				(2.5)
December	BSFW(7.0)***				BSFW(.2)			(7.2)
Total days of observation by POBSP	(1.9)	(6.3)	(15.0)	(9.6)	(11.5)	(2.0)	(0.0)	(46.3)
Total days of observation	(8.9)	(6.3)	(15.0)	(14.3)	(14.9)	(ca. 3.0)	(5.0)	(ca. 67.4)

*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.

**Exact details of the itinerary of this visit are not presently available.

***This survey was under the leadership of the HDFG but this agency was performing its work under contract to the BSFW.

HISTORY SECTION
FOOTNOTES

1. The source Stackpole cites (which we have not seen) is the "Journal" of Captain Stephen Reynolds, date cited 24 September 1824, that is in the Peabody Museum, Salem, Massachusetts. The date in the citation certainly implies that the island the Lyra discovered was sighted earlier than 1828.

2. Log of the U.S. Schooner Fenimore Cooper, Rec. Group 37, U.S. Nat. Archives, Washington.

3. See Hawaiian Star Bulletin, 1 April 1893. This lease was not to the North Pacific Phosphate and Fertilizer Company as Bryan (1942: 186) states. That firm did not yet exist.

4. Hawaiian Star Bulletin, 25 June 1890.

5. Act published in the Hawaiian Star, 1 April 1893.

6. Copy of agreement between J.A. King and the North Pacific Phosphate and Fertilizer Company, 17 April 1893, Rec. Group 126, U.S. Nat. Archives, Washington.

7. Copy of Surrender of Lease to the Commissioner of Public Lands of the Territory of Hawaii, Rec. Group 126, 31 October 1908, U.S. Nat. Archives, Washington.

8. Schlemmer had been foreman of the Japanese laborers as early as 1894 (Farrell, 1928: 414).

9. Bryan (1942: 186) stated that active guano digging began in 1892 but this statement is evidently in error.

10. Farrell, 1928: 400, 402, 459, states that the man's name was "Kosten, or something resembling that," and that he died in late 1893 or early 1894.

11. Periods of inclement weather often made it hazardous for the ships offshore awaiting their cargos. The American barque Albert was nearly beached by a stiff northeast wind in 1902. In 1905 the schooner C. Kennedy was driven ashore and totally demolished. During that summer, the C.L. Woodbury, which was taking a load of guano to Honolulu, met with heavy seas and had to return to Laysan for repairs (Anon., 1905).

12. This account is derived from articles in The Honolulu Pacific Commercial Advertiser of 8, 12-15, 18-19, 21-22 September 1900.

13. Subsequent testimony reveals that Goto, one of the two Japanese killed, was not shot dead but died of his wounds aboard the Ceylon two days later. The Ceylon was the primary carrier of supplies to Laysan and guano to Honolulu from 1900 until 3 July 1902 when it broke up as a result of bad weather and sank with a cargo of guano. The crew took to boats and made it back to Laysan 4 days later (Thrum, 1902: 154).

14. Spencer's first account of the shooting, given to Honolulu reporters, is somewhat at odds with his later testimony. We believe that Spencer somewhat exaggerated his first account as he thought of himself as a hero who had stemmed a bloody uprising by the "yellow peril."

15. Although not mentioned in the first account of the homicides, Wahlers had been on the platform with the four others when the shooting occurred.

16. The McNear was lost on Dowsetts' Reef 14 May 1900 while en route to Laysan. The 33 persons aboard set out in the ship's boats on the 15th for Laysan, about 60 miles away, and arrived there 36 hours later (Lydgate, 1914: 138).

17. The various testimonies make it clear that none of the Japanese was suffering from want of food.

18. Testimony conflicts as to who fired the first shot. The Japanese agreed that Spencer's son fired the first shot but Spencer himself claims to have done so.

19. Copy of Agent's Commission from Pacific Guano and Fertilizer Company, 6 May 1904, Rec. Group 126, U.S. Nat. Archives, Washington.

20. Schlemmer to G.R. Carter, Governor of Hawaii, 14 April 1904, State of Hawaii, State Archives, Honolulu.

21. Bryan (1942: 186) stated that "On May 1, 1904, the schooner Robert Lewers made a last trip to Laysan for the final cargo of guano for Hackfeld and Company...." We suspect that "Hackfeld and Company" was in fact the Pacific Guano and Fertilizer Company which had been originally financed by Hackfeld and Company and which had several of the Hackfeld family on its board of trustees (Anon., 1939: 10).

22. Schlemmer to Carter, 17 December 1904, State of Hawaii, State Archives, Honolulu.

23. Carter to William Dutcher, President of the National Audubon Society, 29 March 1905 (Dutcher, 1905: 306).

24. American vice-consul in Japan to the Assistant Secretary of State of the United States, 3 April 1909, Rec. Group 126, U.S. Nat. Archives, Washington.

25. An article, originally published in the Japan Times (cf. The Pacific Commercial Advertiser, 20 April 1909) was apparently a cover story for these operations. It stated that the Suminoye Maru, which had sailed from Japan for "shark fishing in the Hawaiian waters" in late November 1908, had been disabled by a storm and had drifted to Laysan where it arrived on 4 January 1909. About a month later the eighteen shipwrecked "sailors" were rescued by the Niigata Maru, which had drifted to the island under the same conditions. It is unlikely that either of these ships was at Laysan for any reason other than feather poaching, since both vessels are on the

list of seven reported by the American vice-consul.

26. It seems likely that this ship was the one that delivered the poachers to Laysan in late April 1909.

27. The C. Kennedy, captained by Schlemmer, went aground on Laysan on 3 March 1905. The vessel was totally destroyed but no one was killed. The crew was rescued on 23 March by the U.S. Gunboat Petrel which was en route from Midway to Honolulu (Lydgate, 1914: 138; Thrum, 1905: 189).

28. Copy of agreement between Schlemmer and Genkichi Yamanouchi, dated 22 December 1908, Rec. Group 126, U.S. Nat. Archives, Washington. Subsequent events make it clear that the Japanese had no intention of mining guano but intended instead to harvest plumage for the millinery trade. Only part of the Japanese operations on the Northwestern Hawaiian Islands is known in detail; it seems likely that feather harvesting occurred on the various islands on several occasions of which we know nothing.

29. Schlemmer had received a Police Constable's Commission from the Hawaiian Government for Oahu and the outer islands on 13 May 1907. The authority was probably granted primarily for the purpose of preventing poaching (implied in a letter from Carter to H.A. Isenberg, 15 December 1904, State of Hawaii, State Archives, Honolulu).

30. Partial copy of lease between Schlemmer and the Commissioner of Public Lands of the Territory of Hawaii, 8 February 1909, Rec. Group 126, U.S. Nat. Archives, Washington.

31. W.F. Frear, Governor of Hawaii, to the Secretary of the Interior, 30 April 1909, Rec. Group 126, U.S. Nat. Archives, Washington.

32. About $54,250 worth of material was shipped to Japan, $51,250 worth was seized by the Thetis, and about $25,800 worth was destroyed on the island.

33. We have found no evidence that the Japanese knew their operations were illegal. It seems likely that the original feather gathering party did not know of the Presidential Order since it was promulgated only about a month before they landed on Laysan.

34. W.A. Bryan to T.S. Palmer, 30 May 1910, Rec. Group 22, U.S. Nat. Archives, Washington.

35. D.B. Kuhns to T.S. Palmer, 14 November 1910, Rec. Group 22, U.S. Nat. Archives, Washington.

36. Log of the U.S. Revenue Cutter Thetis, Rec. Group 26, U.S. Nat. Archives, Washington.

37. Log of the U.S.S. Iroquois, Rec. Group 24, U.S. Nat. Archives, Washington.

38. Nutting to T.S. Palmer, Bureau of Biological Survey, 26 September 1910, Rec. Group 22, U.S. Nat. Archives, Washington.

39. Henshaw to Nutting, 25 April 1912, Rec. Group 22, U.S. Nat. Archives, Washington.

40. Nutting to Henshaw, 29 April 1912; Henshaw to Nutting, 2 May 1911, Rec. Group 22, U.S. Nat. Archives, Washington.

41. Dill to Henshaw, 20 December 1911, Rec. Group 22, U.S. Nat. Archives, Washington.

42. Henshaw to Dill, 31 May 1912, Rec. Group 22, U.S. Nat. Archives, Washington.

43. T.S. Palmer to G.R. Salisbury, 18 November 1912, Rec. Group 22, U.S. Nat. Archives, Washington.

44. Log of the U.S. Revenue Cutter Thetis, Rec. Group 26, U.S. Nat. Archives, Washington.

45. Salisbury to T.S. Palmer, 20 March 1913, Rec. Group 22, U.S. Nat. Archives, Washington.

46. Log of the Thetis, Rec. Group 26, U.S. Nat. Archives, Washington.

47. Most information concerning this visit is from Schlemmer and Schlemmer (ms.), a log of the Helene, and a diary kept by Schlemmer and his son Eric.

48. Henshaw to W.A. Bryan, 1 July 1915, Rec. Group 22, U.S. Nat. Archives, Washington.

49. J.H. Brown to the Captain Commandant of the Coast Guard, 13 December 1915, Rec. Group 26, U.S. Nat. Archives, Washington.

50. See also Log of the Thetis, Rec. Group 26, U.S. Nat. Archives, Washington.

51. Log of the U.S.S. Pelican, Rec. Group 24, U.S. Nat. Archives, Washington.

52. Gregory (1925: 10) stated that "During July [1924 Wilder] took advantage of an invitation extended by officials of the United States Navy to visit Laysan and Midway Islands--a trip which yielded collections and notes on land and marine fauna." Despite considerable searching in the files of the Bureau of Biological Survey in the National Archives and in the files of the Bernice P. Bishop Museum, Honolulu, we have been unable to find any of his observations.

53. Warner (1963: 7) reported that "living rabbits were reportedly seen on Laysan by a visitor to the island in 1926." We have no other record of this visit.

54. Log of the U.S.S. Marblehead, Rec. Group 80, U.S. Nat. Archives, Washington.

55. An unpublished four-page report by Wilder (ms. b) gives a little

additional data and a few notes on birdlife which have been incorporated into this report.

56. Log of the U.S.C. and G.S.S. Pioneer, Rec. Group 27, U.S. Nat. Archives, Washington.

57. Log of the U.S.C.G.S. Reliance, Rec. Group 26, U.S. Nat. Archives, Washington.

58. Log of the U.S.C.G.S. Reliance, Rec. Group 26, U.S. Nat. Archives, Washington.

59. Most information on such visits may be found in the scientist's logs and narrative reports of each cruise. These data are filed at the Bureau of Commercial Fisheries in Honolulu.

60. Svihla (1959: 227) gives the result of a seal count made during this visit. He implies incorrectly that Laysan was visited during January.

61. The BSFW assumed direct responsibility for inspection, patrol, and management of the refuge in 1964 when a refuge manager was assigned to Hawaii.

VEGETATION

The first fully documented botanical collection from Laysan was made by Schauinsland in 1896.* Subsequently, the following collections were made: J.O. Snyder, May 1902; W.A. Bryan, April and May 1903 and April 1911; D.T. Fullaway, December 1912; Fullaway and E.L. Caum, April 1923; G.P. Wilder, August 1930; G.D. Butler, April and July, 1959; C.W. Daniel, July 1959; C.H. Lamoureux, September 1961; J.W. Beardsley, June 1962; R.T. Tsuda, December 1963; C.R. Long and A. Young, September 1964; P.C. Shelton, June 1966; and possibly others for which data are not available.

Several highly useful papers have been published on the flora and vegetation of Laysan. Schauinsland (1899) dealt at length with conditions on the island in 1896 and reported the first collection of specimens on which additional notes were published by Bitter (1900). Christophersen and Caum (1931) reported conditions in 1923 when the island had been largely denuded of vegetation by rabbits. Their annotated list included valuable material on most specimens collected up to that time.

The most recent thorough summary of the vascular flora was by Lamoureux (1963) whose account, as well as that of Christophersen and Caum, should be consulted for historical accounts of the vegetation not included here or in the history section of this account. Lamoureux also gave a brief annotated list of the vascular plants recorded from Laysan through 1961; discussed vegetative associations; and presented a vegetation map which, in general, if not in detail, well represents the present distribution of the primary associations.

Lamoureux's account has been supplemented recently by Tsuda (1965) who gave brief observations on the vascular flora as observed in December 1963.

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*Two previous collections reportedly were made. "25 varieties of plants" were collected in 1859 by Brooks (1859: 501) and "twenty-one species of flowering plants" were collected by Lyons (1890: 91) in 1890. The locations of these collections, doubtfully still in existence, are unknown.

His paper primarily summarized current knowledge of the algal flora of Laysan and should be consulted by those interested in that aspect of the island's botany.

Other recent work includes that by St. John (1970) who designated three new species of Sicyos from Laysan. One of these, Sicyos semitonsus, and Pritchardia sp. (regarded by some as probably a distinct species), are the only vascular plants endemic to Laysan. Two varieties, the still extant Cyperus pennatiformis var bryanii, and the extirpated Santalum cuneatum var laysanicum were regarded by Lamoureux (1963: 8) as endemic. Fosberg (1962: 34), however, does not consider the latter distinct from plants found on Oahu.

Although relatively little new information has been added recently, we nevertheless think it worthwhile to update knowledge of the island flora and to present a brief annotated list of native and introduced vascular plants.

At present 42 species of vascular plants are known from Laysan, four more than reported by Lamoureux (1963: 1).* The difference consists solely of plants introduced by man. Two (onion and potato) probably would not have successfully colonized the island in any case. The grass, Cenchrus echinatus, is a tenacious weed and although believed to have been extirpated in September 1969, may well be found by future observers. The fourth, Conyza bonariensis, a weedy composite, seems well established despite efforts at eradication and will probably become much more numerous on Laysan in ensuing years.

Twenty-four species were present on Laysan in 1961 (Lamoureux, 1963: 2),** whereas 27 were present in 1969. The additional species resulted from the unintentional introduction of Conyza bonariensis, by the intentional introduction of Chenopodium oahuense (formerly an abundant species on Laysan) and by the reappearance of Solanum nigrum.

Present data are insufficient to justify any major emendation of Lamoureux's vegetation map (Lamoureux, 1963: Fig. 1) but examination of recent (1966) aerial photographs (Fig. 4) and personal ground observations suggest two changes. The large, predominately bare, sandy area on the southwest portion of the island is not indicated on his map. Secondly, Scaevola is somewhat better developed at present, particularly on the east side of the island, than his map suggests.

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*Only 36 species are included in Lamoureux's annotated list. Both Cyperus laevigatus L. and Sicyos microcarpus Mann were evidently omitted through oversight. Specimens of the latter were recently attributed to distinct species by St. John (1970).

**Lamoureux's annotated list reports only 22 species for reasons listed in the preceding footnote.

Annotated List

The following list of species closely follows the able summary of Lamoureux (1964), particularly for species no longer present on Laysan. For completeness we have included all species recorded as present on Laysan whether or not the species ever became established. Considerable attention has been given to details of plant introduction, whether deliberate or accidental, since the future composition of the terrestrial flora may well be dependent on these events.* Species formerly established on Laysan but no longer growing there are indicated by asterisks. Known introductions not known to have become established are enclosed in brackets. Names of species currently present on Laysan are unadorned.

GRAMINEAE

*Cenchrus agrimonioides var. laysanensis F. Br.

Specimens were collected in 1896, 1902, 1903, and 1911 but the species had disappeared from Laysan by 1923 (Christophersen and Caum, 1931: 10).

In December 1963, seeds collected on Kure Atoll in September 1961 were planted north of the north coconut grove and near the northwest edge of the lagoon (Tsuda, 1965: 26-27). These seeds evidently did not germinate as none was found by visitors during the next few years.

*(?)Cenchrus echinatus L.

This species was probably introduced by military personnel in the 1960's. A single plant found near the campsite on the northwest side of the island was destroyed in March 1969 by BSFW personnel. Two more plants flowering in the same general area in September 1969 were also destroyed.

Cynodon dactylon (L.) Pers.

Bermuda grass, first collected on Laysan in 1903 (Lamoureux, 1963: 2), was introduced from Honolulu by employees of the guano company and was scattered over the island by 1905 (Wilder, 1905: 392). It was not found in 1911 or 1923 but in 1930 Wilder collected a specimen from a patch growing at the edge of the lagoon. Specimens were subsequently collected in 1959, 1961, 1963 and 1964. At present, Cynodon occurs around the lagoon with dense stands along the northern perimeter (Fig. 25) and with poorest development on the west side.

[Melinus minutiflora Beauv.]

Molasses grass was planted in 1930 (Wilder, ms. b) but was not found by subsequent observers.

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*Species other than those included in the list below were certainly introduced. Existing records of the 1924 and 1930 plantings by Wilder are known to be incomplete.

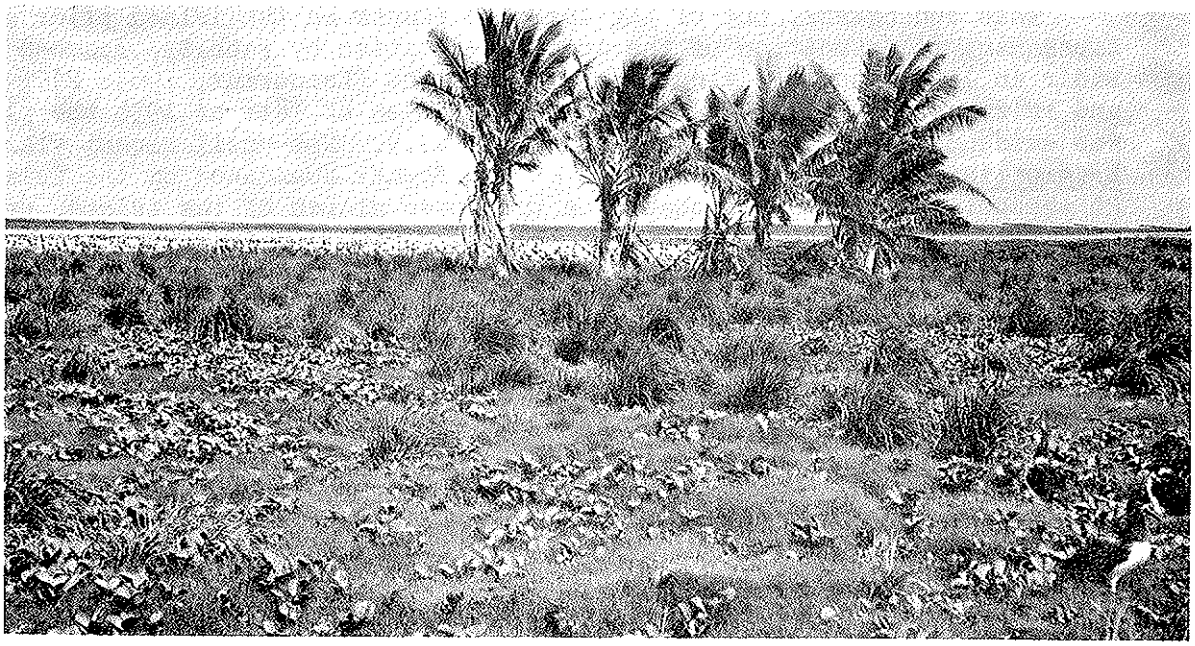


Figure 25. Looking southeast toward the lagoon, dense stand of Cynodon dactylon much infiltrated by Ipomoea pes-caprae in foreground; Eragrostis variabilis and Cocos nucifera beyond. POBSP photograph by P.C. Shelton, 21 June 1966.

Figure 26. Sesuvium portulacastrum (left), Cyperus laevigatus (center) and Heliotropium curassavicum (center and right) along west shore of lagoon. POBSP photograph by P.C. Shelton, 21 June 1966.

Eragrostis variabilis (Gaud.) Steud.

This bunchgrass, one of the dominant plants on the island prior and subsequent to denudation of the island vegetation by rabbits, reached its nadir in 1923 when no living plants were found (Lamoureux, 1963: 2). Seeds and rhizomes were planted at that time but even as late as 1936 the plant was evidently not very abundant (Coultas, ms.). Not until recent years has Eragrostis regained a good measure of its former abundance on the island. At present it forms dense stands on the inner slopes of the island, particularly on the western side (Fig.24).

Eragrostis was collected in 1896, 1902, 1903, 1911, 1930, 1959, 1961, 1963 and 1964.

*Lepturus repens (Forst.) R. Br.

This small bunchgrass was formerly common growing near the beaches, particularly on the north side of the island (Schauinsland, 1899: 99). It was collected in 1896 and 1903 but not found subsequently.

In 1923 plants from Pearl and Hermes Reef were introduced by the Tanager Expedition (Christophersen and Caum, 1931: 14) but albatross pulled up much of the grass (Wetmore, ms.).

*Sporobolus virginicus (L.) Kunth.

This grass was found growing near the ocean shore in 1896 (Schauinsland, 1899: 99). Specimens were reported collected in 1896 and 1903 (Christophersen and Caum, 1931: 22). (The 1903 specimen listed by Christophersen and Caum was apparently misdetermined and is actually Cynodon dactylon).

CYPERACEAE

Cyperus laevigatus L.

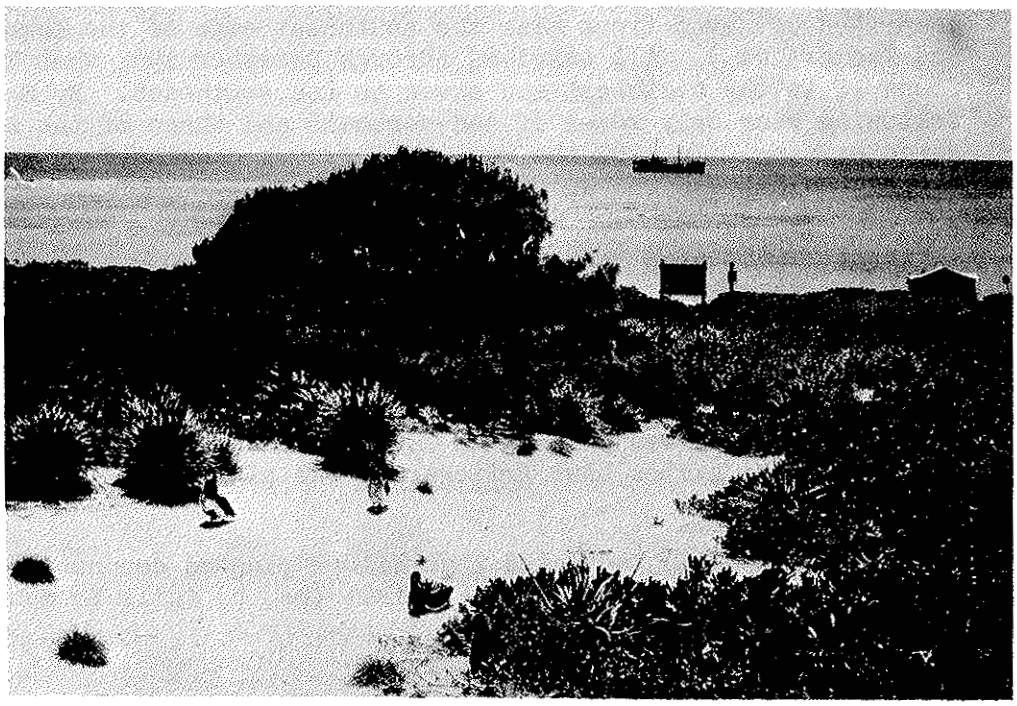
This rush-like plant now grows in dense stands (Figs. 26,35) around the perimeter of the lagoon as it did in 1896. Specimens were collected in 1896, 1903 and 1911 but no Cyperus was found in 1923. This species was next collected by Wilder in 1930 and more recently in 1959, 1961, 1962, 1963, and 1964.

Cyperus pennatiformis var. bryanii Kükenthal

This sedge, collected in 1896, 1902, 1903, and 1911 was absent in 1923 but was thereafter collected in 1959, 1962, 1963 and 1964. Schauinsland (1899: 98) found this species confined to the vicinity of the lagoon but widespread in this area. In 1903 Bryan considered it not at all common and saw only a few bunches near the southwest corner of the lagoon. It presently has much the same distribution as in 1903, being largely confined to an area near the southern end of the lagoon (Tsuda, 1965: 24, Fig. 7; Fig. 27). Tsuda's specimen data indicate that he found this species growing only in a

Figure 27. Stand of Cyperus pennatiformis near south end of lagoon. POBSP photograph by P.C. Shelton, 14 June 1966.

Figure 28. Casuarina tree inland from campsite on northwest shore of island. POBSP photograph by P.C. Shelton, 21 June 1966.



small area about 50 meters southwest of the coconut grove present near the southeastern perimeter of the lagoon.

Fimbristylis cymosa R. Br.

Fimbristylis, first collected in 1930, may occur on Laysan as the result of plantings made in 1923 (Lamoureux, 1963: 3) or thereafter. This sedge is presently widely distributed over the drier portions of the island, being abundant at times on the slopes of the western interior (Fig. 9). Recent collections were made in 1959, 1961, 1962, 1963, and 1964.

PALMAE

Cocos nucifera L.

Coconuts were planted on Laysan on several occasions but relatively few survived for very long. In 1902 four palms that had been imported from Honolulu were seen by Thomas (ms.). By 1905 the number had been reduced to two, thought by Wilder (1905: 392) to be about 12 years old. At this time another tree was planted and 20 sprouted nuts were left with the island manager for planting.

Attempts to establish coconuts continued. In 1912 the Bureau of Biological Survey planted 100 sprouted nuts, surrounding them with woven wire guards (Salisbury, ms.). Evidently none long survived for only two trees were found by the Tanager Expedition (Christophersen and Caum, 1931: 13; Figs. 19, 21). The latter are most likely the same trees mentioned by Wilder in 1905, and subsequently seen by Bailey (1956: 24) in 1912 and by Coultas (ms.) in December 1936.*

Most recently young trees were planted in 1959 (Lamoureux, 1963: 3). By March 1961 two small groves were well established. One, comprised of "some 13" trees, was near the northwest corner of the lagoon; the other was comprised of seven trees near the southeast edge of the lagoon (Woodside and Kramer, ms.). All survived through December 1963 when Tsuda (1965: 23) found 12 to the northwest and seven to the southeast. By September of the following year only seven of the northern and three of the southern trees were thriving. In 1969 the remaining groves consisted of nine northern and two southern trees (BSFW, cf. Figs. 25, 35, 36).

[Phoenix dactylifera L.]

Date palms were planted in 1930 by Wilder (ms. b) but did not survive.

[Pritchardia pacifica Wendl]

This species was planted in 1923 but was not found subsequently. Gregory (1931: 16) states that Pritchardia was planted during Wilder's 1930 visit

*Gregory (1931: 16) indicated that Wilder planted coconuts during his 1930 visit but Wilder's report of his visit (ms. b) fails to mention this species.

but this species does not occur in the list appearing in Wilder's (ms. b) report of his trip.

*Pritchardia sp.

A small fan palm was seen on Laysan by Isenbeck in 1828, Paty in 1857, Brooke and Brooks in 1859, Lyons in 1890 and by Munro in 1891 (Lyons, 1899: 90; Lamoureux, 1963: 3). At least five trees up to 15 feet tall were present in 1859 but Schauinsland (1899: 99-100) found only numerous dead stumps and roots, some in the northern part of the island and others not far from the lagoon on the southeast part.

Christophersen and Caum (1931: plate VI) include a photograph of two still living trees. This photograph, listed as having been taken between 1891 and 1896 by an unknown photographer, may have been one of the series of photographs of Laysan that was taken by J.J. Williams in 1892 and/or 1893.

This palm has been thought to be the same as that occurring on Nihoa (Pritchardia remota) or alternatively, to be a distinct species (Lamoureux, 1963: 3).

LILIACEAE

*Allium sp.

Onions were planted in 1859 (Brooks, 1859: 501) but did not survive. A few plants, evidently growing from garbage left by the HIRAN operation, were found growing on Laysan in June 1962. These were all uprooted (Kramer and Beardsley, ms.).

CASUARINACEAE

Casuarina equisetifolia L.

Ironwoods were introduced to Laysan on at least three occasions. In September 1905 Wilder (1905: 392) planted a box of ironwood trees, one of which may have survived to be recorded in 1923 by the Tanager Expedition (Christophersen and Caum, 1931: 13; Fig. 21) and by recent visitors. In 1923 two pounds of ironwood seeds were sown (Wetmore, ms.) and in 1930 Wilder planted an unstated number of trees (Wilder, ms. b; Gregory, 1931: 16). Some of the latter evidently survived for some years since Coultas (ms.) found five trees in December 1936. One was near the old buildings and the other four were near the north side of the lagoon.

At present, the single remaining tree (Fig. 28) often suffers some damage from wind and salt spray of winter storms but is usually luxuriant and supports the largest Black Noddy colony on the island. Specimen material from this tree was collected in 1961, 1963, and 1964.

SANTALACEAE

*Santalum ellipticum var. littorale (Hillebr.) Skottsberg

The Laysan sandalwood, listed by others as Santalum freycinetianum Gaud. and as S. cuneatum var. laysanicum Rock, was first collected in 1896 when it was found along the shoreline. At that time it was most abundant on the northwest side and was the largest plant on the island growing to as much as 2.5 meters tall (Schauinsland, 1899: 98). It was subsequently collected in 1902, 1903, and 1912 but by 1923 the only remaining plants were found in a small patch along the southwestern side of the island (Christophersen and Caum, 1931: 10, pl. VII). Some of the leafless stumps were trying to sprout but evidently did not long survive as none was found by subsequent observers.

POLYGONACEAE

[Coccoloba uvifera L.]

Gregory (1931: 16) stated that this species was planted by Wilder in 1930.

CHENOPODIACEAE

[Atriplex muelleri Benth.]

Seeds of the Arizona salt bush were sown by Wilder (ms. b) in 1930 but no plants were found subsequently.

Chenopodium oahuense (Meyen) Aellen

In 1896 this shrub was second in abundance only to Eragrostis (Schauinsland, 1899: 98). Specimens were collected then and in 1902 and 1903. In 1903 Chenopodium was still a common plant but between then and 1911 disappeared from the island. (Coultas, ms., noted seeing a few small bushes in December 1936 but there are no specimens to verify this report.)

In recent years a number of efforts were made to reestablish the aweoeo on Laysan. In June 1962 HDFG personnel planted seeds from Nihoa on the northwestern interior slope, a little more than halfway from the usual campsite to the lagoon shore. In December 1963 Tsuda found no evidence that any of these seeds had germinated. During Tsuda's visit other Chenopodium seeds, obtained on Nihoa in December 1961, were planted at two locations in the northwestern portion of the island (Tsuda, 1965: 26-27, see Cenchrus agrimonioides above). Subsequent observations by the POBSP and others suggest that this planting also failed.

Other seeds, from French Frigate Shoals, were subsequently introduced by BSFW personnel. A number were planted near the northwest shore of the lagoon in March 1966 and seeds were broadcast around the campsite on the northwestern rim of the island in September 1966. A single plant was found growing in the latter area in September 1967. In March 1969 a single plant observed in this area was producing seed and two thriving plants were found there the following September (BSFW).

AMARANTHACEAE

*Achyranthes splendens var. reflexa Hillebr.

In 1896 Schauinsland (1899: 97) found a small patch approximately 100 paces in diameter on the northwest side of the island near the beach. Specimens were subsequently collected by Bryan in April 1903 (Christophersen and Caum, 1931: 26) but the plant was not found by subsequent collectors.

In December 1963, seeds, collected on Kure Atoll in September 1961, were sown north from the northernmost coconut tree and on the northwestern side of the island near the lagoon edge (Tsuda, 1965: 26-27), but the introduction was unsuccessful.

*Amaranthus viridis L.

Schauinsland found individuals of this species along stagnant pools in the southern guano fields and scattered among the Chenopodium at the north end of the island near the lagoon (Bitter, 1900: 432). Specimens were collected subsequently in 1902 and 1903, the latter being found along the tramway and in the guano beds (Christophersen and Caum, 1931: 26).

NYCTAGINACEAE

Boerhavia diffusa L.

Except for 1923, when only dead plants were seen, this plant has apparently always been a major constituent of the flora. It is now, as in 1896, widely distributed over the island (Fig.9). Specimens were collected in 1896, 1902, 1903, 1930, 1959, 1961, 1963 and 1964.

AIZOACEAE

Sesuvium portulacastrum L.

This is a common species forming luxuriant mats in low areas bordering the lagoon (Figs.26,29; cf. Bailey, 1956: 46; Christophersen and Caum, 1931: pl. VI). First collected by Schauinsland in 1896, it was the only native species at all abundant in 1923 (Lamoureux, 1963: 40; Fig.20). After 1896 specimens were collected in 1902, 1903, 1911, 1923, 1959, 1961, 1963 and 1964. Sesuvium covered large areas just above the high water mark of the lagoon in 1930 but none was collected (Wilder, ms. b).

PORTULACACEAE

Portulaca lutea Sol.

This species is present in most collections from Laysan through 1964.*

*Lamoureux (1963: 4) indicates that this species was not collected by Wilder in 1930 but Wilder's (ms. b) report states that it was collected. Perhaps the specimen or specimens were later lost.

In 1896 it was mostly found in scattered localities in drier parts of the island (Schauinsland, 1899: 94). By 1923 only a small patch within a Sesuvium patch east of the lagoon remained (Christophersen and Caum, 1931: 11; Fig. 18). At present it is once more widely distributed over the island.

Portulaca oleracea L.

This species, first collected in 1959, is apparently a recent introduction (Lamoureux, 1963: 9).* Specimens were subsequently collected in 1961 and 1963 (Lamoureux, op. cit.; Tsuda, 1965: 25). The latter was noted as occurring on the southwestern side of the island near the beach.

CRUCIFERAE

*Lepidium bidentatum var. o-waihiense (C. & S.) Fosb.

This species was collected only by Schauinsland (1899: 94), who found a single stunted shrub 30 cm. high on the east side of the island near the beach. Seeds from Kure Atoll were sown in two localities (see Cenchrus agrimonioides above) in December 1963 (Tsuda, 1965: 26-27) but the introduction failed.

CAPPARIDACEAE

Capparis sandwichiana DC

The puapilo was evidently first seen by Brooks in 1859 and was present on the island through at least 1903 (Lamoureux, 1963: 5). It was not found again until collected in 1930 by Wilder and was collected subsequently in 1959, 1961, and 1964.

In 1896 it occurred abundantly primarily on the west side of the island (Schauinsland, 1899: 94). In 1903 it occurred in patches all over the higher parts of the island; Wilder found it on higher elevations of the sand dunes. All recent collections were from the west side of the island usually within or close to the bordering fringe of Scaevola south of the Casuarina tree.

LEGUMINOSAE

[Caesalpina crista L.]

Single seeds were found washed up on the beach in 1923 (Christophersen and Caum, 1931: 13) and in 1963 (Tsuda, 1965: 26).

[Canavalia ensiformis (L.) DC]

This species was planted by Wilder in 1930 but did not survive.

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* Lamoureux (1963: 4) points out that specimens formerly attributed to this species by Schauinsland, Bitter, and Christophersen and Caum are in fact examples of Portulaca lutea.

Figure 29. Cyperus, Sesuvium portulacastrum, and Tribulus cistoides along southeastern side of lagoon. POBSP photograph by P.J. Gould, October 1966.

[Dioclea altissima (Velloso) Rock]
[Dioclea violacea Mart.]
[Entada scandens (Roxburg) Benth.]

Seeds of all three species have been found on Laysan. In 1923 two seeds of D. altissima were found on the north beach and a single seed of E. scandens was found on the south side of the island, halfway between the lagoon and the shore (Christophersen and Caum, 1931: 13). In 1963 a seed of D. violacea was found on the beach by Tsuda (1965: 26).

[Haematoxylon campechianum L.]
[Leucaena leucocephala (Lam. de Wit)]

Both species were planted by the Tanager Expedition in 1923 (Lamoureux, 1963: 6; Wetmore, ms.) but neither survived.

[Mucuna gigantea (Willd.) DC]
[Mucuna urens (L.) DC]
[Mucuna sp.]

Seeds of the above plants have washed up on Laysan with some frequency. M. gigantea was found in 1923, 1930, and 1963 and urens was found during the latter visit (Christophersen and Caum, 1931: 26; Wilder, ms. b; Tsuda, 1965: 26). A sprouting seed of Mucuna sp. was found in 1962 (Kramer and Beardsley, ms.) and Shelton collected a seed from the shore of the lagoon in 1966.

ZYGOPHYLLACEAE

Tribulus cistoides L.

First collected in 1896, this species has appeared in most subsequent collections. In 1896 this plant was found throughout the island, particularly in drier areas but by 1923 only tiny seedlings and numerous seeds could be found (Christophersen and Caum, 1931: 11). In 1930 it grew in many places on the island and at present can once again be found commonly throughout the island (Tsuda, 1965: 26, Fig. 8 ; Fig. 29). Collections were made in 1896, 1902, 1903, 1911, 1923, 1930, 1959, 1961, 1963 and 1964.

EUPHORBIACEAE

[Aleurites moluccana (L.) Willd.]

Candlenut seeds were found on Laysan on at least three occasions. In 1902 Snyder found several seeds in the interior of the island (Fisher, 1903: 788) and more were found along the beaches in 1923 (Christophersen and Caum, 1931: 13). In 1966 Shelton collected a single seed from the shores of the lagoon.

MALVACEAE

*Hibiscus tiliaceus L.

Hau was introduced early in the 1900's, possibly in 1905. At that

time Wilder (1905: 392) planted branches. In 1923 three trees were growing near the buildings left by the guano workers (Christophersen and Caum, 1931: 13). During that visit ten plants, a packet of seeds, and 40 seed branches were planted (Wetmore, ms.) but none was found on the island during later visits.

[Thespesia populnea Sol.]

Several pounds of milo seeds were sown by the Tanager Expedition in 1923 and several trees were planted in 1930 by Wilder, but the species never became established.

CONVOLVULACEAE

Ipomoea indica (Burm.) Merr.

In 1896 Schauinsland (1899: 96) found this species dispersed over the island except in the vicinity of the lagoon. It was evidently considerably less common than the following species. Snyder and Bryan collected specimens in 1902 and 1903 but the species was apparently not seen thereafter until 1959 when collected by Daniel. Subsequently it was collected in 1961, 1963 and 1964.

At present this morning glory is apparently largely confined to low areas near the lagoon. Despite an extensive search of other areas in 1963, Tsuda (1965: 24) could find but one small patch--on the southwest side of the island, halfway between the lagoon and the beach.

Ipomoea pes-caprae (L.) Sw.

Beach morning glory, first noted by Munro in 1891 (Lamoureux, 1963: 5), was in 1896 found everywhere in higher places along the beach (Schauinsland, 1899: 96). By 1903 the species was evidently much less common and was apparently absent by 1911 (Christophersen and Caum, 1931: 11). In 1923 only two seeds were found. At that time a half-pound of seeds was sown (Wetmore, ms.).

By 1930 beach morning glory was well reestablished, particularly in sandy, more elevated areas, and extended on the southeast almost to the edge of the ocean (Wilder, ms. b). In 1959 the first collections since 1903 were made and specimens were since collected in 1961, 1963 and 1964. It is now once again widespread, occurring on almost all areas of the island (Fig. 30 ; Lamoureux, 1963: Fig. 4).

[Convolvulus sp.]

Wilder (ms. b) planted Convolvulus in 1930 but the introduction failed.

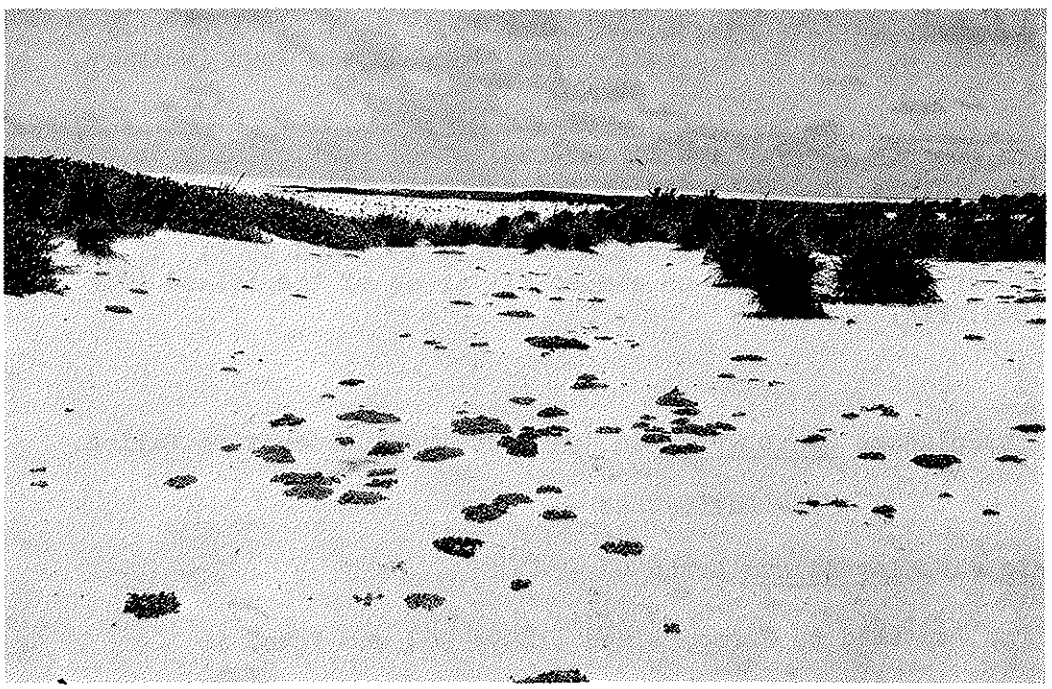
HYDROPHYLLACEAE

Nama sandwichensis var. laysanicum Brand

Nama was first reported by Schauinsland (1899: 96) who found it

Figure 30. Black-footed Albatross chick in dense growth of Ipomoea pes-caprae. POBSP photograph by A.B. Amerson, Jr., 10 March 1964.

Figure 31. Nama sandwicensis near north end of island. North Cocos grove in mid-background. POBSP photograph by P.C. Shelton, 21 June 1966.



distributed around the island on the higher parts of the beach. Like many other species it decreased in abundance under the onslaught of the rabbits and was not found in 1923. It now approaches its former abundance and is found most abundantly on the wide sandy beaches of the northern end of the island (Fig. 31).

Specimens were collected in 1896, 1903, 1911, and from 1959 through 1964.

BORAGINACEAE

[Cordia subcordata Lam.]

Trees planted by Wilder (ms. b) in 1930 did not survive.

Heliotropium curassavicum L.

In 1896 seaside heliotrope was confined to the water-free part of the lagoon. It was abundant there through at least 1903 (Christophersen and Caum, 1931: 11) but was not found again until collected by Wilder in 1930 (Lamoureux, 1963: 5). It appears in all recent collections through 1964 and now occurs both on the outer beach and in the inner band of vegetation surrounding the central lagoon (Figs. 26,32).

Tournefortia argentea (L.f.)

This species was first found on Laysan in September 1961 when a small tree was found growing at the top of the northwest beach between the Nama and Scaevola associations (Lamoureux, 1963: 12). In June 1962 the plant appeared in excellent condition but in December 1963 appeared all but dead, likely from the effect of salt spray. On closer examination a few new shoots were seen (Tsuda, 1965: 25, Fig. 4). On subsequent visits (March and September 1964) the tree was thought to be dead but it still survived in December 1967 (BSFW). Specimen material from this plant was collected in 1961, 1963 and 1964.

Two additional small trees were found alive in recent years. Kridler (BSFW) noted in December 1967 that two trees south of the northwest landing were thriving and in bloom. At least one of these trees, and probably both, had been present more than a year earlier (Fig. 33).

LABIATAE

*Phyllostegia variabilis Bitter

Specimens found by Schauinsland in 1896 were later described as this species by Bitter (1900: 437). In 1896 it was scattered near the beach of the west and east sides (Schauinsland, 1899: 97). It was still present in small patches in 1903, mostly on the windward side (Christophersen and Caum, 1931: 11). It disappeared from Laysan before 1911.

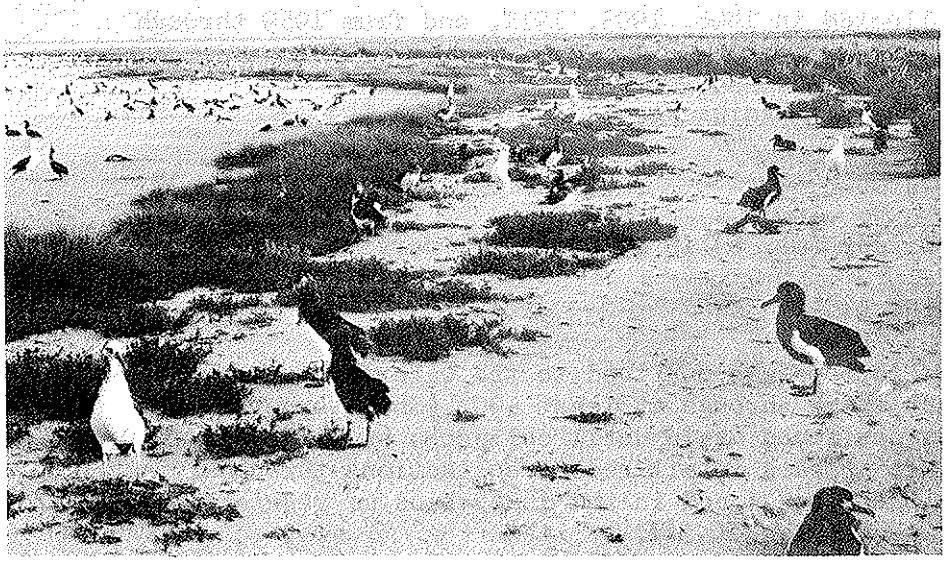


Figure 32. Cyperus laevigatus and Heliotropium curassavicum near northwestern corner of lagoon. POBSP photograph by P.C. Shelton, 21 June 1966.

Figure 33. Small Tournefortia at top of west beach south of northwest campsite. POBSP photograph by P.C. Shelton, 15 June 1966.

SOLANACEAE

[Nicotiana glauca Grah.]

Tree tobacco was introduced by Wilder in 1930 but did not long survive.

Nicotiana tabacum L.

Introduced early in the 1900's, tobacco was first collected by W.A. Bryan in 1911. In 1923 a rather large patch was found near the southern end of the lagoon and spreading through the southern and southwestern portions of the island (Christophersen and Caum, 1931: 13; Fig. 22). Specimens were collected subsequently in at least 1930, 1959, 1963 and 1964. At present scattered plants can be found in many locations in the interior of the island (Fig. 34) and apparently most abundantly on the west side.

*Solanum nelsoni Dunal

In 1896 Schauinsland (1899: 96) found this species on small sand dunes in a few places near the north beach. The only further record of this plant, once described as Solanum laysanense (Bitter, 1900: 433-435), was a few patches observed in the same area in 1903 (Christophersen and Caum, 1931: 12).

Seeds collected on Nihoa were planted in the northwestern interior of the island in June 1962, and others, collected on Kure in September 1961, were planted in this area and north of the northern coconut trees in December 1963 (Kramer and Beardsley, ms.; Tsuda, 1965: 26-27). Subsequent observers found no evidence that any of these survived.

Solanum nigrum L.

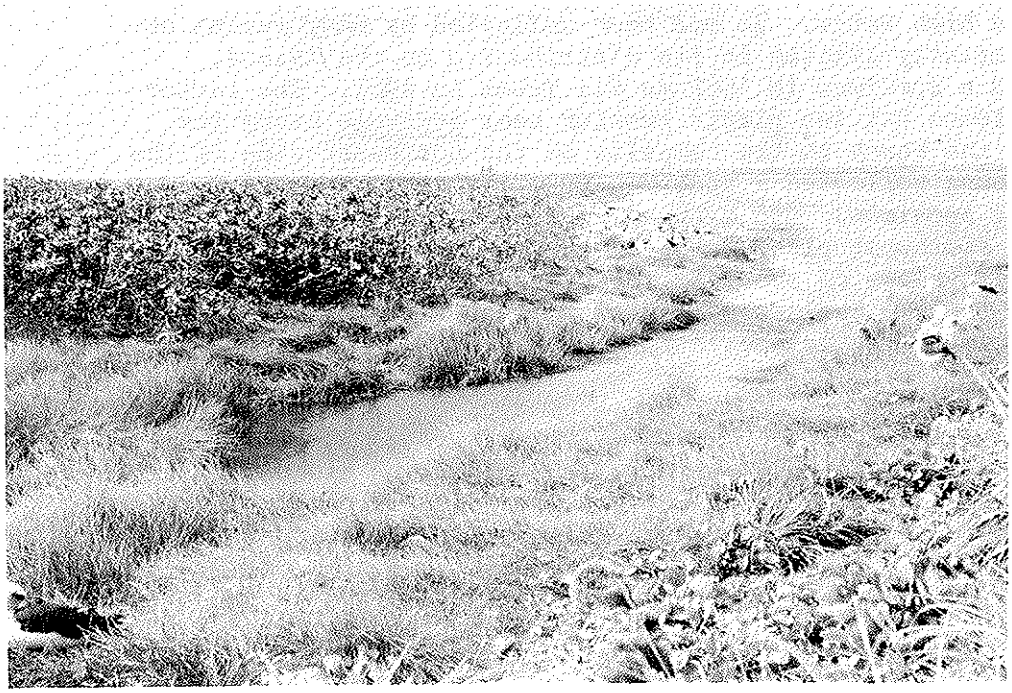
The black nightshade was first collected on Laysan (as Solanum nodiflorum Jacq.) by Wilder in 1930 who found it growing along the eastern end of the lagoon above high water. It has been collected by many recent observers but is apparently limited in its distribution on the island. Beardsley collected a specimen in 1962 as did Tsuda in 1963. The latter (Tsuda, 1965: 26) found but two plants growing near Scaevola along the trail leading from the beach to the campsite on the northwest side of the island. In 1964 Young collected a specimen from the same area and Long collected two other specimens, one growing in association with Eragrostis and Ipomoea on the southwest side of the lagoon and another growing in an open area on the west slope of the interior in association with the above and Fimbristylis. In 1966 Shelton collected a plant from among Scaevola along the western rim of the island.

*Solanum tuberosum L.

Potatoes were planted in 1859 (Brooks, 1859: 501) but did not survive. Several found growing in 1962 were uprooted. These were probably introduced during 1961-62 by military personnel (Kramer and Beardsley, ms.).

Figure 34. Nicotiana tabacum (left foreground) and Conyza bonariensis (right foreground) at top of west seaward slope. POBSP photograph by P.C. Shelton, 14 June 1966.

Figure 35. Scaevola taccada, Cyperus laevigatus, and Ipomoea pes-caprae along small slough near southeast corner of lagoon. South Cocos grove in mid-background. POBSP photograph by R.B. Clapp, 18 March 1968.



CUCURBITACEAE

[Cucurbita pepo L.]

Pumpkins were planted in 1859 (Brooks, 1859: 501) but did not survive.

Sicyos atollensis St. John

St. John (1970) recently examined specimens of Sicyos from the northwestern Hawaiian Islands and described six new species which include all Sicyos occurring on these islands. S. atollensis, first collected by Schauinsland in 1896, was subsequently collected in 1911, 1930 and 1962. The 1896 and 1903 specimens are evidently those formerly attributed to Sicyos hispidus Hillebrand by Christophersen and Caum (1931: 37).

Sicyos laysanensis St. John

This species was first collected by W.A. Bryan in April 1903 and subsequently listed as Sicyos sp. by Christophersen and Caum. Subsequent collections were made in 1911, 1959, 1962, 1963 and 1964* (St. John, 1970: 442). It has been collected at many localities near the lagoon and may be the most abundant species of Sicyos on Laysan judging from the greater frequency with which it has been found in recent collections.

[Sicyos nihoaensis St. John]

Seeds of this species, at the time believed to be Sicyos microcarpus Mann, were brought from Nihoa to Laysan in June 1962 and were planted inland from the campsite on the northwestern perimeter of the island (Kramer and Beardsley, ms.). Subsequent observers found no evidence that these seeds ever germinated.

Sicyos semitonsus St. John

This species was described from specimens collected from a flat area at the northwest end of the lagoon by Long on 19 September 1964. Details of the distribution on Laysan of this and other species of Sicyos must await a detailed examination of a considerably larger series of specimens than has been available previously.

Sicyos sp.

Several specimens from at least September 1964 and June 1966 have not been critically re-evaluated since the publication of St. John's paper in 1970.

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*St. John (1970) lists a specimen (C.R. Long #2,370) as both the holotype of Sicyos semitonsus (p. 448) and as an example of Sicyos laysanensis (p. 442).

GOODENIACEAE

Scaevola taccada (Gaertn.) Roxb.

Scaevola* was in 1896 limited to the zone along the beach, abundant along the west beach, more stunted along the east side (Schauinsland, 1896: 95-96). By 1923 the growth had been reduced to three "exceedingly poor" patches, one southeast of the lagoon halfway between shore and lagoon, one on the north side of the island, and another in the northeastern corner of the island (Christophersen and Caum, 1931: 12). During this visit and in 1930 Wilder planted seeds and plants, respectively (Wetmore, ms.; Wilder, ms. b; Gregory, 1931: 16).

At present this species has largely recovered its former abundance and in fact may be more widespread than in 1896. It is now found in abundance in a well developed band around the outer perimeter of the island just inland from the beach (cf. darker vegetation in Figs. 2-4). Scattered plants are found inland on the west side of the island to within about 50 yards of the lagoon. It occurs in greater abundance in the eastern interior, occasionally forming well developed stands near the lagoon edge (Fig. 35).

The recovery of this species no doubt played an important role in the recovery of the seabird populations since it is the principal nest site for populations of Great Frigatebirds, Red-footed Boobies, and Black Noddies and provides as well the necessary cover for nesting Red-tailed Tropicbirds.

COMPOSITAE

Conyza bonariensis (L.) Cronq

The hairy horseweed was probably introduced by the HIRAN operation of the early 1960's. It was first found growing just south of the campsite on the northwest side of the island. All plants seen at that time were uprooted (Tsuda, 1965: 23). Specimens were subsequently collected from the same area in 1964 and 1966.

Despite continued effort in recent years, BSFW personnel have been unable to eradicate the plant and it continues to survive and spread (Fig. 34). In September 1969 numerous dry plants retaining much seed were seen (BSFW).

*Lipochaeta integrifolia (Nutt.) Gray

In 1896 it occurred in a band just oceanward from the association of Sesuvium, Heliotropium and Cyperus bordering the central lagoon (Schauinsland,

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*We have records indicating that specimens were collected in 1896, 1902, 1911, 1923, 1930, 1959, 1963 and 1964. Lamoureux (1963: 6) states that the species "is represented in all collections from Laysan" which implies that it was also collected in 1903 and 1961. Christophersen and Caum (1931: 38), however, fail to list any specimens from 1903.

1899). Specimens were collected by Schauinsland and by Bryan (in 1903) who found it growing in the fine guano around the edge of the lagoon. It was not reported by later observers and presumably is one of the species that vanished under the onslaught of rabbits.

Seeds from Kure were sown in two localities (see Cenchrus agrimonioides, above) in December 1963 (Tsuda, 1965: 27), but no plants were reported by later visitors.

Pluchea indica (L.) Less.

Pluchea is a recent introduction, first collected by Butler in April 1959 and subsequently in 1959, 1961, 1963 and 1964. It occurs in many areas around the lagoon, being largely absent from the western border and reaching its maximum development at the northwest (Fig. 36)and northeast corners of the lagoon.

GUTTIFERAE

[Calophyllum inophyllum (L.) Sol]

LECYTHIDACEAE

[Barringtonia asiatica (L.) Kurz]

COMBRETACEAE

[Terminalia catappa L.]

[Terminalia myriocarpa Huerck & Muell.-Arg.]

[Conocarpus erecta L.]

The five species listed above were all unsuccessful introductions to Laysan. All five were planted in 1930 and Calophyllum and Barringtonia were planted in 1923 as well (Wetmore, ms.; Wilder, ms. b).

Figure 36. Stand of Pluchea indica north of lagoon. North Cocos grove in background. POBSP photograph by P.C. Shelton, 21 June 1966.

LAYSAN ISLAND FAUNA

Introduction

Laysan has long been the most familiar biologically of the Northwestern Hawaiian Islands and was one of the first to be exploited. Its relatively easy access, large area, fresh water supply, and natural resources permitted profitable occupancy for over a decade. Laysan also had the most remarkable biota of any island in the chain with a very high degree of endemicity including four (of 27) plants, five birds, and a number of insects. The combination of tolerable living conditions at the guano headquarters and the remarkable biota early attracted several biologists and their reports soon made Laysan synonymous with teeming colonies of fearless seabirds--a veritable paradise for biologists. Unfortunately island occupancy also resulted in a continuing conflict between the native biota and man and his introductions. In less than 35 years this conflict resulted in the destruction of two endemic plants (and nine other native species), three endemic birds, and a number of the endemic insects. Other populations, notably those of seals and turtles, were gravely depleted and only the timely arrival of the Tanager Expedition prevented complete destruction of the vegetation and the entire endemic biota.

Reports published prior to and including Schauinsland's suggest that the island flora was little affected by man through 1896. One species, the endemic palm, Pritchardia sp., had become extinct and only one introduced species, Amaranthus viridis, was yet present. Schauinsland's description of the fauna also agrees with those of Palmer and Munro and again suggests minimal disturbance by man. He listed 5 endemic land birds, 17 breeding seabirds, and 18 transients and accidentals. Three of the endemics later became extinct. Subsequently many additional transients and accidentals were recorded. However, the number of species of breeding seabirds has not changed although great population changes have occurred in the last seventy-five years.

Seabird colonies flourished throughout the 19th century. Although the island was occupied during the last part of this period, most birds were not adversely affected by the guano operation. In fact this occupancy may have protected the island from the ravages of feather harvesters. Some populations were, however, being affected before termination of the main guano operation in 1904 and feather hunters did great damage in 1909, 1910, and 1915. The designation of Laysan as a bird reservation in 1909 and subsequent patrolling and inspection by U.S. Revenue Cutters probably prevented even greater destruction. Ironically the most lasting damage to the Laysan biota resulted not from feather raids but rather from the introduction of rabbits by a well-meaning island manager. Rabbits were introduced about 1903 and were already causing significant damage to the vegetation by 1911. Efforts to eliminate all rabbits in 1912 and 1913 failed and not until 1923 was a second attempt made. By this time Laysan was a near desert, three endemic birds were near

extinction and two had vanished forever (a third became extinct within a month). Elimination of rabbits and artificial planting started the island on the way to recovery and by 1936 conditions were superficially near normal.

Breeding bird populations fluctuated with changes in island conditions and environment. For example, the Laysan Albatross numbered in the many hundreds of thousands, perhaps a million or more, in 1891. By 1911 the population was reduced to under 200,000 breeding birds with continued drastic decreases to under 50,000 in 1915 and under 30,000 in 1923. Even though the number of non-breeding birds is unknown, the magnitude of the population decline is nevertheless readily apparent. By 1950 and the return of favorable habitat the population had increased to over 100,000 birds and by the 1960's had reached at least a half million birds. Another dramatic example is the Laysan Teal which survived a population low of one in 1930 but which was recently believed to number at least 600 birds.

Birds

Fifty-nine species have been recorded from Laysan but over half of these are accidental or irregular visitors. The original 22 breeding species (Tables FI-1 and FI-2) represented six orders: Procellariiformes (7), Pelecaniformes (5), Anseriformes (1), Gruiformes (1), Charadriiformes (5), Passeriformes (3). The remaining transient and accidental species (Tables FI-3 and FI-4) are predominantly shorebirds, gulls, and ducks.

The 17 breeding seabirds occur also on most of the other Northwestern Hawaiian Islands but Laysan has the largest total seabird population of the group and many species have their largest populations there. Among the exceptions are the Bonin Petrel, most abundant on nearby Lisianski, and the Great Frigatebird, most abundant on Nihoa Island.

All breeding species exhibit a definite annual cycle which, however, for some species may vary a month or more from year to year. Five species, Black-footed Albatross, Laysan Albatross, Bonin Petrel, Sooty Storm Petrel, and Black Noddy, have their peak breeding season in winter and spring while the other species are spring and summer breeders. Some, notably the White Tern and Blue-faced Booby, have far more extended seasons than others with a few birds breeding at all seasons of the year but with the main population breeding at a peak period as shown in Table FI-1.

The partial temporal replacement of species utilizing similar nesting areas has been discussed by numerous writers including Schauinsland (1899) and Richardson (1957). Thus the Bonin Petrel and the two albatrosses are well into their breeding cycles before the arrival of the Wedge-tailed Shearwater. Competition for the same space is reduced as a result of nest loss and reduced space requirements of the former as the nesting cycles progress. The marked specific requirements for nesting sites have also been discussed at length, notably by Fisher (1903a).

Table FI-1. Present status of breeding seabirds on Laysan.

Species	Status and Numbers	Primary Breeding Period
Black-footed Albatross	Abundant (40,000 - 80,000)	Mid-November through mid-July
Laysan Albatross	Abundant (500,000 - 600,000)	Mid-November through early July
Bonin Petrel	Abundant (200,000)	Mid-January to late June
Bulwer's Petrel	Common (10,000 - 20,000)	Late May through August
Wedge-tailed Shearwater	Abundant (200,000 - 400,000)	June through November
Christmas Shearwater	Common (6,000 - 10,000)	Mid-April through late September
Sooty Storm Petrel	Common (2,000 - 3,000)	Late December to June
Red-tailed Tropicbird	Common (4,000)	Late April through early October
Blue-faced Booby	Common (1,000 - 2,000)	Late March through September
Brown Booby	Uncommon (100 - 200)	Late March through October
Red-footed Booby	Common (2,000 - 3,000)	February through September
Great Frigatebird	Common (5,000 - 8,000)	March through October
Sooty Tern	Abundant (2,000,000)	Early April to early September
Gray-backed Tern	Common (12,000 - 40,000)	March through early August
Brown Noddy	Common (20,000 - 40,000)	March through September
Black Noddy	Common (5,000)	November through July
White Tern	Common (1,500)	May through August

Table FI-2. Status of endemic Laysan birds.

Species	Previous Status*	Present Status
Laysan Teal	Uncommon to common (6 - 12)	Uncommon (500-700)
Laysan Rail	Abundant (2,000)	Extinct, ca. 1923**
Laysan Millerbird	Common to abundant (under 300)	Extinct, prior 1923
Laysan Honey-eater	Uncommon to common (300)	Extinct, April 1923
Laysan Finch	Abundant (2,700)	Abundant (10,000)

*First statement gives relative abundance during the late 19th century; numerical estimate in parentheses is from 1911 just before major habitat destruction occurred.

**Birds transplanted to Midway survived until 1944.

Table FI-3. Status of regular shorebird species on Laysan.*

Species	Status	Months Recorded											
		J	F	M	A	M	J	J	A	S	O	N	D
Golden Plover	Abundant	X	———	———	X	X	X	X	X	———	X	?	X
Ruddy Turnstone	Abundant	X	———	———	———	X	X	X	———	———	X	?	X
Bristle-thighed Curlew	Common	X	X	———	———	X	X	X	X	———	X	?	X
Wandering Tattler	Common	X	———	———	X	X	X	X	———	———	X	?	X
Sanderling	Uncommon	X	X	———	X	X			X	———	X	?	X

*Solid lines indicate period of greatest abundance.
?No specific records, probably because of no recent visits.

Table FI-4. Months of occurrence of accidental and vagrant species on Laysan.

Species	Total Records	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sooty Shearwater	1				X								
Pelagic Cormorant	1										X		
Emperor Goose	1			X									
Mallard	3	X	X	X								X	
Pintail	11			X	X		X			X	X		X
Common Teal	2			X							X		
[Garganey Teal]*	1												
American Widgeon	2			X							X		
Shoveler	7	X		X							X	X	X
Bufflehead	2	X											X
Harlequin Duck	1				X								
Semipalmated Plover	1									X			
Black-bellied Plover	1	X											X
[Whimbrel]	1									X			
Greater Yellowlegs	1										X		
Lesser Yellowlegs	3			X						X	X		
Sharp-tailed Sandpiper	3			X							X		
Pectoral Sandpiper	1									X			
Baird's Sandpiper	1									X			
Dunlin	3	X		X									
Unidentified Sandpipers	7		X	X				X		X	X		X
Dowitcher sp.	1									X			
Marbled Godwit	1										X		
Bar-tailed Godwit	4			X						X	X	X	
Red Phalarope	4	X	X								X		
Northern Phalarope	2			X									X
[Glaucous-winged Gull]	1												
Glaucous Gull	1	X											
Herring Gull	3	X	X		X								
Unidentified large gulls	3			X									X
Bonaparte's Gull	1												X
Black-legged Kittiwake	1	("winter")											
Blue-gray Noddy	2						X			X			
Horned Puffin	1		X										

*The occurrence of species listed in brackets has not been adequately confirmed.

Thus the Black Noddy, Great Frigatebird, and Red-footed Booby utilize the branches of woody vegetation while the Red-tailed Tropicbird and Christmas Shearwater nest under the deep cover and the Brown Noddy chooses the more open edges. Likewise the Sooty Tern and Laysan Albatross nest on the surface of the more open bunch grass association while

the Bonin Petrel and Wedge-tailed Shearwater burrow in the same area. Black-footed Albatrosses prefer to nest on sandy beaches whereas Laysans prefer open areas inland from the beach, especially the flat area near the lagoon. Numerous other examples are cited by Fisher.

The relatively large number of species of endemic land birds formerly present (five) was probably made possible by the large island area, the varied and stable vegetation, and perhaps also the presence of a fresh or mildly brackish pond. The three extinctions were clearly the result of devegetation and with the return of stable vegetation the surviving teal and finch have probably returned to their original numbers (Table FI-2).

By far the majority of the transient and accidental species recorded from Laysan are strong-winged shorebirds and ducks that breed in the arctic or subarctic and migrate southward for the winter months. Five of these shorebirds (Table FI-3) are of regular occurrence in considerable numbers and winter regularly throughout the central Pacific. Others, such as the Pintail and the Shoveler, occur regularly in the Northwestern Hawaiian Islands and probably visit Laysan during most years. Most of the transients, however, are stragglers into the central Pacific and occur sporadically in small numbers during the fall months. Since relatively few accidentals are seen during the spring months, most must either move farther south during the winter or succumb to the environment. Observation of living gulls on one trip up the leeward chain in 1963 and the finding of dead gulls on a subsequent trip suggest the latter. The presence of a large central lagoon and extensive mudflats undoubtedly makes Laysan an attractive spot for ducks and shorebirds. Surprisingly few oceanic birds and vagrant land birds have been reported, probably because of inadequate coverage of the island for an extended period of time. Continued occupancy of the island by an alert ornithologist would undoubtedly result in a marked increase in the number of accidentals recorded.

Mammals

The native mammalian fauna is limited to one species, the Hawaiian Monk Seal, Monachus schauinslandi, which uses the sandy beaches bordering Scaevola for hauling grounds. The monk seal was considered "numerous" by Paty in 1852 but was hunted almost to extinction during the last half of the 19th century. With protection the population has increased greatly and it is again a regular part of the Laysan fauna.

Numerous domestic animals were imported to Laysan during the period of human occupancy. Among these were hogs, mules, cows, horses, a donkey (?), guinea pigs, and rabbits. All except the rabbits were either removed when the island was deserted or else failed to survive. The rabbits multiplied tremendously and had nearly destroyed the island vegetation by 1923 when the last ones were believed killed.

Reptiles

Two species occur on Laysan--the Green Sea Turtle, Chelonia mydas, and the Snake-eyed Skink, Ablepharus boutoni--and another, the Fox Gecko (Hemidactylus garnoti), formerly occurred there. Both the lizards were probably introduced to the island by man but the turtle is native to Laysan. Turtles still use the island as hauling grounds but probably only a very few breed there. They were abundant on Laysan during the 19th century and were heavily utilized by visiting seamen and fishermen. Numbers were greatly reduced and there has been little increase in the population since.

Species Accounts

Birds

In the following species accounts (birds), the common and scientific names and the sequence of species are from standard references, primarily the AOU Checklist (1957)--and for the Procellariiformes and Laridae, King (1967).

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

Status: Intended to provide a very brief summary of the occurrence and activity of each species while on Laysan. 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--populations of less than 500 individuals. These limits were chosen because estimated breeding populations of all species fall easily within one of these categories. A different scale is used for transient shorebirds and endemic land birds 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.

B. Status: Two categories are used: 1) breeder--a species breeding on the island but most individuals absent during some part of the non-nesting season; varying numbers of non-breeding birds (local, from other islands, or both) may be present during the non-nesting season; 2) migrant--species visiting the island only during the non-reproductive season; may visit the island only briefly in transit elsewhere or remain for a substantial period, usually during the winter months.

C. Maximum recent estimate: These are maximum (conservative) estimates during the last decade. All extreme estimates have been re-evaluated and some have been omitted from the text. All such estimates are enclosed in brackets in the appropriate table of observations or wherever mentioned in the text. Whenever available, estimates made by the POBSP are used but some estimates were provided by the BSFW.

D. Period present: The inclusive period of usual presence on Laysan is indicated, together with duration of stragglers if appropriate. Period of absence is also provided.

E. Nesting period: The period of major breeding activity is given together with (when appropriate) the extent of minor breeding periods.

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

G. Nest: A summary statement gives the usual nest site and, if pertinent, the type of nest built.

Populations: All available data (published and unpublished) are summarized in a chronological table which is placed at the end of the species account. Where available, actual counts or population estimates are presented; when unavailable, more qualitative data are cited. Where sufficient data exist, the variation in population estimates is discussed, particularly where historical changes can be documented or strongly indicated by available data. Factors affecting these changes (e.g. feather raids and habitat destruction) are discussed.

Annual Cycle: A generalized annual cycle based chiefly on observational data is presented for each species. Where actual observations are lacking (as in November with no recent trips), interpolated data based on incubation period and fledgling period are included. Variations in the nesting cycle are discussed as are such topics as breeding peaks, and, when available, actual dates of egg-laying, hatching and fledging.

Ecology:

A. Breeding: Both historical and current data are presented and whenever possible the two are compared. Details concerning preferred nesting areas and nest sites are included. Where possible, known changes in breeding ecology are presented and analyzed together with environmental changes.

B. Non-breeding: Utilization of the island by any non-breeding birds is discussed whenever data are available.

Specimens: Nearly all known Laysan museum skins were examined but a detailed listing or analysis is impractical because of the large numbers involved. A tabular summary indicates the current distribution of study skins in a number of major museums. The locations of a few additional specimens (including skeletons, alcoholics, and nests and eggs) are noted briefly in the text. The tabulation of study skins (divided into three categories--adult males; adult females; other, including unsexed, chicks, etc.) is intended to indicate the most profitable sources of specimens for future work. A more detailed listing of Laysan specimens, providing additional data, is on file at the U.S. National Museum and can be obtained upon request.

Banding and Movements: A brief summary of all POBSP banding is presented in tabular form (often broken down into age and sex classes) by date of banding. When available, banding data from HDFG and BSFW personnel are included, especially if POBSP bands were used. Interisland movements are presented in summary form and are also listed in Appendix Tables. These include both birds banded on Laysan and recaptured elsewhere and birds banded elsewhere and recaptured on Laysan. In a few cases birds are known to have made several movements, often involving several different islands. No detailed analysis of interisland movement is attempted.

BLACK-FOOTED ALBATROSS — *Diomedea nigripes*

Status

Abundant breeder; maximum recent estimate of breeding population about 67,000. Present from early November through early August; absent remainder of year. Most nesting is from mid-November through mid-July. Nests in open areas, especially the outer beaches.

Populations

No population estimates are available for the entire period preceding the feather raid of 1909 to 1910 but numbers (Table BFA-3) apparently never approached those of the Laysan Albatross. Dill and Bryan estimated 85,000 breeding birds in 1911 and commented that this species suffered less than did the Laysan Albatross. Two years later Bailey estimated a population of 15,444 breeding birds (based on nest count) and following the 1915 raid Munter estimated 20,000 birds. Both Bailey's and Wetmore's estimates of the breeding populations (the latter, 18,800) are considerably less than those during the last two decades.

The largest recent estimates (Table BFA-3) are those of Rice and Kenyon whose work suggests a breeding population on the order of 65,000 birds. Of the more accurate recent estimates, only one (near 40,000 birds in December 1963) was made at a comparable time of year. All the other recent estimates were made in March or later in the year and probably reflect less than maximum populations due to nest mortality prior to censusing. Allowing for annual variation in the size of the breeding population (which evidently may be considerable), the more accurate recent estimates of the number of young (March, 1964, 1969; May, 1958; June, 1966, 1967) rather consistently suggest maximal breeding populations on the order of 25,000 to 30,000, occasionally perhaps as large as 40,000. Thus we feel that the breeding population is somewhat smaller than that indicated by Kenyon and Rice. We rather suspect that the 1957 estimates were somewhat excessive or the result of a particularly large nesting population that season.

Annual Cycle

Adults arrive in early November and egg laying begins shortly after the birds return to the island. Bailey (1956: 37) found eggs common in late December 1912. He found the first nestling on 21 January 1913, indicating that the first egg was laid about 16 November. This agrees well with Schlemmer's 1915 observations (Table BFA-3). Willett's observations indicate eggs may be laid through mid-January.

Young begin fledging in June and all are gone by September. From 5 to 12 August 1965 only 25 emaciated young remained, indicating that the majority of the birds had left the island by the end of July.

Peak numbers of adults occur on the island during the winter, and they decrease rapidly after the chicks hatch. By late spring only a few adults are on the island at any one time (more at night), and by early summer they visit the island only infrequently to feed the young. No birds have been found on the island in September or early October.

Ecology

Breeding: Nesting is typically on open sand beaches and to a lesser extent in large openings among Scaevola and Eragrostis. In 1891 Palmer (Rothschild, 1893-1900: 55) found the main concentration of birds on the south beach. Fisher (1903a: 790) found them on the sandy beaches on the north, east, and south sides, with only a few on the west side and in the interior. Other early observers (Dill and Bryan, 1912: 17; Bailey, 1956: 37; Wetmore, ms.) found the same pattern of distribution. However, Munter (1915: 139) in April 1915 found the young that had survived a raid by the feather poachers principally on the southwestern, southern, and southeastern beaches.

The distribution of birds in recent years has been similar to that of the early part of the 20th century, with the major concentration along the northern beach.

Non-breeding: Non-breeding birds roost on the beaches among the nesters. Before they fledge, young birds gather in small groups along the outer edges of the beach, where they fan their wings and practice flying, especially during strong winds.

Specimens

Fifty-seven Black-footed Albatross skins from Laysan are currently distributed in museums as indicated in Table BFA-1. Twenty-five additional mounted specimens are distributed as follows: AMNH (2 adult males and 1 adult female in Laysan exhibit); BPBM (2 adult males, 2 adult females, 1 immature); CMNH (2 adult males and 2 adult females in Laysan exhibit); SUI (12 in Laysan exhibit); MCZ (1 immature). At least 6 skeletons (BPBM, 1; UCLA, 1; USNM, 4) and 26 eggs (BPBM, 14; MCZ, 12) are also preserved.

Table BFA-1. Locations of Black-footed Albatross skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	4	3	2	9
BPBM	0	0	7	7
CMNH	1	1	0	2
DMNH	0	2	5	7
MCZ	1	0	0	1
UMMZ	0	2	2	4
USNM (non-POBSP)	13	4	6	23
(POBSP)	0	0	0	0
Other*	3	1	0	4
Totals	22	13	22	57

*Dickey Coll. (2 ♂♂); Law Coll. (1 ♂); U. Minnesota (1 ♀).

Banding and Movements

Various agencies have banded 2,385 Black-footed Albatrosses on Laysan (Table BFA-2). Bands from two Black-footed Albatrosses banded as locals on Whale-Skate, French Frigate Shoals, were subsequently recovered on Laysan. Three birds banded on Laysan were later recovered at sea (Appendix Tables 4-3a and 4-3b).

Table BFA-2. Black-footed Albatross banded on Laysan.

Period of Survey	Bander	Adults	Young	Age Unknown	Total
1957 June-July	HDFG	0	200		200
1958 June	BSFW	-	-	900*	900
1965 July	POBSP	0	685	0	685
1967 June	POBSP	0	600	0	600
Totals		0	1,485	900*	2,385

*These birds were probably all or mostly young.

Table BFA-3. Observations of Black-footed Albatross on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1828	24 Mar.	common	Young (Isenbeck, in Rothschild, 1893-1900: iii).
1891	16-27 June	fairly numerous	Young (Rothschild, 1893-1900: 55).
1896	24 June-24 Sept.	?	Breeding (Schauinsland, 1899: 101).
1902	16-23 May	?	Less abundant than Laysan Albatross; young (Fisher, 1903a: 790).
	20 Nov.	?	14 eggs collected by Schlemmer (MCZ).
1903	18-24 Apr.	?	At least 9 skins and 1 skeleton collected by W.A. Bryan (AMNH, BPBM).
1905	20-21 Mar.	?	2, including 1 juvenile, collected (MCZ).
1906	18-20 Nov.	?	12 fresh eggs collected (MCZ).
1911	24 Apr.-5 June	85,000*	Estimate based on nest density* and colony area computations (Dill and Bryan, 1912: 17).
1912-1913	12 Dec.-11 Mar.	28,000 (15,444)*	Count in Feb.: 7,506 occupied and 216 abandoned nests. First eggs hatched 21 January. First estimate includes 5,000 young and 7,500 unemployed birds (Bailey, 1952a: 39, 55). All eggs laid by 15 January (Willett, ms.).
1915	3 Apr.	20,000	Young (Munter, 1915: 139).
	14 July	no more than 100 seen	(Schlemmer and Schlemmer, ms.).
	26 Oct.	1	First bird arrives (Schlemmer and Schlemmer, ms.).
	28 Oct.	4	(Schlemmer and Schlemmer, ms.).
	2 Nov.	71	Count (Schlemmer and Schlemmer, ms.).

Table BFA-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1915	6 Nov.	500	Estimate (Schlemmer and Schlemmer, ms.).
	8 Nov.	?	Arriving in large numbers (Schlemmer and Schlemmer, ms.).
	13 Nov.	?	1st egg found (Schlemmer and Schlemmer, ms.).
	24-25 Nov.	?	350 eggs pickled (Schlemmer and Schlemmer, ms.).
1916	9 Feb.	?	Nesting; more numerous near shores of island (Munter, ms.).
1918	8-10 Sept.	0	(Diggs, ms.).
1923	8-13 Apr.	?	Young (Wetmore, ms.).
	29 Apr.-14 May	18,800+	4,700 young, based on count (Wetmore, ms.).
1930	2-18 Aug.	0	(Wilder, ms.b).
1936	7-18 Mar.	countless thousands	Young; 2 banded with brass rings (Trempe, ms.).
	12 Dec.	?	"Some on North and East beaches" (Coultas, ms.).
1950	23 June	numerous	Fully-feathered young (POFI).
1951	12 May	?	Young (POFI).
	late June-early July	36,480*#	Estimate (from transect censuses) of ca. 18,240; most, if not all, young (Brock, 1951b: 18).
1955	10 Feb.	?	Ca. half as numerous as Laysan Albatross. More with young than eggs (POFI).
1957	7 Jan.	64,000*	Estimate of 32,128 nests from aerial photos (Rice and Kenyon, 1962: 375).
	25 June-3 July	?	Estimate of ca. 9,000 young, based on transect census (Woodside, ms. b).

Table BFA-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1957	8-12 July	few	(Labrecque, 1957: 17).
	28 Dec.	67,000*	Estimate of 33,523 nests from aerial photos (Rice and Kenyon, 1962: 375).
1958	27 May-4 June	?	"Few adults present at any one time;" estimate of 8,700 young, 1/2 to 2/3 grown (Warner, ms.).
1959	28 Apr.-1 May	?	Nesting; young, most on NW part of island (Kramer, ms.).
1961	7-8 Mar.	?	Young (Woodside and Kramer, ms.).
	4-10 Sept.	0	None present (Woodside, ms.c).
1962	14-19 June	?	Downy and flying young (Kramer and Beardsley, ms.).
1963	11-13 Feb.	abundant	Young (POBSP).
	3-10 Dec.	38,666	Evidently a count; eggs (Walker, ms.b).
1964	10-11 Mar.	37,000-42,000	Ca. 10,700 young on outer beach; less than 1,000 elsewhere (BSFW, POBSP).
	16-20 Sept.	0	(BSFW, POBSP).
1965	6-11 Mar.	30,000*-45,000*	Ca. 10,000 to 15,000 young, 1/4 to 1/3 grown (POBSP).
	17-21 July	?	Ca. 4,500 large young (POBSP).
	5-12 Aug.	?	Ca. 25 emaciated young. No adults seen (POBSP).
1966	26-31 Mar.	?	Estimate of 10,000 young, 3/4 to nearly full grown (BSFW).
	10-16, 20-21 June	1,500	Estimate of 10,000 young, based on partial count of 7,652 young 3/4 to nearly full grown (POBSP).
	17-18 Sept.	0	(BSFW).
	20-23 Oct.	0	(POBSP).

Table BFA-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 18-19 Mar.	?	Estimate of 10,000-20,000 young (BSFW, POBSP).
7-12 June	?	Estimate of 10,000 young based on partial count of 8,732 young; some losing down (POBSP).
5-11 Sept.	0	(POBSP).
13 Dec.	thousands	Nesting (BSFW).
1968 17-19 Mar.	10,000-20,000*	An estimated 5,000-10,000 young present; many unemployed birds (BSFW, POBSP).
1969 26-29 Mar.	?	Estimate of 14,694 young based on 159 transect censuses (BSFW).
9 Sept.	0	(BSFW).

*Estimate is of the number of breeding birds.

+Estimate is of breeding population prior to estimated mortality observed by Wetmore. Rice and Kenyon (1962: 375) give the post-mortality figure.

#The figure given by Rice and Kenyon for this visit (1962: 375) is evidently the result of a misreading of Brock's paper.

LAYSAN ALBATROSS — *Diomedea immutabilis*

Status

Abundant breeder; maximum recent estimate 500,000 to 600,000. Present from late October through August or early September; absent during remainder of year. Most nesting is from mid-November through early July. Nests over most of the island with the major concentration around the lagoon.

Populations

It is evident from the photographs (Rothschild, 1893-1900: plate 38) and general comments of the earliest visitors to Laysan that the Laysan

Albatross was abundant on Laysan in the 1890's and early 1900's. For example, in 1891 Palmer (Rothschild, 1893-1900: 57) reported that the species "literally covers the island...the young in some places being as thick as they could stand." During this period (no specific year given) Max Schlemmer, the island manager, estimated that two million birds were present. No subsequent estimates are this high.

Although some albatrosses were killed and parts of the colony disrupted by guano operations on Laysan, it is probable that the presence of guano workers prevented the massive kills that occurred on other islands during this period. The spectacular decline in population occurred later and was probably the result of feather raids in 1909 to 1910 and 1915.

Dill's estimate of 180,000 birds in late April 1911, one year after the first raid, was based on a nest count during mid-season but nevertheless represented a major and sudden decline from the great numbers present at the turn of the century.

Numbers were still very low during the 1912-1913 season and in February Willett and Bailey estimated only about 24,600 breeding birds with considerable nest loss. Following the 1915 feather raid, Munter reported the Laysan Albatross to be the "chief sufferer" among the 150,000 to 200,000 dead birds found on the island. He estimated that only 40-50,000 live birds (with very few young) remained on the island.

When visited in 1923, Laysan was a near desert. Wetmore (ms.) calculated an adult breeding population of 13,600 based on a chick count and a 50 percent nest loss. Unless a large number of unsuccessful breeders had departed the island prior to his arrival, this represents the lowest level ever reported for Laysan. By 1936 the island and apparently the albatross population were recovering nicely and today the population is considerably larger than in 1911.

It is difficult to determine accurately the population size today for we lack estimates of the number of nests at the peak of the nesting season, the amount of yearly nest loss, and the number of non-nesting birds present. The data suggest, however, maximal breeding populations on the order of 300,000 to possibly as many as 500,000 birds (Table LA-3).

Since some available estimates include all birds, including non-nesters using the island, and others include only the number of birds present at one time, it is of little value to compare these figures (e.g., 5 to 12 August 1965 and 7 to 12 June 1967). The only comparable figures are nest counts and these show considerable yearly variation. In March 1965, 15,000 nestlings were banded and an estimated 20,000 to 25,000 were present, while in June 1966 an estimated 150,000 were present (91,403 actually counted). This most likely represents a difference in nest loss rather than a change in the population and demonstrates the difficulty in determining long range population trends with the available data.

Annual Cycle

According to Fisher (1903a: 789), who probably received his information from Schlemmer, Laysan Albatross begin to arrive about 25 to 26 October and remain until the following August. Only one recent record, from September 1961, falls outside these limits. Evidently most of the population is present by December.

Egg laying begins by at least 20 November (Bailey, 1956: 44) and probably continues no later than late December. The earliest hatching date is 23 January 1913 (Bailey, 1956: 44). Schlemmer (in Fisher, 1903a: 789) reported that the eggs hatched in February, suggesting a peak hatching period in this month, and a peak egg laying period in December.

Young birds begin to leave the island by late June and most have left by the end of July. However, a few weak young, which probably soon died, were found 4 to 10 September 1961.

Largest populations are present during the winter. After the chicks hatch, one adult spends most of its time at sea, and as the chicks mature both adults spend an increasing amount of time away from the island. By May and June relatively few adults are present during the day, though larger numbers may come in at night to feed the chicks. Visits become less and less frequent and few adults are present at any one time in July and August. By September only a few late-maturing or deserted chicks remain.

Ecology

Breeding: Laysan Albatross nest over the island in various habitats, but only a few use dense vegetation or open beaches.

Fisher (1903a: 786) found them distributed over the whole island, with the single exception of the beaches. "The flat plain surrounding the lagoon is their favorite habitat, and we found them here in the greatest numbers. This great colony extended all the way around the lagoon, but certain portions were more congested than others. The largest single colony of young is on the south side of the lagoon, where the ground has been leveled off in past years by the phosphate-rock diggers."

Dill and Bryan (1912: 15) found them only "along the shores of the lagoon and on a small area at the south end of the lagoon." Munter (1915: 139) found the few young that remained after the raid of feather poachers "in the central parts of the island around the lagoon."

Recent observers found the main concentration of nestlings around the lagoon but birds were also found on the east, north, and south beaches, several open areas on the southwest section, and along the beach perimeter.

"The nest is made by the female by merely scraping together the earth or mud wherever she is resting, and building it into an elevated

ring within which her single egg is deposited." (Schlemmer, in Nutting, 1903: 325-326). This embankment proves of great service when the lagoon floods. In December 1912, Bailey (1956: 44) observed the loss of several thousand nests by flooding, and thought that many more would have been lost, except for the dikes erected by the incubating birds. Flooding of nests around the lagoon apparently occurs during most winters.

Young birds, as they mature, congregate in open areas and along the beaches during the day, seeking shade during the warmest periods and often retiring to denser vegetation at night. As they mature, an increasing amount of time is spent exercising on the beaches and by early August the older and stronger birds have left the island. Perhaps up to 3 percent of those which survive to mid-summer starve to death on the island, apparently as the result of desertion or insufficient feeding by the adults.

Non-breeding: Data concerning the activities of unemployed birds on Laysan are lacking.

Specimens

One hundred six Laysan Albatross skins from Laysan are currently distributed in museums as indicated in Table LA-1. Thirty additional mounted specimens are distributed as follows: AMNH (3 females in Laysan exhibit); BPBM (2 adult males, 2 adult females, 1 chick); CMNH (2 adult males, 2 adult females in Laysan exhibit); MCZ (1 adult male, 1 adult female, 1 nestling); SUI (15 birds in Laysan exhibit). Also preserved are at least 8 skeletons (BPBM, 1; USNM, 6; Carnegie Mus., 1), a head (DMNH) and 22 eggs (BPBM, 10; MCZ, 12).

Table LA-1. Locations of Laysan Albatross skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	6	6	11	23
BPBM	0	0	10	10
CMNH	1	1	2	4
DMNH	3	4	0	7
SUI	3	9	7	19
UMMZ	2	2	3	7
USNM (non-POBSP)	12	15	5	32
(POBSP)+	0	0	0	0
Other*	3	0	1	4
Totals	30	37	39	106

+One hybrid.

*Brit. Mus. (Nat. Hist.) (1); Law Coll. (1 ♂); Leningrad (1 ♂); Acad. Nat. Sci. Phila. (1 ♂).

Hybrid (Laysan X Black-footed) Albatrosses have been reported from Laysan on several occasions and three specimens are preserved. Data for the three skins (all males) are as follows: BPBM, taken by Bompke, May 1905; CMNH 156076, taken by Willett 22 February 1913; USNM 494113, taken by the POBSP on 7 March 1965. Another believed to be a hybrid was seen in March 1968 by Karl W. Kenyon (pers. comm.).

Banding and Movements

Various agencies have banded 22,237 Laysan Albatross on Laysan Island (Table LA-2). Four Laysan Albatross banded elsewhere (Kure, 1; Lisianski, 1; Pearl and Hermes Reef, 2) have been recorded from Laysan; and 16 birds banded as nestlings or locals on Laysan have been recovered elsewhere (2 at Pearl and Hermes Reef; 1 at Midway; 2 at Kure; 1 at Japan and 10 at sea) (Appendix Tables 4-4a and 4-4b). A 17th bird originally banded on Kure was recaptured on Laysan and then later recaptured on Kure. At least 142 of the 15,000 chicks banded in March 1965 died before fledging, and their bands were recovered from the carcasses.

Table LA-2. Laysan Albatross banded on Laysan.

Period of Survey	Bander	Adults	Young	Age Unknown	Total
1957 June-July	HDFG	0	200	0	200
1958 June	BSFW	0	0	2,000*	2,000
1964 Mar.	BSFW	0	200	0	200
1965 Mar.	POBSP	0	15,000	0	15,000
July	POBSP	0	1,807	0	1,807
Aug.	POBSP	0	151	0	151
1966 June	POBSP	0	1,979	0	1,979
1967 June	POBSP	0	900	0	900
Totals		0	20,237	2,000	22,237

*These birds were probably all or mostly young.

Table LA-3. Observations of Laysan Albatross on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	(Isenbeck, in Rothschild, 1893-1900: iii).
1890 16 July	?	Young (Lyons, 1890: 90).
1890's	2,000,000	(Schlemmer, in Nutting, 1903: 322).

Table LA-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1891	16-27 June	?	Nearly fledged young (Munro, 1942a: 72).
1896	24 June-24 Sept.	?	(Schauinsland, 1899: 101).
1902	16-23 May	"thousands"	Young 2/3 grown (Fisher, 1903a: 786; 1940a: 9).
	Nov.	?	8 eggs collected by Schlemmer (BPBM).
1903	Apr.	?	11 skins and 1 skeleton collected by W.A. Bryan (BPBM).
1904	11 May	?	1 collected by Schlemmer (MCZ).
	15-16 Nov.	?	12 fresh eggs collected by Schlemmer (MCZ).
1905	18 Mar.-Apr.	?	3 collected, including a nestling, by Schlemmer (MCZ).
1906	May	?	1 collected by Schlemmer (AMNH).
1911	24 Apr.-5 June	180,000*	Ca. 90,000 young based on count of nests (Dill and Bryan, 1912: 16; Dill, 1916b: 173).
1912 1913	22 Dec.-11 Mar.	34,000 (25,000)*	Count in Feb. of 9,201 occupied and 3,120 abandoned nests. First estimate includes 4,600 non-nesting birds. First egg hatched 23 January (Bailey, 1952a: 55; 1956: 44).
1915	3 Apr.	40,000-50,000	Few young (Munter, 1915: 139).
	22 Aug.	?	1 seen (Schlemmer and Schlemmer, ms.).
	28 Oct.	?	First two arrived (Schlemmer and Schlemmer, ms.).
	29 Oct.	?	8 more seen (Schlemmer and Schlemmer, ms.).
	2 Nov.	10	Counted (Schlemmer and Schlemmer, ms.).

Table LA-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1915	8 Nov.	300	Estimate (Schlemmer and Schlemmer, ms.).
	12 Nov.	600	More arrived than total for past two weeks (Schlemmer and Schlemmer, ms.).
1916	9 Feb.	?	Nesting (Munter, ms.).
1918	8-10 Sept.	?	Few seen (Diggs, ms.).
1923	8-13 Apr.	?	Young (Wetmore, ms.).
	29 Apr.-14 May	13,600+	3,400 young (Wetmore, ms.).
1930	2-18 Aug.	?	A few unfledged young still present (Wilder, ms.b).
1936	7-8 Mar.	countless thousands	Ten banded with brass rings (Trempe, ms.).
	12 Dec.	"abundant"	(Coultas, ms.).
1950	23 June	abundant	Well-feathered young (POFI).
1951	12 May	?	Young (POFI).
	late June-early July	207,800#	Count of ca. 103,900 (most, if not all). young (Brock, 1951b: 18).
1955	10 Feb.	?	Ca. twice as numerous as Black-footed Albatross. Ca. 80% of nests contained young, ca. 10% eggs (POFI).
1957	7 Jan. and/or 28 Dec.**	263,000*	An estimate of 131,328 nests made from aerial photos (Rice and Kenyon, 1962: 375).
	25 June-3 July	?	Estimate of 45,000 young based on transect census; estimate of 215,000 young based on banding of chicks and density/area relationship (Woodside, ms.b).
	8-12 July	"most numerous...bird on the island."	Half-grown to almost mature young (Labrecque, 1957: 17).

Table LA-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1958	27 May-4 June	?	Ca. 67,000 1/2 grown young based on 12 transect censuses. A considerable number of unemployed birds still in area (Warner, ms.).
1959	28 Apr.-1 May	?	Estimate of ca. 69,000 young (based on 2 of same transect lines [Kramer, ms.] as used in 1958).
	20-27 July	?	"Downy, but full grown chicks" noted (Udvardy, 1963: 191).
1961	7-8 Mar.	?	Young (Woodside and Kramer, ms.).
	4-10 Sept.	?	10-20 young, most weak and emaciated, one adult seen 4 Sept. (Woodside, ms.c).
1962	14-19 June	?	Young. Many apparently almost ready to take flight (Kramer and Beardsley, ms.).
1963	11-13 Feb.	thousands	Mostly with small downy young; few eggs (POBSP).
	3-10 Dec.	497,948	Evidently a count; most birds on eggs (Walker, ms.b).
1964	10-11 Mar.	500,000-600,000	An estimated 150,000 young (BSFW, POBSP).
	16-20 Sept.	0	(BSFW, POBSP).
1965	6-11 Mar.	75,000-100,000	An estimate of 20,000 to 25,000 1/4 to 1/2 grown young based on 15,000 young banded (POBSP).
	17-21 July	?	An estimated 10,000 downy to almost fledged young (POBSP).
	5-12 Aug.	5	Less than 1,000 young (POBSP).
1966	26-31 Mar.	300,000	Estimate includes 150,000 non-nesting adults, ca. 75,000 young present (BSFW).
	10-16, 20-21 June	?	An estimated 150,000 young from 3/4 grown downy chicks to almost fully fledged birds (based on a partial count of 91,403 young and 4,246 adults). An estimated 5,000 to 6,000 adults on the island at any one time (POBSP).

Table LA-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1966 17-18 Sept.	0	(BSFW).
20-23 Oct.	0	(POBSP).
1967 18-19 Mar.	thousands	Ca. 30,000-60,000 young (BSFW, POBSP).
7-12 June	200,000	Ca. 25,000 young (based on count of ca. 16,500). Estimate includes all adults using the island (POBSP).
5-11 Sept.	0	(POBSP).
13 Dec.	?	Nesting (BSFW).
1968 17-19 Mar.	120,000-200,000*	Ca. 60,000-100,000 young present (BSFW, POBSP).
1969 26-29 Mar.	?	Estimate of ca. 77,300 young based on 159 transect censuses (BSFW).
9 Sept.	0	(BSFW).

*Estimate is of the breeding population.

**It is not clear which date or dates this estimate is for.

+Estimate of breeding population prior to estimated 50% loss of young. Rice and Kenyon (1962: 375) calculated 6,800 breeding pairs based on Wetmore's post-mortality estimate.

#The figure given by Rice and Kenyon for this visit (1962: 375) is evidently the result of a misreading of Brock's paper.

BONIN PETREL — Pterodroma hypoleuca

Status

Abundant breeder; maximum recent estimate: "several hundred thousand." Present from mid-August to late June or July; absent remainder of year. Most nesting is from mid-January to late June. Nests in burrows chiefly under the Eragrostis association between the lagoon and the beach crest.

Populations

This is one of the most difficult species to census accurately because of the large numbers involved and its burrowing and nocturnal habits. Dill and Bryan and Willett estimated populations of 160,000 and 100,000 in 1911 and 1912 to 1913 respectively (Table BP-2). They did not detail the basis for these estimates but Willett's discussion indicates that his was little more than a guess.

Willett (1919: 61) described considerable nest loss when burrows were filled with blowing sand in February 1913 but no quantitative data were given. It is likely, however, that the species sustained heavy losses throughout the period when too little vegetation was present to hold the sand during high winds. No nesting occurred during Wetmore's visit (April 1923) and only a few were seen.

The larger recent estimates, especially those for September 1966 and 1967, indicate that the population has regained its earlier size (Table BP-2).

Annual Cycle

Bonin Petrels appear to have an unusually synchronous and regular breeding cycle. Schauinsland (1899: 50) described in detail the arrival of the first birds on 17 August 1896. His statement that these birds arrived "over a period of several years from 15 to 18 August every year without fail," probably was based on information obtained from island residents. The single recent August visit found a few birds on the 5th, with a marked increase by the 12th.

Throughout the fall the birds apparently return to the island each night, dig burrows, and court. Although Kridler noted copulation in September (BSFW, 1966), eggs are not laid until January. Max Schlemmer told Fisher (1903a: 793) that "eggs are laid about the first of January, but the birds arrive in vast numbers months before." Willett (1919: 60) said "laying commenced the first week in January and was at its height about 20 January."

A marked change in behavior accompanies the beginning of incubation. Willett (1919: 60) noted that "the air at night fairly swarmed with the birds" from the time of his arrival, 22 December, until 7 January, after which the birds were still abundant but the numbers in the air decreased considerably. These high numbers immediately before egg laying may indicate that the birds do not leave the island for an intensive feeding period just before laying.

Hatching probably occurs as early as late February, with a peak from early March through perhaps early April. On most March visits observers reported eggs and/or small young; no eggs have been found later than March but the presence of unfledged young in July 1957 implies that they may be present through late April. Some young may fledge in early May but

most fledge from mid-May to mid-June. All are gone from the island by late June or early July. During June they spend considerable time outside their burrows at night. Personnel visiting Laysan in June 1966 and 1967 found noticeable mortality of young Bonin Petrels, but no quantitative data were obtained.

Few adults are present in June, and probably are usually absent in July. As long as adults are on the island, some may be seen courting and digging, but whether these are young non-breeding birds, birds that lost eggs or young earlier, or normal breeding adults is unknown.

Ecology

Breeding: Fisher's (1903a: 793) description of the nesting area of Bonin Petrels on Laysan is equally appropriate today: "The long burrows in which the birds nest honeycomb the sandy soil over all the region covered by coarse bushy grass (Eragrostis), or from the edge of the plain surrounding the central lagoon to the divide overlooking the sea." The only additional information from recent visits is that on the inner or lagoon side of the nesting area, birds nest in cover composed of both Ipomoea and Eragrostis. Greatest numbers occur on the west side of the lagoon where the Eragrostis belt is widest.

The breeding habitat of this species widely overlaps that of the Wedge-tailed Shearwater, the other major burrower on the island. Although the breeding cycles of the two species are staggered so that the shearwater eggs are not laid until petrel chicks are well grown, there are periods in spring and fall when adults of both species are digging and courting at the same time. Observations of relationships between these two species (e.g., competition for sites, use of each other's burrows) are few. Willett (1919: 61) thought that the shearwaters used petrel burrows later in the season, but he did not document his information.

Fisher (1903a: 793) wrote "the burrows are quite long, 6 feet at least, and usually turn either to the right or to the left after the first few feet." Willett (1919: 61) found them to be 6 to 10 inches in diameter at the mouth and 7 or 8 feet in length, with the nest cavity at the end fairly well lined with grass and leaves. He also found one bird nesting under an overturned basket. In March 1964 Walker found one on an egg under a pile of boxes. Nests examined in March 1968 were invariably well lined with grass and sedge.

Non-breeding: As far as is known, non-breeding birds in the population use the same habitat as the breeders.

Specimens

One hundred fifteen Bonin Petrel skins from Laysan are currently distributed in museums as indicated in Table BP-1. Six additional mounted specimens are distributed as follows: AMNH (1 adult in Laysan exhibit); BPBM (1 male); CMNH (1 adult); SUI (3 in Laysan exhibit). Also preserved are at least 2 skeletons (BPBM, USNM) and 4 skulls (USNM).

Table BP-1. Locations of Bonin Petrel skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	10	9	1	20
BPBM	9	3	6	18
CMNH	4	1	0	5
MCZ	5	2	1	8
SUI	0	0	1	1
UMMZ	4	4	0	8
USNM (non-POBSP)	16	17	3	36
(POBSP)	4	10	2	16
Other*	2	1	0	3
Totals	54	47	14	115

*Brit. Mus. (Nat. Hist.) (1 ♀); Law Coll. (1 ♂); Moseley (1 ♂).

Banding and Movements

The POBSP banded 3,895 Bonin Petrels on Laysan: 399 adults in February 1963; 500 adults in March 1964 and 352 adults in September 1964; 2,544 adults in March 1965 and 100 young in June 1966.

One adult, 723-60810, banded at Southeast Island, Pearl and Hermes, on 1 March 1963, was recaptured on Laysan on 19 September 1964. None banded on Laysan has been recovered elsewhere.

Table BP-2. Observations of Bonin Petrels on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1891 16-27 June	?	4 molting birds found in burrows. Freeth, the island manager, said the breeding season was over and that they occurred in large numbers during their breeding time (Rothschild, 1893-1900: 49). Nearly all, both old and young, had left the island (Munro, 1941c: 17).
1896 24 June-24 Sept.	?	First returned 17 August; 1,000's present by 19 August (Schauinsland, 1899: 50).

Table BP-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1902	16-23 May	great numbers	Most abundant procellariid on the island. Young partially molted into juvenal plumage (Fisher, 1903a: 793).
1903	Apr.	?	10 skins and 1 skeleton collected by Bryan (AMNH, BPBM).
1907	20-21 May	?	8 collected by Schlemmer (MCZ).
1911	24 Apr.- 5 June	160,000	Young nearly fledged (Dill and Bryan, 1912: 18).
1912 1913	22 Dec.- 11 Mar.	100,000	Laying began during first week of January and reached its peak about 20 January (Willett, 1919: 60); egg noted 9 January (Willett, ms.); 1 laid as late as 25 January (Bailey, 1956: 58).
1918	8-10 Sept.	250,000	Estimate considered conservative; 2nd most abundant species (Diggs, ms.).
1923	8-13 Apr.	?	Seen occasionally in evening (Wetmore, ms.).
1936	12 Dec.	?	3 seen; others in holes (Coultas, ms.).
1957	25 June- 3 July	?	Post-nesting; 1 young (Woodside, ms.b).
	8-12 July	?	(Labrecque, 1957: 18).
1958	27 May- 4 June	?	Young present but not in large numbers. All examined had some down, but flight feathers were in final stages of development (Warner, ms.).
1961	7-8 Mar.	very abundant	Digging burrows and mating; eggs noted (Woodside and Kramer, ms.).
	4-10 Sept.	?	Great numbers at night; none during day; much digging (Woodside, ms.c). Appeared every night in increasing numbers; not nesting; inspecting burrows, pairing, or, in a few cases, excavating burrows or cleaning old ones (Udvardy, 1963: 193).

Table BP-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1962 14-19 June	?	Only 1 pair seen; no eggs or young found (Kramer and Beardsley, ms.).
1963 11-13 Feb.	tens of thousands	Several eggs were moderately incubated (POBSP).
3-10 Dec.	?	1 burrow dug up contained 2 mature birds not breeding (Walker, ms.b).
1964 10-11 Mar.	5,000	Ca. 2,000 nests; 1 bird on egg (BSFW, POBSP).
16-20 Sept.	2,500	Many paired and excavating burrows (BSFW, POBSP).
1965 6-11 Mar.	30,000-50,000	Burrow digging; eggs, and small young (POBSP).
17-21 July	0	(POBSP).
5-12 Aug.	2,000	Only a few on 5 August, but many more by 12 August; burrow digging noted on 11 August (POBSP).
1966 26-31 Mar.	thousands	Many birds digging burrows (BSFW).
10-16, 20-21 June	500*	Estimated 3,000 young; most molted into juvenal plumage; ca. 30-40% still with tufts of down (POBSP).
17-18 Sept.	several hundred thousand	Many fresh burrows; copulating (BSFW).
20-23 Oct.	20,000	Courtship and burrow digging; no eggs or young found (POBSP).
1967 18-19 Mar.	10,000	Courtship and burrow digging; 1 heavily incubated egg found (BSFW, POBSP).
7-12 June	10,000	Young present; most near fledging (POBSP).
5-11 Sept.	75,000	Most birds digging burrows or sitting on surface; no eggs found in burrows examined; present only at night (POBSP).

Table BP-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 13 Dec.	?	Only 1 moribund adult seen during diurnal visit (BSFW).
1968 17-19 Mar.	10,000	Conservative estimate; 4 burrows contained small downy young (BSFW, POBSP).
1969 26-29 Mar.	thousands	Large downy young (BSFW).

*Estimate is of the number of adults present.

BULWER'S PETREL — Bulweria bulwerii

Status

Common breeder; maximum recent estimate: 20,000. Present from late March or April through September or perhaps early October; absent remainder of year. Most nesting is from late May through August. Nests most commonly in shallow burrows or in crevices beneath rocks on the south and southwest beaches and on the ground beneath Scaevola on the island rim.

Populations

The two earliest numerical estimates (1,000 in April-June 1911; 750 in May 1923, see Table BuP-3) are considerably smaller than the largest recent estimates (3,000 in June-July 1957; 10,000 and 20,000 in June 1966 and 1967), but the variability of recent estimates and the limited number of early estimates make it clear that we cannot definitely establish any change in population levels.

The extreme variation in recent estimates demonstrates the difficulty of obtaining good numerical estimates of this petrel. Some of this variability is probably due to differences in the birds' behavior during different periods of the breeding cycle. The three largest estimates were made early in the breeding season when courting and burrowing birds are most conspicuous; all smaller estimates were made later in the season when burrows are easily overlooked and when adults become much more secretive and difficult to observe.

Annual Cycle

Bulwer's Petrels begin to arrive at Laysan in late March or April. A few eggs may be laid in the last week of April (1903, 1923) but the

data suggest that most egg laying occurs during early June. A few eggs may be laid as late as the third week of June (1959, 1961, 1967). Young may hatch as early as early June but most hatch in mid-July. Fledging may begin as early as mid-August but the peak fledging period is probably from mid- to late September. Late fall observations are insufficient to determine exactly when the last birds depart but a few birds may fledge as late as early October.

Ecology

Breeding: Bulwer's Petrels have nested in at least four distinct hatitats on Laysan: (1) under rocks, especially on the south and southwest sides of the island, and in favorable areas throughout the island such as the rock piles south of the lagoon (1891, 1911, 1961, and most recent visits); (2) under Scaevola in small depressions on top of fallen leaves (September 1964, August 1965, June 1966 and 1967); (3) in burrows under Eragrostis, particularly when it is covered with Ipomoea, as in a belt on the west shore of the lagoon (August 1965, June 1966 and 1967); (4) under old and partly buried sheets of roofing iron (July 1957, May and June 1958).

Birds are most conspicuous among the rocks where they were reported both early in the century and in nearly all recent reports. In this situation they may scoop out depressions less than a foot deep or crawl into cavities more than four feet deep under large boulders.

POBSP notes and reports indicate that birds nesting under Scaevola may be as numerous as those nesting elsewhere. Eragrostis was used to a much lesser extent but birds were apparently common there during peak breeding periods. Nesting under vegetation was not noted previously but whether birds were overlooked or whether this is a recent development is not known. If the latter is true, this could account for apparent larger populations at the present time. Use of artificial sites (roofing, boards, etc.) is now less frequent, probably because most of these have been covered with sand or have rotted or rusted away.

Non-breeding: In June 1967 two groups of at least 1,000 birds each were sitting around on the southwest and south portions of the island at night. Such clubs have not been previously observed for this species. Like other petrels, they are rarely observed in the open during the daytime.

Specimens

Sixty-eight Bulwer's Petrel skins from Laysan are currently distributed in museums as indicated in Table BuP-1. Three additional mounted specimens are in the Laysan exhibit at SUI. Also preserved are at least 3 skeletons (BPBM, 1; USNM, 2); 2 alcoholics (USNM) and 1 egg (BPBM).

Banding and Movements

The POBSP and BSFW banded 478 Bulwer's Petrels on Laysan (Table BuP-2). No interisland movements were recorded.

Table BuP-1. Locations of Bulwer's Petrel skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	8	4	0	12
BPBM	2	1	0	3
CMNH	0	1	0	1
DMNH	3	3	0	6
MCZ	4	5	1	10
SUI	3	2	0	5
USNM (non-POBSP)	17	9	0	26
(POBSP)	2	1	0	3
Other*	1	1	0	2
Totals	40	27	1	68

*Basel Museum (1), Bonn (1).

Table BuP-2. Bulwer's Petrels banded on Laysan.

Period of Survey	Bander	Adults	Young	Age Unknown	Total
1958 June	BSFW	0	0	138	138
1964 Sept.	POBSP	2	15	0	17
1967 June	POBSP	200	0	0	200
Sept.	POBSP	14	68	41	123
Totals		216	83	179	478

Table BuP-3. Observations of Bulwer's Petrels on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1891 16-27 June	?	Breeding season appeared to be over; not many were seen ashore during day, while many came at night (Rothschild, 1893-1900: 51). Munro (1941b: 2), however, stated that he found them incubating eggs.
1896 24 June-24 Sept.	?	Not mentioned by Schauinsland (1899) who nonetheless collected 10 specimens (AMNH).
1902 16-23 May	0	(Fisher, 1903a: 794).

Table BuP-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1903 28 Apr.	?	3 specimens and 1 egg collected by W.A. Bryan (BPBM and AMNH).
1904 18-20 May	?	2 skins collected by M. Schlemmer (MCZ).
1907 18-20 May	?	10 skins collected by M. Schlemmer (MCZ).
1911 24 Apr.- 5 June	1,000	First fresh egg, 2 June; other nests with fresh eggs found subsequently (Dill and Bryan, 1912: 18).
1912 22 Dec.- 1913 11 Mar.	0	(Bailey, 1956).
1923 8-13 Apr.	0	(Wetmore, ms.).
17 Apr.	?	2 pairs found under buildings (Ball, ms.); 5 found in crevices in guano (Dickey, ms.).
26 Apr.	?	Egg laid (Ball, ms.).
29 Apr.- 14 May	750	Common and in pairs by 29 April, becoming more numerous thereafter (Wetmore, ms.).
1957 25 June- 3 July	3,000	Adults (Woodside, ms.b).
8-12 July	?	Quite a few in burrows (Labrecque, 1957: 17).
1958 27 May- 4 June	locally common	Egg-laying had just begun. All eggs checked were fresh or nearly fresh (Warner, ms.).
1959 20-27 July	?	Adults incubating (Udvardy, 1963: 193).
1961 7-8 Mar.	0	(Woodside and Kramer, ms.).
4-10 Sept.	few	Full-grown young observed (Woodside, ms.c). "Almost or quite full-sized chicks," with complete plumage but some down on neck (Udvardy, 1963: 193).
1962 14-19 June	?	1 pair; not nesting* (Kramer and Beardsley, ms.).

:e BuP-3. (continued)

	of Survey	Population Estimate	Breeding Status, Remarks, References
,	11-13 Feb.	0	(POBSP).
+	10-11 Mar.	0	(BSFW, POBSP).
	16-20 Sept.	?	9 downy young and ca. 10 adults; estimated 50 half-grown to nearly fledged young (BSFW, POBSP).
1965	6-11 Mar.	0	(POBSP).
	17-21 July	1,800	Ca. 200 young present; 2 newly hatched young seen (POBSP).
	5-12 Aug.	2,000	Estimated 500 small young present (POBSP).
1966	10-16, 20-21 June	10,000	Burrow excavation to incubated eggs; estimated 3,000 burrows with eggs (POBSP).
	20-23 Oct.	0	(POBSP).
1967	18-19 Mar.	20	Heard calling (BSFW, POBSP).
	7-12 June	20,000	Fresh to moderately incubated eggs; estimated 5,000 burrows with eggs (POBSP).
	5-11 Sept.	1,600	Completely down-covered young to downless near fledging young; ca. 65% of burrows with young more than 90% clear of down (POBSP).
1968	17-19 Mar.	?	None positively identified; none in usual areas (BSFW, POBSP).
1969	9 Sept.	?	2 seen (BSFW).

*Eggs probably present but overlooked by observers.

SOOTY SHEARWATER — Puffinus griseus

Status

Accidental; one record: April 1906.

Observations

Bailey (1956: 57) reported the only known record from Laysan, a male collected 17 April 1906 by Bompke and now in the Bishop Museum (BPBM 4536). These shearwaters commonly migrate through the Hawaiian area and specimens, mostly carcasses that have washed up on the beach, are known from Midway and Kure Atolls in the northwestern Hawaiian chain (Clapp and Woodward, 1968: 8).

WEDGE-TAILED SHEARWATER — Puffinus pacificus

Status

Abundant breeder; maximum recent estimate [1,000,000]. Present from March through early December; absent remainder of year. Most nesting is from June through November. Nests in burrows, chiefly under the Eragrostis association between the lagoon and the beach crest.

Populations

The maximum recent estimate (1,000,000 June 1967) is probably excessive since no other recent estimates, made independently by a series of different observers, have exceeded 200,000 birds (Table WT-3). This nocturnal, burrowing species is difficult to census, however, and more accurate appraisals of the Laysan population must await lengthier, more detailed studies. Maximal populations probably are more on the order of several hundred thousands than one million.

The earliest available population estimates, those by Dill and Bryan (100,000), and Wetmore (77,500) are probably not significantly different from most large estimates made recently.

Annual Cycle

Most observations indicate that birds begin returning in March after an absence during the late fall and winter. During March, April, and May they engage in a long period of courting activities and burrow preparation which culminates with egg laying in early June. Eggs are laid through perhaps early July and eggs hatch from the last week of July through mid- or possibly late August. Young fledge from early November through mid-December.

However, two observations do not fit this breeding regime. Dill and Bryan reported that young had "nearly fledged" by 4 June 1911 and Kramer found "only two downy young" at the end of April 1959 (while otherwise

indicating that the breeding season was beginning). We think both observations are probably erroneous in view of the consistency of many other observations by many other observers. Kramer, who failed to mention the presence of Bonin Petrels in his report, may have confused the young of that species with those of the Wedge-tailed Shearwater.

Ecology

Breeding: In May 1902 Fisher (1903a: 791-792) found most Wedge-tailed Shearwaters in "a zone perhaps 50 yards wide around the lagoon, some distance seaward from the bare flood plain" and noted that they were rare elsewhere on the island. They burrowed among the tall bunchgrass and in the open "among matted juncus [Cyperus] and succulent portulaca." Fisher noted that burrows were usually at least 3 feet long--often longer and very rarely shorter.

In April to June 1911 Dill and Bryan (1912: 17) found them "on nearly every part of Laysan, with the exception of the beaches and the hard shores of the central lagoon." In May 1923 (Wetmore, ms.) they were on the open sand in many areas of the island but more abundant near the lagoon.

POBSP personnel found them burrowing in a wide variety of habitats. Some birds burrowed under the hardpan in open areas on the southwest portion of the island. These strong-roofed burrows can withstand a considerable amount of weight and may be used several years in succession. Others dig burrows in loose sand under rocks, particularly at the north, southwest, and south ends of the island (Fig. 37). Most burrow beneath the varied vegetation associations such as the belt of Scaevola around the island and the belt of Ipomoea near the edge of the lagoon. Most POBSP survey parties, however, reported greatest densities of nesting birds under Eragrostis, particularly on the inner slope of the west side of the island. Burrow depths in such areas were three feet or more as opposed to those found under rocks, some of which were no more than a foot deep. Occasionally eggs were found being incubated on the surface of the ground.

Non-breeding: Clubs (aggregations of roosting birds) were noted by Dill and Bryan (1912: 17) and by POBSP observers. Dill and Bryan noted during April to June 1911 that "at times a dozen or more of these birds congregate." POBSP observers found such aggregations on most visits to Laysan. In September 1964 groups of up to 50 birds were found on the open beaches of all but the west side of the island and clubs were seen in open areas of the interior in July 1965. In August 1965, October 1966, and September 1957 clubs containing from 30 to several hundred birds were seen in open areas bordering the lagoon, notably the northwest corner (Fig. 38), in open areas of the interior such as the blowouts at the southwest corner of the island, and on the beaches, particularly the north beach. Notes from the August visit indicate that larger clubs were found inland and that the aggregations along the lagoon were decidedly smaller. No such difference was noted in clubs seen in the same area in September 1967.

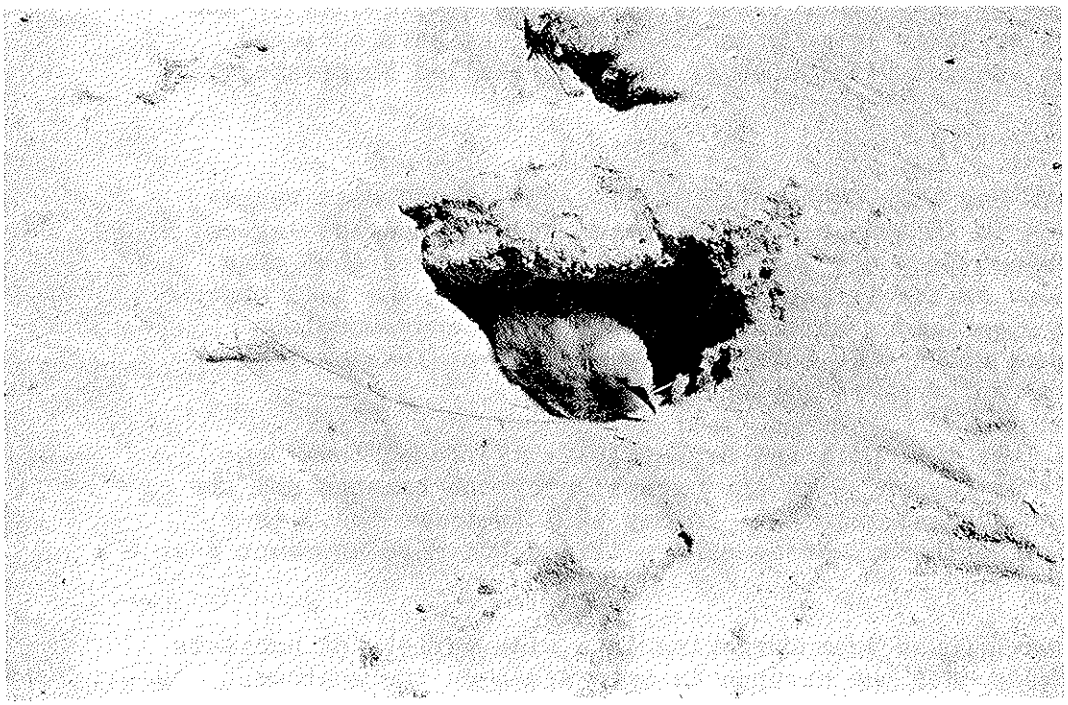

Figure 37. Downy young Wedge-tailed Shearwater at nest site under rock on southwest beach, September 1967. Photo by D.I. Hoff.

Figure 38. Wedge-tailed Shearwater club near northwest corner of lagoon, September 1967. Photo by R.B. Clapp.

Data from June visits suggest that clubs are smaller and less numerous earlier in the breeding cycle. No clubs were seen in June 1966 and those present in June 1967 were considered smaller than those observed later in the nesting season. These clubs probably contain non-breeders or birds that failed in early nesting attempts but critical observations to determine the status of these birds are lacking.

Specimens

Sixty-nine Wedge-tailed Shearwater skins from Laysan are currently distributed in museums as indicated in Table WTS-1. Three additional mounted specimens are distributed as follows: SUI (1 in Laysan exhibit); BPBM (2). Also preserved are at least 8 skeletons (BPBM, 2; USNM, 6); 1 alcoholic (BPBM); and 3 eggs (BPBM).

Table WTS-1. Locations of Wedge-tailed Shearwater skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	6	4	2	12
BPBM	6	3	5	14
DMNH	1	1	0	2
MCZ	1	0	0	1
SUI	2	2	0	4
UMMZ	0	0	1	1
USNM (non-POBSP)	14	14	4	32
Other*	0	0	3	3
Totals	30	24	15	69

*Hachisuki (1); Yale U. (1); Indiana U. (1).

Banding and Movements

The POBSP banded 7,392 adult Wedge-tailed Shearwaters on Laysan (Table WTS-2).

One, 615-18119, banded on Lisianski as an adult on 22 August 1964 was recaptured on Laysan on 8 August 1965. On 16 September 1964 a Wedge-tailed Shearwater with an orange streamer (indicating that it had been banded on Johnston Atoll) was seen but not captured. None from Laysan has been recovered elsewhere.

Table WTS-2. Wedge-tailed Shearwaters banded on Laysan by the POBSP.

Period of Survey		Number Banded
1964	Sept.	700
1965	Mar.	25
	July	1,000
	Aug.	4,000
1966	June	396
	Oct.	100
1967	June	800
	Sept.	371
	Totals	7,392

Table WTS-3. Observations of Wedge-tailed Shearwaters on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	Probably present; based on Isenbeck's vague description that was later identified by Rothschild (1893-1900: v).
1890 16 July	?	Probably present (Lyons, 1890: 91).
1891 16-27 June	very scanty numbers	(Rothschild, 1893-1900: 47). Eggs being laid 16-18 June (Munro, 1941a: 2).
1896 24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902 16-23 May	abundant	Second in numbers to Bonin Petrel; egg-laying began early June (Schlemmer vide Fisher); preparing burrows in May but no eggs found (Fisher, 1903a: 791-792).
1903 Apr.	?	10 specimens and 2 eggs collected by Bryan (AMNH, BPBM).
1904 10 May	?	1 collected by Schlemmer (MCZ).
1906 17 Apr.	?	At least 1 collected by Bompke (BPBM).
1911 24 Apr.-5 June	100,000	Young nearly fledged (Dill and Bryan, 1912: 17).
1912-1913 22 Dec.-11 Mar.	?	1 half-grown young in burrow late December; first adults returning 10 March (Bailey, 1956: 55). Only bird seen during winter [Bailey's half-grown young?] was a dying bird on 24 December (Willett, ms.).

Table WTS-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1915	3 Apr.	possibly 250,000	(Munter, 1915: 139).
1918	8-10 Sept.	150,000	(Diggs, ms.).
1923	8 Apr.	thousands	Sitting in pairs (Dickey, ms.).
	29 Apr.-14 May	77,500	Copulating and preparing burrows (Wetmore, ms.).
1930	2-18 Aug.	2nd most abundant species	Mating and burrowing (Wilder, ms. b).
1936	7-8 Mar.	?	Some present in burrows (Trempe, ms.).
	12 Dec.	?	1 adult seen; hundreds of dead young (Coultas, ms.).
1950	23 June	numerous	In burrows (POFI).
1951	12 May	?	Nesting (POFI).
	late June-early July	6,290	Diurnal census of shearwaters, largely Wedge-tailed (Brock, 1951b: 18).
1957	25 June-3 July	40,000	1 or more nests with eggs found (Woodside, ms. b).
	8-12 July	?	(Labrecque, 1957: 18).
1958	27 May-4 June	?	Most copulating and preparing burrows. "After inspection of hundreds of burrows" a single egg found 1 June (Warner, ms.).
1959	28 Apr.-1 May	?	Most beginning to nest; only 2 downy young seen (Kramer, ms.).
1961	7-8 Mar.	not many	Not breeding, no eggs found (Woodside and Kramer, ms.).
	4-10 Sept.	?	Many adults present during day; large numbers arriving at night. Young about 1/4 grown (Woodside, ms. c).

Table WTS-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1962 14-19 June	usual abundance	Egg laying just begun (Kramer and Beardsley, ms.).
1963 11-13 Feb.	0	(POBSP).
3-10 Dec.	?	Young nearly feathered; ca. 150 dead young seen on beach (Walker, ms. b).
1964 10-11 Mar.	50-100	25-30 seen; courtship behavior observed (BSFW, POBSP).
16-20 Sept.	25,000	Many non-breeding birds present; nearly all burrows contained small young but a few half-grown chicks seen (BSFW, POBSP).
1965 6-11 Mar.	100-200	Beginning to return (POBSP).
17-21 July	10,000	Second in abundance only to Sooty Terns. All burrows examined contained eggs in varying stages of incubation (POBSP).
5-12 Aug.	150,000	Ca. 25,000 newly hatched chicks and 25,000 near-hatching eggs; many eggs hatched during survey (POBSP).
1966 26-31 Mar.	thousands	No eggs found (BSFW).
10-16, 20-21 June	200,000	Egg-laying just begun; much burrowing activity (POBSP).
17-18 Sept.	many thousands	Thousands of large downy young in burrows (BSFW).
20-23 Oct.	200,000	Ca. 40-70,000 young present. All seen were beginning to assume juvenal plumage (POBSP).
1967 18-19 Mar.	very few	Not breeding (BSFW, POBSP).
7-12 June	[1,000,000]	Ca. 10,000 burrows present. All eggs observed were fresh or slightly incubated. Estimate probably excessive (POBSP).

Table WTS-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 5-11 Sept.	85,000	Small to large downy young; most burrows contained medium-sized downy young (POBSP).
13 Dec.	?	No adults; 1 bedraggled immature found in surf (BSFW).
1968 17-19 Mar.	100	Scattered birds; little moaning; no breeding (BSFW, POBSP).
1969 26-29 Mar.	thousands	Adults digging burrows; no evidence of egg laying (BSFW).
9 Sept.	many thousands	3 downy young (BSFW).

CHRISTMAS SHEARWATER — *Puffinus nativitatus*

Status

Common breeder; maximum recent estimate: 10,000. Present from mid-February through late October; absent remainder of year. Most nesting is from mid-April through late September. Nests throughout the island, chiefly on the surface under dense vegetation or in a shallow trench under debris, vegetation or boulders.

Populations

Population estimates for the early part of this century are about ten times larger than recent estimates (Table CS-3). This may indicate a decline in population but may also reflect the absence of recent visits during April and May--the early part of the breeding season when birds are presumably most conspicuous. Recent summer estimates suggest a population of 3,000 to possibly 10,000 birds at that season.

Annual Cycle

Bailey noted that the first birds arrived on 13 February 1913, but none was seen on the only other February visit (11 to 13 February 1963). Birds were reported on all March visits. Eggs may be laid as early as 5 to 8 March (1961), but no eggs were found on the six recent March visits (1964 to 1969).* Most egg-laying occurs from late April

*On some visits, as in March 1967, the presence of eggs may have been overlooked.

through mid-May. Laying is essentially finished by the end of May but possibly a few eggs are laid in early June. Hatching may begin in the last week of May but the peak is from mid-June through early July. Young may fledge as early as the last week in July, but most fledging occurs from early September through early October, with a very few late young probably fledging in early November.

Birds probably are absent from the island from sometime in November until mid-February. Christmas Shearwaters were not mentioned on any of the three December visits.

Ecology

Breeding: At night, early in the breeding season, concentrations of birds have been noted around the lagoon and open Eragrostis areas. Most nesting occurs under the Scaevola rimming the island (especially the north and west sides) and among various rock outcrops and boulders (particularly along the outer beaches). Smaller numbers of nests are scattered throughout the island. Nests are occasionally reported under Eragrostis and regularly in the Ipomoea areas but never on the open beaches. Essentially the same habitat was utilized by birds early in the century (Fisher, 1903a: 792) but during the denudation of the island the rocky outcrops must have been of major importance.

Eggs are usually laid on the ground under dense Scaevola and also in shallow unlined trenches under other vegetation, boards, or rocks. Schauinsland (1899: 54) mentioned burrows underground but was probably referring to burrows of P. pacificus. Fisher (1903a: plate 8) shows a bird incubating an egg at the edge of vegetation without overhead shelter. Nests are easily overlooked early in the cycle but nearly fledged chicks are commonly seen outside the nest burrows and along the edges of vegetation at night.

Non-breeding: At night roosting birds are usually found in open areas at the edge of vegetation. Most birds leave the island by dawn and by mid-morning the remainder retire to the shade of rocks or vegetation and disappear into shelter as the day advances.

Specimens

Eighty-four Christmas Shearwater skins from Laysan are currently distributed in museums as indicated in Table CS-1. Four additional mounted specimens are distributed as follows: BPBM (1 immature male); CMNH (1 adult in Laysan exhibit); SUI (2 birds in Laysan exhibit). Also preserved are at least 7 skeletons (BPBM, 3; USNM, 4); 1 alcoholic (USNM); and 11 eggs (BPBM, 1; USNM, 10).

Banding and Movements

The POBSP and BSFW banded 317 Christmas Shearwaters on Laysan (Table CS-2). No interisland movements were recorded.

Table CS-1. Locations of Christmas Shearwater skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	7	3	5	15
BPBM	0	2	8	10
CMNH	1	1	1	3
DMNH	3	1	0	4
MCZ	2	3	0	5
SUI	0	2	0	2
UMMZ	0	4	0	4
USNM (non-POBSP)	13	24	1	38
(POBSP)	0	0	1	1
Other*	1	1	0	2
Totals	27	41	16	84

*Law Coll. (1 ♂); Utah St. Univ. (1 ♀).

Table CS-2. Christmas Shearwaters banded on Laysan.

Period of Survey	Bander	Adults	Young	Age Unknown	Total
1964 Mar.	BSFW	0	0	8	8
Sept.	POBSP	2	88	0	90
1967 June	POBSP	100	0	0	100
Sept.	POBSP	58	23	38	119
Totals		160	111	46	317

Table CS-3. Observations of Christmas Shearwaters on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1891 16-27 June	?	Nesting (Rothschild, 1893-1900: 45). Near-hatching eggs and recently hatched chicks (Munro, 1941c: 16-17).
1896 24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902 16-23 May	?	Eggs (Fisher, 1903a: 792-3). Of 4 eggs collected 1 was fresh and 3 were almost ready to hatch (USNM).

Table CS-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1903 Apr.	?	5 specimens and 1 egg collected by W.A. Bryan (AMNH, BPBM).
1904 24 May	?	1 collected (Schlemmer?) (MCZ).
1907 20 May	?	4 collected (Schlemmer?) (MCZ).
1911 24 Apr.- 5 June	75,000	Fresh eggs, first 2 weeks of May (Dill and Bryan, 1912: 17).
1912 22 Dec.- 1913 11 Mar.	?	First pair arrived 13 Feb.; abundant by 17 Feb.; "nest building and preparing to breed" by 9 Mar. (Bailey, 1956: 55, 57).
1915 3 Apr.	50,000	(Munter, 1915: 139).
1916 9 Feb.	?	1 seen (Munter, ms.).
1918 8-10 Sept.	75,000	(Diggs, ms.).
1923 8 Apr.	?	Only a few dozen seen by day but numbers becoming larger at night (Dickey, ms.).
12 Apr.	?	Becoming more common daily. Bird collected with fully formed egg in oviduct (Dickey, ms.).
8-13 Apr.	fairly common	(Wetmore, ms.).
12-14 Apr.	?	7 fresh eggs collected (Dickey, ms.; USNM).
29 Apr.- 14 May	2,000	1 egg found 7 May (Wetmore, ms.).
1957 25 June- 3 July	10,000	(Woodside, ms. b).
1958 27 May- 4 June	?	Eggs under 2 weeks old (Warner, ms.).
1959 28 Apr.- 1 May	<100	None found nesting, no pairs noted (Kramer, ms.).
1961 7-8 Mar.	?	Paired, few with eggs (Woodside and Kramer, ms.).

Table CS-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1961	4-10 Sept.	?	Well-developed young; many had departed (Woodside, ms. c).
1963	11-13 Feb.	0	(POBSP).
1964	10-11 Mar.	30-50	Courtship behavior (BSFW, POBSP).
	16-20 Sept.	250-450	Ca. 200 chicks; most nearly fledged (BSFW, POBSP).
1965	6-11 Mar.	1,000-2,000	Pairs; no eggs (POBSP).
	17-21 July	2,500	Ca. 500 large chicks (POBSP).
	5-12 Aug.	3,000	Ca. 500 large chicks (POBSP).
1966	26-31 Mar.	several hundred	No nesting activity (BSFW).
	10-16, 20-21 June	1,000	Ca. 200 incubated eggs (POBSP).
	17-18 Sept.	15	Adults; 3 full-grown young with scant down on nape (BSFW).
	20-23 Oct.	50	Nearly fledged chicks (POBSP).
1967	18-19 Mar.	100	Pre-nesting (BSFW, POBSP).
	7-12 June	6,000	Lightly incubated eggs to medium-sized young; of 36 nests tabulated, 24 (67%) contained eggs and 12 (33%) contained small downy chicks; estimated 2,000 nests (POBSP).
	5-11 Sept.	2,000	Medium-sized downy young to nearly fledged young; most nests contained large downy young (POBSP).
1968	17-19 Mar.	400-500	Many apparently paired; no nesting (BSFW, POBSP).
1969	26-29 Mar.	7,500	Seemed more abundant than on previous March visits (BSFW).
	9 Sept.	?	More common than on earlier visits (BSFW).

SOOTY STORM PETREL — *Oceanodroma tristrami*

Status

Common breeder; maximum recent estimate: 2,000 to 3,000. Present from late October through June; absent remainder of year. Probably nests from late December until June. Nests in burrows in small, local colonies under the zone of dense vegetation (usually *Eragrostis* and *Ipomoea*) or under guano hardpan near the lagoon.

Populations

No highly accurate population data are available because of this species' secretive nature and the paucity of scientific visits during their peak nesting period. It occurs in small, local, scattered colonies, and on Laysan is often unsuccessful as a breeding species (Table SSP-2).

The several hundred nests present in 1913 suggest a population of a thousand or more, which is roughly the same as recent estimates. (Willett's [ms.] estimate of 20,000 breeding birds was almost certainly excessive.)

Annual Cycle

Birds evidently return to the island in October after an absence of almost five months. Egg laying begins in mid- or late December and continues through at least January. The only definite record of egg-laying is for late December and the first two weeks of January 1913.

Hatching probably begins in early February and continues through at least early March. In mid-March 1968 one medium-sized downy young was found while other burrows contained only the adult birds and their empty nests. Fledging probably occurs from April through June.

Ecology

Breeding: Fisher (1903a: 795) reported (*vide* Max Schlemmer) that these petrels nested in burrows under scattered coral boulders on the southwest side of the island. In view of more recent observations, we suspect that this comment may, in fact, have referred to Bulwer's Petrels.

During the winter of 1912 to 1913, Bailey and Willett (Bailey, 1956: 61) found two colonies, one on low ground at the north end of the lagoon, and the other in the southwest corner. Burrows averaged 5 inches in diameter and 2 1/2 feet in length; the nests were composed of rootlets, weed stems, and leaves (Willett, 1919: 61).

Many observers have reported dead birds in the vicinity of the lagoon. Much of this mortality seems to be the late season loss of young typical of many seabirds. Bailey (1956: 61) recorded a considerable nest loss from flooding and shifting sand during the winter of 1912 to 1913. Since flooding of the lagoon is common, it may have an important limiting effect on storm petrel populations.

In recent years most birds have been found near the lagoon in the Eragrostis-Ipomoea zone. In 1965 birds were restricted to an area within 100 yards of the lagoon. In March 1968 a small colony (100 yards in diameter) was present at the south end of the lagoon under dense Ipomoea and hardpan about 200 yards from the lagoon border. A calling bird was also heard at the northwest end of the lagoon.

Specimens

Forty-five Sooty Storm Petrel skins from Laysan are currently distributed in museums as indicated in Table SSP-1. An additional mounted specimen is in the Laysan Exhibit at SUI. Also preserved are a skeleton and a head at USNM.

Table SSP-1. Locations of Sooty Storm Petrel skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	3	2	2	7
BPBM	3	2	1	6
CMNH	1	2	0	3
UMMZ	4	6	0	10
USNM (non-POBSP)	6	5	1	12
(POBSP)	2	2	0	4
Other*	2	1	0	3
Totals	21	20	4	45

*Law Coll. (2 ♂♂); Mus. d'H. Naturelle (1 ♀).

Banding and Movements

One hundred one Sooty Storm Petrels have been banded on Laysan: 91 adults and 1 chick by the POBSP in March 1965, and 9 adults by the BSFW in March 1966. No interisland movements were recorded.

Table SSP-2. *Observations of Sooty Storm Petrels on Laysan.*

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1896 24 June-24 Sept.	0	Remains of skeletons found; skin sent to Bremen later in year after birds returned to nest (Schauinsland, 1899: 101; Rothschild, 1893-1900: 308).

Table SSP-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1902	16-23 May	hardly common	1 hurt or sick bird with a trace of down, and up to a dozen dead ones (Fisher, 1903a: 795).
1903	23-29 Apr.	?	At least 9 (6 adults) collected by W.A. Bryan (AMNH, BPBM).
1911	24 Apr.- 5 June	not common	A few dead and dying fledged young; 2 adults (Dill and Bryan, 1912: 18).
1912 1913	22 Dec.- 11 Mar.	20,000*	Substantial breeding colony (Willett, 1919: 61). Eggs laid in late December and early January (Willett, ms.). Several hundred nests destroyed by rising lagoon waters; others by sand storms (Willett, 1919: 61; Bailey, 1956: 61).
1918	8-10 Sept.	0	(Diggs, ms.).
1923	27 Apr.	?	Nearly fledged young found dead (Ball, ms.).
1936	12 Dec.	apparently not many	One found in one of many burrows examined (Coultas, ms.).
1957	25 June- 3 July	?	Post-nesting (Woodside, ms. b).
1961	7-8 Mar.	?	1 dead week-old chick (Woodside and Kramer, ms.).
	4-10 Sept.	0	(Woodside, ms. a).
1963	11-13 Feb.	12	No nests (POBSP).
	3-10 Dec.	?	Not nesting (Walker, ms. b).
1964	10-11 Mar.	?	1 dead bird (BSFW, POBSP).
	16-20 Sept.	0	(BSFW, POBSP).
1965	6-11 Mar.	2,000-3,000	Young near fledging; adults digging burrows (POBSP).
	17-21 July	0	(POBSP).

Table SSP-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1965 5-12 Aug.	0	(POBSP).
1966 26-31 Mar.	?	1 nearly full-grown chick; 9 adults banded (BSFW).
20-21 June	?	1 carcass (POBSP).
17-18 Sept.	0	(BSFW).
20-23 Oct.	1,500	No nests; numbers apparently increasing from night to night (POBSP).
1967 18-19 Mar.	several	No nests (BSFW, POBSP).
7-12 June	10	3 or 4 dead birds; 1 fledged chick (POBSP).
5-11 Sept.	0	(POBSP).
1968 17-19 Mar.	200	1 local colony; others possibly present; only a single medium-sized downy young (and adults) found in the several burrows examined (BSFW, POBSP).
1969 26-29 Mar.	?	2 adults found in a nest-burrow (BSFW).
9 Sept.	0	None found in colony at southern end of lagoon (BSFW).

*Estimate of number of breeding birds by Willett (ms.).

RED-TAILED TROPICBIRD — Phaethon rubricauda

Status

Common breeder; maximum recent estimate: 4,000. Some present in all months but only small numbers present from late fall through winter. Most nesting is from late April through early October. Nests on the ground under Scaevola or other vegetation, chiefly around the perimeter of the island.

Populations

Population figures for Red-tailed Tropicbirds (Table RTTB-3) are probably less reliable than those for any other large, primarily diurnal seabird nesting on the island because nests are usually hidden beneath dense shrubbery and are easily overlooked by survey parties.

Recent estimates suggest that populations are larger now than during the period about 1915 through 1930 but the paucity of estimates from 1890 through 1913 makes it impossible for us to determine whether populations of that period differed from those of today. It is very likely that the tropicbird population was greatly reduced when the island was denuded of vegetation since almost no nesting sites were then available. In May 1923, Wetmore noted, "They are hard put here to find any shelter for nests and I doubt if many will succeed in breeding successfully here." His count of 80 birds is the lowest ever recorded in the period from May to July.

Annual Cycle

There probably is no time when Red-tailed Tropicbirds are not present on Laysan, but very few are present in winter. Numbers apparently begin to increase in late March or April with peak numbers present from mid-May to August. The population begins to decline in September, and by late October there are few birds on the island. Population size closely corresponds with the amount of nesting activity. Minimal numbers are present in winter and early spring when few birds are nesting.

Laying may begin as early as early January (1913) but in most years nesting probably begins in March (1958, 1962, 1965-67, 1969); however, in 1923 and 1911, it apparently did not begin until May. The peak laying period is probably most often from the last week of April through early June but eggs may be laid through early October (1912). It seems likely that future visits during the winter months will reveal that at least a few eggs or young may be present in any month. Eggs may hatch from mid-February through mid-November and young may fledge from mid-May through the end of January. Peak periods of hatching and fledging rather consistently fall between early June and mid-July and late August and early October, respectively.

Despite the extended breeding period, the population as a whole apparently follows a distinct annual cycle with most breeding occurring from late April through early October.

Ecology

Breeding: Fisher (1903a: 795) found Red-tailed Tropicbirds under bushes, including the now extinct Chenopodium oahuense, and stated that "...not infrequently several will congregate beneath colonies of Fregata..." In 1923 when vegetation was almost non-existent, Wetmore (ms.) found the few birds present nesting about rock piles and inside buildings.

Presently most nesting occurs under Scaevola and is therefore concentrated around the perimeter of the island. In June 1966 the largest concentrations were found on the western side. In September 1967 birds were considerably more abundant on the west, northwest, north, and east sides of the island than they were on the south and southeast sides. Birds often nest in loose groups of 5 to 20 or more, with 30 or 40 yards between the groups. Eggs are laid in shallow scrapes without nesting material but some plant debris may be present incidentally.

Specimens

Eighty-six Red-tailed Tropicbird skins from Laysan are currently distributed in museums as indicated in Table RTTB-1. Twenty-three of these are dataless "Japanese trade skins," at least in part from the 1909 to 1910 feather raids. Six additional mounted specimens are distributed as follows: BPBM (2); CMNH (1 in Laysan exhibit); SUI (3 birds in Laysan exhibit). Also preserved are at least 3 skeletons (BPBM, 2; USNM, 1); 1 alcoholic (BPBM); 1 skull (USNM); and 12 eggs (BPBM, 6; USNM, 6).

Table RTTB-1. Locations of Red-tailed Tropicbird skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	6	4	14*	24
BPBM	1	3	6	10
CMNH	1	1	3**	5
DMNH	1	5	2**	8
MCZ	4	3	0	7
SUI	1	2	0	3
UMMZ	1	0	12***	13
USNM (non-POBSP)	8	6	2	16
Totals	23	24	39	86

*Includes 7 "Japanese trade skins."

**"Japanese trade skins."

***Includes 11 "Japanese trade skins."

Banding and Movements

The POBSP and BSFW banded 638 Red-tailed Tropicbirds (Table RTTB-2). One adult, 705-13327, banded on 10 September 1967, was recovered at sea ca. 15°00'N, 117°30'W on 27 February 1968. In addition, an adult banded on Laysan 31 May 1958 by Dale Rice was recaptured there by the POBSP on 19 September 1964.

Table RTTB-2. Red-tailed Tropicbirds banded on Laysan.

Period of Survey		Bander	Adults	Young	Age Unknown	Total
1958	June	BSFW	0	0	125	125
1964	Sept.	POBSP	35	65	0	100
1965	Mar.	POBSP	2	0	0	2
	Aug.	POBSP	62	37	0	99
1966	Mar.	BSFW	3	0	0	3
	June	POBSP	4	0	0	4
1967	June	POBSP	98	0	0	98
	Sept.	POBSP	90	117	0	207
	Totals		294	219	125	638

Table RTTB-3. Observations of Red-tailed Tropicbirds on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1890	16 July	?	Incubating eggs, few of which had hatched (Lyons, 1890: 91).
1891	16-27 June	?	Breeding; eggs (Rothschild, 1893-1900: 34).
1896	24 June-24 Sept.	?	Breeding (Schauinsland, 1899: 101).
1902	16-23 May	fairly common	Most nests had heavily incubated eggs (3 collected had begun incubation [USNM]). 1 downy nestling seen (Fisher, 1903a: 796).
1903	Apr.	?	3 specimens and 5 eggs collected by Bryan (BPBM).
1905	2 May	?	1 collected by Schlemmer (MCZ).
1907	4-21 May	?	6 collected by Schlemmer (MCZ).
1911	24 Apr.-5 June	300	Very few seen first 3 weeks; common later and nesting (Dill and Bryan, 1912: 19).
1912 1913	22 Dec.-11 Mar.	?	"Nesting in small numbers from late December into March." Adults rarely seen in December and January but plentiful by mid-February. A juvenile noted on 24 December; large young noted on 29 December and 9 January; eggs on 4 and 19 January (Bailey, 1956:

Table RTTB-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1912 1913	22 Dec.- 11 Mar. (cont'd.)		62). Rather plentiful by 11 March (Willett, ms.).
1918	8-10 Sept.	30	(Diggs, ms.).
1923	8 Apr.	?	3 or 4 pairs with eggs on the southwest ridge (Dickey, ms.).
	8-13 Apr.	fairly common	Seeking nest sites (Wetmore, ms.).
	29 Apr.- 14 May	80	Eggs (Wetmore, ms.).
1930	2-18 Aug.	few in number	Evidently nesting (Wilder, ms. b).
1936	7-8 Mar.	?	Ca. 12 seen in air and several others found with eggs. 5 banded with brass rings (Trempe, ms.).
	12 Dec.	0	(Coultas, ms.).
1950	23 June	?	Nesting (POFI).
1951	late June- early July	200	Diurnal census (Brock, 1951b: 18).
1957	25 June- 3 July	1,000	(Woodside, ms. b).
	8-12 July		Eggs to nearly full-grown young (Labrecque, 1957: 18).
1958	27 May- 4 June	?	Fresh eggs to young about a month old; most nests with heavily incubated eggs or newly hatched young (Warner, ms.).
1959	28 Apr.- 1 May	?	Nests with eggs, including 1 that was pipped (Kramer, ms.).
1961	7-8 Mar.	?	A few seen flying; none on ground (Woodside and Kramer, ms.).
	4-10 Sept.	not at peak abundance	Only large young (Woodside, ms. c).

Table RTTB-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1962 14-19 June	abundant	Young in all stages (Kramer and Beardsley, ms.).
1963 11-13 Feb.	several	(POBSP).
3-10 Dec.	?	A fully feathered young found 5 December was gone by 9 December (Walker, ms. b).
1964 10-11 Mar.	7	No nests (BSFW, POBSP).
16-20 Sept.	400	Eggs to fledging young; most nests with nearly fledged immatures; estimated 160 nests present on island. Sample count of 80 nests: 6 (8%) with eggs; 8 (10%) with small downy young; 34 (43%) with medium-sized or large downy young; 32 (40%) with dependent immatures (POBSP).
1965 6-11 Mar.	7-10	3 seen on ground but no nests found (POBSP).
17-21 July	2,000	Partially incubated eggs to fledging young; most eggs heavily incubated; estimated 1,000 nests with young (POBSP).
5-12 Aug.	2,500	Eggs to fledging young. Sample count of 80 nests: 25 (31%) with eggs; 14 (18%) with small downy young; 33 (41%) with medium-sized or large downy young; 8 (10%) with dependent immatures. Estimated 200 nests with eggs; 800 young (including flying immatures) (POBSP).
1966 26-31 Mar.	very common	Nests with eggs but no young found (BSFW).
10-16, 20-21 June	1,000	Estimates 400 nests; 88 of 90 (98%) nests in sample count contained eggs, 1 contained small young, and 1 contained large young (POBSP).
17-18 Sept.	?	Eggs to nearly full-grown young (BSFW).

Table RTTB-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1966 20-23 Oct.	50	Several nearly fledged young; no nests with eggs or small young (POBSP).
1967 18-19 Mar.	50	Several nests with eggs. Ca. 30 seen in flight on 18 March (BSFW, POBSP).
7-12 June	4,000	Estimate includes all birds using the island; eggs to large downy young; most nests contained eggs. Sample count of 87 nests: 69 (79%) with eggs; 16 (18%) with small downy young; 2 (3%) with medium-sized or large downy young. Estimated 1,000 nests (POBSP).
5-11 Sept.	1,500	Eggs to fledging young; 117 young banded. Less than 5% of nests with eggs; ca. 5% with small downy young; ca. 10% with medium-sized or large downy young; ca. 85% with dependent immatures (POBSP).
13 Dec.	4	No check made of breeding status (BSFW).
1968 17-19 Mar.	100	Apparently just returning; none found nesting (BSFW, POBSP).
1969 26-29 Mar.	500	Most incubating eggs (BSFW).
9 Sept.	common	A few nests examined contained eggs to nearly fledged young (BSFW).

BLUE-FACED BOOBY — Sula dactylatra

Status

Common breeder; maximum recent estimate: 2,000. Present and may breed throughout the year but most nesting occurs from the end of March through September. Nests chiefly around the island perimeter and around the central lagoon, normally in areas of open sand or scant vegetation. The nest is a scrape in bare sand, occasionally with a little added vegetation.

Populations

No 19th century population estimates are available and more recent data (Table BFB-3) are too scanty to determine whether any significant population changes have occurred on Laysan during the 20th century. Recent estimates show nearly as much variation within a single year (e.g., 1965) as for various years. This annual variation is probably correlated with the stage of the nesting cycle and the number of non-nesting birds present.

Munter found over a hundred Blue-faced Boobies killed by feather poachers; undoubtedly many more were destroyed in the 1909 raid as white birds were favored by the feather hunters. Thus, there probably was some population decline during the 1908-15 period.

Since this species nests on bare sand, its nesting habitat probably was not greatly affected by the loss of vegetation. However, Wetmore (ms.) noted that it usually nested where some faint trace of vegetation remained.

Annual Cycle

Blue-faced Boobies occur on Laysan throughout the year, but peak numbers are evidently present in the summer, coincident with the largest number of nests.

Blue-faced Boobies have bred during all months, although perhaps not in every month in most years. Although the initiation of the breeding cycle may vary by a month or more from year to year, the population as a whole exhibits a distinct annual breeding regime. Eggs may be laid as early as February (1911, 1923, 1963, 1966, 1969) and even December (1912) but the number laid during these months is only a small proportion of the total laid during the entire season. In most years peak egg laying probably occurs during the last week of March and the first two weeks of April, with at least a few eggs being laid through early July.

Peak hatching and fledging periods usually occur during the last three weeks of May and last three weeks of September, respectively. Late-fledging young may be present through mid-December but in most years breeding is essentially completed by mid- or late October.

Ecology

Breeding: Many observers noted that Blue-faced Boobies nested primarily around the outer perimeter of the island and several noted that they tended to nest more on the east than on the west. Palmer (Rothschild, 1893-1900: 26) noted that "they invariably frequented the shore and never went inland." Fisher (1903a: 796), more specific in his observations than others, reported that these boobies were "most plentiful on the northeast, east, and southern exposures, where the littoral slope

is broadest, but on the west side, where a little bluff replaces the seaward slope, the birds (were) absent." Neither Palmer nor Fisher reported any nesting on the inner slopes of the island, but Dill and Bryan (1912: 19) found some nesting on the interior slope of the east side of the island.

In 1923 Wetmore found these birds nesting on bare sand but believed that most preferred to nest where some trace of vegetation remained.

More recently, POBSP observers found these boobies nesting in many areas of the island. Most of the population nested around the island perimeter or along the central lagoon and only a relatively small proportion were found on the inner slopes.

Nests on the perimeter were usually on the littoral slope and could be found on both sides of the Scaevola belt. Those on the seaward side of the Scaevola were usually in little openings; those on the inland side usually in the sand-Eragrostis association just behing the Scaevola. The former nesting situation was found most frequently on the north, east, and south sides of the island, while the latter appeared to be more common on the west side. Some also nested at the edges or within the sandy southwest blowouts.

Surveys from August 1965 and June 1966 and 1967 reported that the most dense nesting concentrations occurred along the central lagoon or in the fringe of vegetation on the north and east beaches. In the former area the birds nested on the sand or mud margin, or in more open areas among the Cyperus. On one survey (March 1965) it appeared that the south end of the lagoon held a more dense concentration of nesting birds than did other areas around the lagoon.

The eggs were laid on the bare sand, usually with no semblance of a nest; occasionally there may be a little vegetation scratched about the eggs or young (Fisher, 1903a: 796).

Non-breeding: Non-nesting birds roost in open areas mainly on the beach and around the lagoon. These roosting flocks or clubs were seen on most POBSP visits. In September 1964 two clubs of 15 and 8 individuals, respectively, were present on the northwest beach. In March 1965 a flock of about 30 birds was found on the south beach. On the night of 10 September 1967 three clubs were found: one with 22 birds in an open sand area on the edge of the southwest beach; another with 50 birds on the south beach; and a third of about 175 birds on the southeast beach near the margin of vegetation.

Data are insufficient to determine seasonal variation in the size and number of these clubs. Little is known about the age composition of the clubs but in September 1967 more than 90 percent of the birds in them were adults.

Specimens

Forty-nine Blue-faced Booby skins from Laysan are currently distributed in museums as indicated in Table BFB-1. Five additional mounted specimens are distributed as follows: CMNH (1 male in Laysan exhibit); SUI (4 birds in Laysan exhibit). Also preserved are at least 3 skeletons (BPBM, 2; USNM, 1); 1 alcoholic chick (USNM) and 24 eggs (BPBM, 11; MCZ, 6 clutches; USNM, 4).

Table BFB-1. Locations of Blue-faced Booby skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	6	6	4	16
BPBM	2	2	6	10
CMNH	1	1	0	2
DMNH	1	1	0	2
SUI	0	3	2	5
UMMZ	0	1	0	1
USNM (non-POBSP)	4	5	3	12
Other*	1	0	0	1
Totals	15	19	15	49

*U. of Florida (1 ♂).

Banding and Movements

The BSFW and POBSP banded 618 Blue-faced Boobies on Laysan (Table BFB-2). Twenty-two birds originally banded or handled on Laysan were later reported elsewhere (Johnston Atoll, 1; French Frigate Shoals, 1; Lisianski, 20); 26 birds banded elsewhere (Johnston Atoll, 5; Gardner Pinnacles, 1; French Frigate Shoals, 4; Lisianski, 11; Pearl and Hermes Reef, 3; Midway, 1; Kure, 1) were recaptured on Laysan (Appendix Tables 4-5a and 4-5b).

Table BFB-2. Blue-faced Boobies banded on Laysan.

Period of Survey		Bander	Numbers of Each Age/Sex Class Banded								
			Adult ♂♂	Adult ♀♀	Adult ??	Subtotal Adults	Subadult ??	Immature ??	Nestling ??	Age ??	Totals
1958	June	BSFW	0	0	0	0	0	0	0	37	37
1963	Feb.	POBSP	0	0	4	4	0	0	0	0	4
1964	Mar.	"	4	11	1	16	0	0	0	0	16
	Sept.	"	69	79	11	159	4	16	0	0	179
1965	Mar.	"	3	0	192	195	1	0	0	0	196
	July	"	0	0	0	0	0	1	0	0	1
	Aug.	"	0	0	0	0	0	1	0	0	1
1966	June	"	4	10	2	16	0	0	0	0	16
	Oct.	"	15	17	1	33	0	0	2	0	35
1967	June	"	36	32	3	71	0	0	0	0	71
	Sept.	"	4	4	0	8	0	0	0	0	8
1968	Mar.	"	25	28	1	54	0	0	0	0	54
Totals			160	181	215	556	5	18	2	37	618

Table BFB-3. Observations of Blue-faced Boobies on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	Probably with fresh eggs; based on description by Isenbeck (in Kittlitz, 1834; Rothschild, 1893-1900).
1890 16 July	?	(Lyons, 1890: 90).
1891 16-27 June	few	(Rothschild, 1893-1900: 26).
1896 24 June-24 Sept.	?	Breeding (Schauinsland, 1899: 101).
1902 16-23 May	?	Eggs and young present in about equal numbers; most eggs heavily incubated; 2 collected (USNM); young from newly hatched to about a week old (Fisher, 1903a: 796).
1903 Apr.	?	2 specimens and 8 eggs collected by Bryan (BPBM).
1904 1-3 May	?	3 single eggs (incubation begun); 3 sets of 2 eggs (2 beginning incubation; 1 advanced) (MCZ).
1911 24 Apr.-5 June	85*	In first week of May colony of 45 birds had large downy young and a few well-incubated eggs; on 5 June another colony of ca. 20 pairs had fresh eggs (Dill and Bryan, 1912: 19).
1912 1913 22 Dec.-11 Mar.	200	Nest with egg found 24 December; several more in early January; 30 nests counted 18 February; first naked young found 26 January (Bailey, 1956: 71; Willett, ms.).
1915 3 Apr.	350	Nesting; 100 or more had been killed by feather poachers (Munter, 1915: 193).
1916 9 Feb.	40	Count (Munter, ms.).
1918 8-10 Sept.	4-5	No eggs or young found (Diggs, ms.).
1923 9 Apr.	?	Hatching eggs noted (Dickey, ms.).
8-13 Apr.	?	Eggs to young about a week old (Wetmore, ms.).

Table BFB-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1923	21 Apr.	?	45 nests in one colony on SE side, largest colony on island (Ball, ms.).
	24 Apr.	?	Ca. half with eggs, many with hatching eggs, and a few with two-week-old young (Dickey, ms.).
	29 Apr.-14 May	160	Fresh eggs to well-grown young; some just laying (Wetmore, ms.).
	7 May	?	2 heavily incubated eggs collected (USNM).
1930	2-18 Aug.	6	No nesting reported (Wilder, ms. b).
1936	7-8 Mar.	?	Only eggs found; 6 banded with brass rings (Trempe, ms.).
	12 Dec.	50-100	Had just finished nesting (Coultas, ms.).
1950	23 June	common	Medium and "full-sized" young (POFI).
1951	12 May	?	"Young in down" noted (POFI).
	late June-early July	?	Not distinguished from other species of booby in census; 2,940 boobies (3 species combined); diurnal count (Brock, 1951b: 18).
1955	10 Feb.	100	Most seen at south end of lagoon (POFI).
1957	25 June-3 July	300	1 nest with 2 eggs noted (Woodside, ms. b).
1958	27 May-4 June	?	Most nesting pairs with naked young to young about a month old; most incubated eggs checked were rotten (Warner, ms.).
1959	28 Apr.-1 May	?	Most birds with eggs; a very few with young (Kramer, ms.).
1961	7-8 Mar.	usual number	Few eggs present; most birds paired (Woodside and Kramer, ms.).
	4-10 Sept.	?	Only large young and immatures (Woodside, ms. c).

Table BFB-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1962 14-19 June	?	Mostly 1/2- to 3/4-grown young; several nests with eggs (Kramer and Beardsley, ms.).
1963 11-13 Feb.	small numbers	1 nest with egg (POBSP).
3-10 Dec.	?	1 full-grown unfledged bird and 1 immature; adults seen (Walker, ms. b).
1964 10-11 Mar.	100-150 (20)*	Estimated 10 nests; all with eggs (BSFW, POBSP).
16-20 Sept.	420	Ca. 50 fledged immatures and 10 subadults; also 2 large flightless young (BSFW, POBSP).
1965 6-11 Mar.	400-500 (80-100)*	Nocturnal estimate; 40-50 nests, all with eggs (POBSP).
17-21 July	800*	Estimated 400 young, half- to full-grown (POBSP).
5-12 Aug.	1,000 (400)*	Estimated 200 young--mostly from 1/2- to full-grown; a few recently hatched; no eggs (POBSP).
1966 26-31 Mar.	250	A few nests with eggs (BSFW).
10-16, 20-21 June	500 (300)*	Fresh eggs to nearly fledged young; ca. 50 nests with eggs; 100 nests with young, mostly small chicks; ca. 100 flying immatures. Presumably from previous breeding season (POBSP).
17-18 Sept.	?	Some nearly fledged young (BSFW).
20-23 Oct.	250	Almost all young fledged; no eggs (POBSP).
1967 18-19 Mar.	150	1 nest with egg (BSFW, POBSP).
7-12 June	[2,000] (600)*	Estimated 300 nests; most with eggs, recently hatched or small downy young. Of 200 nests counted, 33% contained eggs, 17% recently hatched young, 33% small downy young, and 17% medium-sized downy young (POBSP).

Table BFB-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 5-11 Sept.	500 (200)*	2 large downy young and ca. 100 dependent immatures; no eggs or small young (POBSP).
13 Dec.	at least several hundred	No nests found but immatures incapable of flight seen (BSFW).
1968 17-19 Mar.	150 (30)*	Most were prenesting; most were paired; 6 nests with fresh or slightly incubated eggs seen (BSFW, POBSP).
1969 26-29 Mar.	64**	32 nests counted, a few more probably present. 4 of 15 nests examined were those of prelaying birds. Of the remaining 11 nests, 9 (82%) contained eggs, 1 (9%) contained an egg and a chick, and 1 (9%) contained a small chick (BSFW).
9 Sept.	?	Some large downy young and several flying immatures seen (BSFW).

*Estimate is of number of breeding birds (birds with eggs or unfledged young).

**An estimate of breeding birds. Possibly no more than 48 birds were with eggs or young.

BROWN BOOBY — Sula leucogaster

Status

Uncommon breeder; maximum recent estimate: [250]. Present in all months but most numerous from May or June through October. Most breeding occurs from late March through October. Nests in small colonies, usually in openings in Scaevola, on the west central part of the island. The nest, usually a substantial mass of vegetation, is on the ground.

Populations

Only in recent years have more than a very few been noted. Prior to 1923 it was recorded as a rare visitor (only 3 definite records) and in 1923 only a single nesting pair was present (Table BB-2). Small

breeding populations have been reported regularly since 1957. Recent POBSP observations indicate a minimum breeding population of 40 birds, although in some years (e.g., 1967) probably fewer birds breed. Populations may reach a maximum of about 100 birds when numbers are swelled by young and visitors from other islands.

Annual Cycle

Few birds occur on the island during the winter, and the early spring population remains low even though nesting may begin in March. Available data on breeding status during various visits suggest that Laysan Brown Boobies may nest in at least ten months of the year (March-December) and further observations may well reveal that breeding may occur in any month. It appears, however, that in most years, very few birds, if any, breed from late December through mid-March and that most birds in the population complete their breeding cycles between mid-spring and mid-fall. Interpolation from the presence of eggs and size of young on various visits suggests that peak periods of laying, hatching, and fledging usually occur respectively in May, late June and early July, and late September and early October.

Ecology

Breeding: Recent nesting has occurred in a relatively small area at the inner edge of the Scaevola zone on the west central part of the island. Here 6 to 25 pairs have been found in one or two loose groups. Substantial nests of grass, sticks, and other vegetable matter are built on the ground.

Non-breeding: Non-breeding birds may occur almost anywhere on the island, but are most frequently seen flying over the reef or roosting on rocks along the shores. No large concentrations have been found, but in September 1967 eleven birds were seen together on a flat rock off the west beach.

Specimens

We know of but three Laysan specimens: an adult male at AMNH and an adult female and an adult male at BPBM.

Banding and Movements

The POBSP and BSFW banded 28 Brown Boobies on Laysan through 1969 (Table BB-1). The only recorded interisland movement is of an adult male, 737-30106, banded on Southeast Island, Pearl and Hermes Reef, on 26 February 1963. It was recaptured where banded on 19 June 1963 with a newly hatched young and subsequently was recaptured on Laysan, 7 March 1965. On 18 March 1965 it was captured on Seal Island, Pearl and Hermes Reef.

Table BB-1. Brown Boobies banded on Laysan.

Period of Survey		Bander	Numbers of Each Age/Sex Class Banded						
			Adult ♂♂	Adult ♀♀	Adult ??	Subtotal Adults	Immature ??	Age ??	Totals
1958	June	BSFW	0	0	0	0	0	5	5
1963	Feb.	POBSP	0	0	2	2	0	0	2
1965	Aug.	"	0	0	3	3	3	0	6
1966	June	"	0	0	3	3	0	0	3
1967	June	"	7	4	0	11	0	0	11
1968	Mar.	"	0	1	0	1	0	0	1
Totals			7	5	8	20	3	5	28

Table BB-2. Observations of Brown Boobies on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	Possibly present; based on vague description by Isenbeck (in Kittlitz, 1834) identified by Rothschild (1893-1900: iv).
1891 16-27 June	?	Not found by Palmer despite intensive search (Rothschild, 1893-1900: 31); Munro (1942b: 6) states they were "very scarce."
1896 24 June-24 Sept.	?	Regular visitor, but not nesting (Schauinsland, 1899: 101).
1902 16-23 May	0	Not seen despite intensive search (Fisher, 1903a: 797).
1903 28 Apr.	?	1 specimen collected by Bryan (BPBM).
1911 24 Apr.-5 June	-	Not mentioned in report (Dill and Bryan, 1912).
1912 22 Dec.-1913 11 Mar.	1	Only 1 seen in 3 months (Bailey, 1956: 69). Seen on 21 January (Willett, ms.).
1923 11 Apr.	1	1 seen in the surf 11 April (Dickey, ms.).
23 Apr.	2	Pair found nesting by Ball (Dickey, ms.).
24 Apr.	2	Birds incubating 2 eggs (Dickey, ms.).
5-7 May	2	Nest still active (Wetmore, ms.).
1936 12 Dec.	0	(Coultas, ms.).
1950 23 June	few	No nests (POFI).
1951 12 May	?	No nests (POFI).
late June-early July	?	2,940 boobies (3 species combined); diurnal count (Brock, 1951b: 18).
1957 25 June-3 July	50	(Woodside, ms. b).

Table BB-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1958 27 May-4 June	a few pairs	1 pair incubating addled eggs; at least 2 pairs with young ca. 3 weeks old (Warner, ms.).
1961 7-8 Mar.	20	Nests with eggs; no young (Woodside and Kramer, ms.).
4-10 Sept.	?	Many immatures, adults, and a few eggs or small young (Woodside, ms. c). Some nearly mature young (Walker, ms. a).
1962 14-19 June	?	More seen this year than in past; most nesting birds with recently hatched young (Kramer and Beardsley, ms.).
1963 11-13 Feb.	2	Evidently not nesting (POBSP).
3-10 Dec.	?	Present, not nesting (Walker, ms. b).
1964 10-11 Mar.	2	None nesting (BSFW, POBSP).
16-20 Sept.	19	Diurnal count; 5 nests; 3 1/2 to 2/3 grown young and 2 almost fledged young (BSFW, POBSP).
1965 6-11 Mar.	5-10	No nests (POBSP).
17-21 July	[250]	Ca. 6 nests with heavily incubated eggs or newly hatched young; estimated 50 young present (estimates probably excessive) (POBSP).
5-12 Aug.	50	Estimated 20 nests: 5 with eggs, 15 with young from newly hatched to full-grown (POBSP).
1966 26-31 Mar.	25	Most at night (BSFW).*
10-16, 20-21 June	80	Fresh eggs to nearly full-grown young; 5 nests with eggs counted; estimated 20 young present (POBSP).
20-23 Oct.	100	Most breeding birds with large dependent young; 1 nest with eggs; number of flying immatures (POBSP).

Table BB-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 18-19 Mar.	15	No nests (BSFW, POBSP).
7-12 June	50	5 nests, 4 with eggs and 1 with a medium-sized downy young (POBSP).
5-11 Sept.	20	4 nests with large downy young; 3 dependent immatures (POBSP).
13 Dec.	3	All adults (BSFW).
1969 17-19 Mar.	4	Only 4 birds (apparently paired) present in colony (BSFW, POBSP).
1969 26-29 Mar.	0	(BSFW).

*One or more active nests present but not seen by survey party.

RED-FOOTED BOOBY — Sula sula

Status

Common breeder; maximum recent estimate: 2,000-3,000. Most breeding is from February through September with smaller numbers present during remainder of year. Builds bulky, well-constructed nest in Scaevola rimming the island and in woody vegetation near the inner lagoon.

Populations

Although observers in the 19th century considered the Red-footed Booby a common part of the breeding avifauna, no actual population estimates were published. More recent observations document a ten-fold increase in population size from the early part of the 20th century to the present time (Table RFB-3).

All observers from 1911 through 1930 noted that very few breeding birds were present, with the lowest breeding population during spring or summer a mere 60 birds in 1930. It seems likely that these low populations resulted from a combination of factors--in part from decimation by feather hunters and in part by destruction of habitat by rabbits introduced to the island. In 1923 Wetmore noted only two colonies nesting in low bushes and remarked further that a number of nests were placed on the ground about the stems of old tobacco plants. Although ground nesting rarely occurs on some bushless islands in the Phoenix Islands to the

south (POBSP data), no ground nests were found from 1963 through 1969 on Laysan or on other Northwestern Hawaiian Islands. The ground nesting reported by Wetmore suggests the extreme lack of nesting habitat available at that time.

Recent numerical estimates indicate that maximum populations are present during the summer and fall. During winter most birds leave the island and the population decreases by about 90 percent. Early spring (March) populations have been quite variable, probably due to variations in the inception of the beginning of the breeding season.

Annual Cycle

Some birds are present during all months but numbers are generally low during mid-winter. A limited amount of egg-laying occurs during February during some years. Generally, however, egg-laying begins in March with the date of inception varying somewhat annually. In 1964 and 1965 about 20 percent of the occupied nests had eggs by the second week of March; in 1967 a similar stage was reached two weeks later.

Egg-laying usually begins in March and probably reaches its peak in April or May. Small young are generally present from sometime in late April or May through June, most nests containing half-grown or larger young thereafter. The first young usually fledge about late June but the peak fledging period is usually in August. Some dependent young are present in September but the breeding season is essentially finished by the end of that month.

Ecology

Breeding: Fisher (1903a: 797) noted that most of the birds nested on the inner slopes of the island, "usually well down towards the lagoon." He further noted that these boobies always built in bushes and never on the ground. Only during 1923 when vegetation was barely existent has ground nesting been observed. Presently, Red-footed Boobies nest primarily in Scaevola and Pluchea bushes (Fig.39). Most of the Scaevola occurs along the rim of the island and it is here, particularly in the northwest quadrate and on the south, that most of the boobies nest. Considerable numbers nest also in the Pluchea and Scaevola surrounding the lagoon, especially in the east and southwest portions.

While most of the boobies nest in colonies by themselves, others often nest among the Great Frigatebirds that utilize much the same habitat.

Non-breeding: Unoccupied and transient boobies utilize the nesting areas for roosting. The Casuarina tree and the palms are other important roosting sites.

Figure 39. Red-footed Booby at nest in low Scaevola, June 1966. Photo by P.C. Shelton.

Specimens

Forty-six Red-footed Booby skins from Laysan are currently distributed in museums as indicated in Table RFB-1. Seven additional mounted specimens are distributed as follows: BPBM (2); MCZ (1 male, 1 female, 1 nestling); SUI (2 birds in Laysan exhibit). Also preserved are at least 1 skeleton (BPBM) and 11 eggs (BPBM, 9; USNM, 2 clutches).

Banding and Movements

The POBSP has banded 860 Red-footed Boobies on Laysan (Table RFB-2). Red-footed Boobies frequently travel between islands. Eighty-four birds originally banded, or handled, on Laysan were subsequently recaptured elsewhere, making 89 movements to other islands. Several birds were recaptured on two or more islands. Recaptures were: Johnston Atoll (39); French Frigate Shoals (25); Lisianski (14); Pearl and Hermes Reef (1); Kure (7); Wake (2); Namu, Marshall Islands (1) (Appendix Table 4-6a). Thirty-six birds (38 movements) from elsewhere visited Laysan from the following islands: Johnston, 14; French Frigate Shoals, 14; Lisianski, 7; Midway, 1; Kure, 1; Wake, 1 (Appendix Table 4-6b).

Table RFB-1. Locations of Red-footed Booby skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	4	2	5	11
BPBM	0	0	5	5
CMNH	2	1	0	3
DMNH	2	0	0	2
MCZ	1	0	0	1
SUI	3	4	0	7
UMMZ	1	1	0	2
USNM	7	6	2	15
Totals	20	14	12	46

Table RFB-2. Red-footed Boobies banded on Laysan by the POBSP.

		Numbers of Each Age Class Banded				
Period of Survey		Adults	Subadults	Immatures	Nestlings	Totals
1963	Feb.	3	0	0	0	3
1964	Sept.	140	2	57	1	200
1965	Mar.	242	0	1	0	243
	Aug.	0	0	184	0	184
1966	June	18	0	0	0	18
	Oct.	115	3	0	2	120
1967	June	30	3	0	0	33
	Sept.	55	3	0	0	58
1968	Mar.	1	0	0	0	1
	Totals	604	11	242	3	860

Table RFB-3. Observations of Red-footed Boobies on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	A vague description by Isenbeck (in Kittlitz, 1834: 123-124) is apparently this species.
1891 16-27 June	very plentiful	Nesting (Rothschild, 1893-1900: 28).
1896 24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).

Table RFB-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1902	16-23 May	?	Most nests with eggs; a few small downy chicks (Fisher, 1903a: 797).
	23 May	?	5 eggs of advanced incubation collected (USNM).
1903	Apr.	?	4 eggs and 3 specimens collected by W.A. Bryan (BPBM).
1904	2 May	?	1 collected by Schlemmer (MCZ).
1905	3 May	?	1 collected by Schlemmer (MCZ).
1906	30 Apr.-28 May	?	2 specimens collected. (One collected on 28 May was a nestling [MCZ]).
1911	24 Apr.-5 June	125	"Not very numerous," increased to peak about 5 June. Nesting (Dill and Bryan, 1912: 20).
1912	late Dec.	very few	(Bailey, 1956: 66).
1913	1 Mar.	40	(Bailey, 1956: 66).
	11 Mar.	100	Nest building (Willett, ms.).
1918	8-10 Sept.	12-15	In bushes at north end of lagoon. No eggs or young found (Diggs, ms.).
1923	8-13 Apr.	?	Small colonies with eggs and small young (Wetmore, ms.).
	29 Apr.-14 May	80	Count (Wetmore, ms.).
	2 May	?	Many eggs still unhatched (Wetmore, ms.).
	13 May	?	Nests under construction and with eggs seen (Wetmore, ms.).
1930	2-18 Aug.	60*	Seen in two colonies, one of them in Casuarina. Young nearly full grown (Wilder, ms. b).

Table RFB-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1936	7-8 Mar.	?	Nesting; only eggs seen (Trempe, ms.).
	12 Dec.	12	One pair nesting in Casuarina (Coultas, ms.).
1950	23 June	common	Medium and "full-sized" young (POFI).
1951	late June-early July	?	2,940 boobies (3 species combined); diurnal count.(Brock, 1951b: 18).
1955	10 Feb.	20	At south end of lagoon (POFI).
1957	25 June-3 July	1,000	(Woodside, ms. b).
1958	27 May-4 June	?	"Most fertile eggs had hatched" (Warner, ms.).
1959	28 Apr.-1 May	?	Most adults on eggs; no young seen (Kramer, ms.).
1961	7-8 Mar.	few	Some with eggs, no young (Woodside and Kramer, ms.).
	4-10 Sept.	?	Many immatures observed; no eggs or small young seen (Woodside, ms. c).
1962	14-19 June	?	Eggs and downy young (Kramer and Beardsley, ms.).
1963	11-13 Feb.	100	Several nests with eggs; 1 full-grown immature (POBSP).
	3-10 Dec.	?	Present, breeding (Walker, ms. b).
1964	10-11 Mar.	500-700	250-300 nests; 10-20% with eggs; some nest building (BSFW, POBSP).
	16-20 Sept.	500	Also an estimated 200 flying immatures; only 1 dependent young (large) seen (BSFW, POBSP).
1965	6-11 Mar.	2,000-3,000	Many sitting on empty nests; ca. 200 nests with eggs; no chicks seen (POBSP).
	17-21 July	1,000*	Ca. 500 nests with half-grown to nearly fledged young (POBSP).

Table RFB-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1965	5-12 Aug.	1,000*	Also an estimated 200 flying immatures. Ca. 400 nests with young half-grown to nearly fledged. A few very small chicks seen (POBSP).
1966	26-31 Mar.	600*	Perhaps 300 nests, a few with eggs, others empty (BSFW).
	10-16, 20-21 June	1,500	Fresh eggs to nearly fledged young; ca. 100 nests with eggs; 300 with young; a fledged immature present (POBSP).
	17-18 Sept.	500+	(BSFW).
	20-23 Oct.	2,500	Only a few near-fledging young present. About 7% of population composed of subadults and flying immatures (POBSP).
1967	18-19 Mar.	150+	Several nests built but no eggs seen (BSFW, POBSP).
	7-12 June	1,500	Estimated 200-250 nests. 172 counted: 89 with eggs (52%); 19 naked chicks (11%); 51 small downy chicks (30%); 12 medium-sized chicks (7%); 1 large downy chick (1%) (POBSP).
	5-11 Sept.	2,000	Ca. 30 large downy young; ca. 80 non-flying immatures; ca. 200 flying immatures (POBSP).
	13 Dec.	at least several hundred	None nesting (BSFW).
1968	17-19 Mar.	100-150	Little nesting; 8 active nests seen (1 with eggs; 7 empty) (BSFW, POBSP).
1969	26-29 Mar.	440*	Of 60 nests whose contents were examined, 20 (33%) were empty but active and 40 (67%) contained eggs (BSFW).
	9 Sept.	?	Several downy young noted (BSFW).

*Estimate is of the number of nesting birds.

PELAGIC CORMORANT — Phalacrocorax pelagicus

Status

Accidental; one record: October 1896.

Observations

The only certain record from Laysan, or from any of the islands of the Hawaiian area, is a female specimen collected 22 October 1896, apparently by one of Schauinsland's correspondents (Rothschild, 1893-1900: 308). Schauinsland (1899: 101) listed the species as a "winter guest."

GREAT FRIGATEBIRD — Fregata minor

Status

Common breeder; maximum recent estimate: 8,000. Peak populations occur between March and September with smaller numbers during the remainder of the year and fewest during winter. May be found nesting in any month but most birds breed from March through October. Builds bulky nests in the Scaevola rimming the island (particularly on the west side) and near the interior lagoon.

Populations

Records from the last decade of the 19th century indicate that Great Frigatebirds, like many other species breeding on the island, were very numerous at the turn of the century but subsequently suffered a great population decline, caused in part by the depredations of feather hunters and in part by the destruction of the vegetation (Table GF-3).

Observations of Munter (1915), who visited the island immediately following the feather poaching era, compared with those of Wetmore (ms.), who visited Laysan when vegetation had become greatly reduced, indicate that the loss of vegetation was by far the more important factor in the reduction of the Great Frigatebird population. In April 1915 Munter observed that some 2,000 frigatebirds had been killed by poachers but he also estimated a population of 30,000, the highest ever recorded for this species on Laysan. Dill and Bryan's (1912) estimate of 12,500 made in the spring four years earlier suggests that the population was indeed large and that Munter did not overestimate numbers present. On the other hand, in May 1923 Wetmore estimated that only about 1,500 frigatebirds were present.

Recent estimates for March, when frigatebirds would presumably be less abundant than in May, suggest that the population has increased concomitant with the reappearance of vegetation. However, even the largest recent estimate, which may be somewhat excessive, is less than two-thirds as large as that recorded by Dill and Bryan.

Annual Cycle

Although POBSP population estimates vary considerably from month to month throughout the year, and in the same month in different years, an annual pattern of population change is apparent.

In only one instance (March 1965) are populations recorded in the spring as large as those recorded in the summer when maximal numbers have been reported. Populations of flying birds (adults, subadults and flying immatures) decrease during the autumn as post-breeding birds disperse from the island. Some of this apparent decrease in population during the fall may be the result of incomplete observation rather than a real phenomenon. The numbers actually utilizing the island may be greater than recorded since many adults would be feeding away from the island during any one census period. Nocturnal populations are usually larger during this period.

During the winter, populations on the whole are considerably smaller than during the breeding season. More observations during the winter are required to further document the reduction in populations at that time.

The breeding cycle, or at least its initiation, is somewhat variable from year to year, but on the whole a fairly consistent annual breeding regime occurs. Eggs may be laid as early as mid- or late January (1936, 1964, 1969) and as late as mid- or late May (1963, 1967) but the peak laying period is usually during March. Peak hatching and fledging periods usually occur during May and late September through late October, respectively. A few young may still be fledging in November and December and young birds, most presumably from the previous breeding season, can be found on the island through at least part of the succeeding breeding season. Although populations breed on an annual basis, it is possible that individuals usually breed no more often than every other year.

Ecology

Breeding: All observers except Wetmore (ms.) report frigatebirds nesting exclusively in woody vegetation; in 1923 birds were nesting on the scanty vegetation remaining and on the ground and slightly elevated ridges. At that time many eggs and some 150 birds (chiefly immatures) were destroyed by sand storms. In June 1967 frigatebirds nested only in Scaevola with nest height averaging 2 feet above ground. In March 1968 heights of eleven nests measured ranged from 12 to 28 inches above ground ($\bar{x}$ = 19.9 in.).

Nesting areas have varied with the distribution of woody vegetation. The chief nesting area from 1890 through 1918 was along the east side of the inner slope of the lagoon basin. Although details are lacking, birds probably nested in Chenopodium, then quite widespread on the island, as well as Scaevola. Birds were scattered in small colonies which in 1911 (Dill and Bryan, 1912: 20) "would cover about 6 acres if placed near together." All observers reported small colonies of from a few to 50 pairs.

Recently birds have nested throughout the island wherever Scaevola was present, particularly on the west side (Fig.40). Nests frequently occur in scattered aggregations whose sizes vary with the amount of Scaevola present.

In March 1968 the numbers of nests in each of eight colonies were recorded. Seven colonies in low (under 4 feet) Scaevola contained 4 to 10 nests each; the eighth colony of 35 nests was in tall (over 5 feet) Scaevola. The more advanced stage of nesting in the tall Scaevola suggests that more elevated positions may be preferred.

Non-breeding: Adults and immatures of various ages spend much time on or over the island and roost in the Scaevola in large numbers at night. A considerable amount of movement to and from the island continues after dark.

Adults spend much time at the nest. Once the nest site is determined, one bird, usually the displaying male, remains at the nest most of the time. After the chick hatches, the young bird is usually sheltered by one parent for a considerable time.

Figure 40. Young Great Frigatebirds in low Scaevola above the west beach, September 1967. Photo by R.B. Clapp.

Specimens

Seventy-nine Great Frigatebird skins from Laysan are currently distributed in museums as indicated in Table GF-1. Eight additional mounted specimens are distributed as follows: BPBM (1 male); CMNH (1 male and 1 female in Laysan exhibit); MCZ (1 nestling); SUI (4 birds in Laysan group). Also preserved are at least 2 skeletons (BPBM); 2 alcoholics (BPBM, USNM); 3 skulls (USNM); and 19 eggs (BPBM, 7; USNM, 12).

Table GF-1. Locations of Great Frigatebird skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	2	5	7	14
BPBM	2	1	5*	8
CMNH	1	2	1	4
DMNH	1	2	1	4
MCZ	3	0	0	3
SUI	6	2	2	10
UMMZ	2	0	1	3
USNM (non-POBSP)	10	4	14	28
Other**	2	2	1	5
Totals	29	18	32	79

*Includes 2 destroyed by dermestids.

**Brit. Mus. (Nat. Hist.) (1 ♂, 2 ♀♀, 1 imm.); U. Minnesota (1 ♂).

Banding and Movements

The POBSP banded 514 Great Frigatebirds on Laysan (Table GF-2). Eleven birds banded on Laysan were later recaptured or recovered as follows: French Frigate Shoals, 2; Kure Atoll, 5; Philippine Islands, 4. One bird originally banded on Kure was recaptured on Laysan (Appendix Tables 4-7a, 4-7b).

Table GF-2. Great Frigatebirds banded on Laysan by the POBSP.

Period of Survey		Numbers of Each Age/Sex Class Banded						
		Adult ♂♂	Adult ♀♀	Subtotal Adults	Sub-Adults	Immatures	Nestlings	Totals
1963	Feb.	2	7	9	1	0	0	10
1964	Sept.	2	8	10	1	4	0	15
1965	Aug.	0	0	0	0	2	0	2
1966	June	23	13	36	2	0	0	38
	Oct.	2	6	8	1	1	135	145
1967	June	139	63	203*	76	0	0	279
	Sept.	15	2	17	8	0	0	25
	Totals	183	99	283	89	7	135	514

*Includes one bird not sexed at time of banding.

Table GF-3. Observations of Great Frigatebirds on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1828	24 Mar.	?	On nests but no eggs (Isenbeck, in Kittlitz, 1834: 121).
1890	16 July	?	Downy young, east of lagoon (Lyons, 1890: 91).
1891	16-27 June	?	Numerous rookeries throughout island; eggs and young present (Rothschild, 1893-1900: 23; Munro, 1953: 56).
1895	Sept.	?	3 or 4 collected by Hall (BPBM).
1896	24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902	16-23 May	?	Eggs and recently hatched young (Fisher, 1903a: 798).
	23 May	?	3 heavily incubated eggs collected (USNM).
1903	22 Apr.	?	4 specimens and 4 eggs taken by Bryan (BPBM).

Table GF-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1906	18 Apr.-30 May	?	5 specimens taken including one nestling (on 30 May) by Schlemmer (MCZ, CMNH).
1911	24 Apr.-5 June	12,500	Nesting (Dill and Bryan, 1912: 20).
1912-1913	22 Dec.-11 Mar.	2,500-3,000	Common on 22 December but most birds were immatures; adults began arriving after 1st of year. Nest building began in middle or late January; first egg found 4 February; in late February a "few over" 1,000 nests counted, ca. 200 containing eggs; an estimated 3,000 birds present by 11 March (Willett, ms., Bailey, 1956: 74).
1915	3 Apr.	30,000	Eggs found (Munter, 1915).
	12 Aug.	?	500 killed as they "have been killing young terns by the hundreds" (Schlemmer and Schlemmer, ms.).
1916	9 Feb.	?	No nests found; 2 large roosts present on the eastern side of the island (Munter, ms.).
1918	8-10 Sept.	16,000	Estimate includes young (Diggs, ms.).
1923	8 Apr.	?	Courting birds and nests with eggs (Dickey, ms.).
	8-13 Apr.	?	Establishing colonies (Wetmore, ms.).
	29 Apr.-14 May	1,500	Fresh eggs, recently hatched young seen; count of 1,377 birds (Wetmore, ms.).
	10 Apr.-4 May		9 fresh eggs collected (USNM).
	18 May	?	Day old nestling noted (Wetmore, ms.).
1936	7-8 Mar.	many thousands nesting	Only eggs present but some eggs pipped. Some birds had evidently not yet laid; 4 banded with brass rings (Trempe, ms.).
	12 Dec.	150	Just completing nesting season (Coultas, ms.).

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1950	23 June	numerous	Eggs and young (POFI).
1951	12 May	?	Eggs and young (POFI).
	late June-early July	9,011	Count, including young birds (Brock, 1951b: 18).
1955	10 Feb.	500	In ca. 5 colonies (POFI).
1957	25 June-3 July	1,500	Adults (Woodside, ms. b).
	8-12 July	?	Most young about 2 months old (Labrecque, 1957: 18).
1958	27 May-4 June	?	From heavily incubated eggs to young a month or more in age (Warner, ms.).
1959	28 Apr.-1 May	?	Some eggs; naked and downy young about equally evident; some courting seen (Kramer, ms.).
1961	7-8 Mar.	very numerous	Courting males; eggs; no young seen (Woodside and Kramer, ms.).
	4-10 Sept.	?	Mostly well-grown young and immatures; no eggs or small young (Woodside, ms. c).
1962	14-19 June	?	Mostly with downy chicks (Kramer and Beardsley, ms.).
1963	11-13 Feb.	100	Nesting? (Probably fledged young) (POBSP).
	3-10 Dec.	?	Most young able to fly; 2 with down on neck (Walker, ms. b).
1964	10-11 Mar.	3,500-4,000	1,200-1,500 nests, most with eggs; a few with recently hatched young. One 2/3 grown young seen (BSFW, POBSP).
	16-20 Sept.	2,000	Mostly young 3/4 grown to nearly fledged and immatures; a few young 1/2 grown or less (POBSP).
1965	6-11 Mar.	4,000-5,000	Ca. 500 nests with eggs (POBSP).

Table GF-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1965	17-21 July	3,500	Ca. 1,500 nests; from recently hatched to nearly fledged young; 200 flying immatures* (POBSP).
	5-12 Aug.	5,000	Ca. 1,500 young from small, downy chicks to flying immatures (POBSP).
1966	26-31 Mar.	3,500-4,000	No count; estimate based on March 1964; very few nests with eggs; no chicks (BSFW).
	10-16, 20-21 June	5,000	From heavily incubated eggs to flying immatures;* 1,000 nests--100 with eggs; most with small to medium-sized downy chicks (POBSP).
	17-18 Sept.	?	Many immatures and large young in nests (BSFW).
	20-23 Oct.	1,500	Most nests with near-fledged or fledged young; no eggs or downy young seen (POBSP).
1967	18-19 Mar.	2,000	On empty nests or eggs; many males seen displaying (BSFW, POBSP).
	7-12 June	8,000	1,177 nests counted: of 1,177 nests examined 460 (39%) with eggs; 202 (17%) recently hatched young; 440 (37%) small downy young; 75 (6%) medium to large downy young. Count believed to be about 90% complete (POBSP).
	5-11 Sept.	3,000	No eggs; 1 small downy young; ca. 500 large young, still downy or retaining some down (POBSP).
	13 Dec.	several thousand	Many immatures; no evidence of nesting (BSFW).
1968	17-19 Mar.	1,500	175 nests counted: 54 (31%) still empty; 121 (69%) with eggs; no downy young seen; flying young present; courtship noted (POBSP).

*Probably young from a preceding breeding cycle.

Table GF-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1969 26-29 Mar.	2,286*	Count of 1,142 nests, a few more may have been present. Of 80 nests examined, 32 (40%) were empty but active and 48 (60%) contained eggs.
9 Sept.	hundreds	Nesting status not checked (BSFW).

*Estimate is of the number of breeding birds.

EMPEROR GOOSE — Philacte canagica

Status

Accidental; one record: March 1969.

Observations

On 27 March 1969 Olsen and Sincock flushed four Pintails and 11 Shovelers from the edge of the southeastern corner of the lagoon. Remaining behind was an Emperor Goose that was carefully studied through a 7 x 35 binocular from a distance of about 75 yards. It was approached to within 30 yards before it flushed, alighting again at the north end of the lagoon.

The following day Kridler saw the bird on the east side of the lagoon and confirmed the identification. It was seen again on 29 March by other members of the field party.

Emperor Geese are among the least common of vagrant waterfowl in the Hawaiian area. They have been recorded only four times in the main Hawaiian Islands (Oahu, Kauai, and Hawaii), and only once each from Kure, Midway, and Laysan in the Northwestern Hawaiian Islands (Clapp, Kleen, and Olsen, 1969).

MALLARD — Anas platyrhynchos

Status

Rare visitor; three records: November 1896, January-February 1913, March 1968.

Observations

Rothschild (1893-1900: 307) reported a specimen collected 7 November 1896, apparently by one of Schauinsland's correspondents. Schauinsland (1899: 101) later listed the Mallard as a "winter guest."

Bailey (1956: 79) recorded the Mallard again when he and Willett visited Laysan. He reported that a male and female "were noted in flight on January 4 [1913], and we flushed them from the little fresh water pond on the southwest end on the 11th and February 8." Extracts from Willett's (ms.) report, however, state that the pair were seen from 22 December through 9 February. Both the male (USNM 24091) and the female (USNM 24092) were collected by Bailey on the latter date.

On the morning of 18 March 1968 Clapp flushed a drake from the northernmost of the two small inlets at the southwestern corner of the lagoon. It was not seen subsequently.

Mallards are occasional migrants to the main Hawaiian Islands (Bryan, 1958: 9) but are decidedly uncommon visitors to the Northwestern Hawaiian Islands.

LAYSAN TEAL — Anas laysanensis

Status

Endemic. Uncommon; maximum recent estimates about 500-700 birds. Occurs throughout the island but predominately in vegetation near the lagoon. Most nesting is from late April through August. Nest is a down-lined depression under vegetation.

Populations

The Laysan Teal was apparently never very common and its confiding ways and dependence on the lagoon increased its vulnerability. Ducks were killed for food and sport by members of the early guano operation (Warner, 1963: 11) but were apparently protected by some island managers. Nevertheless, Fisher estimated the population at under 100 in 1902 (Table LT-3). More were killed for food during the feather raids of 1909 and in 1911 Dill and Bryan estimated a total remaining population of only six adults (7 adults and 5 young according to Bryan on p. 28). Next year Bailey counted seven birds. At this time rabbits were seriously affecting the vegetation and teal were concentrated at the small fresh water pond near the southwest corner of the lagoon, always a favorite spot.

In 1915 Munter counted 13 on the fresh water pond during a quick survey of the island on 3 April and Schlemmer recorded 18 birds on 26 July. Probably others had been killed by feather hunters earlier that year. Efforts to exterminate the rabbits in 1912-1913 failed but

perhaps slowed destruction of the vegetation for a time. However, almost no vegetation remained when Wetmore arrived in April 1923 and his maximum of 20 birds seen was probably the entire remaining population. By this time the fresh water pond had filled with drifting sand and even the lagoon was filling. The few brief surveys made during the next decade, as the vegetation became re-established, indicate an almost miraculous escape from extinction.

Later counts suggest a steady increase in population even though the number of birds seen remained low. By 1936 the vegetation was recovering and Coultas (ms.) counted 11 birds during a brief survey of the island. In June 1950 Brock (1951a: 371-372) counted 26 adults and two broods during a walk around the lagoon and in the following summer he counted 39 birds. These counts are probably quite conservative because most teal remain under vegetative cover during the day.

In 1957 22 adults were counted on a transect census by Woodside (ms. b) and the population was estimated at between 580 and 740 birds. Similar transect censuses conducted in 1958 and 1961 gave population estimates within the range of 600 to 700 birds which is probably about the present population. Population estimates of the POBSP from 1963 to 1968 are not comparable as these are visual estimates and not census figures. Potentially valuable data from banding ratios by BSFW and HDFG personnel are not presently available. Warner's statement (1963: 14) that a level of about 600 birds is at or near the saturation level is probably correct.

Habits

Most observers visiting Laysan commented on the teal and most of this literature (and his observations) were compiled by Warner (1963: 3-23) in the most useful single work on the species. The following account draws heavily from his compilation. As a result of recent interest in the teal and other endangered species by BSFW personnel, the POBSP made only cursory observations on the endemic species.

Teal are largely terrestrial but can fly when pressed. They usually seem reluctant to fly and most flights are for not more than a few hundred yards. When approached, birds usually walk into vegetative cover but less often paddle out onto the lagoon or take flight. Many observers have commented that teal rarely occur on the main lagoon and almost never on the ocean. However, in February 1963 Kramer (1963) reported over 60 birds, in flocks of 8 to 12, far out on the lagoon. Birds usually occur singly, in pairs or in small groups except when concentrated near the lagoon--here flocks of up to 55 birds have been observed (Walker, 1963: ms. b). During the guano period, teal were said to be very tame and even today are very curious and can often by approached closely with a little care.

Human activity, particularly the killing of adults for food, undoubtedly did grave harm to the population until early in the 20th

century. Adults have no known enemies on the island and destruction of eggs (by Laysan Finches) and young (by frigatebirds) was probably negligible. The limiting factor throughout much of the teal's history, as now, must have been the environment. That the teal survived the destruction of vegetation in the 1920's is remarkable as the vegetation provided both cover and food. Wetmore (ms.) noted that birds rested during the day among rocks and at night walked inland to the lagoon margin and patches of vegetation. The rocks probably provided cover from sand storms and the lagoon and vegetation provided their food supply. Warner noted that Sesuvium, so heavily utilized when it was the major remaining vegetation on Laysan, is now "completely ignored" as a food source. He also believed that a much greater dependence on littoral feeding probably occurred during the critical devegetated period.

Warner suggests that larger areas of fresh water habitat were available during the evolutionary development of the species. The fresh water pond present near the southwest end of the lagoon was heavily utilized by teal until its disappearance in the 1920's. More recently ducks have concentrated at the slightly brackish water available at several points on the island following heavy rains. Although captive birds utilize fresh water for both bathing and drinking, the Laysan population survives long periods without apparent harm when neither fresh nor slightly brackish water is available.

Teal occur throughout the island but most are concentrated, during the daylight hours, at the beach morning glory near the lagoon. Most spend the day resting under cover but a few can usually be seen walking around the lagoon edge, in the sedges nearby or just loafing in either area. The teal is largely nocturnal and most feeding and other activity begins at dusk. Warner (op. cit., 11) determined that "movements followed a regular pattern and indicated favored routes for feeding activities." He determined the home range to be about two acres--much smaller during the summer molting (and flightless) period. Woodside and Kramer (ms.) state "it appears that the home range (territory?) of each pair usually contains a strip of lagoon shore." Banding returns also suggest that the birds do little moving about the island.

The Laysan Teal is primarily insectivorous, at least during the summer months. Warner (p. 15) describes in detail their nocturnal feeding on cutworms, both from vegetation and sifted from the sand beneath, and the pursuit of brine flies along the lagoon edge. Teal also sift sand around rotting carcasses, probably for fly and beetle larvae and pupae. Early observers noted crepuscular feeding on the myriads of small moths then so prevalent on the island. Teal also puddle around the edges of small potholes near the lagoon (in 1967 on the southeast end). Warner also observed feeding on littoral invertebrates, particularly at the south end of the island.

The nesting cycle is apparently an extended one. Pairing has been observed by early March (Woodside and Kramer, ms.) and continues until at least mid-summer. Although numerous observers report "pairing activity"

and Warner noted copulation, there seems to be no published report of actual courtship behavior. Warner suggests that pair bonds may be formed in September after the late-summer molt. Some observers report considerable aggression (territorial defense?) between birds while others (e.g., Woodside and Kramer, ms.) comment on its lack. In captivity birds are very aggressive both toward other species and their own. Breese (in Warner, p. 20) reported infra-specific aggression as one of the major factors in acclimating the birds to captivity.

The nest is a shallow bowl of vegetation lined with bits of down and secreted under vegetation, usually Cyperus, Chenopodium or Scaevola. Kridler (1964) reported a nest site being prepared under a bush on 10 March. The eggs are greenish-white and large for the size of the bird (55 x 38 mm., Fisher). The usual clutch size is five or six. Few nests with eggs have been reported in the wild and the earliest hatching date is 19 May (Fisher, 1903a: 799-800). Interpolation of dates based on the sizes of chicks observed and an incubation period of 27 to 28 days would indicate that most egg laying occurs during May with a span from early May through probably July. Woodside (ms. c) reported "gravid females" in early September. In captivity (Lint, 1960: 7) the drake guards the incubating female (also observed on Laysan, 30 April [Kramer, ms.]) and the chicks remain in the nest with the hen for two days. In the wild, males sometimes attend the brood. Warner commented that it was rather common to find elements of two broods being cared for by a single bird.

Introductions

A report of flightless ducks on Lisianski in 1828 is not convincing and is almost certainly erroneous. Wetmore (ms.) reported that 24 or 25 were brought to Honolulu by George D. Freeth about 25 years earlier and released about 1894 by a Mr. Whitney in the Kewalo marsh in the outskirts of Honolulu. The birds were strong and flew well but none was taken since. In 1958, thirty-six adults were transported to the Honolulu Zoo for acclimatization and were ultimately donated to selected aviculturalists in the United States and Europe (Warner, op. cit.). These aviaries were generally successful in rearing teal, and preservation of the species seems assured.

In March 1968 twelve birds were introduced (from Laysan) to Southeast Island, Pearl and Hermes Reef, by BSFW personnel. Three days later at least four of these birds had left the island or were dead on the island and at present none remains.

Specimens

Fifty-three Laysan specimens are currently distributed in museums as indicated in Table LT-1. Eight additional mounted specimens are distributed as follows: AMNH (2 in Laysan exhibit); BPBM (2); DMNH (2 in Laysan exhibit); SUI (2: 1 in Laysan exhibit; 1 in extinct bird case).

Banding and Movements

A total of 525 Laysan Teal was banded since 1958, chiefly by BSFW and HDFG personnel. No natural interisland movements are known for this sedentary species.

Table LT-1. Locations of Laysan Teal skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	7	10	2	19
BPBM	2	3	9	14
MCZ	4	2	0	6
USNM (non-POSSP)	5	7	1	13
Other*	0	0	1	1
Totals	18	22	13	53**

*Carnegie Mus. (1).

**Additional specimens are said to be at Berlin, Bremen, Chicago, London, Los Angeles and Paris (Greenway, 1958: 168, 169).

Table LT-2. Laysan Teal banded on Laysan.

Period of Survey		Bander	Males*	Females*	Adults ??	Young	Sex/Age Unknown	Totals
1958	June	BSFW	0	0	0	0	94**	94
1961	Sept.	HDFG***	119	74	0	11	0	204
1963	Dec.	HDFG	5	12	0	0	0	17
1964	Mar.	BSFW	58	41	0	0	0	99
	Sept.	BSFW	4	7	0	0	0	11
1965	Mar.	POBSP	0	0	25	0	0	25
1966	Mar.	BSFW	27	7	0	0	0	34
	Sept.	BSFW	1	2	0	0	1	4
1967	Sept.	BSFW	3	4	0	6	0	13
1968	Sept.	BSFW	8	8	0	8	0	24
Totals			225	155	25	25	95	525

*Presumably adults except those in March and September 1966 for which age is not known.

**36 of these birds were transported to the Honolulu Zoo.

***In conjunction with the Coolidge Expedition.

Table LT-3. Observations of Laysan Teal on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1828	24 Mar.	small flocks	Not breeding (Isenbeck in Rothschild, 1893-1900: v).
1891	16-27 June	not very plentiful	Breeding (Rothschild, 1893-1900: 20).
1895	Sept.	?	At least 1 collected by Hall (BPBM).
1896	24 June-24 Sept.	?	Breeding (Schauinsland, 1899: 101).
1902	16-23 May	<100	Eggs hatching and small ducklings 19-21 May (Fisher, 1903a: 799-800).
1903	5-28 Apr.	?	At least 15 collected by W.A. Bryan (AMNH, BPBM).
1907	16-20 May	?	At least 7 collected by M. Schlemmer (MCZ, AMNH).
1911	24 Apr.-5 June	?	"Flocks of up to 6" (Dill in Dill and Bryan, 1912: 23). Only 7 adults seen in 1 day; 5 young seen (Bryan, loc. cit.: 28). 3 specimens collected (SUI, UMMZ).
1912 1913	22 Dec.-11 Mar.	7	3 pairs and an odd male (Bailey, 1956: 80). Not nesting by 11 March (Willett, ms.).
1915	3 Apr.	13	On pond (Munter, 1915: 139).
	26 July	18	Counted (Schlemmer and Schlemmer, ms.).
1916	9 Feb.	35	On pond near south end of island (Munter, ms.).
1918	8-10 Sept.	quite numerous	1 flock of at least 20; others of from 2-6 birds. No nests found (Diggs, ms.).
1923	8-13 Apr.	17	Small flocks and pairs, pre-laying (Wetmore, ms.).
	29 Apr.-14 May	20	18 seen in Sesuvium patch on NE side of lagoon on 23 April (Ball, ms.). 6 collected (Wetmore, ms.).
1924	6 May	2(?)	Only 2 seen (Wilder, ms. a).

Table LT-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1928	6 May (?)	15	Seen in 1 flock by W.G. Anderson (Wilder, ms. b).
1930	2-17 Aug.	1	A single female seen. A nest with eggs punctured by a curlew found (Wilder, ms. b).
1936	7-8 Mar.	40-50	Most seen in 2 flocks (Trempe, ms.).
	12 Dec.	11*	2 collected (Coultas, ms.).
1950	23 June	26	Also 7 downy young counted around lagoon (Brock, 1951a: 371-372).
1951	late June-early July	39	Count (Brock, 1951b: 17).
1955	10 Feb.	≤200	"161 counted and more known to be on nests" (POFI; Warner, 1963: 13).
1957	25 June-3 July	580-740	Based on census; as many as 22 adults and 13 young seen feeding on flies at one time; 10 teal seen with broods of young (1 with 6, 2 with 4, 4 with 3, 1 with 2 and 2 with 1), copulation and a nest (or nests) with eggs observed (Woodside, ms. a, b).
		400-600	Based on cursory transect census (Warner, 1963: 13).
	8-12 July	?	"...perhaps a dozen...together...they were no doubt much more numerous..." (Labrecque, 1957: 18).
1958	27 May-4 June	594	Estimate based on transect census. Actual count of 25 on census. No nests found; behavior "suggested that egg laying and possibly incubation were occurring" (Warner, 1963: 13; ms.).
1959	28 Apr.-1 May	600-700	150 counted along lagoon; 2 nests found 30 April, 1 with 6 eggs and 1 with 4 eggs; an estimated 90-95% paired (Kramer, ms.).

*Bailey (1956: 80) gives the number seen as 14.

Table LT-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1961 7-8 Mar.	600-700	437 counted in a circuit of the lagoon over a period of a day and a half. No young nor nests found; pairing behavior observed (Woodside and Kramer, ms.).
4-10 Sept.	688-746	Low estimate based on transect census (Warner, 1963: 13). 21 teal actually counted (Woodside, ms. c).
		High estimate based on banding data; 11 young from two weeks old to full grown seen at night; an additional 1 or 2 broods of 1 young seen during day (Woodside, ms. c).
1962 14-19 June	?	1 duckling, perhaps 2 weeks old, seen; several females apparently heavy with eggs (Kramer and Beardsley, ms.).
1963 11-13 Feb.	500	300 counted (POBSP); 145 counted by Kramer (BSFW).
3-10 Dec.	?	Daily counts of 103-112 (Walker, ms. b).
1964 10-11 Mar.	400-500	"Prenesting" (POBSP). Count of 235 around lagoon on 10 March (BSFW).
16-20 Sept.	400	Count of 202, a few 1/3 grown ducklings seen (POBSP).
19-20 Sept.	400	Count of 257 (BSFW).
1965 6-11 Mar.	200-300	No nests found (POBSP).
17-21 July	200	Few seen (POBSP).
5-12 Aug.	150-200	Less than 50 large ducklings (POBSP).
1966 26-31 Mar.	?	169 counted around lagoon on 27 Mar. A brood of 3 ducklings less than week old seen (BSFW).
10-16, 20-21 June	300	215 counted on 13 June. 4 broods of 2 young seen (POBSP).
17-18 Sept.	?	126 counted; census considered unsatisfactory; no broods (BSFW).

Table LT-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1966 20-23 Oct.	450	137 seen at about same time (POBSP).
1967 18-19 Mar.	?	No count made (BSFW).
7-12 June	300	No nesting recorded (POBSP).
5-11 Sept.	300-400	Young in post-juvenal molt (POBSP).
13 Dec.	?	6 seen; no census made (BSFW).
1968 17-18 Mar.	several hundred seen	No eggs or young found (BSFW, POBSP).
1969 ~~26~~-29 Mar.	476	Estimate derived from transect census. (14 teal actually counted during census). 123 counted on beatout census around lagoon (BSFW).
2-3 June	?	85 counted around lagoon on evening of 2 June. Most ducks apparently paired; a day old dead young found (BSFW).
9 Sept.	?	74 counted on beatout census along lagoon. No broods of young seen (BSFW).

PINTAIL — Anas acuta

Status

Uncommon but regular visitor; at least eleven records.

Observations

The most abundant anatid migrant to the Hawaiian area, Pintails have been reported from Laysan in larger numbers than any other species of vagrant or migrant duck (Table P-1). This species probably occurs on Laysan almost every year.

Table P-1. Observations of Pintails on Laysan.

When Observed	Number Seen	Remarks and References
1896 (7?)	?	Listed by Schauinsland (1899: 101) as "winter guest;" 3 specimens taken by him or his correspondents later deposited in Bremen Museum (Rothschild, 1893-1900: 307).

Table P-1. (continued)

When Observed		Number Seen	Remarks and References
1903	19 Apr.	?	Hitherto unreported specimen (♀, BPBM 2981), collected by W.A. Bryan is in Bishop Museum.
1912	24 Dec.	15	Seen over the ocean by Willett and Bailey (Bailey, 1956: 83).
	26 Dec.	8	(Bailey, 1956: 83).
	27 Dec.	12	(Bailey, 1956: 83).
1958	1 June	1	Drake on mud-flats near lagoon (Warner, 1963: 6).
1963	7 Dec.	3	Males; on west side of lagoon (Walker, ms. b).
1966	26-31 Mar.	1	Female on east side of lagoon some time during survey period (BSFW).
	17-18 Sept.	3	Males. 14 other migratory ducks also observed but not identified (BSFW); these may have been some of those subsequently seen by a POBSP survey team.
	21 Oct.	19	On pond at north end of lagoon (POBSP).
1968	18 Mar.	3	Drake and hen seen under Scaevola with a few Laysan Teal near the southwestern corner of lagoon. 2 hens subsequently flushed from this area (POBSP).
1969	27 Mar.	5	Seen at southeast corner of lagoon (BSFW).
	9 Sept.	63	Censused in central lagoon (BSFW).

COMMON TEAL
(GREEN-WINGED TEAL) — Anas crecca

Status

Accidental; two records: October 1896; March 1969.

Observations

The Common Teal was reported as a "winter guest" on Laysan by Schauinsland (1899: 101). Rothschild (1893-1900: 307) reported a female specimen collected by one of Schauinsland's correspondents on 27 October 1896. He listed this bird as Nettion carolinense [= A. crecca carolinensis] because A. c. crecca had not been taken on the Pacific coast of America. Bailey followed him by listing the record as A. c. carolinensis. Recently, on 27 March 1969, Kridler (pers. corrs) saw three other female teal on the lagoon.

Since females of the two subspecies are very difficult to distinguish, we believe that no subspecific designation should be attached to the specimen until it has been re-examined.

Teal, either crecca or carolinensis, have also been reported from Midway Atoll in the Northwestern Hawaiian Islands (Clapp and Woodward, 1968: 12-13) and are occasional migrants to the main Hawaiian Islands (Udvardy, 1961a: 84).

[GARGANEY TEAL — Anas querquedula]

Status

Hypothetical; one unconfirmed record.

Observations

Schauinsland (1899: 101) reported this species as a "winter guest" on Laysan but Rothschild (1893-1900: 307) later stated that he thought the bird seen by Schauinsland was "more likely" a Blue-winged Teal (Anas discors). Rothschild stated (1893-1900: 308) that, with the exception of two shorebirds, he had examined the specimens of the fifteen species (including the Garganey Teal) added to the Laysan list by Schauinsland. This clearly suggests that he had seen a specimen of this duck.

Checklists of the Hawaiian area (Henshaw, 1902; Bryan and Greenway, 1944; Bailey, 1956; Bryan, 1958; and Udvardy, 1961a make no mention of this record. Since Garganey Teal recently were reported from Midway Atoll (Clapp and Woodward, 1968: 12) and, since Blue-winged Teal have not been reported from the Northwestern Hawaiian Islands, we feel that Schauinsland's original identification could well have been correct.

AMERICAN WIDGEON (BALDPATE) — Mareca americana

Status

Rare visitor; two records: October 1896; March 1964.

Observations

The only specimen record from Laysan is an immature female collected 15 October 1896 and subsequently reported by Rothschild (1893-1900: 307). On 10 March 1964 Walker (BSFW) saw two drake American Widgeons standing on a sandbar on the east side of the lagoon.

This species has also been reported from Midway in the Northwestern Hawaiian Islands (Clapp and Woodward, 1968: 13) and is a regular visitor in small numbers to the main Hawaiian Islands (Udvardy, 1961: 85).

SHOVELER — Spatula clypeata

Status

Uncommon visitor; at least seven records.

Observations

Shovelers have been observed more frequently on Laysan than any species of vagrant duck but the Pintail. This is not surprising since these two species of ducks are the most abundant of those that regularly migrate to the main Hawaiian Islands; thousands of Shovelers and Pintails were reported from there by Medeiros (1958: 111). Table Sh-1 summarizes known records of Shovelers from Laysan Island.

Table Sh-1. Observations of Shovelers on Laysan.

When Observed	Number Seen	Remarks and References
1896 Oct.-Nov.	?	Rothschild (1893-1900: 275, 307) lists records from October, November
1897 Jan.	?	and January apparently based on specimens secured by Schauinsland or his correspondents; "winter guest" (Schauinsland, 1899: 101).
1913 30 Jan.	6	Flock seen by Willett (Bailey, 1956: 84).
1916 Nov. or Dec.	1	Shot by Eric Schlemmer who identified bird by its broad bill (Wetmore, ms.).
1961 7 or 8 Mar.	2	Pair on north shore of lagoon (Woodside and Kramer, ms.).
1963 7 Dec.	9	5 males, 4 females on west side of lagoon (Walker, ms. b).

Table Sh-1. (continued)

When Observed	Number Seen	Remarks and References
1966 22 Oct.	3	On small pond north of lagoon (Clapp and Woodward, 1968: 14; POBSP).
1969 22 Mar.	14	At southeast corner of lagoon (BSFW).

BUFFLEHEAD — Bucephala albeola

Status

Rare visitor; two records: January 1897, December 1912-January 1913.

Observations

Schauinsland (1899: 101) recorded this species as a "winter guest" on Laysan. Rothschild (1893-1900: 307) reported a juvenile male collected 15 January 1897, apparently by one of Schauinsland's correspondents.

Bailey and Willett saw a female Bufflehead over the beach on 27 December 1912. On 3 January 1913 Willett collected a female (USNM 240989), probably the same bird, on a fresh water pond (Bailey, 1956: 84).

HARLEQUIN DUCK — Histrionicus histrionicus

Status

Accidental; one record: April 1906.

Observations

An immature female (BPBM 4538) taken by Bompke (Bailey, 1956: 84) on 17 April 1906 is the only record for any of the Hawaiian Islands.

LAYSAN RAIL — Porzanula palmeri

Status

Endemic. Formerly an abundant permanent resident. Extinct, probably since 1923. Nested in bunch grass and especially in the Cyperus fringe around the lagoon. Nesting apparently occurred from April through July.

Populations

The Laysan Rail, both abundant and conspicuous, was recorded by even the casual observer. General descriptions by Isenbeck in 1828 and

by a Captain Wood in 1872 were referred to this species by Rothschild (1893-1900: 10). Palmer (in Rothschild, 1893-1900: vii) purchased several live birds from a ship captain before his voyage up the Leeward Chain and the number of old, unlabelled specimens in the Bernice P. Bishop Museum suggests that others were captured as curiosities. Frohawk (1892: 247) used live birds shipped to Europe in his formal description of the species.

Although all visitors reported the species, only two (prior to Wetmore) gave population estimates (Table LR-2). The rail was still "abundant" during the winter of 1912-1913 although rabbits were then making serious inroads on the vegetation. Two years earlier Dill and Bryan had estimated a total population of 2,000 birds. Munter estimated a population of 5,000 in 1915 and said they were "everywhere" on the island. The population probably dropped drastically as the vegetation disappeared.

Wetmore found only one or two mummies from 8 to 13 April 1923 but reported that two singles were seen at different parts of the island during his temporary absence (14 to 28 April). He introduced eight birds from Midway on 29 April and later found several mummies believed to be from this stock. Subsequent to his introduction the party saw one or two birds at intervals at two points on the island. The species probably became extinct soon after this visit--at any rate the species was never again seen on Laysan and with the destruction of the Midway population in June 1944 the species vanished forever. A re-introduction to Laysan after the vegetation became re-established might well have saved the species.

Laysan Rails were introduced to other islands on several occasions: to Midway 13 July 1891 (Munro, 1947: 24), and in 1904 [1905?] (Wilder, ms. b), 14 March 1913 (Bailey, 1956: 89); to Lisianski in March 1913 (Bailey, op. cit.); from Midway to Pearl and Hermes Reef in 1929 (Baldwin, 1947: 14); from Midway to Laysan in 1923. However, only on Midway did rails become well established. The introduction to Lisianski and re-introduction to Laysan occurred after massive destruction of the vegetation by rabbits; the Pearl and Hermes Reef population was probably destroyed by storms during the first winter; the Midway population survived until rats were introduced to the islands. Suggestions that rails were introduced on islets off Oahu are without documentation (Munro, op. cit.).

Habits

Paul H. Baldwin compiled nearly all available information on the Laysan Rail in a popular account (Baldwin, 1945) and later (Baldwin, 1947) in a scientific paper. The latter paper included both published material and data from personal conversations with several men who had observed the rail in life, either on Laysan or on Midway. The most informative original account is that of Fisher (1903a: 800-802). The following summary is from several sources but draws most heavily from Baldwin (1947).

The Laysan Rail was conspicuous and very active, running rapidly between bits of cover, creeping through vegetation or darting in and out of burrows. On Laysan, rails were most active during the morning and evening but on occasion were equally active throughout the day. Though flightless the wings were used for balancing when running, jumping, or fighting. Rails were inquisitive and comparatively fearless, readily entering buildings for such tidbits as meat scraps from the skinning table. Palmer (in Rothschild, 1893-1900: 10) comments on this inquisitiveness as follows: "I could always catch them by placing my net edgeways on an open space of ground, for they would immediately run up to see what it was."

Rails were virtually omnivorous, eating a wide variety of arthropods, eggs of seabirds (which they on occasion broke themselves), and bits of flesh from carcasses. Fresh water was used for bathing and drinking when available. Birds were quite vocal, calling intermittently when foraging and occasionally giving a "rattle" which seemed to be a territorial call. Frohawk (1892: 248) described a dusk chorus by several birds and lasting but a few seconds which sounded like a handful of marbles thrown onto a glass roof and then descending in a succession of bounds.

Rails occurred over the entire vegetated area of the island. The preferred nesting area was the ring of "Juncus" (actually Cyperus) surrounding the lagoon but bunch grass was heavily utilized as well. Nest building began in April and nests were present into July. Nests were placed on the ground. Those in Cyperus were often a hollowed-out, rearranged accumulation of dried stems; those in grass tussocks were bulkier masses of dried grasses and leaves, lined with shredded stems and young albatross down. The nature of the vegetative cover (especially in Cyperus) often "roofed" the nest.

Eggs were recorded during May and June. The usual clutch was three, less frequently two. Eggs were pale olive buff with faint varied markings of "pale clay color or raw sienna and faint lilac gray" (Fisher, 1903a: 801). On Laysan most chicks hatched in June. The downy chicks (all black with yellow bill and black legs and feet) were very noisy and probably stayed with the parents for a month. They soon learned to feed themselves and in five days could run as fast as their parents.

Specimens

One-hundred thirty-two Laysan Rail skins are currently distributed in museums as indicated in Table LR-1. Eight additional mounted specimens are distributed as follows: BPBM (1 male, 1 female); DMNH (2 males and 1 female in Laysan exhibit); SUI (3 birds in Laysan exhibit). Also preserved are at least 9 skeletons (1 a partial) at USNM; 3 nests (BPBM, 2; USNM, 1); and at least 12 eggs (BPBM, 6; USNM, 6).

Table LR-1. Locations of Laysan Rail skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	18	11	16	45
BPBM	9*	14	3	26
CMNH	2	2	0	4
MCZ	1	2	0	3
UMMZ	0	0	16	16
USNM	21	14	0	35
Other**	2	1	0	3
Totals	53	44	35	132***

*Includes 1 transplant from Midway.

**Law Coll. (1 ♂, 1 ♀ [missing]); Acad. Nat. Sci. Phila. (1 ♂).

***According to Greenway (1958: 235), additional specimens are at Berlin and London.

Table LR-2. Observations of Laysan Rails on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	?	An inaccurate description by Isenbeck (in Kittlitz, 1834: 124) was applied to this species by Rothschild (1893-1900: v).
1872	?	Finsch (in Hartlaub, 1893: 400) reported species on basis of description by Capt. Walter Edward Wood (in Rothschild, 1893-1900: 10).
1891 16-27 June	?	"Very plentiful," all over the island; 2 nests (Rothschild, 1893-1900: 10).
1896 24 June-24 Sept.	?	Present, apparently numerous (Schauinsland, 1899: 42-43).
1902 16-23 May	?	"Great numbers;" everywhere; many nests with fresh eggs; young apparently begin to hatch in middle of June (Fisher, 1903a: 800-802).
23 May		4 clutches of eggs (1 partly incubated) and 2 nests collected (USNM).

Table LR-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1903	15-25 Apr.	?	At least 19 birds and nest and egg taken by W.A. Bryan (AMNH, BPBM).
1904	10 May	?	2 collected by Schlemmer (MCZ).
1905	19 Sept.	?	Mentioned in report (Wilder, 1905: 393).
1911	24 Apr.- 5 June	2,000	"Fairly abundant;" nests (but no eggs); 2 chicks on 4 June (Dill and Bryan, 1912: 21).
1912 1913	22 Dec.- 11 Mar.	?	"Abundant" all over island, about 100 transported to other islands (Bailey, 1956: 84-90). Not nesting by 11 March (Willett, ms.). At least 45 collected (CMNH, JEL, MCZ, UMMZ, USNM).
1915	3 Apr.	5,000	"Everywhere on the island" (Munter, 1915: 139).
1916	9 Feb.	?	"Seen everywhere" (Munter, ms.).
1918	8-10 Sept.	?	Often seen (Diggs, ms.).
1923	8-13 Apr.	-	1 or 2 mummies found (Wetmore, ms.).
	14 Apr.	-	1 seen east of lagoon by Reno (Ball, ms.).
	16 Apr.	-	Rail mummy found by Reno (Dickey, ms.).
	18 Apr.	2	Two rails known to be alive, one seen in guano piles, the other in Sesuvium (Dickey, ms.; Wetmore, ms.).
	23-28 Apr.	0?	Storm with heavy winds, driving sand (Dickey, ms.).
	29 Apr.	8	8 introduced from Midway (Wetmore, ms.).
	12 May	2	Two seen.
	13 May	1	One seen.

SEMIPALMATED PLOVER — *Charadrius semipalmatus*

Status

Accidental; one record: September 1967.

Observations

Ely saw a Semipalmated Plover late in the afternoon of 5 September 1967 as it fed with Ruddy Turnstones on the mudflats on the west shore of the lagoon. The following day Clapp saw this bird feeding by itself around the margins of the small pond north of the lagoon. He collected it later in the day as it fed along the muddy northwestern margin of the lagoon.

The specimen (USNM 543043), an immature female, was not molting and had heavy fat deposits. It constitutes the first record from Laysan. These plovers are of fairly regular occurrence in the main Hawaiian Islands but have been recorded only rarely from the Northwestern Hawaiian Islands (Midway, Lisianski, Laysan).

GOLDEN PLOVER — *Pluvialis dominica*

Status

Abundant migrant; maximum recent estimate: 1,200. Probably present all year; recorded for all months for which data are available; most numerous in February, March, and September. Occurs both singly and in small to large flocks. Found over most of the island but most common along the lagoon shore.

Populations and Annual Cycle

Golden Plovers are most common during the spring and fall when large migrating flocks occur. The extent of the migration period is unknown but in 1966 very few were seen after 10 June when 233 were counted (Table GP-3). Our data suggest migration peaks in March and September. Populations are probably lowest during mid-summer (mid-June to early August) and moderate during the winter season. The length of time migrants stay on the island and the amount of daily population turnover are not known.

Ecology

Plovers utilize the area between the beach and lagoon to a much greater degree than do any other shorebirds, with the possible exception of the Bristle-thighed Curlew. Many birds occur singly in small open areas scattered throughout the vegetation and many set up and defend "winter" territories. Large flocks are sometimes present, such as the flock of 750 to 1,000 birds seen in a large open area near the south end

of the island in mid-September 1964. Golden Plovers occasionally flock with turnstones, tattlers, and curlews, but at least in September 1964 and 1967 most of them occurred in pure flocks.

When feeding in the lagoon, plovers wade further from shore than do turnstones. Wetmore (ms.) saw them eating bird eggs and also noted that many were killed by sandstorms and alkali poisoning in April and May 1923.

Specimens

Fifty-one Golden Plover skins from Laysan are currently distributed in museums as indicated in Table GP-1. Two additional mounted specimens are in the Laysan exhibit at SUI.

Banding and Movements

Various workers banded 188 Golden Plovers on Laysan (Table GP-2). One banded on 9 March 1965 was recaptured there by Eugene Kridler on 17 September 1966.

Table GP-1. Locations of Golden Plover skins from Laysan.

Museum	Males	Females	Other	Totals
AMNH	6	4	0	10
BPBM	1	1	1	3
CMNH	1	1	0	2
DMNH	1	0	0	1
SUI	1	0	1	2
UMMZ	10	8	0	18
USNM (non-POBSP)	6	1	0	7
(POBSP)	4	1	0	5
Other*	2	1	0	3
Totals	32	17	2	51

*Law Coll. (1 ♂, 1 ♀); Museo Parense (1 ♂).

Table GP-2. Golden Plovers banded on Laysan.

Period of Survey	Bander	Number Banded
1958 June	BSFW	1
1961 Sept.	HDFG	71
1963 Feb.	POBSP	5
Dec.	HDFG	17

Table GP-2. (continued)

Period of Survey		Bander	Number Banded
1964	Mar.	BSFW	23
	Sept.	POBSP	4
1965	Mar.	POBSP	4
1966	Mar.	BSFW	29
	Sept.	BSFW	8
1967	Mar.	BSFW	4
	Sept.	POBSP	10
		BSFW	1
1968	Mar.	POBSP	11
	Total		188

Table GP-3. Observations of Golden Plovers on Laysan.

Date of Survey		Population Estimate	Remarks and References
1890	16 July	?	(Lyons, 1890: 91).
1891	16-27 June	?	Frequently seen (Rothschild, 1893-1900: 11).
1896	24 June-24 Sept.	?	Regular visitor (Schauinsland, 1899: 101).
1902	16-23 May	common	Flock near lagoon; all in winter plumage (Fisher, 1903a: 803).
1903	29 Apr.	?	2 collected by Bryan (BPBM).
1911	24 Apr.-5 June	2,000	(Dill and Bryan, 1912: 21).
1912-1913	22 Dec.-11 Mar.	flocks of 100 or more	(Bailey, 1956: 91).
1915	19 Sept.	?	Eric Schlemmer killed 14 "plovers" with one shot (Schlemmer and Schlemmer, ms.).
1916	9 Feb.	common	(Munter, ms.).
1918	8-10 Sept.	great numbers	Seen in large flocks along lagoon (Diggs, ms.).
1923	8-13 Apr.	?	Fairly common (Wetmore, ms.).

Table GP-3. (continued)

Date of Survey		Population Estimate	Remarks and References
1923	29 Apr.-14 May	several hundred	Some in full breeding plumage and others in winter dress (Wetmore, ms.).
1930	2-18 Aug.	?	Beginning to arrive (Wilder, ms. b).
1936	7-8 Mar.	?	Several flocks of 50-100 seen feeding along lagoon (Trempe, ms.).
1950	23 June	numerous	(POFI).
1955	10 Feb.	50-100	Common along lagoon (POFI).
1957	25 June-3 July	20	(Woodside, ms. b).
1958	27 May-4 June	uncommon	Several in winter plumage were apparently residents in the area (Warner, ms.).
1959	28 Apr.-1 May	?	Several (Kramer, ms.).
1961	7-8 Mar.	300	Over entire island (Woodside and Kramer, ms.).
	4-10 Sept.	400	71 banded (Woodside, ms. c).
1962	14-19 June	?	Common throughout island (Kramer and Beardsley, ms.).
1963	11-13 Feb.	1,000	Found in all habitats (POBSP).
	3-10 Dec.	?	Count of 462; 10 (2%) on outer beaches; 452 (98%) in the interior (Walker, ms. b).
1964	10-11 Mar.	800-1,000	Count of 583: 183 (37%) on outer beaches; 400 (63%) in the interior; many beginning to change into breeding plumage (BSFW, POBSP).
	16-20 Sept.	1,200	One flock of ca. 1,000 birds on bare island area (BSFW, POBSP).
1965	6-11 Mar.	1,000	Entire island (POBSP).
	17-21 July	50	Most around lagoon (POBSP).

Table GP-3. (continued)

Date of Survey		Population Estimate	Remarks and References
1965	5-12 Aug.	450	1 flock of 300 birds (POBSP).
1966	26-31 Mar.	1,000	850 seen, primarily in lagoon; some molting into breeding plumage (BSFW).
	10-16, 20-21 June	250	Count of 233: 158 (68%) on outer beaches, 75 (32%) in the interior; most had left by 11 June; many in breeding plumage (POBSP).
	17-18 Sept.	900	Most using lagoon; 600 in one huge flock (BSFW).
	20-23 Oct.	600	Count of 477: 27 (6%) on outer beaches; 450 (94%) along the lagoon; all in winter plumage (POBSP).
1967	18-19 Mar.	1,200	635 counted, 560 at the northwest end of the lagoon and 75 around the beaches; concentrated around lagoon; about 1/4 in obvious prenuptial molt (BSFW, POBSP).
	7-12 June	300	Over 200 birds, most in breeding plumage by lagoon (POBSP).
	5-11 Sept.	1,200	Primarily on mud flats, west side of lagoon (POBSP).
	13 Dec.	?	1 flock of 300; all in winter plumage (BSFW).
1968	17-19 Mar.	500	Count of 204 around lagoon in morning (36 on north and east; 68 on south; 20 on southwest; 80 on northwest). Flock of 179 feeding in northwest corner in late afternoon (BSFW, POBSP).
1969	26-29 Mar.	990	Along lagoon (BSFW).
	9 Sept.	large numbers	Seen feeding along lagoon (BSFW).

BLACK-BELLIED PLOVER — *Squatarola squatarola*

Status

Accidental; one record: December 1912-January 1913.

Observations

The only record of Black-bellied Plovers on Laysan was made by Bailey (1956: 90) who noted that two were seen along the lagoon on 28 December 1912,* and that one (USNM 240985), a male, was collected by Willett. The other, or another, was seen subsequently on 10 January 1913.

RUDDY TURNSTONE — *Arenaria interpres*

Status

Abundant migrant; maximum recent estimate: 5,000. At least a few birds recorded during all months for which data are available; most numerous from February through April and in September. Occurs in most habitats but most common along the lagoon shore.

Populations and Annual Cycle

The Ruddy Turnstone is the most abundant shorebird on Laysan at all seasons, but for brief periods it may be equaled or exceeded in numbers by the Golden Plover. Peak populations occur from at least December through May and in September (Table RT-3); lowest numbers occur during the summer when most turnstones are on the northern nesting grounds.

Daily population variations, possibly due to migration, were noted in April 1923, June 1966, and September 1967. The data are too scant to determine accurately migration periods, migration peaks, or the amount of population turnover on the island.

Ecology

Turnstones occur in a variety of habitats: tidal pools along the rocky beaches, sandy beaches, open areas in the upland part of the island, and along the shore of the lagoon. On four counts--September 1961, December 1963, March 1964, and September 1967--they were considerably more abundant along the shore of the lagoon than on the outer beaches. However, on various trips turnstone concentrations were found along different areas of the lagoon shore, probably because the wave action that apparently concentrates suspended materials, including food items, varies with wind conditions. In September 1964 and March 1965 birds were most common along the eastern shore; in October 1966 along

*Extracts from Willett's report (ms.) state that the plovers were actually first seen 27 December.

the northern shore; and in September 1967 and March 1968 from the northwest to southwest corners of the lagoon. The lagoon is probably the best feeding area on the island because of the concentration of fly larvae and brine shrimp.

Dill and Bryan (1912: 21) found turnstones in the shallow water of the lagoon and about the fresh-water pond feeding on small black flies. In April and May 1923 Wetmore (ms.) found them feeding on Gray-backed Tern eggs, meat and fat scraps, flies, brine shrimp, and mollusks on coral that had been placed on the beach to dry. In September 1967 turnstones were noted wading up to their breasts in the lagoon.

At night turnstones roost along the lagoon, in the vegetation on the slopes of the island, and on the rock wall at the south end of the island. In September 1964 an increase in the number of birds along the outer beach in the evening was noted.

Wetmore (ms.) reported many dead and dying turnstones with paralysis of the nictitating membrane and lack of control of feet, wings, and neck suggesting alkali poisoning. No similar mortality has been reported recently.

Specimens

Fifty-three Ruddy Turnstone skins are currently distributed in museums as indicated in Table RT-1. Four additional mounted specimens are distributed as follows: BPBM (1 female); MCZ (1 male, 1 female); SUI (1 bird in Laysan exhibit).

Banding and Movements

The POBSP and BSFW banded 79 Ruddy Turnstones on Laysan (Table RT-2). A bird with a broken wing, banded on Laysan in March 1965, was recaptured there on 10 June 1966; it was unable to fly but healthy.

On 6 September 1967, three adults, 1103-00277, 1103-01393, and 1103-02152, banded on St. George Island, Alaska, on 3, 9, and 17 August 1967, respectively, were collected along the lagoon. Three additional turnstones color-marked on St. George were seen but not collected.

652-45015, of unknown age, banded on Laysan on 17 September 1964, was recaptured on St. George Island in the Pribilofs, Alaska, on 18 August 1968.

Table RT-1. Locations of Ruddy Turnstone skins from Laysan.

Museum	Males	Females	Other	Totals
AMNH	4	4	0	8
BPBM	0	4	0	4

Table RT-1. (continued)

Museum	Males	Females	Other	Totals
CMNH	1	1	0	2
MCZ	2	2	0	4
UMMZ	4	2	0	6
SUI	0	2	0	2
USNM (non-POBSP)	5	9	0	14
(POBSP)	4	6	1	11
Other*	1	1	0	2
Totals	21	31	1	53

*Law Coll. (1 ♂, 1 ♀).

Table RT-2. Ruddy Turnstones banded on Laysan.

Period of Survey	Bander	Number Banded
1964 Mar.	BSFW	7
Sept.	POBSP	40
1965 Mar.	POBSP	7
1966 Mar.	BSFW	5
Sept.	BSFW	1
Oct.	POBSP	1
1967 Sept.	POBSP	11
1968 Mar.	POBSP	7
Total		79

Table RT-3. Observations of Ruddy Turnstones on Laysan.

Date of Survey	Population Estimate	Remarks and References
1891 16-27 June	common	(Rothschild, 1893-1900: 13).
1896 24 June-24 Sept.	?	"Regular visitor" (Schauinsland, 1899: 101).
1902 16-23 May	abundant	Concentrated near lagoon. Flocks seen (Fisher, 1903a: 803).
1907 15 Oct.	?	6 collected by Schlemmer (MCZ).
1911 24 Apr.-5 June	2,500	Large flocks of plovers and turnstones, especially along lagoon (Dill and Bryan, 1912: 22).

Table RT-3. (continued)

Date of Survey	Population Estimate	Remarks and References
1912 22 Dec.- 1913 11 Mar.	common	Seen daily (Bailey, 1956: 92).
1915 3 Apr.	5,000	Flock on lagoon shore (Munter, 1915: 140).
1916 9 Feb.	common	(Munter, ms.).
1918 8-10 Sept.	great numbers	Seen in flocks along lagoon (Diggs, ms.).
1923 8-13 Apr.	common	Considerable daily variation in numbers due to migration. Many molting into breeding plumage (Wetmore, ms.).
29 Apr.- 14 May	3,000- 4,000	(Wetmore, ms.).
1930 2-18 Aug.	great numbers	(Wilder, ms. b).
1936 7-8 Mar.	thousands	Flocks of 75-100 feeding along lagoon (Trempe, ms.).
12 Dec.	3,000- 5,000	Along lagoon edge (Coultas, ms.).
1950 23 June	numerous	(POFI).
1951 12 May	?	(POFI).
1955 10 Feb.	?	Presence not noted but reference to "Sanderlings" probably referred to this species (POFI).
1957 25 June- 3 July	150	(Woodside, ms. b).
8-12 July	?	Flocks of a dozen or so (Labrecque, 1957: 18).
1958 27 May- 4 June	?	Flocks of 10-20 seen commonly (Warner, ms.).
1959 28 Apr.- 1 May	small numbers	(Kramer, ms.).

Table RT-3. (continued)

Date of Survey		Population Estimate	Remarks and References
1961	7-8 Mar.	500-700	Feeding along lagoon (Woodside and Kramer, ms.).
	4-10 Sept.	1,500	Count of 71 (5%) along the beaches and 1,400 (95%) along the lagoon (Walker, ms. a).
1962	14-19 June	large numbers	(Kramer and Beardsley, ms.).
1963	11-13 Feb.	5,000	3,000 counted around lagoon (POBSP).
	3-10 Dec.	3,000	Count of 2,768: 427 (15%) on the outer beach and 2,341 (85%) along the lagoon (Walker, ms. b).
1964	10-11 Mar.	2,000	Count of 1,777: 189 (11%) on the outer beaches and 1,588 (89%) along lagoon (BSFW, POBSP).
	16-20 Sept.	1,600	Most along east shore of lagoon (BSFW, POBSP).
1965	6-11 Mar.	3,000-5,000	Most along lagoon (POBSP).
	17-21 July	250	Most along lagoon (POBSP).
	5-12 Aug.	400	1 flock of 400 birds (POBSP).
1966	26-31 Mar.	2,450	Some molting into breeding plumage (BSFW).
	10-16, 20-21 June	500	Count of 493: 85 (17%) on outer beach, 408 (83%) in the interior; ca. 30% in full breeding plumage; most departed soon after 10 June (POBSP).
	17-18 Sept.	2,000	An estimated 90% along lagoon (BSFW).
	20-23 Oct.	550	A number in breeding plumage (POBSP).
1967	18-19 Mar.	800	638 counted (250 along beaches, remainder in northwest corner of lagoon (BSFW, POBSP).
	7-12 June	300	No large flocks (POBSP).

Table RT-3. (continued)

Date of Survey	Population Estimate	Remarks and References
1967 5-11 Sept.	5,000	Concentrated around lagoon (POBSP).
13 Dec.	several thousand	Most on east shore of lagoon (BSFW).
1968 17-19 Mar.	3,000	Count of 1,839 around lagoon on the morning of the 18th; 246 on north and east shores, 246 on south shore, 475 on southwest half of west shore, and 872 on northwest half. Considerably more abundant on west shore in late afternoon (BSFW, POBSP).
1969 26-29 Mar.	1,580	Seen along lagoon (BSFW).
9 Sept.	several thousand	Feeding with lesser numbers of Golden Plovers along lagoon shoreline.

[WHIMBREL *Numenius phaeopus*]

Status

Hypothetical; one unconfirmed record: September 1961.

Observations

Woodside's report (ms. c) states that "One whimbrel was identified by Dr. Udvardy." We have been unable to obtain confirmation of this sighting and so treat its occurrence on Laysan as hypothetical. The only other records for the Hawaiian area are two sight records from Midway Atoll (Udvardy, 1961a: 86).

BRISTLE-THIGHED CURLEW *Numenius tahitiensis*

Status

Common migrant; maximum recent estimate: 150-200. Probably occurs in all months but most numerous during March, April, and September. Usually occurs singly or in small flocks. Occurs throughout the island in all habitats.

Populations and Annual Cycle

Probably small numbers of Bristle-thighed Curlews occur on Laysan throughout the year (Table BTC-3), with the largest populations (several

hundreds) present during the March to April and the September migration periods. The number of birds spending the winter or summer on Laysan is unknown.

Ecology

Curlews utilize all major habitats on Laysan and are common both throughout the interior and along the rocky shores, mainly on the south beach. In September 1964, August 1965, and March and September 1967 the only concentrations were found along the rocky shores. This is probably the only shorebird on Laysan that is as common away from the lagoon as near it. Curlews usually occur singly or in small groups, but flocks of up to 48 individuals have been seen, usually near the south end of the island.

The egg-eating habits of this species are well known. Bailey (1956: 94) found them opening albatross eggs that had been deserted and Wetmore (ms.) found them feeding on Gray-backed Tern, Red-footed Booby, and Great Frigatebird eggs. Curlews regularly patrolled the tern colonies for eggs. A curlew would empale an egg with its beak, then run away to devour it at its leisure. Wetmore also watched a curlew fly to an unattended Red-footed Booby nest in a low bush and remove the egg. Another removed an egg from a frigatebird which momentarily raised up but did not leave the nest. In this instance the egg was carried off unbroken. He also reported that they ate fat that was discarded during bird skinning operations. Wilder (ms. b) recorded curlews eating Brown Noddy eggs and avidly devouring near-hatched embryos. Walker (ms. a) observed a curlew feeding on a recently killed Laysan Finch. Other foods include Scaevola berries and insects. Curlews also feed along the lagoon, in tide pools and among the inland vegetation.

Dill and Bryan (1912: 21) reported that as many as 20 birds roosted on the roofs of the old buildings. Scattered individuals have been found roosting in the interior at night and on 10 September 1967 a flock of 20 birds was found roosting on the south beach.

Specimens

Seventy-one Bristle-thighed Curlew skins from Laysan are currently distributed in museums as indicated in Table BTC-1. Additional mounted specimens are distributed as follows: DMNH (1 male, 1 female in Laysan exhibit); MCZ (2 males); SUI (1 in Laysan exhibit); BPBM (1, possibly 3).

Banding and Movements

The POBSP and BSFW banded 50 Bristle-thighed Curlews on Laysan (see Table BTC-2). An adult, 645-12620, banded 31 May 1967 by the POBSP on Southeast Island, Pearl and Hermes Reef, was recaptured by the BSFW on Laysan on 27 September 1967.

Table BTC-1. Locations of Bristle-thighed Curlew skins from Laysan.

Museum	Males	Females	Other	Totals
AMNH	5	7	0	12
BPBM	3	3	1	7
CMNH	3	4	0	7
DMNH	3	1	0	4
MCZ	7	5	0	12
SUI	1	0	0	1
UMMZ	3	3	1	7
USNM (non-POBSP)	8	8	0	16
Other*	2	3	0	5
Totals	35	34	2	71

*Law Coll. (1 ♂, 1 ♀); Leningrad (1 ♀); Coryndon Mus. (1 ♂, 1 ♀).

Table BTC-2. Bristle-thighed Curlews banded on Laysan.

Period of Survey	Bander	Number Banded
1958 June	BSFW	2
1963 Feb.	POBSP	2
1964 Mar.	BSFW	3
Sept.	POBSP	10
	BSFW	1
1965 Mar.	POBSP	10
1966 Mar.	BSFW	3
1967 Sept.	POBSP	13
1968 Sept.	BSFW	6
Total		50

Table BTC-3. Observations of Bristle-thighed Curlews on Laysan.

Date of Survey	Population Estimate	Remarks and References
1890 16 July	?	(Lyons, 1890: 91).
1891 16-27 June	?	(Rothschild, 1893-1900: 18).
1895 Sept.	?	At least 3 collected by Hall (AMNH, BPBM).
1896 24 June-24 Sept.	?	Regular visitor (Schauinsland, 1899: 101).

Table BTC-3. (continued)

Date of Survey		Population Estimate	Remarks and References
1902	16-23 May	?	Small flocks (Fisher, 1903a: 803).
1903	1-20 Apr.	?	3 collected by Bryan (AMNH, BPBM).
1904	17 May, 6 Sept.	?	1 specimen collected each date (MCZ).
1906	26-27 Apr.	?	7 collected by Schlemmer (MCZ).
1907	18-22 May	?	6 collected by Schlemmer (MCZ).
1911	24 Apr.- 5 June	250	Along lagoon and beaches (Dill and Bryan, 1912: 21).
1912 1913	22 Dec.- 11 Mar.	common	Flocks of up to a dozen birds (Bailey, 1956: 94).
1915	3 Apr.	1,000	Scattered over island (Munter, 1915: 140).
1916	9 Feb.	common	(Munter, ms.).
1918	8-10 Sept.	1,000	On all parts of island (Diggs, ms.).
1923	8-13 Apr.	common	(Wetmore, ms.).
	29 Apr.- 14 May	30	(Wetmore, ms.).
1930	2-18 Aug.	?	(Wilder, ms. b).
1936	7-8 Mar.	?	Many groups of from 2-3 to 25-30 birds found mostly in grass and along shore of lagoon; 2 banded with blue celluloid rings (Trempe, 1936).
	12 Dec.	150-200	(Coultas, ms.).
1950	23 June	a few	(POFI).
1951	12 May	?	(POFI).
	late June- early July	50	Diurnal census (Brock, 1951b: 18).
1955	10 Feb.	?	Ca. 100 along the northeast shore (POFI).

Table BTC-3. (continued)

Date of Survey		Population Estimate	Remarks and References
1957	25 June-3 July	50	(Woodside, ms. b).
	8-12 July	?	Flocks of up to 25 birds (Labrecque, 1957: 18).
1958	27 May-4 June	15	Most at south end (Warner, ms.).
1959	28 Apr.-1 May	small numbers	(Kramer, ms.).
1961	7-8 Mar.	75-100	(Woodside and Kramer, ms.).
	4-10 Sept.	400	Count of 140: 132 (94%) on outer beaches; 8 (6%) in the interior (Walker, ms. a).
1962	14-19 June	very common	(Kramer and Beardsley, ms.).
1963	11-13 Feb.	20	(POBSP).
	3-10 Dec.	90	Count of 75: 23 (31%) on outer beaches; 52 (69%) in the interior (Walker, ms. b).
1964	10-11 Mar.	150-200	Count of 73: 12 (16%) on outer beach; 61 (84%) along lagoon (BSFW, POBSP).
	16-20 Sept.	100	Over entire island (POBSP).
1965	6-11 Mar.	100-200	(POBSP).
	17-21 July	25	Scattered along beaches (POBSP).
	5-12 Aug.	70	Flock of 48 (POBSP).
1966	26-31 Mar.	150	18 on outer beach (BSFW).
	10-16, 20-21 June	60	Count of 51: 18 (35%) on outer beaches and 33 (65%) in the interior (POBSP).
	17-18 Sept.	?	15 seen (BSFW).
	20-23 Oct.	50	Count of 41: 31 (74%) on outer beaches; 10 (25%) near the lagoon (POBSP).

Table BTC-3. (continued)

Date of Survey	Population Estimate	Remarks and References
1967 18-19 Mar.	60-120	Flock of 48 (BSFW, POBSP).
7-12 June	20	(POBSP).
5-11 Sept.	100	Flock of 43 (POBSP).
13 Dec.	100	(BSFW).
1968 17-19 Mar.	100	Count of 41 around edges of lagoon on the morning of the 18th: 26 along north and east edges, 4 along southwestern half of the west side, 7 along northwestern side, 4 along south end (BSFW, POBSP).
1969 26-29 Mar.	63	Counted along lagoon shoreline (BSFW).

WANDERING TATTLER — *Heteroscelus incanum*

Status

Common migrant; maximum recent estimate: 200-500. Probably present in all months; most numerous during February, March, August, and September. Usually occurs singly or in small flocks; most common around the lagoon and on the rocky beaches; rarely inland in vegetated areas.

Populations and Annual Cycle

All recent counts and estimates (Table WT-2) indicate that the tattler ranks behind the Golden Plover and Ruddy Turnstone in numbers at all seasons. Since tattlers show less flocking tendency than the other two species and utilize the rocky shoreline to a greater extent than do other shorebirds, counts were probably often low. The generally higher counts made recently are probably the result of more complete censuses rather than an increase in population. As with other shorebirds, peak populations are present in the spring and fall.

Ecology

Wandering Tattlers frequent the shores of the lagoon and rocky areas around the ocean beaches, particularly those at the southern end of the island. Unlike plovers and turnstones, tattlers seldom occur inland on the more-vegetated portions of the island but are usually quite common along the shores. On only one of five counts (October 1966) were they found to be more common on the outer beaches than around the lagoon.

Wandering Tattlers occasionally occur in turnstone and plover flocks. The POBSP recorded a large flock of 150 on the rocky southeast shore on 11 August 1965. Pure flocks of as many as 50 to 75 birds are occasionally seen (October 1966; March 1968).

Fisher (1903a: 802) saw them wading in the lagoon feeding on flies and possibly brine shrimp. Wetmore (ms.) indicated that they caught fish on the reef.

Specimens

Twenty Wandering Tattler skins from Laysan are currently distributed in museums as indicated in Table WT-1. An additional mounted bird is in the Laysan exhibit at SUI. Also preserved is a skeleton at the USNM.

Banding and Movements

Ten Wandering Tattlers were banded on Laysan through 1969: 9 by the POBSP (5 in September 1964, 1 in September 1967, and 3 in March 1968); and 1 by the BSFW (September 1964). No interisland movements were recorded.

Table WT-1. Locations of Wandering Tattler skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	3	5	0	8
BPBM	0	2	0	2
SUI	1	0	0	1
UMMZ	0	0	5	5
USNM (non-POBSP)	3	0	0	3
(POBSP)	1	0	0	1
Totals	8	7	5	20

Table WT-2. Observations of Wandering Tattlers on Laysan.

Date of Survey	Population Estimate	Remarks and References
1828 24 Mar.	?	Probably present. Vague description by Isenbeck subsequently identified as this species by Rothschild (1893-1900: v) could apply to several species.
1891 16-27 June	few	(Rothschild, 1893-1900: 15).
1895 Sept.	?	Specimen which from label was probably collected by Hall (BPBM).

Table WT-2. (continued)

Date of Survey		Population Estimate	Remarks and References
1896	24 June-24 Sept.	?	"Regular visitor" (Schauinsland, 1899: 101).
1902	16-23 May	?	Least common of migrants. Few seen each day. 1 in breeding plumage collected 18 May (Fisher, 1903a: 802).
1911	24 Apr.-5 June	very few	Usually on the reefs or on large rocks on the beach (Dill and Bryan, 1912: 21).
1912 1913	22 Dec.-11 Mar.	?	Regularly seen; 7 collected (Bailey, 1956: 95). Very common around lagoon and on beaches (Willett, ms.).
1916	9 Feb.	common	(Munter, ms.).
1918	8-10 Sept.	1	Only 1 observed (Diggs, ms.).
1923	8-13 Apr.	2	Single birds (Wetmore, ms.).
	29 Apr.-14 May	50	Flocks of 10-20 seen; along rocky shore and lagoon (Wetmore, ms.).
1930	2-18 Aug.	a few seen	(Wilder, ms. b).
1936	12 Dec.	100	(Coultas, ms.).
1957	25 June-3 July	20	(Woodside, ms. b).
1958	27 May-4 June	5	Very uncommon and wary (Warner, ms.).
1961	7-8 Mar.	150	Most in lagoon; few on outer beaches (Woodside and Kramer, ms.).
	4-10 Sept.	253	Count. 38 (15%) on outer beach and 215 (85%) along lagoon (Woodside, ms. c).
1962	14-19 June	hundreds	Least common of shore birds (Kramer and Beardsley, ms.).
1963	11-13 Feb.	100	All habitats (POBSP).
	3-10 Dec.	59	Count. 22 (37%) on outer beach and 37 (63%) in the interior (Walker, ms. b).

Table WT-2. (continued)

Date of Survey		Estimate	Remarks and References
1964	10-11 Mar.	125-150	Count of 120: 40 (33%) on outer beach and 80 (67%) along lagoon. One flock of 35 seen (BSFW, POBSP).
	16-20 Sept.	200	West shore of lagoon; 132 counted (POBSP).
	19-20 Sept.	200	(BSFW, POBSP).
1965	6-11 Mar.	200-500	Lagoon and rocky beaches (POBSP).
	17-21 July	0	None seen (POBSP).
	5-12 Aug.	350	Flock of 150; lagoon and rocky shores (POBSP).
1966	26-31 Mar.	4	(BSFW).
	10-16, 20-21 June	20	Count of 12 scattered birds: 4 (33%) on outer beach, 8 (67%) in the interior (POBSP).
	17-18 Sept.	7	(BSFW).
	20-23 Oct.	150	Count of 147: 91 (62%) on outer beaches, 56 (35%) along lagoon. Flocks of 50 and 75. Nearly all birds in winter plumage (POBSP).
1967	18-19 Mar.	20	Most near lagoon (BSFW, POBSP).
	7-12 June	20	Estimate (POBSP).
	5-11 Sept.	250	Most common along the west shore of lagoon; small numbers in rocky areas of southwest shore (POBSP).
1968	17-19 Mar.	200	Count of 65 around lagoon in morning (22 on north and east shores; 7 on south; 12 on southwest; 24 on northwest). Ca. 40-50 feeding in mixed flock with plovers at northwest corner in afternoon (BSFW, POBSP).
1969	26-29 Mar.	135	Seen along shoreline (BSFW).
	9 Sept.	?	Some seen feeding along lagoon shore (BSFW).

GREATER YELLOWLEGS — Totanus melanoleucus

Status

Accidental; one record: October 1966.

Observations

POBSP personnel collected one of two Greater Yellowlegs seen feeding with a group of Wandering Tattlers in the lagoon on 21 October 1966. The specimen (USNM 496780), a very fat immature female, constitutes the first record from Laysan and the first specimen from the Hawaiian area.

The only other record from the Northwestern Hawaiian Islands is the sighting of a single individual on Midway in June 1941 (Donaghho, 1953-1954: 49); at least seven sight records have been reported from the main Hawaiian Islands (Clapp and Woodward, 1968: 18).

LESSER YELLOWLEGS — Totanus flavipes

Status

Rare visitor; three records: October 1966, September 1967, March 1968.

Observations

On 21 October 1966 POBSP personnel saw a Lesser Yellowlegs feeding with two Greater Yellowlegs and a number of Wandering Tattlers. This bird was closely compared with the Greater Yellowlegs (Clapp and Woodward, 1968: 18). It called several times, giving the distinctive di-syllabic note of this species.

On 5 September 1967 Clapp saw a Lesser Yellowlegs at dusk as it roosted among Wandering Tattlers at the northwestern corner of the lagoon. He collected two immature females the following day. One (USNM 543047) was shot as it stood in the shallow muddy pond north of the lagoon. The other (USNM 543048) was shot at the northwestern corner of the lagoon. Both yellowlegs were roosting alone when collected and both were less wary than the other species of shorebirds that usually frequent the island. USNM 543047 was molting lightly on the head and breast and had moderate fat deposits when collected.

The following spring, on 18 March 1968, Kridler (pers. corr.) saw another Lesser Yellowlegs among plovers and turnstones on the west shore of the lagoon.

The only other atolls in the northwestern chain of islands from which this species was reported previously are Midway and Kure (Clapp and Woodward, op. cit.; Clapp, 1968: 76-77). Sight records of Lesser Yellowlegs

have been reported frequently from the main Hawaiians and they are apparently regular but uncommon visitors to the Hawaiian area.

SHARP-TAILED SANDPIPER — Erolia acuminata

Status

Uncommon visitor; three records: 1896, October 1966, March 1969. Probably more common than the records indicate.

Observations

Two specimens were collected on Laysan, one by Schauinsland or his correspondents in 1896 (Rothschild, 1893-1900: 307), the other by POBSP personnel, 21 October 1966 (Clapp and Woodward, 1968: 24). The POBSP specimen (USNM 496697) is an immature male taken from a flock of sandpipers also thought to be of this species (see Sandpiper spp. below).

In addition, Kridler (pers. comm.) saw one or possibly two Sharp-tailed Sandpipers feeding along the edge of the lagoon on 27 March 1969.

PECTORAL SANDPIPER — Erolia melanotos

Status

Accidental; one valid record: September 1967.

Observations

The only definite record of this species from Laysan is two specimens collected 6 September 1967. Clapp collected an immature male (USNM 543046) as it roosted on the sandy margin south of the north pond; Ely collected an immature female (USNM 544003) at the southwestern end of the lagoon. The only other Laysan record is a doubtful sighting in February 1963 (see Sandpiper ssp. below).

Recent records of this species from Midway and Kure Atolls (Clapp and Woodward, 1968: 23) suggest that this species may occur regularly on many of the low Northwestern Hawaiian Islands.

BAIRD'S SANDPIPER — Erolia bairdii

Status

Accidental; one record: September 1967.

Observations

Clapp collected two Baird's Sandpipers 6 September 1967 as they foraged at the northwestern corner of the lagoon. These birds usually

fed apart from the flocks of plovers and turnstones but when flushed occasionally flew with flocks of turnstones. On several occasions they fed and flew with a Semipalmated Plover. Both sandpipers (USNM 543044, 543045) proved to be immature females. Neither was in molt and both had little fat.

The specimens mentioned above and one collected on Oahu constitute the only certain records for this species for the Hawaiian area (Woodward and Clapp, 1969: 25).

DUNLIN — *Erolia alpina*

Status

Rare visitor; three records: 1896 or 1897, January 1913, March 1968.

Observations

Schauinsland (1899: 101) first reported the Dunlin from Laysan (calling it *Tringa americana*) as a "winter guest." It is not known whether he or his correspondents only saw these birds or if specimens were taken.

Bailey (1956: 96) collected (USNM 240987) a female, the only Dunlin he saw on the island, on 20 January 1913 along the shore of the lagoon where he found Golden Plovers.

On 18 March 1968 Clapp saw a Dunlin feeding with turnstones in a small pool near the southwest corner of the lagoon. He collected the bird the following day as it fed along the west shoreline of the lagoon. The specimen (USNM 543337) was a very fat male in heavy body molt.

Dunlins have been reported from three other Northwestern Hawaiian Islands: Kure, Midway, and Pearl and Hermes Reef (Kenyon and Rice, 1957: 3; Clapp and Woodward, 1968: 24). They apparently occur there more regularly than early records indicate.

SANDPIPER Spp.

Observations

On seven occasions unidentified, or inadequately identified, small sandpipers were seen on Laysan (Table Ss-1). Some of these records were thought to be of Pectoral, Sharp-tailed, or Least Sandpipers; one (September 1967) record was probably of a fourth species. The December 1963 record of a "Least Sandpiper" is included here because it was not accompanied by either detailed notes or a specimen.

Table Ss-1. Observations of small Sandpiper Spp. on Laysan.

Date of Survey	Population Estimate	Remarks and References
1961 7-8 Mar.	?	"Small sandpiper type birds may have been seen but [were] not identified." (Woodside and Kramer, ms.).
4-10 Sept.	1	Walker's (ms. a) notes 5 Sept. state that a small sandpiper-like bird was seen near the small pond just inside the lagoon shore. "It had a dark cap, light bill with a dark tip, light legs --pale yellow, light belly (white), about least sandpiper size, dark brown stripe down back, upper tail, light on either side."
1963 11-13 Feb.	1	The observer thought that the bird might have been a Pectoral Sandpiper (POBSP).
3-10 Dec.	1	On 8 December, Walker's (ms. b) notes state that "Nixon Wilson saw a least sandpiper yesterday." No other details are given.
1965 17-21 July	Ca. 70	Thought to have been Sharp-tailed Sandpipers. The birds were seen in a compact flock along the shore of the lagoon (POBSP).
1966 20-23 Oct.	Ca. 30	Thought to have been Sharp-tailed Sandpipers but observers disagreed on the identification. A Sharp-tailed Sandpiper was collected (POBSP).
1967 5-11 Sept.	2	An unidentified "peep" was seen on the morning of 8 Sept.; two were seen the following day, and one on 10 Sept. All were apparently of the same species and no more than two individuals were probably involved. The birds were brownish above, white below with a faint wing stripe and with white showing to either side of the base of the tail. They appeared to be less than half the size of Ruddy Turnstones (POBSP).

DOWITCHER Sp. *Limnodromus* sp.

Status

Accidental; one record: September 1967.

Observations

Kridler (pers. comm.) observed a dowitcher along the shoreline of the lagoon on the morning of 24 September 1967. The bird was observed from within 15 feet for over 15 minutes and when it flushed the white back was clearly seen.

More than 15 sightings of dowitchers have been recorded from the main Hawaiian Islands, but only two from the Northwestern Hawaiian Islands (Clapp and Woodward, 1968: 20-21). None had been reported previously from Laysan.

MARBLED GODWIT *Limosa fedoa*

Status

Accidental; one record: October 1966.

Observations

Marbled Godwits were first recorded on Laysan when POBSP personnel observed two feeding in the northern half of the lagoon on 21 October 1966. One of these, an immature male with heavy fat deposits (USNM 496790), was collected the same day. This specimen is not only the first record from Laysan, but also the first record for the entire Hawaiian area (Clapp and Woodward, 1968: 17).

BAR-TAILED GODWIT *Limosa lapponica*

Status

Rare visitor; four records: November 1896, September 1964, March 1965, October 1966. Probably more common than the number of records suggests.

Observations

The preponderance of fall records (Table BTG-1) of Bar-tailed Godwits, despite the greater amount of observation time in the spring, indicates that this species visits Laysan primarily in the fall. A similar preponderance of fall records from the Phoenix Islands (Clapp and Sibley, 1967: 124) suggests that it is primarily a fall migrant throughout most of the central Pacific.

Since all recent specimens of Bar-tailed Godwits from the northwestern Hawaiian chain have been L. l. baueri (Clapp and Woodward, 1968: 17; Fisher, 1960: 480), it seems likely that those seen on Laysan were of the same race.

Table BTG-1. Observations of Bar-tailed Godwits on Laysan.

Date Observed	Number Seen	Remarks and References
1896 5 Nov.	1	Male specimen in the Tring Museum (Rothschild, 1893-1900: 307).
11 Nov.	1	Male specimen (AMNH 738526) formerly in the Bremen Museum.
Ca. 1896	?	Several specimens (including the one above) were collected and deposited in the Bremen Museum (Rothschild, op. cit.); these godwits were listed as a winter guest by Schauinsland (1899: 101).
1964 19 Sept.	1	Seen on the west shore of the lagoon (POBSP).
1965 6-11 Mar.	2	Seen foraging together on the south and east beaches (POBSP).
1966 21 Oct.	1	Sight record (POBSP).

SANDERLING — Crocethia alba

Status

Uncommon migrant; maximum recent estimate: 30 to 35. Recorded from February to May, from August to October, and during December; most numerous during March and September. Occurs singly or in small flocks, mainly along the lagoon edge.

Populations and Annual Cycle

Sanderlings have been reported on most recent visits to Laysan and are apparently more numerous in March and September (Table S-1). A few birds probably occur throughout the winter but apparently there is no summering population.

Ecology

Sanderlings occur most commonly in sandy areas along the lagoon. In December 1963, however, Walker (ms. b) found them most abundant on the outer beaches.

They occur singly or in flocks of up to eight birds, occasionally in flocks of Golden Plovers or Ruddy Turnstones.

Specimens

We know of only one specimen from Laysan, a male (USNM 240988) taken by Willett on 29 January 1913.

Table S-1. Observations of Sanderlings on Laysan.

Date of Survey	Population Estimate	Remarks and References
1896 24 June-24 Sept.	?	"Winter guest" (Schauinsland, 1899: 101).
1911 24 Apr.-5 June	?	(Dill and Bryan, 1912).
1912-1913 22 Dec.-11 Mar.	?	Several noted 29 and 30 January; 1 collected from a flock of 5 (Bailey, 1956: 97).
1923 8-13 Apr.	12	Maximum of a dozen at one time (Wetmore, ms.).
29 Apr.-14 May	2	A few along lagoon (Wetmore, ms.).
1951 12 May	?	(POFI).
1955 10 Feb.	-	Presence noted but context of notes suggests that Ruddy Turnstones were meant (POFI).
1959 28 Apr.-1 May	1	(Kramer, ms.).
1961 7-8 Mar.	30	(Woodside and Kramer, 1961).
4-10 Sept.	30	Count; all along lagoon (Walker, ms. a).
1963 11-13 Feb.	6	Along lagoon (BSFW, POBSP).
3-10 Dec.	8	Count of 7 on outer beach; 1 along lagoon (Walker, ms. b).
1964 10-11 Mar.	30-35	Count of 27: 1 (4%) on outer beach, 26 (96%) along lagoon (BSFW, POBSP).
16-20 Sept.	8	With Golden Plovers (BSFW, POBSP).

Table S-1. (continued)

Date of Survey	Population Estimate	Remarks and References
1965 6-11 Mar.	15+	15 on 7 March, increased thereafter (POBSP).
17-21 July	0	(POBSP).
5-12 Aug.	3	Seen on 9 August; west side of island (POBSP).
1966 10-16, 20-21 June	0	(POBSP).
20-23 Oct.	2	In winter plumage (POBSP).
1967 18-19 Mar.	9-12	Around lagoon (BSFW, POBSP).
7-12 June	0	(POBSP).
5-11 Sept.	5	(POBSP).
1968 17-19 Mar.	15	Around lagoon; none seen on beaches (BSFW, POBSP).
1969 26-29 Mar.	1	Along lagoon (BSFW).

RED PHALAROPE — *Phalaropus fulicarius*

Status

Rare visitor; four records: 1896 or 1897, January-February 1913, February 1963, October 1966.

Observations

The Red Phalarope was first reported from Laysan by Schauinsland (1899: 101) who listed the species as a "winter guest." It is not known whether this record is based on a sighting or a specimen.

Bailey (1956: 97) saw several of these phalaropes along the shallow waters of the lagoon on 6 January 1913; he saw two on 9 January, and several the next day when a female was collected (USNM 240986). A second female was collected by Willett on 13 January (CMNH 188914). All were in winter plumage. Willett (ms.) states that these phalaropes were frequently noted in flocks of plovers and turnstones until the middle of February.

Recently POBSP personnel twice saw Red Phalaropes on Laysan in the central lagoon; two on 11 February 1963 and one on 22 October 1966.

NORTHERN PHALAROPE — Lobipes lobatus

Status

Rare visitor; two records: March 1965, December 1967.

Observations

Northern Phalaropes were first recorded from Laysan when Clapp shot a male and a female (USNM 494118, 494119) on 7 March 1965 as they fed near large flocks of Golden Plovers, Ruddy Turnstones, and Wandering Tattlers on the south shore of the lagoon (Clapp and Woodward, 1968: 25). Both were very fat and in winter plumage.

On 13 December 1967 Northern Phalaropes were again recorded from Laysan when Kridler (BSFW) saw two, both in winter plumage, "in excellent light for several minutes with field glasses at a distance of 20 to 25 feet."

[GLAUCOUS-WINGED GULL — Larus glaucescens]

Status

Hypothetical; one unconfirmed record.

Observations

A gull collected by one of Schauinsland's correspondents (in 1896 or 1897) and initially identified as a Glaucous Gull (Larus hyperboreus) by Schauinsland (1899: 101) was reidentified as probably a young female glaucescens by Rothschild (1893-1900: 307).

Three additional sight records are attributed to this species or to Herring or Glaucous Gulls.

On 6 December 1963, Kramer (ms.) saw a gull, almost as large as an albatross, that was "gray all over with black and white flecks." It was feeding in flooded Cyperus mats near the south end of the lagoon. He found the same gull feeding along the lagoon shore the following day and recorded it as either a Glaucous-winged or a Herring Gull.

A second gull, tentatively identified as an immature Glaucous-winged Gull by POBSP personnel, was seen off the west beach on 6 March 1965. It was first seen when it alighted on the water near a group of Black-footed Albatrosses that had gathered to feed on garbage thrown over the stern of the support vessel. It flew away before any attempt to collect it could be made and was not seen on Laysan during the subsequent survey of the island.

Two other gulls, believed to be adult Glaucous (Larus hyperboreus) or Glaucous-winged Gulls, were seen near the south point of the island

on 10 March 1965 but were so wary that they could not be approached closely enough either for accurate identification or for collection.

Since we have not seen Schauinsland's specimen and since all sight records are inadequate for certain identification, we prefer to regard the occurrence of Glaucous-winged Gulls on Laysan as hypothetical.

GLAUCOUS GULL — *Larus hyperboreus*

Status

Accidental; one record: January 1906.

Observations

Bailey (1956: 98) reported that a specimen (BPBM 4546) collected by Bompke on 29 January 1906 was in the Bernice P. Bishop Museum, Honolulu. Bailey thought the specimen might prove to belong to the race *L. h. burrovianus*. (See also Glaucous-winged Gull above.)

HERRING GULL — *Larus argentatus*

Status

Rare visitor; three records: April 1906, January 1913, February 1963.

Observations

Bailey (1956: 97) reported two specimens of Herring Gulls taken on Laysan prior to POBSP investigations. A female, collected by Bompke on 20 April 1906 and deposited in the Bishop Museum (BPBM 4539), was subsequently identified as *Larus argentatus smithsonianus*. Bailey remarked, however, that E.H. Bryan, Jr. had informed him that this bird might prove to be *L. a. vegae* upon further critical comparison.

The second specimen (USNM 240940), an immature female, was collected along the shore of the lagoon by Bailey on 25 January 1913. It was later identified by Dr. Herbert Friedmann as *L. a. vegae*.

The third specimen (USNM 493352) was collected on 12 February 1963 by POBSP personnel (Clapp and Woodward, 1968: 26). This bird, a female in first nuptial plumage, was subsequently identified as *L. a. vegae* by Mrs. Roxie C. Laybourne and Dr. Lester L. Short, Jr. of the Bureau of Sport Fisheries and Wildlife.

BONAPARTE'S GULL — *Larus philadelphia*

Status

Accidental; one record: December 1912.

Observations

Bailey (1956: 98) collected an immature female (USNM 240984) on 27 December 1912 as it hovered low over the water along the shore of the lagoon.

This is the only confirmed occurrence of Bonaparte's Gull in the Northwestern Hawaiian Islands. A single individual was recorded (without comment) from Sand Island, Midway Atoll, 29 January 1963 by POBSP personnel (Sibley and McFarlane, 1968: 318).

BLACK-LEGGED KITTIWAKE — Rissa tridactylus

Status

Accidental; one record: winter 1906.

Observations

Bryan and Greenway (1944: 118) reported this species from Laysan on the basis of fragments in the Bishop Museum. Wetmore, in his field notes of 1923, stated that the remains (BPBM 4537), consisting of wings, feet, tarsi, and bill, had been found on the beach by Bompke during the winter of 1906. He also noted that the wings were in partial molt.

SOOTY TERN — Sterna fuscata

Status

Abundant breeder; maximum recent estimate: 2,000,000. Usually present from mid-February through mid-October. Absent except for occasional wandering birds during remainder of year. Most nesting is from early April to early September. Nests in shallow scrapes in the soil over most of the island, exclusive of the beaches and lagoon shore, but chiefly in the Eragrostis association of the island interior.

Populations

The Sooty Tern is presently the most abundant bird nesting on Laysan. Peak populations occur in summer but are difficult to estimate because of the immense numbers and the large area covered. Most, if not all, estimates (Table ST-3) are conservative. Recent estimates are generally higher than figures given earlier in the century for probably two reasons--(1) these earlier visits were usually made early in the season before population maximums had been reached; (2) recent estimates usually include birds using the island but which may be absent at the actual time of the count (e.g., absent mates of incubating birds).

Schauinsland's and Dill and Bryan's estimates for 1896 and 1911 indicate huge populations, probably not greatly different from present

numbers. The latter estimated 333,900 birds, with the colony still increasing in size. Fisher's description of the area covered by the breeding colony in 1902, which is similar to that used today, implies a population of at least several hundred thousand birds.

Estimates by Willett and Bailey for 1913, Munter for 1915, and Wetmore for 1923 were too early in the breeding season to be directly comparable with either the earlier or the more recent figures. Diggs, who made the September 1918 estimate which seems very large for that time of year, was not a biologist and his estimate is probably little more than a guess. Therefore, it is not possible to determine accurately the effects on this species caused by denudation of the island by rabbits or by the depredations of the feather poachers who took very large numbers of Sooty Terns.

Annual Cycle

The timing of the Sooty Tern breeding cycle on Laysan may vary more than a month from year to year. A new breeding cycle begins with the appearance of a swirl, or swirls, of birds offshore at night. Later these swirls move over the island at night but remain offshore during the day. As the swirls grow larger, birds begin landing on the island at night and stay over and around the island longer during the day. At about this time a few birds lay, but usually abandon their eggs during the day when the flock moves off. Not until large numbers lay do the birds remain on their eggs. The first groups to lay and incubate form loose nuclei around and among which later arrivals expand the colony. Members of sub-groups within the population usually lay in close synchrony, but the sub-groups found on different parts of the island may vary by several weeks in their stage of breeding. These sub-groups are not clearly defined but form a nearly continuous colony, both in space and time.

On Laysan the first birds probably return to the vicinity of the island in January (one observation in 1913), or possibly even in December (1963), and begin building up substantial numbers by the end of February. Some birds were settling on the ground in February 1963. All March observers found birds swirling over the island, and most of them reported at least a few birds on the ground.

The earliest known egg laying occurred in 1959, when Kramer (ms.) found small chicks 28 April to 1 May. The eggs from which these chicks hatched must have been laid during the last days of March or the first week of April. Munter's (1915) observations indicate egg laying by at least the first week of April. Eggs may be laid as late as late June (1964, 1967) or even mid-July (1965), but in most years the peak period of egg laying falls between mid- or late May and mid-June.

Hatching begins as early as late April (1959) and continues to at least mid-August (1965) with the peak period usually from mid- or late June to early July. Young may begin to fly by late June (1959) or more often July, and most of them have fledged by the end of August or the

first week of September. The last chicks probably fledge in late September or October when nearly all the adults and young have left the island, leaving behind a few crippled and emaciated chicks which probably die within a few weeks.

No November observations are available but Sooty Terns were reported on two of three December visits. Between 3 and 10 December 1963 they were common at night, possibly indicating the beginning of the pre-breeding swirls. A single adult seen in December 1967 was probably a traveling or feeding bird that was attracted to the island briefly as it passed through the area.

Ecology

Breeding: Sooty Terns nest over nearly the entire surface of the island except the open sand beaches, the open lagoon shore, and dense shrubby vegetation. Fisher (1903a: 779) described "a great colony which extends along the upper half of the interior slope completely around the island, with only a few interruptions, and are thus found almost entirely among the bushy grass; on the west side the community extends nearly to the low bluff overlooking the sea."

In 1923 Wetmore mentioned colonies "in the Sesuvium" and "at the tobacco patch." These birds probably were attracted to any vegetation available at this time when most of the island was barren sand.

The nesting area used in recent years resembled that described by Fisher. In June 1966 nesting occurred continuously around the island except for a small gap between the north end of the lagoon and the broad north beach. On the west and south sides nearly all birds were in the Eragrostis association, while some of those on the east side were in Ipomoea cover, and a few were found under Pluchea. Heaviest concentrations of birds occurred on the northwest, northeast, and southwest corners of the island, and a huge swirl of birds not yet nesting was present over the southeast corner when the party left the island on 21 June.

Eggs are simply deposited on the sand, usually near or under a grass clump or other protective vegetation.

Non-breeding: Birds not occupied with eggs or chicks are usually found with the breeders. Late in the nesting cycle large numbers of these unemployed birds come to the island in company of those returning to feed the remaining chicks.

Birds without eggs roosted on open sand on the east side of the island in June 1966 and September 1967 (flocks of 500+), but they were never more than several yards from nesting birds.

Specimens

Ninety Sooty Tern skins from Laysan are currently distributed in various museums as indicated in Table ST-1. Seventeen additional mounted

specimens are distributed as follows: BPBM (1 male); DMNH (2 in Bahamas exhibit); SUI (14 in Laysan exhibit). Also preserved are at least 2 skeletons (USNM); 1 alcoholic (BPBM); and 72 eggs (BPBM, 37; USNM, 35).

Banding and Movements

The POBSP banded 130,425 Sooty Terns on Laysan (Table ST-2). Forty-eight birds banded on Laysan were recovered elsewhere as follows: Johnston Atoll, 12; French Frigate Shoals, 4; Lisianski, 20; Midway, 1; Kure, 4; Japan, 1; Philippines, 1; Marshal Islands, 1; Phoenix Islands, 1; Line Islands, 1; Atafu, 1; at sea in Western Pacific, 1 (Appendix Table 4-8a). Forty birds banded elsewhere were recaptured on Laysan as follows: Johnston Atoll, 23; French Frigate Shoals, 3; Lisianski, 10; Midway, 2; Kure, 2 (Appendix Table 4-8b). The high number of recaptures involving Johnston Atoll is undoubtedly because most of them were color-marked individuals.

Table ST-1. Locations of Sooty Tern skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	5	5	7	17
BPBM	1	1	3	5
CMNH	1	1	0	2
DMNH	4	4	2	10
MCZ	2	2	0	4
SUI	2	11	0	13
UMMZ	1	2	0	3
USNM (non-POBSP)	17	13	2	32
(POBSP)	3	1	0	4
Totals	36	40	14	90

Table ST-2. Sooty Terns banded on Laysan by the POBSP.

Period of Survey		Adults	Young	Totals
1964	Sept.	900	1,000	1,900
1965	July	9,186	2,814	12,000
	Aug.	30,900	9,100	40,000
1966	June	69,900	0	69,900
1967	June	5,000	0	5,000
	Sept.	1,425	200	1,625
Totals		117,311	13,114	130,425

Table ST-3. Observations of Sooty Terns on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1890 16 July	?	Dense population with eggs and small chicks (Lyons, 1890: 90-91).
1891 16-27 June	?	Nesting (Rothschild, 1893-1900: 40). Eggs present (Munro, 1930: 687).
1895 Sept.	?	4 adults collected by Hall (AMNH, BPBM).
1896 24 June-24 Sept.	10,000-100,000	"On the verge of selecting their nesting places [24 June]" (Schauinsland, 1899: 48).
1902 16-23 May	?	Evidently very abundant; fresh eggs (Fisher, 1903a: 780).
22 May	?	5 fresh eggs collected (USNM).
1903 Apr.	?	1 specimen and 36 eggs collected by Bryan (BPBM).
1907 16 May	?	4 collected by Schlemmer (MCZ).
1911 24 Apr.-5 June	333,900	Laying dates not given, but up to 7 to 9 eggs per square yard present by 4 June; on 23 April 2 colonies of ca. 500 each; thousands appeared ca. 6 May and increased daily; final estimate made from area x density measurements 4 June (Dill and Bryan, 1912: 13).
1912-1913 22 Dec.-11 Mar.	?	Several seen first on 7 January; arriving in great numbers by 28 February; no colonies established by 11 March (Bailey, 1956: 102).
1915 3 Apr.	10,000	Beginning to lay in east-central portion of the island (Munter, 1915: 139).
1918 8-10 Sept.	500,000	Nesting; most common species (Diggs, ms.).
1923 8-13 Apr.	?	Large flock circling east of lagoon (Wetmore, ms.).
27 Apr.	?	Laying begun; perhaps 20 eggs laid by this date (Dickey, ms.).

Table ST-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1923	28 Apr.	?	Terns flooded out of colony (Dickey, ms.).
	29 Apr.-14 May	12,000	Egg-laying and fresh eggs (Wetmore, ms.).
	4-8 May	?	30 fresh eggs collected (USNM).
1930	2-18 Aug.	most abundant species	Young about 3/4 grown (Wilder, ms.).
1936	7-8 Mar.	?	Evidently no nests found (Trempe, ms.).
1950	23 June	abundant	Eggs and young (POFI).
1951	12 May	?	Eggs (POFI).
	late June-early July	115,800	Based on count of birds present on island (Brock, 1951b: 18).
1955	10 Feb.	2	(POFI).
1957	25 June-3 July	400,000	(Woodside, ms. b).
	8-12 July	?	Heavy concentrations; hatching eggs and some older young (Labrecque, 1957: 17).
1958	27 May-4 June	?	Thousands of eggs; those near the center of the colony about 1 week incubated, those near the periphery fresh; more being laid (Warner, ms.).
1959	28 Apr.-1 May	?	Egg laying to small downy young; most with eggs (Kramer, ms.).
1961	7-8 Mar.	?	Not nesting; "very numerous" in air, a few on the ground (Woodside and Kramer, ms.).
	4-10 Sept.	?	Most colonies with flying immatures; no eggs or small young observed; great increase in numbers at night (Woodside, ms. c).

Table ST-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1962 14-19 June	abundant	Some colonies almost entirely on eggs; others almost entirely with downy young; others not nesting (Kramer and Beardsley, ms.).
1963 11-13 Feb.	1,000	Not nesting; mostly overhead; some birds settling (BSFW, POBSP).
3-10 Dec.	?	Not nesting; common in air at night, but none seen on ground; none seen during the day (Walker, ms. b).
1964 10-11 Mar.	300,000-600,000	Pre-breeding; 3,000 to 4,000 on the ground by day (BSFW, POBSP).
16-20 Sept.	50,000-75,000	Ca. 25,000 flying immatures; a small number of still unfledged young (BSFW, POBSP).
1965 6-11 Mar.	7,000-12,000	2 separate breeding colonies forming; largest (5,000-10,000) on ground for short periods during day; smaller group of a few thousand circling and spending little time on ground (POBSP).
17-21 July	450,000	Ca. 50,000 young; stage of sub-colonies varied from heavily incubated eggs to a few fully feathered chicks, none of which could fly; many areas had no eggs or chicks (POBSP).
5-12 Aug.	1,000,000	Also 200,000 young from downy to flying immatures. Ca. 200 heavily incubated eggs near north end of lagoon; many areas with adults only; restless milling behavior at dusk (POBSP).
1966 26-31 Mar.	250,000	Mostly over the island; several hundred on ground at night; no eggs or young (BSFW).
10-16, 20-21 June	2,000,000	Also 500,000 nests with eggs; stages of cycle ranged from birds just settling on the ground to slightly incubated eggs (POBSP).

Table ST-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1966 17-18 Sept.	20,000-30,000	Primarily present at dusk; some emaciated (apparently deserted) almost full-grown chicks and several hundred dead chicks (BSFW).
20-23 Oct.	100	Few crippled immatures and a few others flying with adults (POBSP).
1967 18-19 Mar.	4,000	Small swirls; ca. 200 on the ground at night (BSFW, POBSP).
7-12 June	1,543,000	All stages from birds settling only at night to newly hatched young; estimated 257,000 eggs, thought to be about 1/4 of total to be laid (POBSP).
5-11 Sept.	60,000	Several thousand young from 3/4 grown to fully fledged; most birds evidently post-breeding (POBSP).
13 Dec.	1	1 adult heard flying overhead (BSFW).
1968 17-19 Mar.	7,500	Not more than several hundred present in mornings; several thousands swirling over island in late afternoon and night; one flock of ca. 200 on ground at night (BSFW, POBSP).
1969 26-29 Mar.	50,000	Birds swirling; no signs of nesting (BSFW).
9 Sept.	thousands	Only adults seen; evidently post-nesting (BSFW).

GRAY-BACKED TERN — *Sterna lunata*

Status

Common breeder; maximum recent estimate: [40,000]. Present from late December or early January through mid-September; absent remainder of year. Most nesting is from March through early August. Nests on ground in semi-open areas near the outer beaches and near the central lagoon.

Populations

No population estimates were made until 1911, when Dill and Bryan estimated 50,000 birds from 24 April to about 5 June 1911 (Table GBT-2).

On 3 April 1915, Munter estimated 5,000, and Wetmore found only about 1,000 between 29 April and 14 May 1923. These figures indicate that the number of breeding birds declined from 1911 to 1923. In 1923 Wetmore noted heavy egg predation by Bristle-thighed Curlews and Ruddy Turnstones, perhaps as a result of almost complete destruction of nesting cover by rabbits.

No further numerical estimates were made until after the mid-1950's. The maximum figure of 40,000 given by POBSP in June 1967 (if not excessive) approximates the 50,000 estimate of 1911 and suggests a population recovery from the low point reached when the island was nearly devoid of vegetation.

Annual Cycle

Birds arrive in late December or January with numbers increasing to their maximum about April.

Egg laying may begin by late February (1913) or early March (1961, 1965) or may not begin until after mid-March (1964). The peak laying usually occurs from mid- through late April. Laying may continue through early June (1958, 1967), but birds laying this late have probably lost eggs earlier in the season. Wetmore found fresh eggs in mid-April, but by mid-May most of these had been destroyed by curlew and turnstone predation or by flooding, and some birds were re-nesting. Hatching may begin as early as the last week of March and may continue through early July. Most young, however, probably hatch in mid- to late May. Fledging begins as early as late May but most young fledge in July or early August. Numbers decrease with the fledging of young and by early September the population is reduced to a few immatures, adults, and weak non-fledged young that probably have been abandoned.

No birds were found during the single October visit (1966), and no visits were made in November. It is unlikely that more than a few wandering birds visit the island from late September until the beginning of the next cycle.

Ecology

Breeding: In mid-May 1902, Fisher (1903a: 780) found Gray-backed Terns in two interrupted bands around the island. Most were scattered in a narrow strip close to the beach on the seaward slope, entirely outside the Sooty Tern colony. A second set of separated, smaller colonies ringed the lagoon, inside the Sooty colony. Dill and Bryan (1912: 15) found these terns on the rocks at the south end of the island and in small rookeries on the east side in 1911. In 1913, the birds nested on open sand at the south end of the island and apparently lost many eggs to the surf (Bailey, 1956: 98-100). Wetmore (ms.) described nesting in broken and eroded coral and sandy areas on and above the beaches on the northwest shore, and on the crest of the highest point at the south end of the island. Many birds laid too far out on the beach and their eggs were destroyed by surf.

The colonies observed during POBSP visits in June 1966 and 1967 were distributed in a pattern similar to that found by Fisher in 1902. Birds were scattered over most of the island wherever Ipomoea was present, especially along the central lagoon and along the ocean beach. Considerable numbers nested also among the Scaevola on the beach crest, especially along the southern half of the west shore. Gray-backed Tern colonies were more open and less crowded than Sooty Tern colonies, and the birds seemed to prefer a vegetated edge bordering open areas. Eggs were laid on open sand, in the lee of coral rocks and drift, on exposed rocks, and sometimes under bushes.

Non-breeding: Pre-nesting birds observed in mid-February 1963 arrived after dark and milled about over the island. Small groups rested briefly on open sand beaches, but they flushed readily if approached.

Throughout the breeding season, roosting flocks, probably of non-nesters, form at night in open areas, particularly on the beaches at the outer edges of the Scaevola. From July to September most of these birds are immatures.

Specimens

One-hundred and ten Gray-backed Tern skins from Laysan are currently distributed in museums as indicated in Table GBT-1. An additional 11 mounted specimens are in the Laysan exhibit at SUI. Also preserved are at least 3 skeletons (BPBM, 1; USNM, 2); and 24 eggs (BPBM, 11; USNM, 13).

Banding and Movements

The POBSP banded 45 adult Gray-backed Terns in February 1963. No interisland movements were recorded.

Table GBT-1. Locations of Gray-backed Tern skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	7	7	9	23
BPBM	3	2	9	14
CMNH	1	1	0	2
DMNH	5	3	1	9
MCZ	3	2	6	11
SUI	3	2	0	5
UMMZ	3	5	0	8
USNM (non-POBSP)	22	13	1	36
Other*	1	1	0	2
Totals	48	36	26	110

*Law Coll. (1 ♂, 1 ♀).

Table GBT-2. Observations of Gray-backed Terns on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1828	24 Mar.	?	Possibly recorded by Isenbeck (see Rothschild, 1893: v).
1891	16-27 June	great numbers	On eggs (Rothschild, 1893-1900: 38).
1896	24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902	16-23 May	?	Heavily incubated and hatching eggs (Fisher, 1903a: 780-781); 3 eggs of advanced incubation collected (USNM).
1903	20-30 Apr.	?	At least 6 specimens and 10 eggs collected by Bryan (AMNH, BPBM).
1905	spring	?	6 collected by Schlemmer (MCZ).
1907	16-18 May	?	5 collected by Schlemmer (MCZ).
1911	24 Apr.-5 June	50,000	Fresh eggs and young in all stages of development (Dill and Bryan, 1912: 15).
1912 1913	22 Dec.-11 Mar.	?	Many present on 22 December; numbers increasing by 24 January. Several thousand present by 24 February when first egg was found; no young by 11 March (Bailey, 1956: 98-100; Willett, ms.).
1915	3 Apr.	5,000	Only eggs, no young (Munter, 1915: 139).
1916	9 Feb.	a few	(Munter, ms.).
1923	8-13 Apr.	common	(Wetmore, ms.).
	13 Apr.	common	10 freshly incubated eggs collected (USNM). Ca. 50 nesting at south end of island (Dickey, ms.).
	29 Apr.-14 May	1,000	Fresh to slightly incubated eggs (Wetmore, ms.).
1936	7-8 Mar.	?	(Trempe, ms.).

Table GBT-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1950	23 June	common	Eggs (POFI).
1951	12 May	?	Eggs (POFI).
1957	25 June-3 July	4,000	Adults (Woodside, ms. b).
	8-12 July	?	(Labrecque, 1957: 18).
1958	27 May-4 June	large numbers	Arriving; beginning to lay on 1 June (Warner, ms.).
1961	7-8 Mar.	?	Sparse colonies; beginning to lay (Woodside and Kramer, ms.).
	4-10 Sept.	very few	Mostly immatures (Woodside, ms. c).
1963	11-13 Feb.	200	Pre-breeding (POBSP).
	3-10 Dec.	?	(Walker, ms. b).
1964	10-11 Mar.	200	Not nesting (BSFW, POBSP).
	16-20 Sept.	9	All unfledged, very weak young (BSFW, POBSP).
1965	6-11 Mar.	3,000-5,000	Fresh eggs, birds laying (BSFW, POBSP).
	17-21 July	5,000	Ca. 2,000 young, 1/2-grown to fledged (POBSP).
	5-12 Aug.	1,600	1,500 young, mostly fledged; ca. 50 adults (POBSP).
1966	26-31 Mar.	many thousands	Few nests with eggs (BSFW).
	10-16, 20-21 June	12,000	Mostly heavily incubated eggs and small chicks; also many flying immatures; ca. 1,000 eggs and 4,000 chicks (POBSP).
	17-18 Sept.	very few	3 or 4 near-fledging young seen (BSFW).
	20-23 Oct.	0	(POBSP).

Table GBT-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1967 18-19 Mar.	1,000	15 eggs found (BSFW, POBSP).
7-12 June	[40,000]	Egg laying to flying immatures; estimated 10,000 nests (POBSP).
5-11 Sept.	40	Ca. 10 large young; some starving, evidently abandoned; very few adults seen (POBSP).
13 Dec.	0	(BSFW).
1968 17-19 Mar.	5,000	Scattered, small groups along west beach. Most pre-nesting; 2 nests with eggs found (BSFW, POBSP).
1969 26-29 Mar.	2,000	Eggs (BSFW).
9 Sept.	1	An immature bird (BSFW).

BLUE-GRAY NODDY — Procelsterna cerulea

Status

Rare visitor; two records: September 1964, June 1967.

Observations

On 19 September 1964 Walker (BSFW) saw one of these terns on the southwest side of the island at a distance of about 18 inches. Stadel (POBSP) saw another on the night of 11 June 1967. This species was not reported previously from Laysan but its appearance there is not surprising since it is common on some of the inner islands of the leeward chain.

BROWN NODDY — Anous stolidus

Status

Common breeder; maximum recent estimate: 20,000 to [40,000]. Present year round but populations much smaller from mid-fall through early spring. Most birds breed from March through September but some also breed during all other months of the year. Usually nests on the ground under or near vegetation throughout the island. Often builds a nest of grass, leaves, and plant stems.

Populations

Recent estimates, with the exception of the June 1967 estimate which seems excessively large, indicate populations of 10,000 to 20,000 birds during the early summer nesting peak (Table BrN-2). Munter's estimate of 6,000 in April 1915 and Dill and Bryan's figure of 5,500 in May 1911 indicate the same order of magnitude for populations then as in the 1960's. These figures are probably lower than maximum figures from recent visits because they were made earlier in the breeding cycle.

Brown Noddies were less popular with feather hunters than some other species, so probably were not destroyed in great numbers. The low number found by Wetmore in 1923 (500 birds) probably was the result of the destruction of island vegetation by rabbits.

Annual Cycle

The Brown Noddy is one of the most, if not the most, irregular breeding species on Laysan. Eggs may be laid or may hatch and young may fledge in any month of the year. However, like other species that breed irregularly on Laysan, most of the birds nest in what appears to be a regular annual cycle.

The breeding season begins with increased egg laying in April or early May, with a peak laying period from mid-May through early June.

The peak hatching period occurs from mid-June through mid-July and the largest numbers of young probably fledge during August or early September. During the latter part of the fledging period, numbers of adults decrease and flying young make up a large proportion of the population. A large proportion of the adults and immatures apparently leave the island from late September or October through February or March. A gradual build-up in numbers of adults probably begins in late winter, culminating in the onset of a new peak breeding period in the spring.

Ecology

Breeding: Brown Noddies nest over most of the island but appear to be more common in the Scaevola zone around its periphery, particularly on the west and northwest sides. Smaller numbers nest in the Eragrostis association, and in the Ipomoea zone around the lagoon, especially at the north end. Wetmore found them preparing to nest only near the north end of the lagoon in 1923, but did not describe the nest sites in detail. Although small colonies may be formed, these noddies are not characteristically colonial but build scattered nests throughout their habitat.

Most nests are merely depressions in the sand under Scaevola or Eragrostis, lined loosely with grass, leaves, and sometimes bones, and on rare occasions unlined. Occasionally more substantial nests are built on procumbent limbs of shrubs, or a platform may be built of sticks and grass in low Scaevola, completely off the ground. The tops of Eragrostis clumps are also used.

Non-breeding: Fisher (1903a: 783) aptly described the activities of non-breeding Brown Noddies as follows: "Noddies like to gather in little companies on the beach, or on rocks near the shore, where they sit for hours dozing away or preening their feathers." Similar behavior has been noted on many subsequent visits, especially those made late in the breeding season when many fledged immatures join these diurnal resting flocks. At night most non-nesting birds roost on Scaevola bushes.

Specimens

Eighty-six Brown Noddy skins from Laysan are currently distributed in museums as indicated in Table BrN-1. Six additional mounted specimens are distributed as follows: BPBM (1 male); CMNH (1 female in Laysan group); DMNH (1 in Bahamas group); SUI (3 birds in Laysan group). Also preserved are at least 2 skeletons (USNM) and 10 eggs (USNM).

Banding and Movements

The POBSP banded 1,225 Brown Noddies: 1 young in September 1964; 35 young in October 1966, and 953 adults and 236 young in September 1967. No interisland movements were recorded.

Table BrN-1. Locations of Brown Noddy skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	6	3	5	14
BPBM	1	1	2	4
CMNH	1	1	0	2
DMNH	3	3	0	6
MCZ	5	1	1	7
SUI	4	6	0	10
UMMZ	3	3	0	6
USNM (non-POBSP)	19	16	1	36
Other*	1	0	0	1
Totals	43	34	9	86

*Law.Coll. (1 ♂).

Table BrN-2. Observations of Brown Noddies on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1891 16-27 June	plentiful	Nesting (Rothschild, 1893-1900: 42).

Table BrN-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1895	Sept.	?	3 or 4 adults collected by Hall (BPBM).
1896	24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902	16-23 May	?	Laying recently begun (Fisher, 1903a: 783).
1903	Apr.	?	Juvenile collected by W.A. Bryan (BPBM).
1904	24 May	?	3 adults collected by Schlemmer (MCZ).
1907	2 May	?	4 adults collected by Schlemmer (MCZ).
1911	23 Apr.-5 June	5,500	Fresh eggs present during last week of May (Dill and Bryan, 1912: 15).
1912 1913	22 Dec.-11 Mar.	400 (nesting)	Incubated eggs to 1/2-grown young on 23 December. Nesting in colonies of 50 to 100 pairs (Bailey, 1956: 106); young birds fairly plentiful by 1 January and fledged young present on 1 March (Willett, ms.).
1915	3 Apr.	6,000	Eggs and young (Munter, 1915: 139).
1916	9 Feb.	very common	Nesting on ground (Munter, ms.).
1923	8-13 Apr.	?	Not nesting (Wetmore, ms.).
	29 Apr.-14 May	500	Selecting nest sites and beginning to build nests (Wetmore, ms.).
	7-9 May	?	8 fresh eggs collected (USNM).
1930	2-18 Aug.	plentiful	Eggs and young (Wilder, ms. b).
1936	7-8 Mar.	?	(Trempe, ms.).
	12 Dec.	?	3 or 4 at south end of island (Coultas, ms.).
1950	23 June	common	Eggs and young (POFI).

Table BrN-2. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1951	12 May	?	Eggs (POFI).
	late June-early July	?	Combined count of this species and the Black Noddy of 9,521 (Brock, 1951b: 18).
1957	25 June-3 July	10,000	Adults (Woodside, ms. b).
1958	27 May-4 June	?	Moderately to heavily incubated eggs; no young seen (Warner, ms.).
1959	28 Apr.-1 May	?	None found nesting; groups of 25 to 50 along beaches (Kramer, ms.).
1961	7-8 Mar.	very few	No eggs noted; only 4-5 immatures seen (Woodside and Kramer, ms.).
	4-10 Sept.	?	Eggs to flying immatures; mostly immatures. Some colonies with 1/2- to 3/4-grown young; a few birds on eggs (Woodside, ms. c).
1962	14-19 June	?	Some downy chicks (Kramer and Beardsley, ms.).
1963	11-13 Feb.	100	1 heavily incubated egg (POBSP).
	3-10 Dec.	?	Low numbers; eggs to fledglings (Walker, ms. b).
1964	10-11 Mar.	100	Ca. 10 nests with eggs; 2 nearly fledged young observed (BSFW, POBSP).
	16-20 Sept.	2,000	A few eggs and young found; most non-breeding (BSFW, POBSP).
1965	6-11 Mar.	500-1,000	Eggs to flying immatures (POBSP).
	17-21 July	15,000	Half-incubated eggs to fledged young; ca. 5,000 young (POBSP).
	5-12 Aug.	20,000	Egg laying to fledged young; ca. 1,000 nests with eggs and ca. 5,000 young (POBSP).
1966	26-31 Mar.	?	At least several thousand; eggs to recently hatched young (BSFW).

Table BrN-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1966 10-16, 20-21 June	20,000	Fresh eggs to nearly fledged young; ca. 5,000 nests with eggs, 5,000 with young (most recently hatched) (POBSP).
17-18 Sept.	?	No chicks seen (BSFW).
20-23 Oct.	800	Only flying immatures (POBSP).
1967 18-19 Mar.	several hundreds	1 egg found (BSFW, POBSP).
7-12 June	[40,000]*	Eggs to fledglings; most nests with eggs. Estimated 10,000 nests (POBSP).
5-11 Sept.	10,000	Eggs to fledged immatures; estimated 10 nests with eggs; 50 small young and 200 large young; at least 1/5 of the flying population comprised of immatures (POBSP).
13 Dec.	?	Several flocks of 75-100 birds seen; no nests found (BSFW).
1968 17-19 Mar.	500-1,000	Most not nesting; few scattered large young and several nests with eggs seen (BSFW, POBSP).
1969 26-29 Mar.	100	Several found incubating eggs; another brooding a rather large downy chick (BSFW).
9 Sept.	?	Several found incubating eggs (BSFW).

*Estimate considered excessive.

BLACK NODDY — Anous tenuirostris

Status

Common breeder; maximum recent estimate: 5,000. Most breeding occurs from November through July; birds present in varying numbers throughout remainder of year. Builds bulky nest in woody vegetation.

Populations

Spring populations in 1911 and 1913 were at least 3,000 to 4,000 birds (Table BlN-3). Munter's 1915 estimate of 20,000 seems unbelievably high; he may have confused this species with the Brown Noddy. Wetmore's estimate of 600 in 1923, the lowest breeding season estimate, suggests that the lack of vegetation may have reduced the population by 75 percent or more from the 1911 to 1913 period.

There is little evidence that the population size has changed since 1911 to 1913. Bailey and Willett counted 1,151 active nests in January 1913, indicating a minimum nesting population of 2,302 birds. This is the highest number of nests ever recorded on the island, but there are no recent counts during the same time of year. Neither are there any 20th century population estimates for either summer or fall, when populations may be larger than in the spring.

Annual Cycle

Black Noddies are present on Laysan throughout the year, but are apparently most common near the end, or after completion, of the nesting cycle.

Egg laying may begin in October (1967), November (1963), or December (1912, 1915, 1964) and continue at least into May (1951, 1962, 1965, 1966). Observations of an egg and a young bird in September 1964 and young birds in September 1969 indicate that at least a few eggs may occasionally be laid through August. Observations from five other September visits (1918, 1961, 1965-67) indicate that in most years nesting has ended prior to September. Bailey's observation of many new eggs being laid in March after an earlier egg peak in January, as well as several recent sets of observations, indicate that there may be several nesting cycles within one breeding season. Within the usual breeding period, hatching occurs from as early as late October through late June or perhaps early July. Similarly, fledging may occur from late December (1967) through early August. Evidently the young do not leave the island immediately after fledging. A non-breeding period usually extends from mid- or late August to at least mid-October.

Ecology

Breeding: Palmer in 1891 (Rothschild, 1893-1900: 43) recorded Black Noddies nesting "in some numbers on the north side of the island, sitting around in clusters." Fisher (1903a: 774, 784) found them nesting in Chenopodium and another bush (probably Scaevola) in scattered communities over the island, either near the sea or in the interior. In 1912 and 1913, Bailey (1956: 108) reported nesting in the few remaining low bushes circling the lagoon. Munter (1915: 139) found four or five colonies in low bushes and a small colony nesting "on the tops of limestone or phosphate rocks at the south end of the island."

In 1923 Wetmore (ms.) found them nesting on the corrugated iron roof of an old building, inside the building (one chick), and in the few remaining trees, and on rock ledges around the beaches. Nesting on artificial structures and rocks was undoubtedly because of lack of vegetation in areas where the birds normally nested. Evidence of competition for nest sites was shown by the nesting of Black Noddies within a few feet of nesting Red-footed Boobies--much closer than under present conditions.

In recent years Black Noddies have nested most densely in the Casuarina tree near the landing on the northwest side of the island where at least 100 active nests were counted in December 1967. In June 1966 and March 1968 this tree contained 48 and ca. 205 nests, respectively. Other nests have been found in widespread locations in Scaevola, Cocos, Pluchea, and Eragrostis (Fig.41). Scaevola, particularly the taller growth along the northwest rim of the island, seems to be the next most favored nest site after Casuarina.

Fisher (1903a: 784) described the nests of this species as follows: "from 18 inches to 3 feet up...constructed of twigs, usually morning-glory stems and leaves, and are from 10-12 inches in diameter. Usually the nests are built flat on top of bushes, or sometimes below in a crotch. There is scarcely any hollow, and occasionally a few feathers enter into the lining of dried leaves. The nests are in a large number of cases completely plastered over with droppings and are used year after year."

Figure 41. Black Noddy at nest with downy young, March 1965. Photo by R.B. Clapp.

Non-breeding: These noddies, especially recently fledged young, congregate during the day in flocks on the beaches, particularly the western ones. Adults and immatures gather at dusk and roost on the tops of Scaevola. These congregations are often much larger than the breeding population and include birds from other islands.

Specimens

One-hundred twenty-one Black Noddy skins from Laysan are currently distributed in museums as indicated in Table BlN-1. Ten additional mounted specimens are distributed as follows: AMNH (1 in Laysan group); BPBM (1 juvenal); CMNH (1 adult); SUI (7 birds in Laysan exhibit). Also preserved are at least 3 skeletons (BPBM, 2; USNM, 1); 2 alcoholics (BPBM, USNM); and 4 eggs (BPBM, 1; USNM, 3).

Banding and Movements

The POBSP and BSFW banded 325 Black Noddies on Laysan Island (Table BlN-2). Five Black Noddies banded on Laysan were recaptured as follows: French Frigate Shoals, 3; Lisianski, 1; Pearl and Hermes Reef, 1 (Appendix Table 4-9a). Seven banded on French Frigate Shoals and 1 banded on Midway were recaptured on Laysan (Appendix Table 4-9b).

Table BlN-1. Locations of Black Noddy skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	11	6	4	21
BPBM	7	3	3	13
CMNH	2	1	1	4
DMNH	6	2	0	8
MCZ	4	1	1	6
SUI	7	3	2	12
UMMZ	1	4	0	5
USNM (non-POBSP)	23	7	5	35
(POBSP)	5	6	2	13
Other*	2	2	0	4
Totals	68	35	18	121

*Moseley (1 ♀); Law Coll. (1 ♂, 1 ♀); Phelps Coll. (1 ♂).

Table BlN-2. Black Noddies banded on Laysan.

Period of Survey	Bander	Adults	Young	Totals
1963 Feb.	POBSP	37	0	37

Table BlN-2. (continued)

Period of Survey		Bander	Adults	Young	Totals
1964	Mar.	BSFW	4	0	4
	Sept.	POBSP	19	1	20
1966	Oct.	POBSP	36	(65)*	101
1967	Sept.	POBSP	117	9	126
1968	Mar.	POBSP	27	10	37
	Totals		240	85	325

*Age not reported; all were at least locals.

Table BlN-3. Observations of Black Noddies on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1891	16-27 June	?	Eggs present (Rothschild, 1893-1900: 43).
1896	24 June-24 Sept.	?	Nesting (Schauinsland, 1899: 101).
1902	16-23 May	?	Nests in considerable numbers; perhaps third in relative abundance among the terns. All eggs were more or less advanced in incubation; fledged young were common (Fisher, 1903a: 784).
1903	April	?	16 specimens and 1 egg collected by Bryan (BPBM).
1904	24 May	?	1 collected (by Schlemmer) (MCZ).
1905	spring	?	1 young collected (by Schlemmer) (MCZ).
1907	2 May	?	4 specimens collected (by Schlemmer) (MCZ).
1911	24 Apr.-5 June	3,000	Fresh eggs to fledged young (Dill and Bryan, 1912: 15).
1912-1913	22 Dec.-11 Mar.	3,000-4,000	Numerous on 22 December and beginning to nest. Many nests with eggs on 24 December. 1,151 nests censused on 17 January and eggs present; young hatched

Table BlN-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1912 1913	22 Dec.- 11 Mar. (cont'd.)		shortly afterward and nearly full-grown young were present by 10 February; fully one-half of young lost subsequently; eggs seen again in March (Bailey, 1956: 108); first young seen 17 January; re-nesting by 20 February; eggs plentiful again by 1 March (Willett, ms.).
1915	3 Apr.	20,000	Eggs and young in nests (Munter, 1915: 139).
1916	9 Feb.	?	Thousands nesting; eggs to more than 1/2 grown young (Munter, ms.).
1918	8-10 Sept.	2,000	No nests or young (Diggs, ms.).
1923	8 Apr.	?	Colony on buildings near camp, ca. 9% with nests under construction, 90% with eggs, only a few with young; colony at south end of island (about 100 pairs), about half building nests and half with eggs (Dickey, ms.).
1923	8-13 Apr.	common	(Wetmore, ms.).
	14 Apr.	?	Colony in tobacco patch building nests (Dickey, ms.).
	29 Apr.- 14 May	600	Fresh eggs and young (Wetmore, ms.).
1930	2-18 Aug.	rare	A few pairs seen (Wilder, ms. b).
1936	7-8 Mar.	?	Nesting in Casuarina trees, eggs present but not clear from ms. whether young were present (Trempe, ms.).
	12 Dec.	?	About 40 in Casuarina trees (Coultas, ms.).
1950	23 June	numerous	Eggs and chicks (POFI).
1951	12 May	?	Eggs (POFI).
	late June-early July	?	Not distinguished from Brown Noddy in diurnal count of 9,521 birds (Brock, 1951b: 18).

Table B1N-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1957	25 June-3 July	1,000	(Woodside, ms. b).
1958	27 May-4 June	?	Few eggs; young from about one week to fledged; aggregations of fledged birds (Warner, ms.).
1959	28 Apr.-1 May	?	All stages of young (Kramer, ms.).
1961	7-8 Mar.	?	From eggs to newly hatched young to 2/3-grown young (Woodside and Kramer, ms.).
	4-10 Sept.	many	Immatures; no nests found (Woodside, ms. c).
1962	14-19 June	common	Eggs and young (Kramer and Beardsley, ms.).
1963	11-13 Feb.	200	Eggs; one examined was well-developed (POBSP).
	3-10 Dec.	?	Most in Casuarina tree had newly hatched young; some eggs present (Walker, ms. b).
1964	10-11 Mar.	1,000	Estimated 150-200 nests with eggs and same number with young (BSFW, POBSP).
	16-20 Sept.	300	1 nest with egg and 1 chick noted; most of population non-nesting (POBSP).
1965	6-11 Mar.	1,000-2,000	Most nests with eggs, but young from recently hatched to fledged also observed (POBSP).
	17-21 July	3,500	Estimated 1,500 young present, from half-grown young to fledged birds (POBSP).
	5-12 Aug.	4,000	Estimated 1,000 flying young present (POBSP).
1966	26-31 Mar.	?	Ca. 300-400 in the Casuarina tree; at night many hundreds more; from eggs to nearly fledged and flying young (BSFW).

Table BlN-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1966	10-16, 20-21 June	4,500	A few half-grown young to flying immatures. Ca. 5 nests with eggs; also ca. 500 young present (POBSP).
	17-18 Sept.	thousands	No nesting noted (BSFW).
	20-23 Oct.	4,000	None nesting; flying immatures seen (POBSP).
1967	18-19 Mar.	350	Eggs and nearly fledged young present; some seen nest-building. In the Casuarina tree 8 of 10 eggs checked were fresh and 6 nearly fledged young were counted (BSFW, POBSP).
	7-12 June	5,000	From small to large downy young in nests; flying immatures observed; most nests had large or medium-sized downy young. Sample count of 38 nests in the Casuarina tree: 6 (16%) with small downy young; 13 (34%) with medium-sized downy young and 19 (50%) with large downy young (POBSP).
	5-11 Sept.	2,000	None nesting (POBSP).
	13 Dec.	?	100 nests checked in Casuarina tree: 42 were being constructed or had been constructed recently. Of those with contents, 53 (91%) contained eggs and 5 (9%) small downy chicks; also several very large chicks, almost capable of flight seen (BSFW).
1968	17-19 Mar.	3,000	Very slightly incubated eggs to fledged immatures. Of 79 nests with contents counted, 69 (88%) held eggs; 1 (1%) a small downy chick; 1 (1%) a medium chick; and 8 (10%) large young. No less than 250 active nests present (BSFW, POBSP).
1969	26-29 Mar.	1,400 ±	In sample count of 100 nests, 5% were empty but active, 71% contained eggs, most of them well incubated, and 24% contained small downy young (BSFW).
	9 Sept.	?	Nests contained downy to near-fledging young. Most nests held large downy young (BSFW).

WHITE TERN — Gygis alba

Status

Common breeder; maximum recent estimate: 1,500. Breeds throughout the year but with a definite peak from about May through August; present in smaller numbers during remainder of year. Lays single egg chiefly on rocky outcrops and ledges, less frequently on limbs or vegetation, rarely on the ground.

Populations

Not since mid-June 1891 has the White Tern been considered abundant (Table WhT-3). In 1902 Fisher considered it "one of the least abundant of the breeding seabirds." It was one of the species most prized by feather hunters and undoubtedly suffered heavily during the feather raids of 1909-1910 and 1915. Maximum populations recorded during that period were about 75 in May and June 1911; 80 in early March 1913 and about 400 in April 1915. These estimates (except the one for 1915) and those for September 1918, and April and May 1923 are lower than recent estimates for the same periods and suggest that present populations are larger than those during the early part of the century.

Annual Cycle

Eggs or young may occur during any month of the year but there is a distinct breeding peak during spring and summer. Eggs may be laid as early as late November or early December (1912, possibly 1963) and as late as early October (1963) but most laying probably occurs from late April through mid- or late May. Peak hatching and fledging periods are respectively from early June through late June and from mid-July through mid-August.

That no nesting birds were reported by the February 1963 survey party probably reflects inadequacies in the survey rather than the actual absence of breeding birds. Bailey's observations of eggs and young in February 1913 as well as recent observations of young in March (1961, 1964, 1967 to 1969) and eggs in December (1963, 1967) indicate that some White Terns usually breed in January. March estimates, ranging from 100 to 500, suggest that numbers begin to increase during this month, and a gradual build-up in numbers probably continues during the succeeding month or months.

Ecology

Breeding: Early observers found White Terns nesting in a wide variety of sites on Laysan. In 1899, Schauinsland (1899: 57) reported finding eggs on the bare sand, on the rim of the lagoon's salt crust, on bare rock cliffs near the edge of the surf, and in the forks of branches in the bushes. Fisher's (1903a: 785) observations suggest that in 1902 these birds nested more commonly in the interior than they do at present. He

found small colonies scattered over the island interior with the largest near the fresh water pond near the south end. Here the White Terns laid their eggs "on lumps of phosphate rock, among bunch grass, or under the overhanging shelter of some shrub or clump of vines..." Munter (1915: 139) also noted nesting on the scattered phosphate rocks in the southern part of the island. Wetmore (ms.) reported nests on rocks and rocky ledges of the south, southeastern, and north beaches, and also on the framework of the buildings and on piles of guano.

More recent observers found White Terns nesting primarily around the periphery of the island with a relatively small proportion in the interior. Eggs were found chiefly on the rocks and rock ledges of the southwestern and south beaches and on the rocks along the north beach, many of which are nearly hidden from view by encroaching vegetation. Small colonies occur on the rock piles in the interior south of the lagoon. Nests were also reported in the Casuarina tree, in Cocos trees (July 1965) and in Scaevola bushes (September 1966, June 1967). Probably the paucity of nests reported from Scaevola indicates that such nests are more easily overlooked than those on the rocks, but may indicate a genuine preference for rock or ledge nesting sites.

Nests occur from ground level to 8 feet or more above the substrate on the larger rock ledges. Nests on the ground, however, are apparently far less common than those which are slightly elevated, even if no more than one or two inches. Only Schauinsland and Fisher of the earlier observers stated or implied that nests were found on the ground and only three such nests were reported during recent POBSP surveys. In August 1965 an adult was found incubating an egg in a slight depression in the sand under a Scaevola bush and two eggs were found under clumps of Eragrostis within the Sooty Tern colony. Many nests were found less than a foot from the ground, usually in a niche on the side of a boulder or on a flat stone ledge.

Non-breeding: Some non-breeding birds roost on the rockpiles and ledges mentioned above and are often abundant in the taller vegetation, particularly Scaevola along the west beach, and the Casuarina and Cocos trees. Most non-breeding birds, however, are absent from the island.

Specimens

Seventy White Tern skins from Laysan are currently distributed in museums as indicated in Table WhT-1. Seven additional mounted specimens are distributed as follows: BPBM (4, including 2 juvenals); SUI (3 birds in Laysan exhibit). Also preserved are at least 3 skeletons (BPBM, 1; USNM, 2); 3 alcoholics (BPBM, 2; USNM, 1 young); and 21 eggs (BPBM, 4; USNM, 17).

Banding and Movements

The BSFW and POBSP banded 480 White Terns on Laysan through 1969 (Table WhT-2) but no interisland movements were recorded.

Table WhT-1. Locations of White Tern skins from Laysan.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	8	7	7	22
BPBM	4	4	4	12
CMNH	2	0	0	2
DMNH	2	0	1	3
MCZ	2	1	1	4
SUI	2	1	1	4
UMMZ	0	1	2	3
USNM (non-POBSP)	7	6	6	19
Other*	1	0	0	1
Totals	28	20	22	70

*Hachisuki (1 ♂).

Table WhT-2. White Terns banded on Laysan.

Period of Survey	Bander	Adults	Young	Totals
1963 Feb.	POBSP	31	0	31
1964 Sept.	POBSP	155	4	159
1965 Mar.	POBSP	84	1	85
1966 Mar.	BSFW	6	0	6
1967 Sept.	POBSP	189	9	198
1968 Mar.	POBSP	1	0	1
Totals		466	14	480

Table WhT-3. Observations of White Terns on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1890 16 July	?	Small flock near lagoon (Lyons, 1890: 91).
1891 16-27 June	great abundance	Nests with eggs (Rothschild, 1893-1900: 36).
1895 Sept.	?	At least 4 adults collected by Hall (BPBM, MCZ).
1896 24 June-24 Sept.	?	Eggs and young (Schauinsland, 1899: 56).

Table WhT-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1902	16-23 May	?	One of the least abundant of the breeding seabirds; fresh eggs to fully fledged young (Fisher, 1903a: 785).
	23 May	?	3 heavily incubated eggs collected (USNM).
1903	7-15 Apr.	?	11 specimens (including 2 juveniles on 7 April) and 3 eggs collected by Bryan (AMNH, BPBM).
1904	24 May	?	1 collected by Schlemmer (MCZ).
1907	8 May	?	2 collected by Schlemmer (MCZ).
1911	24 Apr.-5 June	75	Only 4 seen during the first week of survey. Found nesting on 15 May (Dill and Bryan, 1912: 15).
1912-1913	22 Dec.-11 Mar.	80	2-3 pairs present 22 December; an egg found 29 December hatched on 6 January and the young was able to fly by 10 March. Eggs seen in January and February. Numbers increased to more than 50 on 11 February and about 40 pairs were present on 1 March; on 11 March not more than six pairs present (Bailey, 1956: 110; Willett, ms.).
1915	3 Apr.	400	Eggs seen (Munter, 1915: 139).
1916	9 Feb.	small number	No eggs (Munter, ms.).
1918	8-10 Sept.	5	(Diggs, ms.).
1923	8-13 Apr.	common	Mostly eggs; a few hatched young present on 8 April (Dickey, ms., Wetmore, ms.).
	18 Apr.	100	(Dickey, ms.).
	29 Apr.-14 May	80	Count; eggs and young destroyed by heavy surf between visits (Wetmore, ms.); 14 fresh eggs collected (USNM).

Table WhT-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1930	2-18 Aug.	scarce	A few pairs nesting in buildings and 3 pairs seen on rocks; some with eggs, some with young (Wilder, ms. b).
1936	7-8 Mar.	?	(Trempe, ms.).
	12 Dec.	?	4 or 5 around house (Coultas, ms.).
1950	23 June	a few	(POFI).
1951	12 May	?	Eggs noted (POFI).
	late June-early July	150	Based on diurnal census (Brock, 1951b: 18).
1955	10 Feb.	4	(POFI).
1957	25 June-3 July	500	Adults (Woodside, ms. b).
	8-12 July	?	Eggs to fully grown young (Labrecque, 1957: 18).
1958	27 May-4 June	?	Eggs and young; all eggs examined moderately or heavily incubated; most chicks less than 2 week old (Warner, ms).
1959	28 Apr.-1 May	?	Eggs through fully feathered immatures (Kramer, ms.).
1961	7-8 Mar.	?	Eggs or small chicks; only 1 flying immature (Woodside and Kramer, ms.).
	4-10 Sept.	?	Eggs to immatures but mostly flying immatures (Woodside, ms. c).
1962	14-19 June	common	With eggs, downy chicks, and fully feathered young (Kramer and Beardsley, ms.).
1963	11-13 Feb.	100	Paired but no eggs seen (BSFW, POBSP).
	3-10 Dec.	?	Eggs and half-grown young (Walker, ms. b).
1964	10-11 Mar.	400	Eggs to flying immatures; ca. 18 eggs and 12 young seen (BSFW, POBSP).

Table WhT-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1964 16-20 Sept.	400	Estimated 15 eggs and 25 young; 1 egg hatched during visit (POBSP).
1965 6-11 Mar.	200-300	Eggs and a few chicks (POBSP).
17-21 July	1,500	Also ca. 500 nestlings from downy chicks to flying immatures; 1 egg seen (POBSP).
5-12 Aug.	1,500	Also ca. 200 eggs and 500 young; fresh eggs to flying immatures (POBSP).
1966 26-31 Mar.	400+	Some incubating eggs (BSFW).
10-16, 20-21 June	900	Eggs to flying immatures; also ca. 100 eggs and 100 young (POBSP).
17-18 Sept.	200-300	Hundred or so present during the day and at least several hundred at night; eggs found (BSFW).
20-23 Oct.	100	Several eggs and a few fledged young (POBSP).
1967 18-19 Mar.	100	1 egg and 3 half-grown young (BSFW, POBSP).
7-12 June	1,000	Eggs through flying immatures; estimated 200 nests (POBSP).
5-11 Sept.	800	Fresh eggs through flying immatures; many nests with medium-sized or large young. Of 15 nests in a sample count: 5 (33%) contained eggs, 1 (7%) had a small downy chick, 7 (47%) had medium-sized or large chicks, and 2 (13%) contained near fledging young (POBSP).
13 Dec.	?	Fairly common along beaches; 3 on eggs (BSFW).
1968 17-19 Mar.	300-350	Most not nesting; 3 nests with eggs and 1 large chick seen (BSFW, POBSP).
1969 26-29 Mar.	250	Eggs to young in all stages (BSFW).

HORNED PUFFIN — *Fratercula corniculata*

Status

Accidental; one record: February 1963.

Observations

The only record is a skeleton (USNM 497918) collected 12 February 1963 by POBSP personnel. The bird was evidently one of many washed up on the Northwestern Hawaiian Islands in the winter of 1962 to 1963. At least 15 other individuals were found by POBSP personnel on Kure, Midway, and Pearl and Hermes Reef (Clapp and Woodward, 1968: 30). Still other puffins, some of which may have been the same birds reported by POBSP field workers, were reported from Kure by Robbins (1966: 53) and from Midway by Fisher (1965: 357).

LAYSAN MILLER-BIRD — *Acrocephalus f. familiaris*

Status

Endemic. Formerly a common to abundant permanent resident; now extinct. Nested during early summer in bunch grass near the lagoon.

Populations

The Laysan Miller-bird was first collected for science by Palmer and Munro in 1891 and was named by Rothschild the next year (1892b: 109). Earliest accounts considered it "plentiful" or "abundant" but few numerical population estimates were ever published (Table LM-2).

The Laysan Miller-bird became extinct sometime between 1915 and 1923 and only sketchy details of its life history were reported by the few biologists to observe the species in life. The most useful information available is a summary by Bailey (1956: 117-118) and the original report by Fisher (1903a: 805-806) from which most of the following account is taken. Its life history was probably very similar to that of its only relative in the central Pacific--the Nihoa Miller-bird (*Acrocephalus f. kingi*) of Nihoa, some 563 miles to the southeast.

Habits

The Miller-bird was fearless and its confiding ways were described by all biologists who encountered it. Birds visited tables at mealtime, alighted on and very near people and searched inside occupied buildings for insect food. Munro (1942b: 2) described feeding inside lighted buildings at night and commented that they became a pest in the laboratory by perching on, tipping and breaking test tubes.

Birds were always described as very active or "busy." Much of this activity was devoted to the pursuit and capture of several species of moths

locally called "millers," hence the common name "miller-bird." According to Munro the moths were swallowed entire. Feeding took place in and around buildings and in various types of vegetation, particularly the mat-like Portulaca surrounding the lagoon where caterpillars were a major food item.

Activity, including singing, reached peaks in morning and late afternoon and birds retired to the shelter of bushes or grass during the warmer parts of the day. The song was described as "liebliches," (lovely) (Schauinsland, 1899: 44) and "musical" (Fisher, 1903a: 806); and its call was "a harsh deep note much resembling that of a thrush" (Rothschild, 1893-1900: 2).

Nesting

Nests were usually placed about two feet from the ground in the middle of large clumps of bunch grass. Fisher stated that largest numbers were found along the inner edge of the bush grass area near the lagoon. The nest was best described by Fisher (1903a: 806) as follows: "The structure itself is composed of dried grass stems and blades, fine rootlets, white albatross feathers. The bowl is 1 3/4 inches wide by the same depth, and the diameter of the mouth is somewhat less than that of the interior, so that the edges of the cup overhang a little. It is lined with fine rootlets, shredded grass, and white albatross feathers, the last being a very characteristic feature of all nests,...Occasionally a trace of down was found on the inside. The outer portion of the nest is rather loosely held together, and forms a globose mass 3 1/2 inches in diameter."

Nesting was just getting underway in mid-May 1902 (1 clutch of 3 eggs; 1 incomplete clutch of 2 eggs and many nests "apparently just ready for eggs"). Eggs were taken by Palmer in late June 1891 and Dill and Bryan (1912: 22-23) found nests with eggs and young birds in late spring or early summer. The clutch size was two or three. Eggs varied in size (Fisher) from 22 x 15 mm to 19 x 14 mm. The ground color varied from very pale olive buff through greenish white, to almost pure white. Most eggs were blotched and spotted with olive chiefly at the larger end and often with tiny white lines and specks scattered over the entire egg.

Although its eggs were known to be sometimes eaten by the Laysan Finch (Dill and Bryan, 1912: 23), extinction was almost certainly due to destruction of habitat by rabbits.

An excellent photograph of this species is found in Fisher (1903a: Fig. 43) and Bailey (1956: 118).

Specimens

Seventy-seven Laysan Miller-bird skins are currently distributed in museums as indicated in Table LM-1. Five additional mounted specimens are distributed as follows: SUI (2 in Laysan exhibit; 1 in extinct bird case); DMNH (2 birds in Laysan exhibit). Also preserved are at least 2 skeletons (BPBM); 4 nests (BPBM, 2; USNM, 2); and 4 eggs (BPBM, 1, USNM, 3).

Table LM-1. Locations of Laysan Miller-bird skins.

Museum	Adult Males	Adult Females	Other	Totals
AMNH	13	9	0	22
BPBM	12	9	3	24
CMNH	1	1	0	2
MCZ	6	3	0	9
UMMZ	0	0	4	4
USNM	4	3	3	10
Other*	4	1	1	6
Totals	40	26	11	77*

*Law Coll. (1 ♂, 1 ♀); Hachusiki (1); Carnegie Mus. (1 ♂); Acad. Nat. Sci. Phila. (2 ♂♂).

**According to Greenway (1958: 393), at least one specimen is at Bremen and at Denver.

Table LM-2. Observations of Laysan Miller-bird on Laysan.

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1891	16-27 June	"plentiful"	Two nests with eggs, 24 June (Palmer in Rothschild, 1893-1900: xi, 2).
1896	24 June-24 Sept.	?	Present (Schauinsland, 1899: 100).
1902	16-23 May	"abundant"	"One of the most abundant of the four strictly land birds; many empty nests and two with eggs" (Fisher, 1903a: 806).
	22-23 May	?	3 eggs and 2 nests collected (USNM).
1903	20-28 Apr.	?	At least 26 specimens and 2 nests and eggs collected by W.A. Bryan (AMNH, BPBM).
1904	12 May	?	1 collected by Schlemmer (MCZ).
1907	17-19 May	?	8 collected by Schlemmer (MCZ, PANS).
1911	24 Apr.-5 June	(under 300)	"least abundant of the indigenous [land] species." A few nests with eggs and young (Dill and Bryan, 1912: 22-23).

Table LM-2. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1912 22 Dec.- 1913 11 Mar.	"abundant"	(Bailey, 1956: 117).
	"at least 600"	"Least plentiful of land birds on Laysan, but...in no present danger of extinction" (Willett, ms.).
1915 3 Apr.	perhaps 1,500	"fairly common" (Munter, 1915: 140).
1916 9 Feb.	?	A few seen around buildings (Munter, ms.).
1918 8-10 Sept.	extinct?	Not seen (Diggs, ms.).
1923 8-13 Apr.	extinct	(Wetmore, ms.).

LAYSAN HONEY-EATER — Himatione sanguinea fraithii

Status

Endemic. Formerly common permanent resident; extinct since 1923. Nested in bunch grass and Chenopodium bushes near the lagoon during spring and early summer.

Populations

The Laysan Honey-eater was first reported by Isenbeck (Kittlitz, 1834: 125) in 1828 and was formally described by Rothschild (1892b: 109-110) in 1892 from specimens taken by Palmer and Munro the previous year. Although all subsequent workers reported the species, the only population estimates (Table LH-2) are those made in 1911 (about 300), 1915 (about 1,000), and just prior to its extinction in 1923 (3).

The few published observations suggest that honey-eaters were never very abundant on Laysan. Isenbeck considered it "not very common" in 1828 and other workers through the early part of the 20th century stated or implied that though it occurred in fair numbers it was nevertheless the least common of the endemic species. Any major reduction in numbers apparently occurred after 1902.

Dill and Bryan estimated the population at 300 birds in 1911 and in 1913 Bailey reported "a few" confined to the few remaining patches of rapidly disappearing vegetation. Munter's 1915 estimate of "about 1,000 birds" and "fairly common" is perhaps too generous since he considered them not very numerous the following year. At any rate only three birds remained by 1923 and the last of these perished in a sandstorm on 20 April (Wetmore, ms.).

Habits

The few biologists who observed the Laysan Honey-eater left few detailed accounts of its life history. The most useful information is contained in the original observations of Fisher (1903a: 803-804) and in the compilation by Bailey (1956: 119, 122).

The honey-eater, like the miller-bird, was very active, constantly flitting about in vegetation or near the buildings. Most accounts suggest that it was less fearless and confiding than the miller-bird although birds did occasionally enter buildings for moths and Dill and Bryan (1912: 22) reported four birds roosting inside a building at night.

Birds originally fed regularly on nectar from the large flowers of Capparus sandwicheana and changed to Portulaca and Sesuvium when the Capparus became extinct. When feeding in bushes, birds flitted rapidly about reminding Schauinsland (1899: 44) of hummingbirds. Fisher (1903a: 804) made a similar comment on birds feeding on the low mat flowers except that birds were then walking from flower to flower rather than hovering before them. Insects were a very important part of the diet and probably more important than nectar at some seasons. Fisher (1903a: 804) reported their feeding on small, green caterpillars taken from Chenopodium bushes and all observers saw them feeding on the abundant moths ("millers") which occurred throughout the island. The moths were held in one foot while the wings were removed and only the soft parts were eaten.

Palmer (in Rothschild, 1893-1900: 4) described the song as low, sweet, and consisting of several notes. One bird, captured and hand-held, sang and answered Palmer's whistle apparently unafraid. Birds were said to be usually silent except during the breeding season. Singing was reported between December and mid-June.

Honey-eaters occurred over the entire island (Fisher, 1903a: 804) but were more abundant in the interior near the lagoon, probably (in 1902) attracted by the flowering vegetation as well as by nesting habitat. Nesting was usually in the bunch grass near the lagoon but Schauinsland (1899: 101-102) found some nests in Chenopodium. The nest was a cup-shaped affair of rootlets and grass, lined with fine rootlets and usually albatross down. Fisher (1903a: 804) commented that nests could be distinguished from the very similar nests of the miller-bird by the absence of white feathers but apparently this was not always true. Schauinsland (1899: 101-102) further distinguished honey-eater nests by their tighter construction and more shallow cup.

Details on the breeding cycle are unavailable. A few nests with eggs and/or young were recorded by various observers but without specific dates. A nest with a single egg was taken by Fisher (1903a: 804) sometime in mid-May and at least one egg was taken by W.A. Bryan on 10 May (BPBM). Bailey (1956: 122) gave the clutch size as "four to five" and several sets of three were taken by early collectors. The eggs were

Populations

The Laysan Finch, always a conspicuous part of the island avifauna, was mentioned by nearly all visitors to Laysan. Its bright colors, song and hardy nature made it a popular cage bird and ships visiting Laysan frequently transported birds to Midway, Honolulu and perhaps elsewhere. The species was formally named (Wilson, 1890: 341) from a captive bird purchased in Honolulu from a shipment of 60 imported in 1889.

A common term used by various observers through 1915 in describing the finch population, "everywhere in abundance," is understandable. The finches were tame, constantly in evidence and entered occupied buildings where they explored everything in sight, roosted, sang and (in 1923) even built nests. Few observers, however, attempted the difficult task of estimating the finch population (Table LF-3). Dill and Bryan estimated 2,700 birds in 1911 and Munter estimated 4,000 in 1915. Finches were still "very common" in 1916. The population dropped to 100 birds in 1923 but had increased to at least 1,000 in 1936. This drastic fluctuation in numbers seems to have paralleled the degradation and subsequent recovery of the vegetation. Birds were again considered "quite abundant" in 1950 by Brock who estimated about 5,000 birds the following year. Woodside estimated about 5,000 birds in 1957. Warner estimated a conservative 10,000 birds as the result of a transect census in 1959. Numbers are believed to have remained at about this level to the present time (Table LF-3).

Habits

Fisher's observations of 1902 (1903a: 804) are equally appropriate today: "quite fearless and unsuspicious. It is also saucy to a marked degree, and ignores the presence of man when he is peaceably disposed. One can not walk anywhere without encountering them singly or in little flocks, diligently searching for food among the bushes, or out in the open. When disturbed they eye the intruder with interest or half in doubt and utter their low, mellow linnet-like call. They do not fly far, but prefer to alight soon, and run along the ground, or elude pursuit by suddenly crouching under a grass tussock." Schauinsland (1899: 44) stated that at meal time finches would "sit on the edge of our plates and share our rice and bacon." Finches today are only slightly less confiding.

Food

Fisher (1903a: 804), the first to report on this species at length, noted that these finches were "fond of the soft parts of grass stems, tender shoots of bushes, seeds, and especially of eggs."

More recent observers have been more specific about vegetation eaten. Apparently Tribulus seeds and seeds of Eragrostis are a major staple, more observers having noted these plants being eaten more often than any other (Labrecque, 1957: 17; Wilder, ms. b; Kramer, ms.; Warner, ms., Crossin, POBSP). Other items apparently frequently eaten are inflorescences of coconuts (Walker, ms. b; Crossin) and the seeds and buds of Boerhavia and

Portulaca (Crossin; Kramer, ms.). They have also been noted feeding on the centers of flowers of Ipomoea (Kramer, ms.) and Nicotiana (Crossin).

Their passion for birds' eggs has been described by numerous observers and any eggs left unattended for a few moments are soon broken and their contents eaten by the finches. Finches also concentrate at the edges of tern colonies and take advantage of any disturbance (such as human entry) by flying in and attacking unattended eggs. Species whose eggs are known to have been eaten by the finch include Bulwer's Petrel and the Wedge-tailed Shearwater, Sooty, Gray-backed and White Terns, and Black and Brown Noddies (Fisher, 1903a: 801; Bailey, 1956: 123; Wetmore, ms.; Crossin, Stadel, POBSP). Bryan and Dill (1912: 22) indicated that the finches also ate finch eggs but no more recent observer has confirmed this. The contents of albatross eggs, most probably old and rotten, are also avidly eaten (Fig. 42) but it is doubtful if the finches themselves break the eggs. Probably most albatross eggs eaten are those broken by other animals (man, seals, Bristle-thighed Curlews) or those that may have burst due to a combination of high internal pressure from egg-decomposition and rough contact caused by storms (as in the instance of eggs wind-rowed along the lagoon edge).

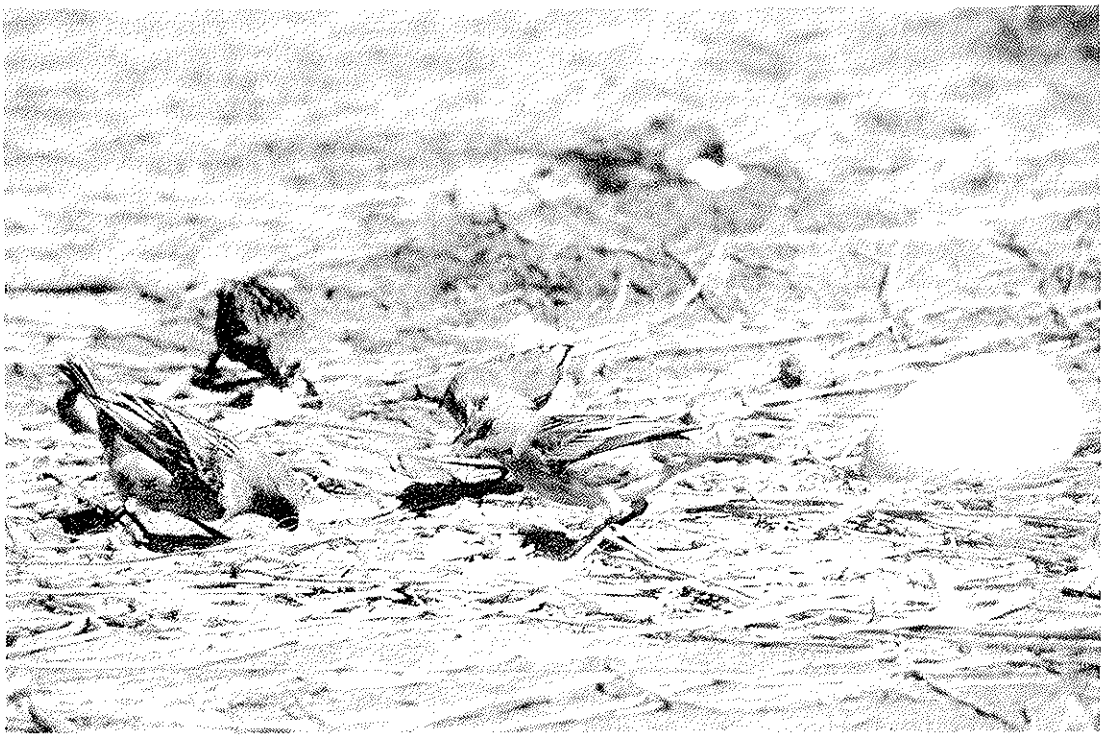

Figure 42. Laysan Finches feeding on remains of albatross egg, March 1965. Photo by R.B. Clapp.

Crossin (POBSP), who watched these birds feeding in Sooty Tern colonies during June 1966, gives the most detailed notes on the egg-eating process:

> When [POBSP] personnel moved through the tern colony, finches were observed on numerous occasions to approach an exposed egg and peck through the shell with...forceful blows. Pieces of the shell were then chipped off and flipped aside until a...large hole...usually [a ragged circle] of about 3/4 inch diameter [was made]. The birds then sipped the contents, lifting their heads back as if drinking water.

Crossin's observations also suggest that egg-eating is a learned trait. In one instance a number of immature finches "were given every opportunity to attack freshly uncovered eggs, but ignored them and continued feeding on seeds of Boerhavia and other plants." On the other hand "as soon as a tern was flushed from its egg, nearby adult finches quickly proceeded to the egg and began feeding."

Observations by Crossin and by Stadel (POBSP) in June 1967 clearly indicate that human disturbance coupled with the finches' propensity for eating eggs can result in considerable Sooty Tern egg mortality. Crossin believed that at least several thousand eggs were destroyed by finches in June 1966 and Stadel estimated that more than 10 percent of the eggs then present were destroyed in June 1967.

Other species of terns may also have a large proportion of their eggs destroyed under the effect of human disturbance. In 1923 Wetmore (ms.) noted that most, if not all, White Tern and Black Noddy eggs in the area of the Tanager Expedition campsite were destroyed within a few hours of the field party's arrival. Bailey (1956: 123) found the brunt of predation to be on Black and Brown Noddies and on Gray-backed Terns but comments by Dill and Bryan (1912: 22) also suggest that considerable egg destruction may occur as the result of human disturbance.

Being somewhat opportunistic feeders, Laysan Finches have been observed feeding on meat. Munro (1942b: 2) reported them feeding on maggots and flesh of dead birds, and more recently, in March 1965, POBSP personnel noted them feeding on the flesh of dead albatross chicks.

Reproduction

Annual Cycle: Although no one visit could obtain sufficient data to delimit the breeding cycle, the various sets of observations (Table LT-3) seem clearly to indicate spring and summer nesting. Bailey reported eggs being laid in February and March but no nests were found recently during those months despite fairly intensive checks of potential nest sites during two March visits (1968 and 1969, BSFW). However, Bailey was on Laysan continuously for nearly three months and made much more thorough observations than could recent observers, who seldom spent more than a few days.

Thus although eggs may occasionally be laid in February and March, other observations and collections suggest that most egg laying occurs from late April through May and June and that most young have fledged by the end of July or early August. Young have been seen in the nest as late as mid-September (1964) but evidently few nests are active in this month, or in following months until the beginning of another breeding season.

Nest Sites: On Laysan, clumps of Eragrostis are used almost exclusively for nest sites. In both 1913 and 1923 however, when far less Eragrostis was available than earlier or at present, birds were seen building nests in holes in piles of phosphate rock. In 1923, one bird built a nest in one of the old buildings, inside one of the windows against a board (Wetmore, ms.) and in 1902 Fisher found one or more nests in Chenopodium bushes.

Apparently only Eragrostis is now used for nest sites. Crossin (POBSP) has given the best recent survey of nest sites. He noted that:

> in the vast majority of cases the sites chosen were the dense portions of the grass clumps where the old blades had fallen down and [where] new green blades overhung. The dense mats of dead grass blades usually formed the foundations for the nest bottoms. All nests were...partially to completely hidden [from] view by overhanging grass blades. A few nests were built entirely within the mass of dead overhanging leaves within a clump. Grass clumps growing adjacent to old Scaevola bushes seemed to be especially favored; one such clump contained three old nests and an active one with one egg. In open grassy areas away from Scaevola the birds choose either very dense single clumps, or much more often, the area between two immediately adjacent clumps of grass where leaves from both plants form a dense canopy and an abundance of fallen dead blades between the two.

Seven nests found by Crossin varied from 4 to 17 inches ($\bar{x}$ = 13.1) above the ground but he noted that the nest height was invariably dictated by the size and form of the grass clump with all nests found in the most secluded portion of any respective clump. Fisher (1903a: 805), the only observer to report nest sites in any detail, noted that nests in grass clumps were "in each case...wedged in the center of the tussock, well hidden by the tall grass stems."

The Nest: The only observer who published a description of the nest was Fisher (1903a: 85) who reported that "it is made of rootlets, twigs, and coarse grass, and the whole structure is rather loosely put together. The shallow cup is 2-3/4 inches in diameter and is tied with shredded grass."

Crossin, who has observed more nests closely than any other observer, noted that "nest dimensions were markedly uniform as was the nature of the

nest material." Outside heights of the seven nests ranged from 2-1/4 to 3 inches ($\bar{x}$ = 2.7), and outside widths ranged from 4-1/2 to 6 inches ($\bar{x}$ = 5.4). The ranges and mean bowl depth and width for the seven nests were, respectively, 1-3/4 to 2-1/4 ($\bar{x}$ = 2.1) and 2-1/2 to 3 ($\bar{x}$ = 2.9) inches. Crossin added the following remarks on the composition of the nest:

> In the few nests found which were just begun, long grass rootlets formed the basis for the bottom and side walls. In all finished nests dead grass blades and stems [were] interwoven among the rootlets and the entire structure ...[was] composed of these plant portions. There [was] essentially no cup lining, the entire cup portion being constructed of smaller and finer grass blades and rootlets. The finished structure is...compact and the surrounding grass blades allow the nest to remain in place for long periods.

Eggs: Fisher (1903a: 805) described the eggs at some length. Clutch size, despite Fisher's (op. cit.) pronouncement that "three eggs are laid" ranges from 2 to 4 eggs, with 3 most often found.

Introductions

Laysan Finches were successfully introduced to Midway in 1891 and following years and survived until 1944 after the accidental introduction of rats. Recently (in March 1967) birds were introduced to Southeast Island, Pearl and Hermes Reef, by BSFW personnel and are now well established there. Laysan Finches breed successfully in captivity and the survival of the species seems assured. A statement by Dill in 1911 (1912: 22) seems appropriate: "One of the last birds to disappear from the island will be the Laysan Finch....Laysan Island is an ideal place for this bird, but should anyone be rash enough to introduce it to a civilized community it would be a pest that would rival the English Sparrow." However, several importations to Honolulu were unsuccessful, perhaps due to some insect-borne bird disease (cf. Warner, 1968: 109-110).

Specimens

One hundred ninety specimens of Laysan Finches are currently distributed in museums as indicated in Table LF-1. Eight additional mounted specimens are distributed as follows: AMNH (1 male and 1 female in Laysan exhibit); BPBM (2 females); DMNH (1 male and 1 female in Laysan exhibit); SUI (2 birds in Laysan exhibit). Also preserved are at least 26 skeletons (BPBM, 1; UMMZ, 20 aviary birds; USNM, 5); 2 alcoholics (USNM); 4 nests (BPBM, 1; USNM, 3); and 5 clutches of eggs (BPBM, 2; USNM, 3).

Banding

Five hundred sixty-six Laysan Finches were banded by BSFW personnel (Table LF-2).

Table LF-1. Locations of Laysan Finch skins.

Museum	Males	Females	Other	Totals
AMNH	16	23	4	43
BPBM	16	15	6	37
CMNH	1	1	0	2
MCZ	7	2	0	9
SUI	1	0	2	3
UMMZ	0	0	14	14**
USNM (non-POBSP)	34	33	6	73
(POBSP)	2	2	0	4
Other*	3	2	0	5
Totals	80	78	32	190

*Yale Univ. (1 ♀); Hachisuki (1 ♂); Moseley (1 ♂); Law Coll. (1 ♂, 1 ♀).

**Includes 2 aviary skins.

Table LF-2. Laysan Finches banded on Laysan by the BSFW.

	Number Banded			
Period of Survey	Males	Females	Immature and Unknown	Totals
1964 March	1	0	0	1
Sept.	16	11	0	27
1966 March	96	139	9	244
Sept.	0	0	1	1
1967 Sept.	20	0	0	20
1968 March	33	29	2	64
Sept.	38	27	144	209
Totals	204	206	156	566

Table LF-3. Observations of Laysan Finches on Laysan.

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1828 24 Mar.	rather common	Vague description by Isenbeck (in Rothschild, 1893-1900: vi).
1891 16-27 June	common	Eggs and small young (Rothschild, 1893-1900: 5).

Table LF-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1894	26 Nov., 8 Dec.	?	Single specimen collected (MCZ).
1896	24 June-24 Sept.	?	Breeding (Schauinsland, 1899: 101).
1902	16-23 May	?	Everywhere; several nests found, all with fresh eggs (Fisher, 1903a: 804-805).
	22-23 May	?	2 nests with fresh eggs (1 with 2 eggs, 1 with 3 collected) (USNM).
1903	17 Apr.-May	?	At least 28 skins and specimens collected by W.A. Bryan or his associates (AMNH, BPBM), including a nest and egg on 10 May.
1904	10 May	?	1 collected by Schlemmer (MCZ).
1905	19 Sept.	?	Present (Wilder, 1905: 393).
1907	16-17 May	?	5 collected by Schlemmer (MCZ).
1911	24 Apr.-5 June	2,700	Many nests with fresh eggs found in May (Dill and Bryan, 1912: 22).
1912 1913	12 Dec.-11 Mar.	?	"Abundant;" first egg on 11 February; another on 3 March and a set of 3 on 10 March (Bailey, 1956: 123).
1915	3 Apr.	4,000	"All parts of island" (Munter, 1915: 140).
1916	9 Feb.	very common	Many singing (Munter, ms.).
1918	8-10 Sept.	?	Found everywhere; most common around old buildings and at southwest end of island (Diggs, ms.).
1923	8-13 Apr.	few	One building nest inside window of house on 8th (Wetmore, ms.).
	20-23 Apr.	numerous	Some seen nest building (Ball, ms.; Dickey, ms.).

Table LF-3. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, References
1923	29 Apr.-14 May	100	Four introduced from Midway on 30 April (Wetmore, ms.); some nest building by 20 April (Ball, ms.); complete clutch (3 eggs) 10 May; several pairs nest building 12 May (Wetmore, ms.) and nest with fresh eggs collected (USNM).
1924	6 May	only a few	(Wilder, ms.).
1930	2-18 Aug.	many hundreds	(Wilder, ms. b).
1936	7-8 Mar.	many hundreds	No nests found (Trempe, ms.).
	12 Dec.	1,000	(Coultas, ms.).
1950	23 June	quite abundant	(Brock, 1951a: 372).
1951	late June-early July	5,059	Estimated from transect censuses (Brock, 1951b: 18).
1955	10 Feb.	thousands	(POFI).
1957	25 June-3 July	5,000	(Woodside, ms. b).
	8-12 July	everywhere	(Labrecque, 1957: 17).
1958	27 May-4 June	10,100	Estimate based on transect census and believed to be conservative. Eggs in all stages of incubation to week old young (Warner, ms.).
1959	28 Apr.-1 May	?	Most paired but no nests found (Kramer, ms.).
1961	7-8 Mar.	very abundant	More than in 1959; no nests found (Woodside and Kramer, ms.).
	4-10 Sept.	10,000	No active nests; several recently fledged immatures (Woodside, ms. c).
1962	14-19 June	very abundant	(Kramer and Beardsley, ms.).

Table LF-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1963 11-13 Feb.	10,000	No nests found (POBSP).
3-10 Dec.	?	(Walker, ms. b).
1964 10-11 Mar.	10,000	No signs of nest-building noted (BSFW, POBSP).
16-20 Sept.	thousands	Very abundant; one near-fledged young seen being fed by parent (BSFW, POBSP).
1965 6-11 Mar.	3,000-5,000	No nests found (POBSP).
17-21 July	10,000	Many flying young still begging for food, about 5,000 fledged immatures (POBSP).
5-12 Aug.	(40,000)*	About 10,000* fledged immatures. One young seen being fed by parent on 6 August (POBSP).
1966 26-31 Mar.	7,400	Estimate based on transect census; no breeding noted; series captured (BSFW).
10-16, 20-21 June	10,000	New nests through fully fledged young; estimated (15,000)* young; 1,000 eggs (POBSP).
17-18 Sept.	very abundant	(BSFW).
20-23 Oct.	10,000	No nests found (POBSP).
1967 18-19 Mar.	4,000-5,000	No nests found (BSFW, POBSP).
7-12 June	10,000	Series captured for transplantation. Eggs to flying immatures (POBSP).
5-11 Sept.	several thousands	Abundant; post-breeding; several young(?) seen begging for food (POBSP).
13 Dec.	very common	(BSFW).

*Estimate probably excessive.

Table LF-3. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, References
1968 17-19 Mar.	several thousand	No nests found despite investigation of several hundred potential nest sites (BSFW, POBSP).
1969 26-29 Mar.	11,882	Estimate based on transect census. Over 500 potential nest sites checked but no nests found (BSFW).
2-3 June	?	365 Eragrostis clumps investigated: 9 nests found: 6 apparently used previously, 1 with a pre-laying bird; 1 with 1 egg and 1 with 1 young (BSFW).
9 Sept.	abundant	(BSFW).

Mammals

RABBIT
(EUROPEAN HARE)

Orytylagus cuniculus

Status

Introduced in 1903 and subsequently. Extirpated in 1923.

Observations

Dill and Bryan (1912: 9) reported that rabbits were introduced to Laysan about 1903 but Bryan later (1915: 293) indicated that these animals were introduced in 1903 and 1904. Most secondary sources repeat the former statement but Tomich (1969: 30) recently stated that the rabbits were introduced in 1902 and 1903. Presumably this conclusion is based on Dill and Bryan's statement that Max Schlemmer "could not give the exact dates [of introduction] but thinks the first were imported eight or nine years ago, or about 1903." However, W.A. Bryan (in Dill and Bryan, 1912: 26) clearly indicated that the rabbits were introduced "shortly after my former visit" (April-May 1903). In any case, these animals were brought to Laysan on more than one occasion (Dill and Bryan, op. cit.).

The rabbits, which were said to have been imported for the purpose of starting a rabbit-canning business, consisted of domestic rabbits, Belgian and English Hares. They prospered greatly and began to cause serious damage to the vegetation (Table R-1). By 1911 the rabbits had eliminated several species of plants that had been present in 1903.

Dill and Bryan's report of their effect eventually resulted in two expeditions which were sent to destroy the rabbits. The former, which spent three months on Laysan in the winter of 1912-1913, killed many thousands but failed to exterminate them, largely due to a lack of ammunition (Salisbury, ms.). The second expedition, the Tanager Expedition of 1923, arrived too late to do little more than apply the coup-de-grace as the animals had nearly extirpated themselves by having eaten almost all of their potential food sources.

Table R-1. Observations of rabbits on Laysan.

Period of Observation		Observations
1910	16-18 Jan.	"A large number of rabbits was found there, and if they should increase to a much greater number, I am of the opinion that they would destroy the vegetation and then attack the birds' eggs. The rabbits should be exterminated." (Jacobs, ms.).
	2 Sept.	"The rabbits...are increasing very rapidly and will no doubt disturb the birds in time if they do not do so now." (Cochran, ms. c).
1911	24 Apr.-5 June	Many bushes killed. Often seen feeding in the green juncus (=Sesuvium portulacastrum) near the lagoon where at times "...there are so many ears protruding that they resemble a vegetable garden." Stated to have been captured by frigate birds (Dill and Bryan, 1912: 10).
1912	22 Apr.	"...apparently no material increase in the number of rabbits." (Cochran, ms. a).
1912-1913	22 Dec.-11 Mar.	Found everywhere and often utilizing petrel burrows for shelter. "Each chenopodium bush would shelter half a dozen, and even the foundations of the buildings were undermined; each clump of grass contained a warren, and out on the open flats could be seen dozens of bunnies feeding on grasses pushing their way through cracks in the phosphate rock." (Bailey, 1942: 154). 100 killed first day on island. 5,024 killed during entire visit but several thousand remained unkilled (Salisbury, ms.).
1914	11 Sept.	"found the number of rabbits greatly decreased" (Log of the Thetis). "There seems to have been a decrease in the number of rabbits..." (Brown, ms. c). Elschner (1915: 30), however, indicated that the earlier attempt to destroy them "seems to have been rather unsuccessful.

Table R-1. (continued)

Period of Observation		Observations
1915	3 Apr.	"The rabbits were found to be very plentiful. They were seen wherever green patches existed. Twenty of them were caught and taken off to the ship for food. About 15 of them were found dead near one of the buildings. They are rapidly eating off the vegetation of the island." (Munter, 1915: 140).
1916	6 Feb.	"The rabbits...are multiplying very fast and the vegetation is disappearing rapidly....The men were set to work catching rabbits. Twenty only were captured as they were very active and easily escaped pursuits." (Munter, ms.).
1918	8-10 Sept.	"The domestic breed, reddish brown, gray, and white were found in number in and around their burrows among the stones, shrubberies and green juncus growing near the lagoon. They could be run down easily and caught in the hands or could be chased into small caverns among the stones or rocks and caught as they seemed to have little endurance when on the run....Only in one spot, and that near the Southwest end of the lagoon, was there any noticeable amount of dead shrubbery and no rabbits at all were to be found at any time during our stay feeding upon this plant....The green juncus growing lower on the ground was quite fresh and seemed to cover an immense area around the lagoon. Here and [there] upon this the rabbits were seen feeding at times. These rabbits,...while numerous in many parts of the island, were not by any means found to be as plentiful as might be expected when considering the length of time left unmolested in which to breed. Only in one case was a young rabbit seen and he was caught and taken aboard....we attempted to estimate the number of rabbits on the island, which we figured to be not more than a hundred at the most liberal estimate, twenty five of these which we caught ourselves for food...." (Diggs, ms.).
1923	7 Apr.-14 May	A few hundred rabbits present when the expedition arrived (Wetmore, 1925: 103). "Low areas here [near the lagoon]...were covered with a mat of Sesuvium...that was making a brave struggle against the depredations of the rabbits. The latter hopped or squatted about among the albatross and

Table R-1. (continued)

Period of Observation		Observations
1923	7 Apr.-14 May	shearwaters occasionally taking alarm and dashing away to run down a hole. About 150 to 200 have been killed here since our arrival. All are of large 'Belgian Hare' size and varying color. Grizzled grays and grayish browns predominate with numbers of reddish brown, dull black, and blackish brown. All had the abdomen well distended two or three that were examined were not at all fat though in good flesh. I noted scattered carcasses of animals that had died before our arrival....All rabbits seen were adult but Reno found embryos in several females." (Wetmore, ms., 9 April). "When we left May 14 no rabbits had been seen for the past 8 days."*
1924	5 May	No rabbits noted (Wilder, ms. a).

*Extract from Major Reno's report on the success of the rabbit extermination. Ms. material in the files of the Bureau of Sport Fisheries and Wildlife, Honolulu.

GUINEA PIG — *Cavia porcellus*

Status

Introduced in 1903 and/or 1904 and once common. Extirpated during the period from December 1911 through March 1912.

Observations

According to W.A. Bryan (1915: 293), guinea pigs were introduced to Laysan at the same time as the rabbits. Subsequent information on their habits on Laysan is scant.

Dill and Bryan (1912: 10) reported that guinea pigs were rather abundant in the thick juncus (=*Cyperus*) at the south end of the island during the spring of 1911. The guinea pigs evidently fared poorly in competition with the rabbits for only four were seen, all of which were killed, during the visit by the Biological Survey party in 1911-1912 (Salisbury, ms.).

BOTTLE-NOSED DOLPHIN — Tursiops truncatus

Status

One sighting offshore: May 1958.

Observations

Rice (1960a: 407) reported that a half-dozen were seen 27 May 1958 from shipboard about three kilometers southeast of Laysan. Bottle-nosed Dolphins are predominantly an inshore species (Rice, op. cit.) and probably occur more commonly offshore Laysan than the single record might indicate.

HAWAIIAN MONK SEAL — Monachus schauinslandi

Status

Common resident present throughout the year. Maximum recent estimates: 326 for an aerial count; 314 for a terrestrial count.

Observations

Tables HMS-1 and HMS-2 briefly summarize earlier and more recent observations of monk seal populations on Laysan. Kenyon and Rice (1959) present a thorough summary of much of what is known of the life history.

The paucity of observations in the late 1800's and early 1900's as well as the scant numbers seen indicate that seals had been nearly extirpated on Laysan, primarily by sealers, by about the turn of the century (Kenyon and Rice, 1959: 215). Not until the latter half of the 20th century did populations show much recovery.

Recent population counts, while variable, seem to indicate a relatively stable population with a breeding population on the order of 140 to 160 animals. Counts from 1966 through 1969 tend to be somewhat lower than for preceding years but we think it likely that this change can be largely attributed to the effect on counts of the greater incidence of disturbance during the latter period.

Variations in age-class terminologies used by different observers make it difficult to assess yearly production of offspring but the data suggest that some 50 to 80 pups are born yearly. These young are born from at least as early as the first week of January through at least the end of June with most being born in the period from mid-February through May.

A considerable number of monk seals has been tagged on Laysan (Appendix Table 2). One of these animals, tagged as a pup on Laysan on 18 March 1968, was later reported present on Johnston Atoll from late July through early December 1968 (Schreiber and Kridler, 1969: 842). Details of the tagging program as well as more detailed recent information on the life history of the seal is to be presented at a later date by the BSFW.

Table HMS-1. Observations of Hawaiian Monk Seals on Laysan prior to 1951.

Date of Survey		Remarks and References
1828	24 Mar.	"On the beach several small Seals...were found" (Isenbeck *in* Rothschild, 1893-1900: vi).
1857	1 May	Seals numerous (Paty, 1857: 40).
1896	24 June-24 Sept.	A skull, skin, and parts of two other skulls and skins were given to Schauinsland by Schlemmer (Bailey, 1952b: 4), this material later serving as the basis of Matchie's (1905) description of the species.
1911	24 Apr.-5 June	No seals seen (Dill and Bryan, 1912: 9).
1912-1913	22 Dec.-11 Mar.	A single seal found on the north end of the island on 30 December was collected by Willett. No others were seen (Bailey, 1952b: 6).
1915	July-Sept.	5 July: single seal seen at south end of island was shot for oil. 15 August: seal seen on beach. 22 August: one seal seen in trip around island. 24 August: a seal killed. 14 September: another seal killed (Schlemmer and Schlemmer, ms.).
1923	7 Apr.-14 May	A male and a female collected and another pair seen (Dickey, ms.).
1936	7-8 Mar.	"Eight or ten were seen in the water or on the sand." (Trempe, ms.).
	ca. 12 Dec.	Five seen (Coultas, ms.).
1949	4 May	An estimated 20 to 30 seals seen from the air (Bailey, 1952b: 12).
1950	23 June	At least 50 seals seen, some with young (POFI; Svihla, 1959: 227).

Table HMS-2. Recent population counts and observations of Hawaiian Monk Seals on Laysan.

Date of Count		No. of seals counted[1]	Adults No.	%	Subadults No.	%	Yearlings No.	%	Pups No.	%	Remarks and References
1951	12 May	174	-	-	-	-	-	-	-	-	Newly born pups seen (POFI).
	June	119	-	-	-	-	-	-	-	-	(Svihla, 1959: 25).
1954	3 Nov.	-	-	-	-	-	-	-	-	-	A rough estimate of 100-150 seals present (POFI).
1955	10 Feb.	101	-	-	-	-	-	-	-	-	(POFI; Svihla, 1959: 227).
	(2 counts made)	105	67	63.8	19	18.1	-	-	19	18.1	Several newly born pups seen (POFI).
1957	Spring	233[2]	214	-	-	-	-	-	19	8.2	Pup seen on 7 January during fly-over of island. Count principally based on aerial surveys on 17 January and 15 April 1957. Adult figure subsumes all age classes (Kenyon and Rice, 1959: 221).
	30 June	177[3]	-	-	-	-	-	-	-	-	Partial count. One newborn pup and 5-6 small black pups seen (Woodside, ms. b).
	8-12 July	-	-	-	-	-	-	-	-	-	Young about one-fourth grown (Labrecque, 1957: 18).
1958	Spring	326	280	-	-	-	-	-	46	14.1	Maximum counts based on 27 May to 4 June visit and on aerial censuses made on 28 December 1957 and 28 June 1958 (Rice, 1960: 376). Adult figure subsumes all age classes but pups. The adult figure had had 150 added to it on the assumption that

Table HMS-2. (continued)

Date of Count		No. of seals counted[1]	Adults No.	%	Subadults No.	%	Yearlings No.	%	Pups No.	%	Remarks and References
1958	Spring										the entire yearling class was not seen (Rice, 1960: 377).
1959	28 Apr.	224	-	-	-	-	-	-	36	16.1	188 seals not identified as to age. Pup total includes "pups and small seals" (Kramer, ms.) but probably is a reasonable estimate of the number of young of the year present. Smythe (1960: 79) gives a total of 223 for the same count and states that about one-quarter were pups. A pup was born on 29 April.
1960	23 Aug.	108	-	-	-	-	-	-	9	8.3	(POFI).
1961	7 Mar.	229	168	73.4	-	-	38[2]	16.6	23	10.0	Newly born pup found on 8 March (Woodside and Kramer, ms.).
	4 Sept.	220	105	47.7	50	22.7	-	-	65	29.5	(Woodside, ms. c; Walker, ms. a). "Pups" here presumably indicates young born during this breeding season while the "yearlings" (included here as subadults) are presumably young of the previous breeding season.
1962	16 June	261	142	54.4	96	36.8	-	-	23	8.8	(Kramer and Beardsley, ms.). The pup total listed here includes only relatively recently born (black-pelaged) pups. Other young of the year are subsumed in the subsequent category.

Table HMS-2. (continued)

Date of Count		No. of seals counted[1]	Adults No.	%	Subadults No.	%	Yearlings No.	%	Pups No.	%	Remarks and References
1963	11-13 Feb.	-	-	-	-	-	-	-	-	-	No count made. At least three pups born on 11 and 12 February (POBSP).
	3 Dec.	179	-	-	-	-	-	-	-	-	(Walker, ms. b).
1964	10-11 Mar.	314	139	44.3	153	48.7	-	-	22	7.0	(BSFW). Animals listed here as subadults were listed as "yearlings" in the ms. report. The total presumably includes both young of the preceding year and older animals.
	19 Sept.	252	164	(68.3)	-	-	76[3]	(31.7)	-	-	(BSFW).
1965	11 Mar.	244	-	-	-	-	-	-	32	13.1	Pup count includes one found dead (POBSP).
	6 Aug.	210	100	47.6	95	45.2	-	-	15	7.1	(POBSP).
1966	26 Mar.	193	110	57.9	-	-	-	-	31	16.1	52 (26.9%) subadults and yearlings counted (BSFW).
	10 June	242	123	50.8	51	21.1	-	-	68	28.1	(POBSP). 14 of the pups were noted as recently born. The pup total includes all animals thought to have been born during the 1966 breeding season through 10 June.
	17-18 Sept.	212	-	-	-	-	-	-	-	-	(BSFW).
	21 Oct.	120	64	53.3	-	-	25[3]	20.8	31	25.9	(POBSP). The preliminary report listed as "immatures" the animals included here as yearlings.

Table HMS-2. (continued)

Date of Count		No. of seals counted[1]	Adults No.	%	Subadults No.	%	Yearlings No.	%	Pups No.	%	Remarks and References
1967	19 Mar.	199	112	56.3	59	29.6	-	-	28	14.1	(BSFW).
	11 June	89	46	51.7	9	10.1	7[3]	7.9	27	30.3	A pup born on 10 June and two other gravid females seen (POBSP). That this count is markedly low does not indicate an incomplete count but rather is likely the result of having been taken late in the survey period (5th day of survey). Note the contrast with the June 1966 count taken on first day of survey. This is a good example of the effect of disturbance on population counts (even if disturbance is unintentional and undesirable from the point of view of the survey party).
	21 Sept.	181	117	64.6	36	19.9	28[3]	15.5	-	-	(BSFW).
	13 Dec.	151	97	64.2	18	11.9	36[3]	23.8	-	-	(BSFW).
1968	18 Mar.	179	86	48.0	41	22.9	38[2]	21.2	14	7.8	(BSFW).
1969	26 Mar.	183	112	(68.7)	21	(12.8)	-	-	30	(18.4)	(BSFW). Animals listed here as subadults were listed as juveniles in the preliminary report. Count total includes 20 unaged animals. Percentages are of the total number of animals counted.

Table HMS-2. (continued)

Date of Count		No. of seals counted[1]	Adults No.	%	Subadults No.	%	Yearlings No.	%	Pups No.	%	Remarks and References
1969	2 June	211	149	(81.9)	4	(2.2)	-	-	29	(15.9)	(BSFW). Count includes 29 unaged seals. Percentages are of the total number of animals counted.
	9 Sept.	147	126	85.7	15	10.2	-	-	6	4.1	(BSFW). Subadult total includes both subadults and yearlings.

1 This figure subsumes all other age classes but pups. Figures in this column may be larger than the total of those in the columns to the right since on some surveys all animals were not aged. Percentages are usually of the total counted. In those instances in which all animals were not aged, percentages are based on the total aged, these figures being enclosed in parentheses.

2. This figure largely indicates young of the previous breeding season.

3 This figure indicates young of the current breeding season.

DOMESTIC HORSE — *Equus caballus*

Status

A hypothetical introduction; see accounts of Donkey and Mule, below.

DONKEY — *Equus asinus*

Status

Hypothetical; may have been present from about 1905 through 1910.

Observations

Wilder (1905: 392) noted that "one old donkey" was present in September 1905. Cochran* implied that this or another donkey was removed from Laysan by Schlemmer in 1910. Possibly this animal is the same as the mule removed from the island in July 1910 (see below).

MULE — *Equus asinus* X *Equus caballus*

Status

Introduced *ca.* 1891 by the guano company. Last mule removed from island *ca.* July 1910.

Observations

The guano company brought mules to Laysan to pull carts of guano to the loading wharf. Munro (1946: 60) indicated that mules were present in June 1891. Since the tramway had not been completed by the preceding November, presumably the mules were introduced early in 1891.

Their occurrence on Laysan was noted on several subsequent occasions. Thomas (ms.) saw "a small herd" of mules during his visit in May 1902. Jacobs (ms.) recorded that two "almost wild" horses (probably mules) were present in January 1910. The Honolulu Evening Bulletin for 6 August 1910 reported that the single surviving mule was removed from the island on or about July 1910 by the crew of the schooner *Concord*. Whether this mule was the donkey referred to above and whether Schlemmer was along during this visit is not known but seems at least likely.

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*Letter from C.S. Cochran to the Secretary of the U.S. Treasury, dated 8 September 1910. Record Group 26, U.S. National Archives.

PIG — Sus scrofa

Status

Introduced by the guano company about 1890; evidently not present for more than a few years.

Observations

In June 1891 Munro (1946: 60) noted that "A few hogs roamed around, feeding on the dead albatross..." F.D. Walker (1909: 30) also noted that pigs were present during this visit and that they were known to feed on the tubers of a "false yam" which Tomich (1969: 79) has identified as Boerhavia.

Two pigs were still present a little more than two years later (Farrell, 1928: 399) but none was noted as present in May 1902 (Thomas, ms.).

DOMESTIC CATTLE — Bos taurus

Status

Introduced in the early 1900's; subsequently died, or were removed from Laysan.

Observations

Only two observers mention the presence of cattle. In May 1902, Thomas (ms.) noted that several cows, kept for the use of Schlemmer, were present. Subsequently Wilder (1905: 392) reported that "a few milch cows" were present in September 1905. Probably these animals were removed from the island during the next few years as none was present in January 1910.

Reptiles

GREEN TURTLE — Chelonia mydas

Turtles, presumably this species, were first recorded on Laysan coincident with the first known report of the island by Europeans in 1828 (von Kittlitz in Rothschild, 1893). Other early observers (e.g. Brooks, 1859) usually reported their presence but indications of the number present were rarely given.

Numbers of turtles seen on Laysan by different observers are summarized in tabular form below. Only those observations which give some idea of their abundance or breeding status are included here.

Laysan Green Sea Turtle populations have clearly decreased gradually and steadily throughout the last two centuries, certainly as a direct result

of predation and disturbance by man. From a formerly abundant resident of the island, these turtles have become uncommon to rare and apparently are in distinct danger of becoming extinct at this breeding station. No recent observers, either POBSP survey teams or those of the U.S. Fish and Wildlife Service, have found any direct evidence that the species still breeds on Laysan although Woodside (1961) found some "nests" in September 1961, none of which, when examined, contained eggs.

Table GT-1. Observations of Green Turtles on Laysan.*

Date of Survey	Number Seen	Remarks and References
1828 24 Mar.	?	Some very large turtles seen (Rothschild, 1893-1900: vi).
1857 1 May	numerous	(Paty, 1857: 40).
1858 14 Jan.	?	6 small turtles killed (Log of the U.S.S. Fenimore Cooper).
1882 26-30 Jan.	?	104 turtles taken by crew of fishing schooner Ada (Hornell, 1934: 432).
3 May	?	26 turtles taken by crew of Ada (Hornell, 1934: 432-433).
1886 ca. late Sept.	?	Some turtles killed (Farrell, 1928: 253-254) by crew of schooner General Siegal.
1896 24 June-24 Sept.	?	Numerous on Laysan's coasts; often in whole schools (Schauinsland, 1899: 64). One female captured contained several hundred eggs.
1905 19 Sept.	?	A few turtles shot (Wilder, 1905: 392).
1911 24 Apr.-5 June	?	1 turtle killed for food (Dill and Bryan, 1912: 421).
1912 22 Dec.-1913 11 Mar.	?	"Turtle appeared occasionally;" [1 or more killed for food]. (Salisbury, ms.).
1915 3 Apr.	?	Decaying turtle meat found in building (Munter, 1915: 138). [Turtles evidently killed for food by Japanese].

*Many early reports do not specifically identify turtles seen on Laysan as Green Turtles. However, as the Hawksbill and Ridley are not known to breed in the Northwestern Hawaiian Islands, we feel it a safe assumption that early records referred to the Green Turtle.

Table GT-1. (continued)

Date of Survey		Number Seen	Remarks and References
1915	12-31 July	4	Turtles captured for food on 14 July (1 small), 15 July (2), 27 July (1) (Schlemmer and Schlemmer, ms.).
	1-31 Aug.	2	Turtles killed or captured on 7 August (1) and 31 August (1) (Schlemmer and Schlemmer, ms.).
	1-31 Oct.	3	Turtles killed or captured 11th (2 small, 1 large) (Schlemmer and Schlemmer, ms.).
	1-30 Nov.	5	Turtles "turned over" and presumably captured on 8th (2 large); others captured 9th (2) and 22nd (1 small) (Schlemmer and Schlemmer, ms.).
1918	8-10 Sept.	in abundance	Many caught by crew of Hermes (Diggs, ms.).
1923	8 Apr.	at least 50	5 seen on west shore; largest thought to weigh over 200 lbs. (Dickey, ms.; Ball, ms.).
	10 Apr.	5	Seen on west shore; 1 ca. 50 lb. turtle captured for food (Dickey, ms.).
	3 May	2	Seen along beach (Wetmore, ms.).
	8 May	3	Small, 1 captured for food (Wetmore, ms.).
1934	26 June	?	A few large turtles seen (Baylis, ms.).
1936	7-8 Mar.	10-12	Seen along eastern beach (Trempe, ms.).
	12 Dec.	15	(Coultas, ms.).
1950	23 June	ca. 10	(POFI). Some presumably tagged (cf. Brock, 1951a: 371).
1951	12 May	?	Turtles numerous along northeast, north, and west side of island. No tagged turtles seen (POFI).
1954	3 Nov.	1	Seen; medium-sized (POFI).
1961	7 Mar.	6	Seen along beaches. All 40 lbs. or more but no evidence of egg laying (Woodside and Kramer, ms.).

Table GT-1. (continued)

Date of Survey	Number Seen	Remarks and References
1961 4-10 Sept.	3-4	2 females tagged. 5 nest sites examined but no eggs found (Woodside, ms. c).
1963 11-13 Feb.	6	All seen were tagged by Kramer who saw no small turtles and no signs of egg laying (POBSP).
3-10 Dec.	3	Counted 3 December. A male and 2 females tagged 4 December (Walker, ms. b).
1964 10-11 Mar.	1	Seen on southeast beach 10 March. About 2 feet long (BSFW, POBSP).
16-20 Sept.	2	Seen close to shore on 16 September (POBSP).
1965 6-11 Mar.	2	Seen on southwest beach 7 March; one, a female, had been tagged in December 1963 (POBSP).
5-12 Aug.	2	Seen offshore west beach (POBSP).
1966 26-31 Mar.	2	Females (BSFW).
10-16, 20-21 June	3	Females seen along beaches; 1 ca. 18". 2 ca. 36" (POBSP).
17-18 Sept.	2	Females; 1 tagged, the other had been tagged February 1963 (BSFW).
20-23 Oct.	2	Large females counted 21 October. Neither previously tagged (POBSP).
1967 18-19 Mar.	2	1 male tagged (BSFW).
7-12 June	4	3 medium-sized, 1 large (POBSP).
21-24 Sept.	1	1 male tagged (BSFW).
13 Dec.	6	All females, 2 of which were returns. 1 had been tagged in February 1963, and was the same turtle that returned in September 1966 (BSFW).
1968 17-19 Mar.	5	4 (3 females and a male) newly tagged and 1 returned (the male tagged in September 1967) (BSFW).

Table GT-1. (continued)

Date of Survey	Number Seen	Remarks and References
1969 26-29 Mar.	2	Counted 26 March. Both small, tagged. 6 others seen swimming offshore (BSFW).
2-3 June	3	Counted 2 June (BSFW).
9 Sept.	0	9 nest sites found, 1 along south shore and 2 groups of 4 on northwest corner. 1 site investigated contained no eggs (BSFW).

FOX GECKO — Hemidactylus garnotii

The first report that the Fox Gecko occurred on Laysan was Werner's (1901: 382) statement that this species occurred there, apparently on the basis of collections made by Schauinsland in 1896. Snyder (1917) later reported that eggs had been found on Laysan, presumably by himself in May 1902. Subsequently, Willett (ms.) indicated that this species was occasionally seen during the visit of the Biological Survey party from December 1912 to March 1913. No more recent observers have reported this large gecko (or, for that matter, any gecko) from the island. It seems likely that the Fox Gecko was accidentally introduced by early visitors to the island and has since become extirpated.

SNAKE-EYED SKINK — Ablepharus boutonii

The earliest report of the occurrence of this lizard on Laysan was by Werner (1901: 385), who examined Schauinsland's reptile collections. Snyder subsequently observed that, of 10 specimens collected there (presumably in May 1902), none had uninjured tails. He attributed these deformities to predation on the skinks by the birds (Snyder, 1917).

Judging from field notes taken by the POBSP, skink populations on this island periodically exhibit great variation in size. On surveys from February 1963 through August 1965, none or very few skinks were seen, most being found in local concentrations in some of the rock formations.

In mid-June 1966 the skinks were evidently somewhat more abundant since some 22 individuals were collected in various locations around the island. During this survey a nest containing 23 eggs was found in a shallow depression beneath an old lumber pile. By the following October these lizards were abundant enough so that POBSP observers reported them as "very numerous."

POBSP specimens: 3, September 18-19, 1964, USNM 157670-157672; 21, June 13, 1966, USNM field numbers 10897-10917.

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LITERATURE CITED

Agassiz, A. and H.L. Clark. 1907-1912. Hawaiian and other Pacific Echini. Mus. Comp. Zool. Harvard, Mem. 34: vii and 383 pp.

Alfken, J.D. 1903. Beitrag zur Insecten fauna der Hawaiischen und Neuseeländischen Inseln...Schauinsland 1896-97. Zool. Jahrb., Syst., Jena 19: 561-628.

American Ornithologists' Union. 1957. Check-list of North American birds. 5th ed. Lord Baltimore Press, Baltimore. xii and 691 pp.

Amerson, A.B., Jr. 1966. Ornithodoros capensis (Acarina: Argasidae) infesting Sooty Tern (Sterna fuscata) nasal cavities. J.. Parasit. 52: 1220-1221.

---1968. Tick distribution in the central Pacific as influenced by seabird movement. J. Med. Ent. 5 (3): 332-339.

Anonymous. 1905. An island schooner's bunch of disasters. Paradise of the Pacific 18 (9): 17-18.

---1939. Manure. The Sales Builder 12 (1): 2-22.

---1951a. Hawaiian Monk Seal - marine rarity - Zoonooz 24 (7): 3.

---1951b. The Laysan Island Cyclorama and late news from Laysan. Elepaio 12: 1-2.

Aoki, J. 1964. Some oribatid mites (Acarina) from Laysan Island. Pac. Insects 6 (4): 649-664.

---1965. Notes on the species of the genus Epihohmannia from the Hawaiian Islands (Acarina: Oribatei). Pac. Insects 7 (2): 309-315.

Bailey, A.M. 1918. The monk seal of the southern Pacific. Nat. Hist. 18: 396-399.

---1934. Wanderers of the seas: albatrosses which nest on coral and volcanic rocks in the Pacific Ocean. Nat. Hist. 34: 273-281.

---1942. The portulaca flats of Laysan. Aud. Mag. 44: 150-161.

---1952a. Laysan and Black-footed Albatrosses. Denver Mus. Nat. Hist., Mus. Pict. 6. 80 pp.

---1952b. The Hawaiian monk seal. Denver Mus. Nat. Hist., Mus. Pict. 7. 32 pp.

---1956. Birds of Midway and Laysan Islands. Denver Mus. Nat. Hist., Mus. Pict. 12. 130 pp.

Baldwin, P.H. 1945. Fate of the Laysan Rail. Aud. Mag. 47: 343-348.

---1947. The life history of the Laysan Rail. Condor 49: 14-21.

Ball, S.C. (ms.). Field notebook kept during the 1923 Tanager Expedition. B.P. Bishop Museum, Honolulu.

Barr, R. 1903. Hornschwämme aus dem Pacific...Schauinsland, 1896-97. Zool. Jahrb., Syst., Jena 19: 27-36.

Bassham, B.L. (ms.). Cruise report of the Reliance for March 1936. Rec. Group 26, U.S. Nat. Arch. 2 pp.

Baylis, J.S. (ms.). Cruise report for the Itasca for the month of June 1934. Rec. Group 26, U.S. Nat. Arch. 6 pp.

Beardsley, J.W. 1966. Insects and other terrestrial arthropods from the Leeward Hawaiian Islands. Proc. Haw. Ent. Soc. 19: 157-185.

Bergh, R. 1900. Ergebnisse einer Reise nach dem Pacific (Schauinsland, 1896-97). Die Opisthobranchier. Zool. Jahrb., Syst., Jena 13: 207-246.

Berry, S.S. 1910. Diagnoses of new cephalopods from the Hawaiian Islands. Proc. U.S. Nat. Mus. (No. 1713): 407-419.

Bitter, G. 1900. Die phanerogamische Pflanzenwelt der Insel Laysan. Abh. Nat. Ver., Bremen.16: 430-439.

Brock, V.E. 1951a. Some observations on the Laysan Duck, Anas wyvilliana laysanensis. Auk 68: 371-372.

---1951b. Laysan Island bird census. Elepaio 12: 16-18.

Brooks, N.C. 1859. Cruise of the Gambia. Pac. Comm. Advertiser, 11 Aug. 1859.

---1860. Islands and reefs west-north-west of the Sandwich Islands, Pacific. Naut. Mag. 29: 499-504.

Brown, J.H. (ms. a). Report to the Captain Commandant of the Coast Guard of observations made during a cruise to Laysan, Lisianski, etc., in March 1915. Rec. Group 26, U.S. Nat. Arch. 14 pp.

---(ms. b). Report to the Captain Commandant of the Coast Guard of the Cruise made to the Hawaiian Bird Reservation in February 1916. Rec. Group 26, U.S. Nat. Arch. 12 pp.

---(ms. c). Report to the Captain Commandant of the Revenue Cutter Service of a cruise to the "Bird Islands" in September 1914. Unpublished ms. material, Rec. Group 26, U.S. Nat. Arch. 4 pp.

Bryan, E.H., Jr. 1932. Notes and exhibitions. Proc. Haw. Ent. Soc. 8: 3.

---1942. American Polynesia and the Hawaiian Chain. Tongg Publ. Co., Honolulu, 253 pp.

---1954. The Hawaiian Chain. B.P. Bishop Mus. Press, Honolulu. iii and 71 pp.

---1958. Check list and summary of Hawaiian birds. Books about Hawaii, Honolulu. 28 pp.

Bryan, E.H., Jr. and J.C. Greenway, Jr. 1944. Contribution to the ornithology of the Hawaiian Islands. Bull. Mus. Comp. Zool. Harvard 94: 79-142.

Bryan, E.H., Jr. et al. 1926. Insects of Hawaii, Johnston Island and Wake Island. B.P. Bishop Mus. Bull. 31: 94 pp.

Bryan, W.A. 1901. Key to the birds of the Hawaiian group. B.P. Bishop Mus. Mem. 1: 259-332.

---1911. Laysan Island, a visit to Hawaii's bird reservation. Mid-Pac. Mag. 2: 303-315.

---1912. The introduction and acclimization of the Yellow Canary on Midway Island. Auk 29: 339-342.

---1915. Natural history of Hawaii. Hawaiian Gazette Co., Ltd., Honolulu. 596 pp.

Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Kailua, Hawaii (unpublished reports and notes):

Kridler, E. personal correspondence, 1968-70.

---1964. [Report on] Hawaiian Islands National Wildlife Refuge... [survey]...September 16 through 27, 1964. 31 pp.

---1966. Hawaiian Islands National Wildlife Refuge trip report. 24 pp.

---1966. Hawaiian Islands National Wildlife Refuge trip - September 8-28, 1966. 34 pp.

---1967. Refuge log book for 6 March - 1 April 1967. 39 pp.

---1967. Refuge log book for 19-29 September 1967. 12 pp.

---1967. Hawaiian Islands National Wildlife Refuge...Preliminary trip report - December 7 through 18, 1967. 13 pp.

---1969. Hawaiian Islands National Wildlife Refuge spring trip. March 19 - April 6, 1969. 32 pp.

Olsen, D.L. 1969. Hawaiian Islands National Wildlife Refuge Field trip, May 28 - June 11, 1969. 18 pp.

Kridler, E. 1969. Hawaiian Islands National Wildlife Refuge Field trip report, August 19 - September 23, 1969. 32 pp.

Butler, G.D., Jr. 1961a. Insects and other arthropods from Laysan Island. Proc. Haw. Ent. Soc. 17: 379-387.

---1961b. Stratiomyiid fly associated with dead albatrosses on Laysan Island. Proc. Haw. Ent. Soc, 17: 331-332.

Butler, G.D., Jr. and M.D.F. Udvardy. 1966. Basking behavior of the Hawaiian monk seal on Laysan Island. J. Wildlife Manage. 30: 627-628.

Butler, G.D., Jr., and R.L. Usinger. 1963. Insects and other invertebrates from Laysan Island. Atoll Res. Bull. 98: 1-30.

Caspers, H. 1968. Biology of a hypersaline lagoon in a tropical atoll island (Laysan). Recent Adv. Trop. Ecol. 1: 326-333.

Chapin, E.A. 1925. Descriptions of new internal parasites. Proc. U.S. Nat. Mus. 68 (No. 2603): 1-4.

Christophersen, E. and E.L. Caum. 1931. Vascular plants of the Leeward Islands, Hawaii. B.P. Bishop Mus. Bull. 81. 41 pp.

Clapp, R.B. 1968. Three unusual shorebirds from Midway Atoll, Pacific Ocean. Elepaio 28: 76-77.

Clapp, R.B., V.M. Kleen and D.L. Olsen. 1969. First records of Emperor Geese from the Northwestern Hawaiian Islands. Elepaio 30: 51-52.

Clapp, R.B. and F.C. Sibley. 1967. New records of birds from the Phoenix and Line Islands. Ibis 109: 122-125.

Clapp, R.B. and P.W. Woodward. 1968. New records of birds from the Hawaiian Leeward Islands. Proc. U.S. Nat. Mus. 124 (No. 3640). 39 pp.

Clark, A.H. 1908. Descriptions of new species of crinoids, chiefly from the collections made by the U.S. Fisheries steamer "Albatross" at the Hawaiian Islands in 1902....Proc. U.S. Nat. Mus. 34 (No. 1608): 209-244.

---1912. Notes on the Laysan Finch. Auk 29: 166-168.

Cochran, C.S. (ms. a). Report to the Captain Commandant of the Revenue Cutter Service of an inspection of the Hawaiian Bird Reservation in April and May 1912. Rec. Group 26, U.S. Nat. Arch. 2 pp.

---(ms. b). Report to the Captain Commandant of the Revenue Cutter Service of a cruise to the Hawaiian Bird Reservation in December 1912. Rec. Group 26, U.S. Nat. Arch. 4 pp.

---(ms. c). Report to the Secretary of the Treasury of a survey of the Hawaiian Bird Reservation in August and September 1910. Unpublished ms., Rec. Group 26, U.S. Nat. Arch. 2 pp.

---1949. Ophiuroidea of the Hawaiian Islands. B.P. Bishop Mus. Bull. 195. 133 pp.

Coultas, W.F. (ms.). Notes taken on Laysan Island, December 1936. Extracts from a letter in the files of the Bureau of Sport Fisheries and Wildlife, Honolulu. 1 p.

Crossin, R.S. and L.N. Huber. 1970. Sooty Tern egg predation by Ruddy Turnstones. Condor 72: 372-373.

Dall, W.H., P. Bartsch, and H.A. Rehder. 1938. A manual of the recent and fossil pelecypod mollusks of the Hawaiian Islands. B.P. Bishop Mus. Bull. 153: 233 pp.

Dickey, D.R. (ms.). Notes taken during the Tanager Expedition.

Diggs, J.T. (ms.). Report of the cruise of the U.S.S. Hermes among the islands of the Hawaiian Group, 1918. Rec. Group 45, U.S. Nat. Arch. 24 pp.

Dill, H.R. 1913. The albatross of Laysan. Amer. Mus. J. 13: 185-192.

---1961a. The mating and nesting habits of Fregata aquila. Wilson Bull. 28: 153-157.

---1961b. The albatross of Laysan. Wilson Bull. 28: 172-175.

Dill, H.R. and W.A. Bryan. 1912. Report of an expedition to Laysan Island in 1911...U.S. Dept. Agr. Biol. Surv. Bull. 42: 30 pp.

Donaghho, W.R. 1953-1954. Ornithological notes. Elepaio, 14: 9-11, 18-21, 30-33, 41-43, 46-49, 57-59.

Dutcher, W. 1905. [Bird protection in the Pacific]. Bird-lore 7: 301-306.

Edmondson, C.H., W.K. Fisher, H.L. Clark, A.L. Treadwell, and J.A. Cushman. 1925. Marine zoology of the tropical central Pacific. B.P. Bishop Mus. Bull. 27: ii and 148 pp.

Edwards, R.L. 1961. Studies of the Philopteridae (Mallophaga) from birds of the order Procellariformes. 1. The genus Halipeurus Thompson. J. Parasit. 47: 125-157.

Elschner, C. 1913. Corallogene Phosphat-Inseln Austral-Oceaniens und ihre Produkte. Max Schmidt, Lübeck. 120 pp. Translation of Chapters I and IV in the files of the Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

---1915. The leeward islands of the Hawaiian Group [Reprint from Honolulu Advertiser]. Honolulu, 69 pp.

Emery, C. 1899. Ergebnisse einer Reise nach dem Pacific (Schauinsland 1896-1897). Formiciden. Zool. Jahrb., Syst., Jena 12: 438-440.

Farrell, A. [ed.]. 1928. John Cameron's Odyssey. The MacMillan Co., New York. 461 pp.

Ferris, G.F. 1927. Fourth report upon Diptera Pupana from the Philippine Islands. Philippine J. Sci. 34: 207-233.

Fisher, H.I. 1960. Records of the Bar-tailed Godwit and Tufted Duck on Midway Atoll. Condor 62: 480.

---1965. Bird records from Midway Atoll, Pacific Ocean. Condor 67: 355-357.

Fisher, W.K. 1903a. Birds of Laysan and the leeward islands, Hawaiian Group. U.S. Fish. Comm. Bull. 23 (pt. 3): 767-807.

---1903b. Notes on birds peculiar to Laysan Island, Hawaiian Group. Auk 20: 384-397.

---1904a. On the habits of the Laysan Albatross. Auk 21: 8-30.

---1904b. Three boobies interviewed. Condor 6: 89-94.

---1906. The Starfishes of the Hawaiian Islands. U.S. Fish. Comm. Bull. 23 (pt. 3): 987-1131.

---1907. The holothurians of the Hawaiian Islands. Proc. U.S. Nat. Mus. 32 (No. 1555): 637-744.

Fosberg, F.R. 1962. Miscellaneous notes on Hawaiian plants -- 3. B.P. Bishop Mus. Occ. Papers 23 (2): 29-44.

Fowler, H.W. 1927. Fishes of the tropical central Pacific. B.P. Bishop Mus. Bull. 38: 32 pp.

---1934. The fishes of Oceania-Supplement 2. B.P. Bishop Mus. Memoir 11 (6): 385-466.

Fowler, H.W. and S.C. Ball. 1924. Descriptions of new fishes obtained by the Tanager Expedition of 1923 in the Pacific Islands west of Hawaii. Proc. Acad. Nat. Sci. Phila. 76: 269-274.

---1925. Fishes of Hawaii, Johnston Island, and Wake Island. B.P. Bishop Mus. Bull. 26: 31 pp.

Frohawk, F.W. 1892. Description of a new species of rail from Laysan Island (North Pacific). Ann. Mag. Nat. Hist. III, 9: 247-249.

Fullaway, D.T. 1914a. A new species of Oodemas from Laysan Island. Proc. Haw. Ent. Soc. 3: 18.

---1914b. A list of Laysan Island insects. Proc. Haw. Ent. Soc. 3: 20-22.

Garrett, L.E. and F.H. Haramoto. 1967. A catalog of Hawaiian Acarina. Proc. Haw. Ent. Soc. 19 (3): 381-414.

Gilbert, C.H. 1905. The deep-sea fishes. U.S. Fish. Comm. Bull. 23 (pt. 2): iii-xi and 575-713.

Greenway, J.C., Jr. 1958. Extinct and vanishing birds of the world. Amer. Committee Internat. Wildlife Protection. Special Publ. 13, New York. x and 518 pp.

Gregory, H.E. 1924. Report of the Director for 1923. B.P. Bishop Mus. Bull. 10: 38 pp.

---1925. Report of the Director for 1924. B.P. Bishop Mus. Bull. 21: 55 pp.

---1931. Report of the Director for 1930. B.P. Bishop Mus. Bull. 82: 36 pp.

Hadden, F.C. 1941. Midway Islands. Hawaiian Planters' Record 45: 179-221.

Hardwick, D.F. 1965. The corn earworm complex. Mem. Ent. Soc. Canada 40: 247 pp.

Hardy, D.E. 1960. Insects of Hawaii. Vol. 10. Diptera: Nematocera - Brachyura. E.C. Zimmerman, Ed. Univ. of Hawaii Press, Honolulu. vii and 368 pp.

---1964. Insects of Hawaii. Vol. 11. Diptera: Brachycera II - Cyclorrhapha 1. E.C. Zimmerman, Ed. Univ. of Hawaii Press, Honolulu. vii and 458 pp.

---1965. Insects of Hawaii. Vol. 12. Diptera: Cyclorrhapha II, Series Schizophora Section Acalypterae I. Family Drosophilidae. Univ. of Hawaii Press, Honolulu. vii and 814 pp.

Harry, R.R. 1953. Skin diving on a Polynesian expedition. Skin Diver 2: 6-7.

Hartert, E. 1919-1927. Types of birds in the Tring Museum....Novitates Zool. 26: 123-178, 32: 259-276, 33: 344-357, 34: 1-38.

Hartlaub, C. 1901. Hydroiden aus dem Stillen Ocean....(Schauinsland 1897-97). Zool. Jahrb., Syst., Jena 14: 349-379.

Hartlaub, G. 1893. Vier Seltene Rallen. Abhdl. d. Naturw., Bremen. 12: 389-402.

Hartman, O. 1966. Polychaetous annelids of the Hawaiian Islands. B.P. Bishop Mus. Occ. Papers 23 (11): 163-252.

Henshaw, H.W. 1902. Birds of the Hawaiian Islands, being a complete list of the birds of the Hawaiian possessions with notes on their habits. Thos. G. Thrum, Honolulu. 146 pp.

---1912. Our mid-Pacific bird reservation. Yearbook U.S. Dept. Agri. 1911: 155-164.

Herald, E.S. 1952. "Pioneer" in the Pacific. Pac. Discovery 5 (5): 15-17.

Holly, M. 1935. Polychaeta from Hawaii. B.P. Bishop Mus. Bull. 129: 33 pp.

Hornell, J. 1934. Log of the schooner Ada on a fishing cruise in the North Pacific, 1882. Mariner's Mirror 20: 436-437.

Jacobs, W.V.E. (ms.). Report to the Secretary of the Treasury of investigation and apprehension of Japanese plumage hunters in January 1910. Rec. Group 26, U.S. Nat. Arch. 18 pp.

Jordan, D.S. and J.O. Snyder. 1904. Notes on collections of fishes from Oahu Island and Laysan Island, Hawaii, with descriptions of four new species. Proc. U.S. Nat. Mus. 27 (No. 1377): 939-948.

Kellogg, V.L. and J.H. Paine. 1910. Mallophaga from the birds of Laysan Island. Ent. News 21: 124-125.

Kenyon, K.W. and D.W. Rice. 1957. Bird observations at Midway Atoll. Elepaio 18: 2-4.

---1958. Birds of Kure Atoll, Hawaii. Condor 60: 188-190.

---1959. Life history of the Hawaiian monk seal. Pac. Sci. 13: 215-252.

King, J.E. 1956. The monk seals (Genus Monachus). Bull. Brit. Mus. (Nat. Hist.) Zool. 3 (5): 201-256.

King, W.B. 1967. Seabirds of the tropical Pacific Ocean. U.S. Nat. Mus., i-xxxii, 11 plates, 126 pp.

Lamoureux, C.H. 1963. The flora and vegetation of Laysan Island. Atoll Res. Bull. 97: 1-14 (with 13 figures).

Lint, K.C. 1960. Preserving the Laysan Teal. Zoonooz 33 (8): 6-7.

Lydgate, J.M. 1914. Wrecks to the North-West. Hawaiian Almanac and Annual for 1915; 133-144.

Lyons, A.B. 1890. In bird land. Part of the journal of a visit to Laysan Island. The Friend, December 1890: 90-91.

Maa, T.C. 1962. Notes on the Hippoboscidae (Diptera), I. Pac. Insects 4: 583-614.

---1968. Records of Hippoboscidae (Diptera) from the Central Pacific. J. Med. Ent. 5: 325-328.

MacCaughey, V. 1918. Algae of the Hawaiian archipelago. Bot. Gaz. 65: 42-57, 121-149.

Marshall, D.B. (ms.). Report of Hawaiian Islands National Wildlife Refuge inspection trip, June 6 through 26, 1962. Bureau of Sport Fisheries and Wildlife, U.S. Dept. of the Interior, Honolulu. 8 pp.

---1964. Treasure islands--of wildlife. Aud. Mag. 66: 160-165.

Matschie, G.F.P. 1905. Eine Robbe von Laysan. S.B. Ges. Naturl. fr. Berl. 1905: 254-262.

Mayer, A.G. 1906. Medusae of the Hawaiian Islands collected by the steamer Albatross in 1902. U.S. Fish. Comm. Bull 23 (3): 1131-1143.

Medeiros, J.S. 1958. Present status of migratory waterfowl in Hawaii. J. Wildlife Mgmt. 22: 109-117.

Meyrick, E. 1900. New Hawaiian Lepidoptera. Ent. Mon. Mag. Ser. 2, 11: 257-258.

Michaelsen, W. 1899. Oligochaten von der Inseln des Pacific...(Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97). Zool. Jahrb., Syst., Jena 12: 211-214.

Möhle, F. 1902. Beitrag zur Petrographie der Sandwich - und Samoa-Inseln. New. Jahrb. Beil., Band 15: 66-104.

Munro, G.C. 1930. Myriad-nested Laysan. Asia 30: 686-689.

---1941a. Birds of Hawaii...[the Wedge-tailed Shearwater]. Elepaio 1 (7): 1-3; 1 (8): 1-4.

---1941b. Birds of Hawaii...Bulwer's Petrel. Elepaio 2: 1-3.

---1941c. Birds of Hawaii...The Christmas Island Shearwater. Elepaio 2: 16-18.

---1942a. Birds of Hawaii...An Ocean Cruise. No. 7. Elepaio 2: 72-73, 77-78.

---1942b. Birds of Hawaii...An Ocean Cruise. No. 8. Elepaio 3: 2-3, 5-6.

---1944. Birds of Hawaii. Honolulu: Tongg Publ. Co. 189 pp.

---1945. Endangered bird species of Hawaii. Elepaio 5: 76-79, 6: 1-6.

---1946. Laysan Island in 1891. Elepaio 6: 51-52, 60-61, 66-69.

---1947. Notes on the Laysan Rail. Elepaio 8: 24-25.

---1953. Cannibalism in Firgate [sic] Birds. Elepaio 13: 56-57.

Munter, W.H. 1915. Report of destruction of bird life on Laysan Island. An. Rep. Coast Guard for 1915: 130-140.

---(ms.). Report to the captain of the Thetis of bird observations made during a cruise to the Hawaiian Bird Reservation in January and February 1916. Rec. Group 26, U.S. Nat. Arch. 19 pp.

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

---1905. Hydroids of the Hawaiian Islands collected by the steamer Albatross in 1902. U.S. Fish. Comm. Bull. 23 (pt. 3): 931-959.

---1908. Descriptions of the Alcyonaria collected by the U.S. Bureau of Fisheries Steamer Albatross in the vicinity of the Hawaiian Islands in 1902. Proc. U.S. Nat. Mus. 34 (No. 1624): 543-601.

Office of Geography. U.S. Dept. of the Interior 1956. NIS [National Intelligence Survey] Gazetteer, Hawaiian Islands. Central Intelligence Agency, Washington, D.C. iii and 89 pp.

Ortman, A.E. 1905. Schizopods of the Hawaiian Islands collected by the Albatross in 1902. U.S. Fish. Comm. Bull. 23 (pt. 3): 961-974.

Paty, J. 1857. Account of the Manuokawai - Interesting account of her explorations. The Polynesian, 6 June 1857, p. 40.

Perkins, R.C.L. 1906. [List of Midway and Laysan Insects collected by G.P. Wilder]. Proc. Haw. Ent. Soc. 1: 33-34.

---1919. A new species of Otiorrhynchine beetle of the genus Rhyncogonus Sharp from Laysan Island. Ent. Mon. Mag. Ser. 3, 49: 4.

Pilsbury, H.A. 1917. Marine molluscs of Hawaii, IV-VII. Proc. Acad. Nat. Sci. Phila. 69: 309-333.

---1920. Marine molluscs of Hawaii, VIII-XIII. Proc. Acad. Nat. Sci. Phila. 72: 296-328.

---1927. Littoral barnacles of the Hawaiian islands and Japan. Proc. Acad. Nat. Sci. Phila. 79: 305-317.

Plehn, M. 1899. Ergebnisse einer Reise nach dem Pacific (Schauinsland 1896-97). Polycladen. Zool. Jahrb., Syst., Jena 12: 448-452.

Pacific Ocean Biological Survey Program, Smithsonian Institution (unpublished reports):

Sibley, F.C. [1964]. Preliminary report on ATF trip No. 1, February-March 1963. 13 pp.

Amerson, A.B., Jr. [1964]. Northwest Hawaiian Islands trip report, March 1964. 20 pp.

Amerman, K.E. [1964]. Laysan Island, 16-20 September 1964. 8 pp.

Fleet, R.R. [1964]. Leewards Islands survey No. 5, September 1964. 10 pp.

Wirtz, W.O., II. [1965]. Leewards Islands Survey...March 1965. 26 pp.

Crossin, R.S. [1965]. Island report---July 1965. 14 pp.

---[1965]. Island report...August 1965. 16 pp.

---[1966]. Leeward Island survey No. 13, June 1966. 18 pp.

---[1966]. Notes on the Laysan Finch (Psittirostra cantans). 10 pp.

Balcomb, K.C. [1966]. Summary report on the status of the Hawaiian monk seak Monachus schauinslandi - Laysan and Lisianski Islands, 10-22 June 1966. 7 pp.

---[1966]. Preliminary report, Laysan Island, October 1966. 13 pp.

Hackman, C.D. [1967]. Preliminary report of Leeward Island survey No. 18, March 6 to March 27, 1967. 12 pp.

Stadel, D.L. [1967]. Preliminary report, Laysan Island, Leeward Island survey 19, June 7-12, 1967. 18 pp.

DeLong, R.L. [1967]. Census and observations of Hawaiian monk seal on Pearl & Hermes Reef, Lisianski, and Laysan Islands, May 31 to June 11, 1967. 8 pp.

Clapp, R.B. and C.A. Ely. [1967]. Leeward survey No. 21, Preliminary report, Laysan Island. 14 pp.

Clapp, R.B. [1968]. Leeward survey No. 22, Preliminary report, Laysan report, Laysan Island. 15 pp.

Pacific Ocean Fisheries Investigations, Bureau of Commercial Fisheries, Honolulu (unpublished notes and reports):

Narrative report of the June-August 1950 cruise of the H.M. Smith (H.M. Smith Cruise No. 5).

Scientists' log for the June-August 1950 cruise of the H.M. Smith (H.M. Smith Cruise No. 5).

Narrative report of the May-July 1951 cruise of the H.M. Smith (H.M. Smith Cruise No. 9).

Scientists' log for the May-July 1951 cruise of the H.M. Smith (H.M. Smith Cruise No. 9).

Scientists' log and notes from the Jan.-Feb. 1955 cruise of the H.M. Smith (H.M. Smith Cruise No. 27).

Narrative report of the Sept.-Nov. 1954 cruise of the C.H. Gilbert (C.H. Gilbert Cruise No. 17).

Scientists' log for the Aug.-Sept. 1960 cruise of the C.H. Gilbert (C.H. Gilbert Cruise No. 48).

Scientists' log for the May 1966 cruise of the C.H. Gilbert (C.H. Gilbert Cruise No. 91).

Preiwisch, J. 1903. Kalkschwämme aus dem Pacific. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97. Zool. Jahrb., Syst., Jena 19: 9-26.

Rathbun, M.J. 1906. The Brachyura and Macrura of the Hawaiian Islands. U.S. Fish. Comm. Bull. 23 (pt. 3): 827-930.

Reinbold, T. 1899. Meersalgen. Ergebnisse einer Reise nach dem Pacific, H. Schauinsland 1896-97. Abh. Nat. Ver., Bremen 16: 287-302.

Reynolds, J.N. 1835. ...A report of J.N. Reynolds, in relation to islands, reefs, and shoals in the Pacific Ocean, Sc. Document No. 105, U.S. House of Rep., 23rd Congress, and Session. Vol. 3: 1-28.

Rhumbler, L. 1906. Foraminiferen von Laysan und der Chatham-Inseln. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97. Zool. Jahrb., Syst., Jena 24: 21-80.

Rice, D.W. 1960a. Distribution of the bottle-nosed dolphin in the Leeward Hawaiian Islands. J. Mammal. 41: 407-408.

---1960b. Population dynamics of the Hawaiian monk seal. J. Mammal. 41: 376-385.

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

Ripley, S.D. 1960. Laysan Teal in captivity. Wilson Bull. 72: 244-247.

Roach, (ms.). East Pacific Survey Phase I, U.S.S. Duval County LST 758. (Typescript copy of report in the files of the 14th Naval District, Honolulu).

Robbins, C.S. 1966. Birds and aircraft on Midway Island, 1959-63 investigations. U.S.D.I., U.S. Fish and Wildlife Serv., Spec. Sci. Rep., Wildlife No. 85: vi and 63 pp.

Rock, J.F. 1916. The sandalwoods of Hawaii. Hawaii Bd. Agr. and For., Bot. Bull. 3: 1-43.

Ross, E.S. 1951. A new species of Embioptera from Oceania. Proc. Haw. Ent. Soc. 14: 307-310.

Rothschild, W. 1892a. [Description of Anas laysanensis]. Bull. Brit. Ornith. Club 1: 17.

---1892b. Descriptions of seven new species of birds from the Sandwich Islands. Ann. Mag. Nat. Hist. (ser. 6) 10: 108-112.

---1893. [Original description of Diomedea immutabilis from Laysan]. Bull. Brit. Ornith. Club 1: 48.

---1893-1900. The avifauna of Laysan and the neighboring islands... London, R.H. Porter. 3 parts, xx and 320 pp.

---1894. Some new species of Lepidoptera. Novit. Zool. 1: 535-540.

St. John, H. 1970. The genus Sicyos (Cucurbitaceae) on the Hawaiian Leeward Islands. Hawaiian Plant Studies 35. Pacific Science 24 (4): 439-456.

Saito, Y. 1969. The algal genus Laurencia from Hawaii and the Philippines. Pac. Sci. 23: 148-160.

Salisbury, G.R. (ms.). Report on Laysan Expedition, December 5, 1912 to April 11, 1913. Rec. Group 22, U.S. Nat. Arch. 8 pp.

Sars, G.O. 1903. Pacifische Plankton-Crustaceen. (Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97). Zool. Jahrb., Syst., Jena 19: 629-646.

Schauinsland, H. 1899. Drei Monate auf einer Korallen-Inseln (Laysan). Bremen, Nossler. 104 pp.

Schilder, F.A. 1933. Cypraeacea from Hawaii. B.P. Bishop Mus. Occ. Papers 10 (3): 1-22.

Schlemmer, M. and E.L. Schlemmer. (ms.). Copy of the log of the yacht "Helene" and diary written on Laysan Island from June 25 to December 2, 1915. Rec. Group 22, U.S. Nat. Arch. (original in possession of E.L. Schlemmer). 32 pp.

Schreiber, R.W. and E. Kridler. 1969. Occurrence of an Hawaiian monk seal on Johnston Atoll, Pacific Ocean. J. Mammal. 50: 841-842.

Sibley, F.C. and R.W. McFarlane. 1968. Gulls in the Central Pacific. Pac. Sci. 22: 314-321.

Simon E. 1899. Ergebnisse einer Reise nach dem Pacific (Schauinsland 1896-97). Arachnoideen. Zool. Jahrb., Syst., Jena 12: 414-437.

Sluiter, C.P. 1900. Tunicuten aus dem Stillen Ocean. Ergebnisse einer Reise nach dem Pacific.(Schauinsland 1896-97). Zool. Jahrb., Syst., Jena 13: 1-35.

Smythe, W.R. 1960. Monk seals on Laysan Island. Elepaio 20: 78-79.

Snyder, J.O. 1904. A catalogue of the shore fishes collected by the steamer Albatross about the Hawaiian Islands in 1902. U.S. Fish. Comm. Bull. 22: 513-538.

---1917. Notes on Hawaiian lizards. Proc. U.S. Nat. Mus. 54 (No. 2224): 19-25.

Speiser, P. 1902. Studien über Diptera pupipara. Zeitschr. Syst. Hym. Dipt. 2: 145-180.

Stackpole, E.A. 1953. The sea-hunters. J.D. Lippincott Co., New York. 510 pp.

Starbuck, A. 1878. History of the American whale fishery from its earliest inception to the year 1876. p. 1-779 in Report of the Commissioner of Fish and Fisheries for 1875-1876. Washington Government Printing Off.

Steindacher, F. 1900. Fische aus dem Stillen Ocean. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97. Denks. Math.-Nat. K.K. Wiss. Wien 70: 483-521.

Stoops, L. 1958. Life on Laysan. Paradise of the Pacific 70 (9): 14-15.

Strasberg, D.W. 1956. Notes on the blennoid fishes of Hawaii with descriptions of two new species. Pac. Sci. 10: 241-267.

Studer, T. 1901. Madreporarien von Samoa, der Sandwich-Inseln und Laysan. Zool. Jahrb., Syst., Jena 14: 388-428.

Suman, T.W. 1964. Spiders of the Hawaiian Islands: catalog and bibliography. Pac. Insects 6 (4): 665-687.

Svihla, A. 1959. Notes on the Hawaiian monk seal. J. Mammal. 40: 226-229.

Swezey, O.H. 1914. Two new species of moths from Laysan Island. Proc. Haw. Ent. Soc. 3: 18-19.

Thomas, C. (ms.). Report of explorations made by the United States Fisheries Commission steamer Albatross in and about the Hawaiian Islands during 1902. Rec. Group 22, U.S. Nat. Arch. 136 pp.

Thompson, G.B. 1948. Mallophaga collected by the Tanager Expedition. B.P. Bishop Mus. Occ. Papers 19: 195-200.

Thrum, T.G. [comp.]. 1902. Hawaiian Almanac and Annual for 1903. T.G. Thrum, Honolulu. 202 pp.

---1905. Hawaiian Almanac and Annual for 1906. T.G. Thrum, Honolulu. 255 pp.

Timberlake, P.H. 1919. Descriptions of new genera and species of Hawaiian Encyrtidae (Hymenoptera). Proc. Haw. Ent. Soc. 4: 197-231.

Tomich, P.Q. 1969. Mammals of Hawaii. A synopsis and notational bibliography. B.P. Bishop Mus. Spec. Pub. 57: 1-238.

Treadwell, A.L. 1906. Polychaetous annelids of the Hawaiian Islands collected by the steamer Albatross in 1902. U.S. Fish. Comm. Bull. 23 (pt. 3): 1145-1181.

Trempe, A.D. (ms.). Report on the bird life observed on the cruise of the Reliance in March 1936. Rec. Group 26, U.S. Nat. Arch. 5 pp.

Tsuda, R.T. 1965. Marine algae from Laysan Island with additional notes on the vascular flora. Atoll Res. Bull. 110: 31 pp.

---1966. Marine benthic algae from the Leeward Hawaiian group. Atoll Res. Bull. 115: 13 pp.

Udvardy, M.D.F. 1961a. Additions to the check list of Hawaiian birds. Elepaio 21: 83-90.

---1961b. The Harold J. Coolidge Expedition to Laysan Island, 1961. Elepaio 22: 43-47.

---1963. Data on the body temperatures of tropical sea and water birds. Auk 80: 191-194.

Vaughan, T.W. 1907. Recent Madreporia of the Hawaiian Islands and Laysan. U.S. Nat. Mus. Bull. 59: ix and 222 pp.

Walker, F.D. 1909. Log of the Kaalokai. The Hawaiian Gazette Co., Ltd., Honolulu. 64 pp.

Walker. R.L. (ms. a). Excerpts from Leeward Island journal, September 2nd to 12th, 1961. Hawaii Dept. of Fish and Game, Honolulu. 4 pp.

---(ms. b). Notes on a visit to Laysan Island, December 3-10, 1963. Hawaii Dept. of Fish and Game, Honolulu. 25 pp.

Warner, R.E. 1958. Wildlife of Laysan Island. Elepaio 19: 8-10, 20-23.

---1963. Recent history and ecology of the Laysan Duck. Condor 65: 3-23.

---1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. Condor 70: 101-120.

---(ms.). Completion report-Midway and Laysan Islands bird studies. Hawaii Dept. of Fish and Game, Honolulu. 11 pp.

Weins, H.J. 1962. Atoll environment and ecology. Yale Univ. Press, New Haven. xxii and 532 pp.

Werner, F. 1901. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896-97. Zool. Jahrb., Syst., Jena 14: 380-387.

Wetmore, A. 1925. Bird life among lava rock and coral sand. Nat. Geog. Mag. 48: 77-108.

---(ms.). Field notes taken on the 1923 Tanager Expedition (original in the possession of A. Wetmore).

Wheeler, W.M. 1934. Revised list of Hawaiian ants. B.P. Bishop Mus. Occ. Papers 10 (21): 1-21.

Wilder, G.P. 1905. A short trip to the Midway Islands with Capt. A.P. Niblack in the U.S.S. "Iroquois." Hawaiian For. and Agr. 2: 390-396.

---(ms. a). Extracts from a letter received by the Bureau of Biology Survey on 12 May 1924. Bureau of Sport Fisheries and Wildlife, Kailua.

---(ms. b). Report of a trip to Laysan in the summer of 1930. Rec. Group 22, U.S. Nat. Arch. 4 pp.

Willett, G. 1919. Notes on the nesting of two little-known species of petrel. Condor 21: 60-61.

---(ms.). [Extracts from a report made to the Bureau of Biological Survey], Bureau of Sport Fisheries and Wildlife, Kailua, Hawaii.

Wilson, C.B. 1950. Copepods gathered by the United States Fisheries Steamer Albatross from 1887 to 1909...U.S. Nat. Mus. Bull. 14 (3): 141-441.

Wilson, N. 1964. Ixodes laysanensis, a new species of tick from birds on Laysan Island (Metastigmata: Ixodidae). J. Med. Ent. 1: 165-168.

Wilson, S.B. 1890. On a new finch from Midway Island, north Pacific. Ibis 7: 339-341.

Woodside, D.H. (ms. a). Report on the population of Laysan Teal and the transport of teal to [the] Honolulu Zoo. [1957]. Hawaii Dept. of Fish and Game, Honolulu. 4 pp.

---(ms. b). Notes on a survey of Laysan Island, July 1957. Hawaii Dept. of Fish and Game, Honolulu.

---(ms. c). Report on a survey of Laysan Island, September 1961. Hawaii Dept. of Fish and Game, Honolulu. i and 32 pp.

Woodside, D.H. and R.J. Kramer. (ms.). A report on a survey trip to the Hawaiian Islands National Wildlife Refuge, March 1961. Hawaii Dept. of Fish and Game, Honolulu. 32 pp.

Woodward, P.W. and R.B. Clapp. 1969. First records of Baird's Sandpiper from the central Pacific. Elepaio 30: 25.

Zimmerman, E.C. 1948a. Insects of Hawaii. Vol. 2. Apterygota to Thysanoptera. Univ. of Hawaii Press, Honolulu. vii and 475 pp.

---1948b. Insects of Hawaii. Vol. 3. Heteroptera. Univ. of Hawaii Press, Honolulu. v and 255 pp.

---1948c. Insects of Hawaii. Vol. 5. Homoptera: Sternorhyncha. Univ. of Hawaii Press, Honolulu. vii and 464 pp.

---1948d. Insects of Hawaii. Vol. 4. Homoptera: Anchenorhyncha. Univ. of Hawaii Press, Honolulu. vii and 268 pp.

---1957. Insects of Hawaii. Vol. 6. Ephemeroptera-Neuoptera-Tridroptera and supplement to Vols. 1 to 5. Univ. of Hawaii Press, Honolulu. ix and 209 pp.

---1958a. Insects of Hawaii. Vol. 7. Macrolepidoptera. Univ. of Hawaii Press, Honolulu. ix and 542 pp.

---1958b. Insects of Hawaii. Vol. 8. Lepidoptera: Pyraloidea. Univ. of Hawaii Press, Honolulu. ix and 456 pp.

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

Date	Personnel	Vessel
1828 24 Mar.	C. Isenbeck	Moller
1859 May	N.C. Brooks	Gambia
1890 16 July	A.B. Lyons	Kaalokai
1891 16-27 June	Rothschild Expedition	Kaalokai
	Henry C. Palmer George C. Munro	
1892 ca. 18 Nov.- 1893 ca. 22 Jan.	J.J. Williams	Liholiho
1895 ca. Sept.	W.H. Hall (BPBM)*	C.D. Bryant (?)
1896 24 June- 24 Sept.	H.H. Schauinsland (BM)	H. Hackfeld
1902 16-23 May	Charles H. Gilbert (SU) Walter K. Fisher (SU) Charles C. Nutting (SUI) John O. Snyder (SU)	Albatross
1903 Apr.-May	William A. Bryan (BPBM)	?
ca. 1903-1908	Max Schlemmer	Various vessels
1905 19 Sept.	Gerrit P. Wilder (HDAF)	Iroquois
1906 26 Jan.- 6 June	Paul E.H. Bompke	?
1910 16-18, 26 Jan.	W.V.E. Jacobs	Thetis
1911 24 Apr.- 5 June	State University of Iowa Expedition	Thetis
	Homer R. Dill (SUI) Clarence J. Albrecht Charles A. Corwin Horace C. Young (SUI) William A. Bryan (BBS)	

*A glossary of abbreviations indicating professional affiliation is appended at the end of this table.

Appendix Table 1. (continued)

Date		Personnel	Vessel
1912 1913	22 Dec.- 11 Mar.	G.R. Salisbury (USN) Alfred M. Bailey (BBS) David T. Fullaway George Willett (BBS) William S. Wallace (SU)	Thetis
1914	11 Sept.	Carl Elschner	Thetis
1915	3 Apr.	William H. Munter (USCG) Members of crew	Thetis
1916	9 Feb.	William H. Munter (USCG) Members of crew	Thetis
1918	8-10 Sept.	Crew of the Hermes	Hermes
1923	7 Apr.- 14 May	Tanager Expedition*	Tanager
	8-14 Apr., 29 Apr.-14 May	Alexander Wetmore (BBS) (ornithologist)	
	8 Apr.-14 May	E.C. Reno (BBS) (small mammal control expert)	
	8-14 Apr.	David T. Fullaway (BPBM) (entomologist)	
	8-14 Apr., 29 Apr.-14 May	Ditlev Thaanum (BPBM) (conchologist)	
	8-14 Apr.	Edward L. Caum (BPBM) (botanist)	
	8-14 Apr., 29 Apr.-14 May	Chapman Grant (naturalist)	
	8-29 Apr.	Donald R. Dickey (naturalist, photographer)	

*Individual itineraries given under entire period during which members of the expedition were encamped on the island.

Two other persons, not official members of the survey party, visited the island briefly on 14 May. These were Theodore Dranga, who was collecting shells for L.A. Thursten, and Austin Jones, a friend of the ship's surgeon.

Appendix Table 1. (continued)

Date		Personnel	Vessel
1923	7 Apr.-14 May	Tanager Expedition (continued)	Tanager
	8 Apr.-14 May	Eric L. Schlemmer (assistant to Wetmore)	
	8 Apr.-14 May	Stanley C. Ball (BPBM) (biologist)	
	8-29 Apr.	J.W. Thompson (preparator)	
	14 May	John Baker (collector)	
	14 May	Gerrit P. Wilder (botanist)	
	8 Apr.-14 May	George Higgs (USN) (cook, camp assistant)	
1924	6 May	Gerrit P. Wilder	Pelican
1928	1 Mar.	Victor Pietschmann (VM)	Lanikai
	6 May	William G. Anderson (Capt.)	Lanikai
1930	2-18 Aug.	Gerrit P. Wilder (BBS)	Pioneer
1936	7-8 Mar.	Alfred D. Trempe (BBS) B.L. Bassham (USCG) Members of crew	Reliance
	12(-15?) Dec.	C. Templeton Crocker Expedition	Zaca
		William F. Coultas (AMNH) Toshio Asaeda (AMNH)	
1950	23 June	Vernon E. Brock (HDFG) POFI personnel	Hugh M. Smith
1951	12 May	POFI personnel	Hugh M. Smith
	late June-early July	George Vanderbilt Pacific Equatorial Expedition	Pioneer
		George Vanderbilt Robert R. Harry (SU)	

Appendix Table 1. (continued)

Date		Personnel	Vessel
1951	late June-early July	Vanderbilt Expedition (continued) Vernon E. Brock (HDFG) Anita Vanderbilt Lucille Vanderbilt B. Green T. Ivar Vatland	Pioneer
1954	1 Nov.*	Johnson A. Neff (BSFW) Philip A. Dumont (BSFW)	Aerial survey
	3 Nov.	POFI personnel	Charles H. Gilbert
1955	10 Feb.	Donald L. McKernan POFI personnel	Hugh M. Smith
1957	7 Jan.	Karl W. Kenyon (BSFW) Dale W. Rice (BSFW)	Aerial survey
	15 Apr.	Karl W. Kenyon (BSFW) Dale W. Rice (BSFW)	Aerial survey
	25 June-3 July	David H. Woodside (HDFG) Richard E. Warner (HDFG)	Coast Guard ship
	8-12 July	Alphonse Labrecque Al Stoops	Koyu Maru
	28 Dec.	Dale W. Rice (BSFW)	Aerial survey
1958	27 May-4 June	Richard E. Warner (HDFG, BSFW) Prentis Burtis Frederick W. Landers Dale W. Rice (BSFW) Richard Takahashi (USN)	Matagorda and Chautauqua
	28 June	Dale W. Rice (BSFW)	Aerial survey
1959	28 Apr.-1 May	Raymond J. Kramer (HDFG) George D. Butler, Jr. (UA) Hubert Caspers (HU) William R. Smythe (HSPA)	Matagorda

*Another aerial survey may have been made on 5 December.

Appendix Table 1. (continued)

Date		Personnel	Vessel
1959	20-27 July	Miklos D.F. Udvardy (UBC) George D. Butler, Jr. (UA) C.H. Danforth Charles W. Daniel Richard E. Warner (HDFG)	-
*1960	23 Aug.	POFI personnel	Charles H. Gilbert
1961	7-8 Mar.	David H. Woodside (HDFG) Raymond J. Kramer (HDFG)	Planetree
	4-10 Sept.	Harold J. Coolidge Expedition	Ironwood
	(0800-0800)	Richard E. Warner (UC) George D. Butler, Jr. (UA) Edward C. Jestes (UH) Charles Lamoureux (UH) A. Starker Leopold (UC) Miklos D.F. Udvardy (UBC) Robert L. Usinger (UC) Martin Vitousek (UH) Ronald L. Walker (HDFG) David H. Woodside (HDFG)	
1962	14-19 June	Raymond J. Kramer (HDFG) John W. Beardsley (HSPA)	Stone County
	(0930-1645)	David H. Woodside (HDFG) David B. Marshall (BSFW)	
1963	11-13 Feb.	Raymond J. Kramer (HDFG) A. Binion Amerson, Jr. (POBSP)	Moctobi
	(1600-1400)	F. Allen Blagden (POBSP) Robert W. McFarlane (POBSP) Fred C. Sibley (POBSP) William O. Wirtz, II (POBSP)	
	3-10 Dec.	Ronald L. Walker (HDFG) Roy T. Tsuda (UH) Nixon Wilson (BPBM)	Matagorda and Chautauqua
1964	10-11 Mar.	Eugene Kridler (BSFW) A. Binion Amerson, Jr. (POBSP)	Planetree
	(0900-0730)	Loren Kroenke (UH) Edward O'Neill (BSFW) Ronald L. Walker (HDFG) George S. Wislocki (POBSP)	

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

Appendix Table 1. (continued)

Date		Personnel	Vessel
1964	16-20 Sept. (0900-0600)	Kenneth E. Amerman (POBSP) Alan H. Anderson (POBSP) Robert Banner (UH) Richard W. Merrill (POBSP) J. Douglas Whitman (POBSP) Paul W. Woodward (POBSP) Alan Lee Young (UH)	Shearwater
	19-20 Sept. (0900-2000)	Eugene Kridler (BSFW) John W. Beardsley (UH) Robert R. Fleet (POBSP) C. Robert Long (POBSP) Ronald L. Walker (HDFG)	Basswood
1965	6-11 Mar. (1100-1500)	William O. Wirtz, II (POBSP) Kenneth E. Amerman (POBSP) Roger B. Clapp (POBSP) J. Vincent Hoeman (POBSP) Dennis L. Stadel (POBSP) Charles Williams, Jr. (USN)	Shearwater
	17-21 July (2040-1000)	Richard S. Crossin (POBSP) Brian A. Harrington (POBSP) Dayle N. Husted (POBSP) Jeffrey P. Tordoff (POBSP)	Shearwater
	5-12 Aug. (1530-2100)	Richard S. Crossin (POBSP) Kenneth E. Amerman (POBSP) Brian A. Harrington (POBSP) Dayle N. Husted (POBSP) Jeffrey P. Tordoff (POBSP)	Shearwater
1966	26-31 Mar. (1345-0730)	Eugene Kridler (BSFW) Andrew J. Berger (UH) Nelson Rice (HDFG) Ronald L. Walker (HDFG)	Buttonwood
	15 May (0830-1100) (1345-1530)	Members of the crew	Charles H. Gilbert
	10-16 June (0945-0330)	Richard S. Crossin (POBSP) Kenneth C. Balcomb (POBSP)	Shearwater
	20-21 June (1300-2245)	Richard D. Chandler (POBSP) David I. Hoff (POBSP) David L. Pearson (POBSP) Philip C. Shelton (POBSP) Frank H. Smith, Jr. (POBSP)	

Appendix Table 1. (continued)

Date		Personnel	Vessel
1966	17-18 Sept.	Eugene Kridler (BSFW)	Ironwood
		Sherwin Carlquist (CC)	
	(1340-1450)	Karl W. Kenyon (BSFW)	
		Warren Roll (HSB)	
		Ronald L. Walker (HDFG)	
	20-23 Oct.	Kenneth C. Balcomb (POBSP)	Tawakoni
		Patrick J. Gould (POBSP)	
	(1945-1210)	Brian A. Harrington (POBSP)	
		T. James Lewis (POBSP)	
1967	18-19 Mar.	Eugene Kridler (BSFW)	Basswood
		C. Douglas Hackman (POBSP)	
	(1330-1430)	Ernest Kosaka (HDFG)	
		John Maciolek (BSFW)	
		Richard Wass (UH)	
	7-12 June	Robert L. DeLong (POBSP)	LT 2081
		David L. Burckhalter (POBSP)	LT 2086
	(0900-0900)	Dennis L. Stadel (POBSP)	LT 2087
		F. Christian Thompson (POBSP)	
		Robert Tuxson (POBSP)	
	5-11 Sept.	Charles A. Ely (POBSP)	LT 2081
		Ronald Amerson (USN)	LT 2086
	(1930-0730)	Roger B. Clapp (POBSP)	LT 2087
		David I. Hoff (POBSP)	
		Edward King (USN)	
	21-24 Sept.	Eugene Kridler (BSFW)	Buttonwood
		Robert Ballou (BSFW)	
	(1645-1600)	John L. Sincock (BSFW)	
		Ronald L. Walker (HDFG)	
	13 Dec. (1100-1600)	Eugene Kridler (BSFW)	Ironwood
1968	17-19 Mar.	Eugene Kridler (BSFW)	Ironwood
		Roger B. Clapp (POBSP)	
	(1700-1600)	Karl W. Kenyon (BSFW)	
		Ernest Kosaka (HDFG)	
		John L. Sincock (BSFW)	
	Sept.	Eugene Kridler (BSFW)	Ironwood
		Derral Herbst (UH)	
		Robert Eddinger (UH)	
		John L. Sincock (BSFW)	

Appendix Table 1. (continued)

Date		Personnel	Vessel
1969	26-29 Mar. (0730-1530)	Eugene Kridler (BSFW) Karl W. Kenyon (BSFW) George Laycock (NAS) David L. Olsen (BSFW) John L. Sincock (BSFW)	Buttonwood
	2-3 June (0630-1600)	Eugene Kridler (BSFW) Karl Bathen (UH) Thomas Clark (UH) Ronald Kent Ernest Kosaka (HDFG) James McVay (UH) David L. Olsen (BSFW) William Patzert (UH) John L. Sincock (BSFW) Douglas Yen (BPBM)	Mahi
	9 Sept. (0730-1430)	Eugene Kridler (BSFW) John Maciolek (BSFW) David L. Olsen (BSFW) John L. Sincock (BSFW)	Buttonwood

Glossary of Abbreviations

AMNH	American Museum of Natural History
BBS	Bureau of Biological Survey
BM	Bremen Museum
BPBM	Bernice P. Bishop Museum
BSFW	Bureau of Sport Fisheries and Wildlife
CC	Claremont College, Claremont, California
HDAF	Hawaiian Department of Agriculture and Forestry
HDFG	Hawaii Division of Fish and Game
HSB	Honolulu Star Bulletin
HSPA	Hawaiian Sugar Planters Association
HU	Hamburg University
NAS	National Audubon Society
POBSP	Pacific Ocean Biological Survey Program
POFI	Pacific Ocean Fisheries Investigations, Bureau of Commerical Fisheries
SU	Stanford University
SUI	State University of Iowa
UA	University of Arizona
UBC	University of British Columbia
UC	University of California
UH	University of Hawaii
USCG	United States Coast Guard
USN	United States Navy
VM	Vienna Museum

Appendix Table 2. Results of scientific visits to Laysan Island, 1828-1969, with emphasis on bird observations.*

Date	Results
1828 24 Mar.	Observations of birds (Kittlitz in Rothschild, 1893-1900).
1859 May	25 varieties of plants collected were subsequently lost. Potatoes, onions, and pumpkins planted.
1890 16 July	Observations of birds (Lyons, 1890); plants collected.
1891 16-27 June	Observations of birds (Rothschild, 1893-1900; Munro, 1930, 1941a, 1941b, 1941c, 1942a, 1942b, 1944, 1945, 1946, 1947, 1953) and many bird specimens collected (no less than 153 skins of 19 species). The following birds were described: Laysan Rail by Frohawk (1892), Laysan Teal by Rothschild (1892a), Laysan Miller-bird, Laysan Honeyeater, and Laysan Finch (the latter subsequently synonomized) by Rothschild (1892b), and Laysan Albatross by Rothschild (1893). Two new moth species described.
1892 ca. 18 Nov.-1893 ca. 22 Jan.	Photographs and a collection of birds made. Two Black-footed Albatross captured and transported to Honolulu.
1895 ca. Sept.	Collections of birds (at least 21 skins of 9 species).
1896 24 June-24 Sept.	Observations and collections of birds (Schauinsland, 1899; Rothschild, 1893-1900). Hartert (1919-1927) lists a number of Schauinsland's and Rothschild's specimens (at least 271 skins of 25 species, and others sent to them by correspondents) in the Tring Museum and describes a new subspecies of White Tern from one of Schauinsland's specimens. Collections of: crustacea, vascular plants, foraminifera, ectoparasites, shrimp, insects, sea squirts, fish, corals, hydroid, turbellarium, oligochaete, molluscs.
1902 16-23 May	Observations and collections of birds (78 skins of 20 species) (Nutting, 1903; Fisher, 1903a, 1903b, 1904a, 1904b). Notes on the anatomy and pterylosis of a Laysan Finch were reported by Clark (1912). Collection of: plants and reptiles; mallophaga, corals, brachyuian and macruian crabs, hydroids from offshore, crustacea, starfishes and other echinoderms, medusae, polychaetous annelids, fish, lizards.

*Papers by Fosberg (1962), Caspers (1968), and St. John (1970) were obtained too late in the preparation of the manuscript for inclusion in this and the following appendix table.

Appendix Table 2. (continued)

Date	Results
1903 Apr.-May	Plants, insects, and birds (331 specimens of 25 species--involving 189 skins, 6 mounts, 24 skeletons, 8 alcoholics, 7 nests, and 92 clutches of eggs) collected by W.A. Bryan.
ca. 1903-1907	Collections of birds (at least 134 skins, 9 mounts, and 30 eggs) and fish by Schlemmer.
1905 19 Sept.	Insects collected; a coconut tree planted; Casuarina, Paritium, Thespesia, Chrysopphyllum, grasses and lily bulbs left to be planted; Laysan Finches captured and transferred to Midway (Bryan, 1912).
1906 26 Jan.-6 June	Birds collected, some of which were new distributional records.
1910 16-18, 26 Jan.	Several bird skins prepared by Japanese and seized by the Thetis later found their way into various museum collections.
1911 24 Apr.-5 June	Observations of birds (Dill and Bryan, 1912; Dill, 1913, 1916a, 1916b; W.A. Bryan, 1911)*; collection of insects, plants; 398 birds of 25 species collected.
1912 22 Dec.-1913 11 Mar.	Observations of birds (Bailey, 1934, 1942, 1952a, 1956; Willett, 1919) and at least 401 specimens of 31 species collected; collections of insects, plants, and a monk seal; 100 coconut sprouts planted; 128 Laysan Rail captured for transport to other areas, a number of Laysan Finches captured and transported to Midway Atoll; 5,024 rabbits killed.
1914 11 Sept.	Study of geology; analysis of lagoon water and phosphates.
1915 3 Apr.	Observations of birds, a few notes on rabbits (Munter, 1915).
1916 9 Feb.	Brief observations of birds and rabbits; samples of beach sand, shells, and shellfish collected for W.A. Bryan.
1918 8-9 Sept.	Observations of birds, turtles, seals, and rabbits.

*Several of these papers are primarily reprints or barely different versions of one another.

Appendix Table 2. (continued)

Date		Results
1923	7 Apr.-14 May	Observations of birds (Wetmore, 1925); extermination of rabbits; many photographs taken; a number of vascular plants sowed; 8 Laysan Rails introduced from Midway. Collected: arachnids, insects, crustacea, sea stars and other echinoderms, polychaetous annelids, foraminifera, vascular plants, sponges, fish, nematode, cestode, many birds (at least 319 skins of 21 species), 2 seals, algae, molluscs. Observations by Wetmore of turnstone predation on eggs later reported by Crossin and Huber (1970).
1924	6 May	Evidently only a few sketchy observations of animals made (Wilder, ms. b; Wetmore, 1925).
1928	1 Mar.	Collected: 8 species of Cypraeacea and 1 polychaete.
	6 May	Larval hemirhamphids collected offshore by Anderson.
1930	2-18 Aug.	Collected: plants, insects, bird eggs, marine organisms (crabs, fish), some artifacts, 4 species of flies. Various plants introduced and some notes taken on bird life.
1936	2-8 Mar.	Brief observations of birds, seals, and turtles.
	12 Dec.	Very brief observations of birds, seals, turtles, and vegetation; small collection of birds made.
1950	23 June	Laysan Teals counted, unspecified number of turtles tagged, seals reported (Brock, 1951a).
1951	12 May	Census of seals.
	late June-early July	Census of seals and turtles; extensive fish collections; bird census (Brock, 1951b).
1954	1 Nov.	Aerial seal count.
1955	10 Feb.	Observations of teal, brief notes on other birds.
1957	7 Jan.	Aerial seal census; albatross census (Rice and Kenyon, 1962).
	15 Apr.	Aerial seal census.
	25 June-3 July	Nine teal captured and 8 taken to Honolulu Zoo (1 died in transit); seals censused and 25 seals tagged; seabird populations estimated; 400 albatrosses banded; observations of teal (Warner, 1963).

Appendix Table 2. (continued)

Date		Results
1957	8-12 July	Amateur observations of birds.
	28 Dec.	Aerial albatross and seal censuses (Rice and Kenyon, 1962).
1958	27 May-4 June	3,302 birds of 9 species banded; census of fauna with emphasis on seals, young albatrosses, Laysan Teal, and Laysan Finches (Warner, 1958). Observations of birds; emphasis on Laysan Teal* (Warner, 1963). 36 Laysan Teal captured and transported to Honolulu Zoo; young seal collected for British Museum; seals tagged; Laysan Finches captured for transport to Honolulu Zoo.
	28 June	Aerial seal census.
1959	28 Apr.-1 May	Census of: seals, teal (Warner, 1963), Laysan Finch, albatross. Detailed observations of seals, Laysan Finch, Laysan Teal; notes made on other birds. Collection of plants, crustacea, and insects; weather observations, mapping of vegetation.
	20-27 July	Collected: insects, crustacea, and other arthropods; plants by Butler and Daniel. Observations on Laysan Teal (Warner, 1963) and body temperature of birds (Udvardy, 1963). Seal census.
1960	23 Aug.	Count of seals; survey of island for fish bait.
1961	7-8 Mar.	Census of seals and turtles; Laysan Teal observations (Warner, 1963).
	4-10 Sept.	Census of Laysan Teal, Laysan Finch, seals, and turtles. 275 birds of 2 species banded; 2 turtles tagged; previous photographic stations refurbished and new ones established. Collected: 8 Laysan Teal by Leopold and Warner; plants; crustacea; insects; arachnids; marine algae by Lamoureux. Geological observations and specimens by Jestes; geophysical measurements by Vitousek; rectal temperatures of seals taken by Udvardy; body temperatures taken for 8 species of birds (Udvardy, 1963); Laysan Teal observations (Warner, 1963).

*Notes on teal in captivity captured during this visit were reported by Ripley (1960) and Lint (1960).

Appendix Table 2. (continued)

Date		Results
1962	14-19 June	Census of seals; observations on vegetation and avifauna; collection of ectoparasites, crustacea, insects by Beardsley.
1963	11-13 Feb.	540 birds of 11 species banded; 10 birds of 8 species collected by POBSP; 27 seals tagged, 1 seal collected; 6 turtles tagged; distribution and condition of vegetation noted.
	3-10 Dec.	Ectoparasites, including a tick, collected by Wilson; plants introduced; seals, turtles, albatrosses, shorebirds, and teal censused; 3 turtles tagged and 17 Laysan Teal banded by Walker; marine algae and vascular plants collected by Tsuda; island water salinity tested.
1964	10-11 Mar.	Census of seals and turtles; geophysical measurements by Kroenke; 516 birds of 2 species banded by POBSP; 442 birds of 9 species banded by BSFW; ticks collected.
	16-20 Sept.	3,792 (plus any Brown Boobies) birds of 15 (or 16) species banded by POBSP. Collected: 9 Bonin Petrels, some insects, spider, and plants; turtles noted.
	19-20 Sept.	Birds observed, seals censused, no turtles seen, teal counted, insects and plants collected; 40 birds of 3 species banded by BSFW.
1965	7-11 Mar.	18,273 birds of 12 species banded by POBSP; turtles noted.
	17-21 July	15,470 birds of 5 species banded by POBSP; 4 birds, ectoparasites, Berlese samples collected.
	5-12 Aug.	44,442 birds of 8 species banded by POBSP, bird observations made; 1 turtle tagged.
1966	26-31 Mar.	Observations of birds; census of seals, turtles, Laysan Teal; estimates of Laysan Finch population from transect counts; 333 birds of 8 species banded; 44 Laysan Finches captured for transport to Honolulu Zoo; refuge sign erected; photographs of vegetation made; Chenopodium seeds planted.
	15 May	Pictures taken of wildlife.

Appendix Table 2. (continued)

Date		Results
1966	10-16, 20-21 June	Observations of birds; census of seals and turtles, 72,454 birds of 9 species banded by POBSP: 58 bird specimens of 9 species collected; 17 ectoparasite collections made from 7 species of birds; 30 Berlese samples taken from nests of 4 species of birds.
	17-18 Sept.	Transect census of finches and teal; observations of birds; census of seals and turtles; 1 turtle and 11 seals tagged; 1 turtle recaptured; 14 birds of 4 species banded.
	20-23 Oct.	Observations of birds; census of seals, turtles, shorebirds; 536 birds of 6 species banded by POBSP; 6 bird specimens of 4 species collected.
1967	18-19 Mar.	Observations of birds, census of seals, turtles; 4 Golden Plovers banded by BSFW; 33 seals and 1 turtle tagged.
	7-12 June	Observations of birds and turtles; census of seals; 8,092 birds of 11 species banded; 2 seal skulls collected and 12 seal pups tagged.
	5-11 Sept.	Observations of birds; 4,085 birds of 15 species banded by POBSP. Collected: 7 bird specimens of 4 species, hippoboscid flies, ticks from various birds.
	21-24 Sept.	34 birds of 3 species banded; 1 turtle tagged.
	13 Dec.	Observations on vegetation and wildlife; census of seals and turtles; 2 turtles tagged.
1968	17-19 Mar.	Census of seals and turtles; observations of birds; 115 birds of 8 species banded by POBSP; 64 Laysan Finch banded by wildlife personnel; 5 bird specimens of 3 species collected by POBSP; 1 Laysan Teal carcass collected by BSFW; 4 turtles and 36 seal tagged, 1 turtle recaptured.
	Sept.	Data are not available at present.
1969	26-29 Mar.	Observations of birds, censuses of seals, turtles, teal, albatrosses, and Laysan Finch. 38 seals and 2 turtles tagged.
	2-3 June	Teal, turtles, and seals censuses; 25 seals tagged.
	9 Sept.	Brief observations on birds; seals, and teal censused; 2 seals tagged; a few observations made of marine life.

Appendix Table 3. Publications on collections and studies (with the exception of birds) made on Laysan Island.*

Protozoa	
Rhumbler, 1906.	Records foraminifera collected by Schauinsland.
Cushman in Edmundson et al., 1925.	Reports collection of 24 species of foraminifera by the Tanager Expedition.
Porifera	
Barr, 1903.	Records 2 species of demonspongiid sponges collected by Schauinsland.
Preiwisch, 1903.	Records 2 species of calcarean sponges collected by Schauinsland.
Coelenterata	
Hartlaub, 1901.	Reports a hydroid collected by Schauinsland.
Studer, 1901.	Reports 18 species of Madreporia collected by Schauinsland (cf. Schauinsland, 1899).
Nutting, 1905.	Reports hydroid collections made offshore May 1902.
Mayer, 1906.	Reports hydromedusa from collections made offshore by the Albatross Expedition.
Vaughan, 1907.	Reports corals (Madreporia) collected by Albatross Expedition; revises some of Studer's taxonomy, and describes several new species.
Nutting, 1908.	Reports 2 species of coral (Alcyonaria) from collections made offshore by the Albatross Expedition.
Platyhelminthes	
Plehn, 1899.	Reports a turbellarian collected by Schauinsland.
Chapin, 1925.	Describes a new species of cestode from an Hawaiian monk seal collected by the Tanager Expedition.

*Authors are in chronological order.

Appendix Table 3. (continued)

Aschelminthes	
Chapin, 1925.	Describes a new species of nematode from a Hawaiian monk seal collected by the Tanager Expedition.
Mollusca	
Schauinsland, 1899.	Mentions occurrence of 2 cephalopods and several gastropods.
Bergh, 1900.	Reports 3 species of opisthobranchs collected by Schauinsland.
Berry, 1910.	Lists 2 cephalopods recorded by Schauinsland.
Pilsbury, 1917.	Describes 3 species of molluscs collected by W.A. Bryan.
Pilsbury, 1920.	Lists 2 species of molluscs, one collected by W.A. Bryan, the other by Capt. Brown of the USCG.
Pilsbury, 1927.	Lists 2 species of barnacles collected by the Tanager Expedition.
Schilder, 1933.	Reports 8 species of Cypraeacea collected in March 1928.
Dall, Bartsch, and Rehder, 1938.	Lists 10 species of pelecypods collected at or offshore Laysan, most of them by the Albatross Expedition.
Butler and Usinger, 1963.	Records 2 species of land snails.
Annelida	
Michaelsen, 1899.	Records an oligochaete collected by Schauinsland (also mentioned by Schauinsland, 1899).
Treadwell, 1906.	Reports collections of 5 polychaetes in May 1902.
Treadwell *in* Edmundson *et al.*, 1925	Reports 5 species of polychaetes collected by the Tanager Expedition.
Holly, 1935.	Reports a single polychaete collected in March 1928.

Appendix Table 3. (continued)

Annelida (continued)	
Hartman, 1966.	Summarizes earlier records and gives current taxonomy.
Arthropods	
Butler and Usinger, 1963.	Records plant-arthropod, bird-arthropod, and lake-arthropod associations.
Arachnomorpha (Arachnida)	
Schauinsland, 1899.	Lists species also reported by Simon (below).
Simon, 1899.	Reports 6 species collected by Schauinsland.
Butler, 1961a.	Reports 3 species of Acarina and 5 Araneida collected in April and July 1959.
Butler and Usinger, 1963.	Lists new records of 3 species of Acarina and 2 Araneida from collections made in September 1961 and June 1962 and summarizes earlier records.
Aoki, 1964.	Records 8 species of oribatid mites (Acarina) from collections made in December 1963.
Suman, 1964.	Gives recent summary of spiders known from Laysan. Lists 9 species.
Wilson, 1964.	Describes new tick (Ixodes laysanensis) (Acarina, Ixodidae) collected December 1963.
Aoki, 1965.	Records 2 species of oribatid mites (Acarina) from collections made in December 1963.
Kohls, Sonenshine, and Clifford, 1965.	Records occurrence of Ornithodorus capensis group (Acarina: Argasidae).
Amerson, 1966.	Reports infestation of Sooty Tern nasal cavities by ticks (Acarina: Argasidae) from specimens collected 8 August 1965.
Beardsley, 1966.	Reports a new distribution record for a spider from collection made September 1964.
Garrett and Harimoto, 1967.	Summarizes earlier records of Acarina.

Appendix Table 3. (continued)

Arachnomorpha (Arachnida) (continued)	
Amerson, 1968.	Reports distribution and hosts of ticks (Acarina) from collections made by the POBSP.
Crustacea	
Schauinsland, 1899.	Mentions some of crustaceans he collected.
Lenz, 1901.	Reports 25 species of crustacea collected by Schauinsland.
Sars, 1903.	Records a brine shrimp collected by Schauinsland.
Ortman, 1905.	Reports a single species of schizopod from the vicinity of Laysan that was collected by the Albatross Expedition.
Rathbun, 1906.	Reports brachyuran and macruran crabs collected by the Albatross Expedition.
Edmundson in Edmundson et al., 1925.	Reports 59 species of decapods, and a phyllopod, collected by the Tanager Expedition.
Wilson, 1950.	Reports a copepod collected north of Laysan by the Albatross Expedition.
Butler, 1961a.	Reports an isopod from April, July 1959 collections.
Butler and Usinger, 1963.	Reports an isopod from collections made in September 1961 and June 1962.
Chilopoda	
Bryan et al., 1926.	Reports a chilopod from collections made by the Tanager Expedition.
Insecta (Hexopoda)	
Rothschild, 1894.	Describes 2 moths from Laysan.
Schauinsland, 1899.	Lists some insects he collected.
Emery, 1899.	Reports 4 species of ants collected by Schauinsland.
Meyrick, 1900.	Describes 2 noctuid moths collected by Schauinsland.

Appendix Table 3. (continued)

Insecta (Hexopoda) (continued)

Speiser, 1902.	Reports a hippoboscid fly from Schauinsland's collection.
Alfken, 1903.	Records 17 species of insects collected by Schauinsland.
Perkins, 1906.	Reports 7 species of insects collected by Wilder in 1905.
Kellogg and Paine, 1910.	Reports 10 species of mallophaga collected in May 1902.
Fullaway, 1914a.	Reports 60 species of insects from collections made in 1905 by Wilder (6 species), 1911 by Bryan (3 species), and 1912 by Fullaway (55 species).
Fullaway, 1914b.	Describes a new beetle from material collected in April 1911 and December 1912.
Swezey, 1914.	Describes 2 new species of moths from collections made in 1912.
Perkins, 1919.	Describes a new species of Otiorrhynchine beetle from specimens collected by W.A. Bryan.
Timberlake, 1919.	Describes a new species of encyrtid (Hymenoptera) from specimens collected in December 1912.
Bryan et al., 1926.	Records ca. 34 species of insects collected by the Tanager Expedition.
Ferris, 1927.	Reports a hippoboscid fly.
Bryan, 1932.	Reports 4 species of flies collected in August 1930.
Wheeler, 1934.	Gives a summary listing 7 species of ants from early collections.
Thompson, 1948.	Reports 10 species of mallophaga collected by the Tanager Expedition.

Appendix Table 3. (continued)

Insecta (Hexopoda) (continued)

Zimmerman,* 1948a	Lists 3 cockroaches, an embiopterid, an earwig and 10 mallophaga.
Zimmerman, 1948b.	Lists a nabid and a mirid.
Zimmerman, 1948c.	Lists a coccid.
Zimmerman, 1948d.	Lists a delphacid.
Ross, 1951.	Reports that an embiopterid collected by the Tanager Expedition as Oligotoma insularis by Bryan et al., 1926, is actually Oligotoma (Apothonia) oceania Ross sp. nov.
Zimmerman, 1957.	Supplement lists an embiopterid.
Zimmerman, 1958a.	Lists 6 noctuid moths.
Zimmerman, 1958b.	Lists 3 pyralids and a pterophorid.
Hardy, 1960.	Describes a stratiomyid fly from specimens collected by the Tanager Expedition.
Butler, 1961a.	Summarizes insects collected by Wilder, Bryan, Fullaway, and the Tanager Expedition and adds collections of 68 species made in April and July 1959.
Butler, 1961b.	Reports association of stratiomyid flies with albatross carcasses from observations in July 1959.
Edwards, 1961.	Describes a new species of mallophage collected from Christmas Shearwaters. Collected ca. 1904-1907.
Maa, 1962.	Reports specimens of hippoboscid flies collected in August 1930 and April-May 1959.
Butler and Usinger, 1963	Adds new insect records from collections of September 1961 and June 1962 and summarizes old records. Lists ca. 189 species from Laysan.

*Zimmerman, and Hardy, in the Insects of Hawaii series, present distributional records derived primarily from the Tanager collections, but extensively revise taxonomy, reidentify specimens, and identify to species hitherto unidentified specimens.

Appendix Table 3. (continued)

Insecta (Hexopoda) (continued)

Hardy, 1964.	Lists 2 dolichopodid flies.
Hardwick, 1965.	Discusses specimens of Heliocoverpa (Noctuidae) collected in September 1961.
Beardsley, 1966.	Reports 5 species of insects collected in September 1964.
Maa, 1968.	Reports hippoboscid flies from collections made 1963-1967 by the POBSP.

Echinodermata

Fisher, 1906.	Reports 6 species of starfish, most newly described, from collections made offshore by the Albatross Expedition.
Fisher, 1907.	Reports 6 species of holothurians collected by the Albatross Expedition.
Clark, 1908.	Reports 2 newly described species of Crinoidea that were collected offshore by the Albatross Expedition.
Agassiz and Clark, 1907-1912.	Reports echinoderms collected by the Albatross Expedition.
Clark in Edmundson et al., 1925.	Reports 8 Ophiuroidea, 9 Echinoidea, and 9 Holothuroidea collected by the Tanager Expedition.
Fisher in Edmundson et al., 1925.	Reports 2 starfish (Asteroidea) collected by the Tanager Expedition.
Clark, 1949.	Reports 6 species of brittle stars (Ophiuroidea) from collections made by the Albatross Expedition and gives summary lists of other echinoderms previously collected from Laysan.

Chordata

Urochordata

Sluiter, 1900.	Records 6 species of sea squirts collected by Schauinsland.

Appendix Table 3. (continued)

Chordata

Vertebrata

Pisces

Steindacher, 1900.	Reports 51 species of fish collected by Schauinsland.
Jordan and Snyder, 1904.	Reports fish collected at Oahu, Hawaii, and Laysan, the latter collection by Max Schlemmer, but does not always give collection localities. Lists 7 species from Laysan.
Snyder, 1904.	Reports 33 species of fish collected by the *Albatross* Expedition.
Gilbert, 1905.	Records 24 species of deep sea fishes collected in the vicinity of Laysan by the Albatross Expedition and one species collected at Laysan by Max Schlemmer.
Fowler and Ball, 1924.	Describes a new family, genus and species for a fish collected by the Tanager Expedition.
Fowler and Ball, 1925.	Reports 71 species of fish collected by the Tanager Expedition.
Fowler, 1927.	Lists 7 species, 6 from the Tanager collections of which 1 was not reported in Fowler 1925, and 1 from a collection in May 1893.
Fowler, 1934.	Lists 2 additional species of fish from Laysan from collection made in August 1930.
Strasberg, 1956.	Revises taxonomy of Hawaiian blennioid fishes recording 3 species from Laysan.

Reptilia

Paty, 1857.	Mentions presence of turtles in 1857.
Schauinsland, 1899.	Gives observations of turtles from 1896.
Rothschild, 1893-1900.	Indicates turtles were seen in 1828.
Werner, 1901.	Reports 2 lizards from Schauinsland's visit.

Appendix Table 3. (continued)

Reptilia (continued)

Wilder, 1905.	Mentions that turtles were shot in September 1905.
Dill and Bryan, 1912.	Mentions occurrence of turtles and their eggs, and the killing of one turtle for food.
Snyder, 1917.	Reports collections and observations of 2 lizards in May 1902.
Munro, 1946.	Reports that "one or two species" of lizards were present in 1891.
Brock, 1951a.	Mentions field party went ashore to tag turtles.
Anon., 1951b.; Coultas, ms.	Reports that 15 turtles were seen in December 1936.
Udvardy, 1961b.	Gives turtle observations made September 1961.
Beardsley, 1966.	Reports collection of a skink in September 1964; erroneously records it as new record.

Mammalia

Paty, 1857.	Mentions presence of seals in 1857.
Rothschild, 1893-1900.	Mentions seals were seen in 1828.
Matschie, 1905.	Describes Hawaiian monk seal from skull collected by Schauinsland.
Wilder, 1905.	Mentions presence of donkey and a few cows in September 1905.
Dill and Bryan, 1912.	Gives information on introduction and habits of rabbits; presence of guinea pigs and absence of seals.
Munter, 1915.	Mentions presence and capture of rabbits in April 1915.
Bailey, 1918.	Notes collection of a seal specimen by the Biological Survey party 1912-1913.
Wetmore, 1925.	Reports that only a few hundred rabbits were present in 1923.

Appendix Table 3. (continued)

Mammalia (continued)

Munro, 1946.	Reports that mules and a few hogs were present in 1891.
Anon., 1951b, Coultas, ms.	Reports that 5 seals were seen in December 1936.
Bailey, 1952b.	Summarizes earlier information on monk seal (with liberal quotes). Original information includes specimen data on seal collected in December 1912 and on 2 specimens collected by the Tanager Expedition; observations made in December 1936, seal count made in June 1951.
King, 1956.	Detailed summary of previous information on Hawaiian monk seal.
Labrecque, 1957.	Gives a few notes on seals made in July 1957.
Warner, 1958.	Gives a few observations of seals from May-June 1958.
Kenyon and Rice, 1959.	Results of Hawaiian monk seal aerial survey January and April 1957, and ground survey June-July 1957.
Svihla, 1959.	Summarizes earlier population data and gives results of counts or estimates made in May 1951, November 1954, and February 1955.
Rice, 1960a.	Records offshore observations of bottle-nosed dolphins on 27 May 1958.
Rice, 1960b.	Gives Hawaiian monk seal observations from aerial surveys in December 1957 and June 1958, and from ground survey May-June 1958.
Smythe, 1960.	Reports seal observations made April-May 1959.
King and Harrison, 1961.	Gives detailed notes on a young seal collected 4 June 1958.
Udvardy, 1961b.	Gives results of seal counts made September 1961.
King, 1964.	Presents historical summary 1824-1954.
Butler and Udvardy, 1966.	Reports observations made July 1959 on the basking behavior of the monk seal.

Appendix Table 3. (continued)

Mammalia (continued)

Schreiber and Kridler, 1969.	Reports movement of a monk seal tagged on Laysan in March 1968 to Johnston Atoll, 547 nautical miles to the south-southeast.

Flora

Reinbold, 1899.	Reports algae collected by Schauinsland.
Schauinsland, 1899.	Lists 27 species of vascular plants with notes on them from observations and collections made in 1896; lists more algae collected; and mentions two species of algae found in the lagoon.
Bitter, 1900.	Reports 26 species of vascular plants collected by Schauinsland.
Fisher, 1903a.	Reports list of vascular plants collected in May 1902.
Lemmermann, 1905.	Reports 45 species of algae collected by Schauinsland.
Wilder, 1905.	Lists plants introduced in September 1905.
Elschner, 1915.	Gives observations of vascular plants and an algae made in September 1914.
Rock, 1916.	Describes sandalwood on Laysan as a new variety from collections by Schauinsland, Bryan, and Fullaway.
MacCaughey, 1918.	Brings together Lemmermann's records and others.
Christophersen and Caum, 1931.	Reports on 4 vascular plants collected by the Tanager Expedition and summarizes records and observations from visits in 1896, 1902, 1903, and 1911.
Lamoureux, 1963.	Reports 24 species of vascular plants collected in September 1961 and gives historical summary; reports plants collected in August 1930 and April and July 1959.
Tsuda, 1965.	Summarizes earlier records and reports algal collections made in April 1923 (43 species or

Appendix Table 3. (continued)

Flora (continued)

Tsuda, 1965. (cont'd.)	varieties), September 1961 (20) and December 1963 (57). A total of 106 species or varieties listed of which 72 are new records. Also gives observations of 22 species of vascular plants collected in December 1963.
Tsuda, 1966.	Corrects specific epithets of algae (3 species of Liagora; 1 Halimeda) that were listed inaccurately in Tsuda, 1965.
Saito, 1969.	Reports 4 species of algae (Laurencia) identifying and reidentifying collections made by Tsuda in December 1963.

Geophysical

Schauinsland, 1899.	Gives extensive descriptive notes on the island including analyses of guano and lagoon water; occurrence of pumice, notes on climatic conditions.
Möhle, 1902.	Reports studies of a few rock samples collected by Schauinsland.
Elschner, 1915.	Gives various descriptive material on the geology as well as analyses of lagoon water, bird excrements, and guano.
Kroenke and Woollard, 1965.	Gives gravity observations made in March 1964.
Tsuda, 1965.	Reports salinity data for water collected at the ocean edge and in the central lagoon.

Appendix Table 4-1. Yearly banding totals of birds banded on Laysan by various agencies.

Species	1957	1958	1961	1963	1964	1965	1966	1967	1968	Totals
Black-footed Albatross	200	900				685		600		2,385
Laysan Albatross	200	2,000			200	16,958	1,979	900		22,237
Bonin Petrel				399	852	2,544	100			3,895
Bulwer's Petrel		138			17			323		478
Wedge-tailed Shearwater					700	5,025	496	1,171		7,392
Christmas Shearwater					98			219		317
Sooty Storm Petrel						92	9			101
Red-tailed Tropicbird		125			100	101	7	305		638
Blue-faced Booby		37		4	195	198	51	79	54	618
Brown Booby		5		2		6	3	11	1	28
Red-footed Booby				3	200	427	138	91	1	860
Great Frigatebird				10	15	2	183	304		514
Laysan Teal		94	204	17	110	25	38	13	24	525
Golden Plover		1	71	22	27	4	37	15	11	188
Bristle-thighed Curlew		2		2	14	10	3	13	6	50
Wandering Tattler					6			1	3	10
Ruddy Turnstone					47	7	7	11	7	79
Gray-backed Tern				45						45
Sooty Tern					1,900	52,000	69,900	6,625		130,425
Brown Noddy					1		35	1,189		1,225
Black Noddy				37	24		101	126	37	325
White Tern				31	159	85	6	198	1	480
Laysan Finch					28		245	20	273	566
Totals	400	3,302	275	572	4,693	78,169	73,338	12,214	418	173,381

Appendix Table 4-2. Interisland movement of banded birds involving Laysan Island.*

To Laysan from:	Black-footed Albatross	Laysan Albatross	Bonin Petrel	Wedge-tailed Shearwater	Blue-faced Booby	Brown Booby	Red-footed Booby	Great Frigatebird	Bristle-thighed Curlew	Ruddy Turnstone	Sooty Tern	Black Noddy	Totals
Gardner Pinnacles					1								1
French Frigate Shoals	2				4		14				3	7	30
Lisianski		1		1	11		7				10		30
Pearl and Hermes Reef		2	1		3	1			1				8
Midway Atoll					1		1				2	1	5
Kure Atoll		1			1		1	1			2		6
Johnston Atoll					5		14				23		42
Wake Island							1						1
Namu Atoll													
Kwajalein Atoll													
Christmas Island													
Phoenix Island													
Atafu Atoll													
Philippine Islands													
Japan													
Alaska										3			3
At Sea													
Total (to)	2(2)**	4(4)	1(1)	1(1)	26(26)	1(1)	38(36)	1(1)	1(1)	3(3)	40(40)	8(8)	126(124)

*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 birds involved in movements.

Appendix Table 4-2. (continued)

From Laysan to:	Black-footed Albatross	Laysan Albatross	Red-tailed Tropicbird	Blue-faced Booby	Brown Booby	Red-footed Booby	Great Frigatebird	Ruddy Turnstone	Sooty Tern	Black Noddy	Total	Grand total - movements
Garnder Pinnacles												1
French Frigate Shoals				1		25	2		4	3	35	65
Lisianski				20		14			20	1	55	85
Pearl and Hermes Reef		2			1	1				1	5	13
Midway Atoll		1							1		2	7
Kure Atoll		2				7	5		4		18	24
Johnston Atoll				1		39			12		52	94
Wake Island						2					2	3
Namu Atoll						1					1	1
Kwajalein Atoll									1		1	1
Christmas Island									1		1	1
Phoenix Island									1		1	1
Atafu Atoll									1		1	1
Philippine Islands							4		1		5	5
Japan		1							1		2	2
Alaska								1			1	4
At Sea	3	10	1						1		15	15
Total (from)	3(3)	16(16)	1(1)	22(22)	1(1)	89(84)	11(11)	1(1)	48(48)	5(5)	197	323

Appendix Table 4-3a. Movements of Black-footed Albatross from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-23659	07-20-65	I	U	At sea, 30°N, 140°W	03-27-66*	U	U
757-24803	07-20-65	I	U	At sea, 50°00'N, 145°00'W	**	U	U
757-33893	06-08-67	L	U	At sea, 31°50'N, 170°00'E	12-05-68	U	U

*Entangled in fishing gear.

**Information from letter dated 08-11-66.

Appendix Table 4-3b. Movements of Black-footed Albatross to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
French Frigate Shoals, Whale-Skate I.							
757-35913	06-05-67	L	U	Laysan I.	09-24-67*	U	U
757-35955	06-05-67	L	U	Laysan I.	09-24-67*	U	U

*Loose band found by BSFW.

Appendix Table 4-4a. Movements of Laysan Albatross from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-00673	03-07-65	N	U	At sea, 1 km. off Hanasakimadii, Nemuro, Hokkaido, Japan (43°17'N, 145°38'E)	08-16-65	U (dead)	U
757-01138	03-07-65	N	U	At sea 50°55'N, 154°09'W	04-26-66	U	U

Appendix Table 4-4a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-01428	03-07-65	N	U	Kure Atoll	03-17-69	A	U
757-03109	03-08-65	N	U	At sea, ca. 42°N, 146°E	07-20-67	U (dead)	U
757-03152	03-08-65	N	U	At sea, 40°32'N, 149°10'E	08-16-65	U	U
757-11728	03-10-65	N	U	Pearl and Hermes Reef, Southeast I.	04-01-69*	U (dead)	U
757-14323	03-10-65	N	U	At sea, ca. 43°20'N, 143°40'E	08-24-66	U	U
757-23141	07-19-65	I	U	Midway Atoll	04-01-68	U (dead)	U
757-23557	07-19-65	I	U	At sea, 47°20'N, 154°36'W	04-26-66	U	U
757-23587	07-20-65	I	U	At sea, 43°39'N, 153°54'E	06-27-66	U	U
757-25451	07-20-65	I	U	At sea, 29°30'N, 134°20'W	05-03-68**	U	U
757-25483	07-20-65	I	U	At sea, ca. 41°30'N, 150°30'W	10-22-68	U (dead)	U
757-31646	06-13-66	L	U	Hachinohe, Honshu, Japan	10-10-66	U	U
757-31819	06-13-66	L	U	At sea, 30°13'N, 142°23'E	02-14-67	U (dead)	U
757-33947	06-08-67	L	U	Pearl and Hermes Reef, Southeast I.	09-28-67+	U (dead)	U
757-33994	06-08-67	L	U	Kure Atoll	04-11-69	A	U

*Returned by BSFW.

**Caught in fishing gear.

+Loose band found by BSFW.

Appendix Table 4-4b. Movements of Laysan Albatross to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Kure Atoll							
737-96135	03-02-65	A	U	Laysan I.	03-08-65	A	U
				Kure Atoll	04-27-66	A	U
Lisianski I.							
757-16905	03-13-65	N	U	Laysan I.	07-19-65 (found dead)	U	U
Pearl and Hermes Reef, Southeast I.							
757-20828	03-15-65	N	U	Laysan I.	03-27-66- 03-30-66*(found dead)	U	U
757-21409	03-16-65	N	U	Laysan I.	03-27-66- 03-30-66*(found dead)	U	U

*Return made by BSFW.

Appendix Table 4-5a. Movements of Blue-faced Boobies from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
767-41289	03-08-65	A	U	Lisianski I.	06-04-67- 06-05-67	A	M
				Laysan I.	06-12-66	A	F
767-41291	03-08-65	A	U	Lisianski I.	06-04-67- 06-05-67 (with chick)	A	M(?)
				Laysan I.	03-18-68	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(?)

Appendix Table 4-5a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
767-41298	03-09-65	A	U	Lisianski I.	06-04-67	A	F(?)
				Laysan I.	10-20-66	A	M
767-41322	03-10-65	A	U	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*			Lisianski I.	09-04-67	A	F (in roosting club)
757-23145	07-19-65*			Lisianski I.	03-20-68	A	M (nesting)
757-23150	07-19-65*			Little Gin I., French Frigate Shoals	06-07-69	A	F (with medium chick)
757-25652	08-09-65	I	U	Lisianski I.	09-03-67		
757-25656	08-09-65	I	U	Lisianski I.	09-03-67		
757-23101	07-19-65*			Lisianski I.	06-04-67- 06-05-67	A	M (with 1 egg)
757-23103	07-19-65*			Lisianski I.	06-05-67	A	M (with 1 egg)
757-23166	07-19-65*			Lisianski I.	09-01-67	A	M
757-23171	07-19-65*			Lisianski I.	06-04-67	A	F
757-23239	07-19-65*			Lisianski I.	06-04-67	A	M
757-23438	07-19-65*			Lisianski I.	06-04-67	A	F
757-23462	07-19-65*			Lisianski I.	06-05-67	A	M
757-23474	07-19-65*			Lisianski I.	09-01-67	A	F

*Listed on banding schedule as a Laysan Albatross.

Appendix Table 4-5b. Movements of Blue-faced Boobies to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
East I., French Frigate Shoals							
737-37106	06-07-63	S	U	Laysan I.	03-18-68	A	M
737-37107	06-07-63	S	U	Laysan I.	03-09-65	A	F
757-27685	08-23-66	A	U	East I.	05-26-67	A	M
				Laysan I.	09-06-67	A	U
Whale-Skate I., French Frigate Shoals							
568-70106	06-26-66	N	U	Laysan I.	09-06-67	S	U
Gardner Pinnacles							
558-83442	06-16-63	A	U	Laysan I.	09-18-64	A	F
Johnston Atoll							
737-44164	03-29-64	A	F(?)	Laysan I.	09-06-67	A	M(?)
737-44546	02-28-65	A	U	Laysan I.	10-20-66	A	M
737-44586	04-09-65	I	U	Laysan I.	09-06-67	A	U
737-43649*	03-24-66	S	U	Laysan I.	06-14-66	S	U
				Laysan I.	06-21-66*		
737-44622	between 06-22-64 & 02-24-65	?		Laysan I.	06-10-67	A	F (with 2 eggs)
Kure Atoll							
737-98160	09-11-64	A	U	Laysan I.	03-17-68	A	M
Lisianski I.							
757-89061	03-12-64	A	F (with 1/4 grown nestling)	Laysan I.	08-09-65	A	U
757-41556	03-12-65	A	U	Laysan I.	06-09-67	A	F
				Lisianski I.	03-20-68	A	F

Appendix Table 4-5b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Lisianski I. (continued)							
757-27725	10-19-66	I	U	Laysan I.	09-06-67	S	U
757-30113	06-02-67	A (in roosting club)	U	Laysan I.	09-06-67	A	F
757-30151	06-03-67	A	M	Laysan I.	09-06-67	A	U
757-30181	06-03-67	A	F	Laysan I.	09-06-67	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
Midway Atoll, Eastern I.							
508-51758**	08-15-57	U	U	Laysan I.	03-10-64	A	U
Pearl and Hermes Reef, Kittery I.							
737-26549	06-26-63	N	U	Laysan I.	09-16-64	A	F
				Johnston Atoll	05-20-65*	A	U
Pearl and Hermes Reef, Little North I.							
558-83563	06-23-63	N	U	Laysan I.	03-09-65	A	F
Pearl and Hermes Reef, Seal I.							
737-26562	06-26-63	N	U	Laysan I.	09-16-64	A	F

*Marked with orange leg streamer.

**Banded by BSFW (DR).

Appendix Table 4-6a. Movements of Red-footed Boobies from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
587-80503	09-17-64	I	U	Johnston Atoll	05-26-65	I	U
587-80507	09-17-64	A	U	Laysan I.	08-09-65	A	U
				Lisianski I.	09-02-67	A	U
587-80544	09-17-64	A	U	Johnston Atoll	02-15-66	A	F
587-80553	09-17-64	A	U	East I., French Frigate Shoals	06-11-66	A	U (with small chick)
				East I., French Frigate Shoals	03-11-67	A	U
				East I., French Frigate Shoals	05-28-67	A	U
				Trig I., French Frigate Shoals	06-24-67	A	U (with large downy chick)
587-80557	09-17-64	I	U	Laysan I.	09-07-67	A	U
				Johnston Atoll	01-06-69	A	U
587-80561	09-17-64	A	U	Johnston Atoll	12-13-65	A	U
587-80564	09-17-64	A	U	Johnston Atoll	02-22-66	A	F
				Laysan I.	10-20-66*	A	U
				Laysan I.	06-09-67	A	U
587-80570	09-17-64			Johnston Atoll	04-23-66	A	U
				Johnston Atoll	01-06-69	U	U
587-80575	09-17-64	I	U	East I., French Frigate Shoals	08-13-66	S	U
				Trig I., French Frigate Shoals	08-23-66	A	F
				Whale-Skate I., French Frigate Shoals	06-05-67	A	U

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
587-80580	09-17-64	I	U	Whale-Skate I., French Frigate Shoals	08-31-65	S	U
587-80595	09-17-64	I	U	Lisianski I.	08-31-67	A	U
587-80598	09-17-64	I	U	Johnston Atoll	02-22-66	S	U
587-80607	09-17-64	A	U	Johnston Atoll	02-22-66	A	F
587-80620	09-17-64	I	U	Johnston Atoll	06-24-65	A	U
587-80625	09-17-64	I	U	Johnston Atoll	02-22-66	S	U
				Lisianski I.	10-19-66*	S	U
587-80643	09-17-64	I	U	Whale-Skate I., French Frigate Shoals	08-16-65	S	U
587-80646	09-17-64	I	U	Johnston Atoll	03-30-65	I	U
587-80663	09-17-64	I	U	Lisianski I.	10-19-66	A	U
587-80697	09-17-64	A	U	Johnston Atoll	02-15-69	A (roosting)	U
587-80700	09-17-64	A	U	East I., French Frigate Shoals	06-12-66	S	U
767-41051	03-07-65	A	U	Laysan I.	10-20-66	A	U
				Laysan I.	09-07-67	A	U
				Johnston Atoll	02-15-69	A (roosting)	U
				Johnston Atoll	06-25-69	A	U
767-41069	03-07-65	A	U	Lisianski I.	10-19-66	A	U
767-41072	03-07-65	A	U	Johnston Atoll	02-18-66	A	M
767-41098	03-07-65	A	U	Johnston Atoll	02-18-69	A	U

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
767-41204	03-07-65	A	U	Laysan I.	10-20-66	A	U
				Johnston Atoll	01-06-69	A	U
767-41231	03-08-65	A	U	Laysan I.	10-20-66	A	U
				Johnston Atoll	01-05-69	U	U
767-41236	03-08-65	A	U	Johnston Atoll	02-22-66	A	F
767-41241	03-08-65	A	U	East I., French Frigate Shoals	06-10-66	A	U
				East I., French Frigate Shoals	05-26-67	A (on egg)	U
767-41242	03-08-65	A	U	Johnston Atoll	01-04-69	A	U
				Johnston Atoll	01-07-69	A (dead?)	U
767-41401	03-10-65	A	U	Trig I., French Frigate Shoals	06-24-68		
767-41404	03-10-65	A	U	Kure Atoll	06-30-68	A	U
767-41411	03-10-65	A	U	East I., French Frigate Shoals	06-12-66	A	U
				Laysan I.	10-20-66	A	U
767-41436	03-10-65	A	U	Laysan I.	10-20-66	A	U
				Johnston Atoll	01-05-69	A	U
767-41469	03-10-65	A	U	Laysan I.	10-20-66	A	U
				Trig I., French Frigate Shoals	06-19-67	A	U
757-25639	08-09-65	I	U	Johnston Atoll	04-23-66	I	U
757-25643	08-09-65	I	U	Lisianski I.	06-04-67	S	U
757-25650	08-09-65	I	U	East I., French Frigate Shoals	06-10-66	S	U

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-25650	08-09-65	I	U	Whale-Skate I., French Frigate Shoals	07-02-66	S	U
				Trig I., French Frigate Shoals	08-13-66	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
757-25658	08-09-65	I	U	Namu Atoll, Marshall I., ca. 08°00'N, 168°10'E	03-24-66	U	U
757-25662	08-09-65	I	U	Wake Island	06-18-66	S	U
757-25667	08-09-65	I	U	Johnston Atoll	12-28-65	I	U
				Whale-Skate I., French Frigate Shoals	08-15-66*	S	U
757-25668	08-09-65	I	U	Johnston Atoll	04-03-66	I	U
757-25693	08-10-65	I	U	Trig I., French Frigate Shoals	06-08-67	S	U
757-25742	08-09-65	I	U	Whale-Skate I., French Frigate Shoals	06-26-66	S	U
757-25744	08-09-65	I	U	Kure Atoll	08-07-66	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

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-25759	08-09-65	I	U	East I., French Frigate Shoals	05-26-67	S	U
757-25769	08-09-65	I	U	Whale-Skate I., French Frigate Shoals	06-25-66	S	U
757-25779	08-09-65	I	U	Johnston Atoll	03-31-66	I	U
757-25832	08-09-65	I	U	Wake I.	06-19-66	S	U
				Wake I.	12-30-66	S	U
757-25835	08-09-65	I	U	Johnston Atoll	01-04-69	A	U
757-25837	08-09-65	I	U	Johnston Atoll	03-31-66	I	U
757-25841	08-09-65	I	U	Lisianski I.	10-19-66	S	U
757-25843	08-09-65	I	U	Whale-Skate I., French Frigate Shoals	06-04-67	S	U
757-25850	08-09-65	I	U	Johnston Atoll	05-27-66	I	U
757-25853	08-09-65	I	U	East I., French Frigate Shoals	06-10-67	S	U
				Whale I., French Frigate Shoals	06-17-67	S	U
757-25854	08-09-65	I	U	Johnston Atoll	02-22-66	I	U
757-25856	08-09-65	I	U	Johnston Atoll	02-18-69 (roosting)	A	U
757-25896	08-09-65	I	U	Johnston Atoll	02-23-66	I	U
757-25898	08-09-65	I	U	Johnston Atoll	03-31-65	I	U
				Laysan I.	10-20-66*	S	U
				Johnston Atoll	02-18-69 (roosting)	A	U
757-25921	08-09-65	I	U	Johnston Atoll	02-22-66	I	U

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-25931	08-09-65	I	U	Kure Atoll	09-16-66	I	U
757-25932	08-09-65	I	U	Johnston Atoll	01-06-66	S (dead)	U
757-25953	08-09-65	I	U	Johnston Atoll	06-12-66	S	U
757-25986	08-09-65	I	U	Laysan I.	10-20-66	S	U
				Kure Atoll	05-30-67	S	U
757-25897	08-09-65	I	U	Whale-Skate I., French Frigate Shoals	06-03-67	S	U
757-25682	08-10-65	I	U	Kure Atoll	06-04-67	S	U
757-25693	08-10-65	I	U	Trig I., French Frigate Shoals	06-08-67	S	U
757-25791	08-10-65	I	U	Whale-Skate I., French Frigate Shoals	06-06-67	S	U
757-25798	08-10-65	I	U	Lisianski I.	10-19-66	S	U
757-28125	10-21-65	A	U	Johnston Atoll	01-06-69	U	U
757-28129	10-21-66	A	U	Southeast I., Pearl and Hermes Reef	08-28-67	A	U
757-28513	10-22-66	A	U	Trig I., French Frigate Shoals	06-08-67	A	U
757-28517	10-22-66	A	U	Lisianski I.	09-04-67	A	U
757-28533	10-22-66	A	U	Trig I., French Frigate Shoals	06-19-67	A	U
587-85218	06-09-67	S	U	Kure Atoll	07-04-67	S	U
587-85223	06-09-67	A (with egg)	U	Johnston Atoll	02-18-69	A (roosting)	U
587-85237	06-09-67	A	U	Johnston Atoll	01-05-69	A	U

Appendix Table 4-6a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
587-85244	06-09-67	A	U	Lisianski I.	09-03-67	A	U

*Marked on leg with orange streamer.

Appendix Table 4-6b. Movements of Red-footed Boobies to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
East I., French Frigate Shoals							
767-43301	08-07-65	S	U	East I.	06-11-66	A	U
				Laysan I.	10-20-66	A	U
				Laysan I.	09-07-67	A	U
767-43851	08-25-65	S	U	Laysan I.	10-22-66	S	U
				Trig I., French Frigate Shoals	06-19-67	S	U
757-26094	06-10-66	A	U	Laysan I.	09-10-67	A	U
757-26175	06-11-66	S	U	Laysan I.	09-07-67	A	U
757-26187	06-11-66	A	U	Laysan I.	10-20-66	A	U
757-29055	05-26-67	I	U	Laysan I.	09-06-67	S	U
757-36081	06-10-67	(I)	U	Laysan I.	09-10-67	(A?)	U
Trig I., French Frigate Shoals							
757-27495	07-03-66	S	U	Laysan I.	09-08-67	A	U
757-27615	08-13-66	S	U	Laysan I.	09-10-67	S	U
757-35854	06-08-67	S	U	Laysan I.	09-06-67	S	U

Appendix Table 4-6b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Whale-Skate Island, French Frigate Shoals							
737-38033	06-14-63	S	U	Whale-Skate I., French Frigate Shoals	06-23-66	A	U
				Laysan I.	10-20-66	A	U
757-27251	06-24-66	A	U	Laysan I.	10-21-66	A	U
Johnston Atoll							
737-44156	02-26-64	I	U	East I., French Frigate Shoals	06-10-66	A	U
				Laysan I.	10-20-66	A	U
				East I., French Frigate Shoals	05-27-67	A	U (with small chick)
737-44958	12-12-65	A	U	Laysan I.	09-10-67	A	U
737-44960	12-12-65	A	U	Laysan I.	10-20-66*	A	U
				Laysan I.	09-07-67	A	U
737-44963	12-13-65	A	U	Laysan I.	09-06-67	A	U
737-44965	12-13-65	A	U	Laysan I.	10-20-66	A	U
737-44989	12-28-65	A	U	Laysan I.	06-12-66*	U	U
				Laysan I.	10-20-66*	A	U
737-43532	02-19-66	S	U	Laysan I.	10-22-66	S	U
737-43562	02-22-66	I	U	Laysan I.	10-20-66*	S	U
737-43569	02-22-66	A	F	Laysan I.	09-08-67	A	U
737-44686	02-23-66	A	M	Lisianski I.	06-18-66	U	U
				Laysan I.	10-20-66	A	U
737-44693	02-23-66	A	M	Laysan I.	10-22-66*	A	U
737-43648	03-24-66	S	U	Laysan I.	06-29-67	S	U

Appendix Table 4-6b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Kure Atoll							
737-95987	12-30-64	A	U	Laysan I.	03-10-65	A	U
Lisianski I.							
757-27939	10-19-66	S	U	Laysan I.	09-07-67	S	U
757-27962	10-19-66	A	U	Laysan I.	09-10-67	A	U
757-27984	10-19-66	S	U	Laysan I.	09-08-67	S	U
757-28457	10-19-66	A	U	Laysan I.	09-10-67	A	U
757-28499	10-19-66	U	U	Laysan I.	09-10-67	A	U
757-28705	09-02-67	S(?)	U	Laysan I.	09-06-67	A(?)	U
Midway Atoll, Eastern I.							
767-40297	07-22-65	N	U	Laysan I.	10-20-66	S	U
Wake I.							
767-48159	06-18-66	I	U	Laysan I.	10-20-66	S	U
				Kure Atoll	07-04-67	S	U

*Marked with orange streamer on leg.

Appendix Table 4-7a. Movements of Great Frigatebirds from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
587-80701	09-20-64	A	F(?)	Kure Atoll	05-07-66	S	U
587-80708	09-20-64	A	F	Trig I., French Frigate Shoals	06-24-69	A	F
757-25564	06-12-66	A	M(?)	East I., French Frigate Shoals	05-30-67	A	F(?)

Appendix Table 4-7a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
757-28563	10-22-66	U	U	Kure Atoll	05-09-67	S	F
757-28576	10-22-66	L	U	Kure Atoll	07-20-68	S	U
757-28622	10-22-66	L	U	In Adanan River, Bayugan, Agusan Province, Philippine Is. ca. 8°50'N, 125°40'E	01-12-68*	U	U
757-28634	10-22-66	L	U	Balusan, Sorsogon, Philippine Is. ca. 12°40'N, 124°00'E	02-??-68	U	U
757-28653	10-22-66	L	U	Kure Atoll	05-30-68	S	M
757-28697	10-22-66	L	U	In the Sea of Bawang, Secogon I., (Carlos Mun.) Philippine Is. ca. 11°20'N, 123°10'E	03-13-68	U	U
587-85247	06-09-67	S	U	Near Virac, Philippine Is. ca. 13°30'N, 124°10'E	03-??-68	U	U
587-85364	06-09-67	S	U	Kure Atoll	06-30-67	S	F

*Found floating on river. Bird subsequently died.

Appendix Table 4-7b. Movements of Great Frigatebirds to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Kure Atoll							
767-45160	05-16-66	S	U	Laysan I.	10-20-66	S	U

Appendix Table 4-8a. Movements of Sooty Terns from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
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
823-01100	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
843-63403	07-18-65	I	U	Johnston Atoll	06-15-69	A	U
843-65340	07-18-65	A	U	East I., French Frigate Shoals	06-15-68	A	U
843-67038	07-19-65	A	U	Johnston Atoll	08-10-67	A	U
893-00856	08-05-65	A	U	Johnston Atoll	08-19-65	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
893-05046	08-05-65	A	U	Eastern I., Midway Atoll	06-21-66	A	U
893-07386	08-05-65	A	U	Lisianski I.	06-04-67	A	U
893-09402	08-06-65	A	U	Lisianski I.	06-18-66	A	U
893-09661	08-06-65	A	U	East I., French Frigate Shoals	05-28-67	A	U
893-10752	08-06-65	A	U	Honshu, Japan, 35°20'N, 139°35'E	04-26-68	U	U
893-11955	08-06-65	A	U	Lisianski I.	09-03-67	A	U
893-12201	08-05-65	A	U	Kure Atoll	05-13-67	A	U
893-16895	08-06-65	I	U	Johnston Atoll	06-16-69	A	U
893-17133	08-06-65	I	U	Johnston Atoll	09-23-68*	A	U
863-62311	08-07-65	A	U	Lisianski I.	06-19-66	A	U
893-12998	08-07-65	A	U	Johnston Atoll	08-07-67	A	U

Appendix Table 4-8a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
893-16158	08-07-65	I	U	Atafu Atoll	01-25-67**	A	U
863-65847	08-08-65	A	U	Johnston Atoll	08-15-67	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
863-69621	08-09-65	I	U	At sea, 11°09'N, 140°53'W	Before 12-06-65	I	U
863-70245	08-09-65	A	U	Christmas I., Line Is.	12-29-67	A	U
863-70414	08-09-65	A	U	Kure Atoll	05-16-66	A	U
				Kure Atoll	06-07-67	A	U (breeding)
863-70890	08-09-65	A	U	Awayon, Silago, Southern Leyte, Philippine Is.	12-17-65	U	U
863-71956	08-09-65	A	U	Lisianski I.	06-04-67	A	U
863-72007	08-09-65	A	U	Phoenix I., Phoenix Is.	01-28-67	A	U
863-74962	08-10-65	A	U	Johnston Atoll	07-11-66	A	U
903-33483	06-11-66	A	U	East I., French Frigate Shoals	08-23-66	A	U
903-41890	06-11-66	A	U	Lisianski I.	06-04-67	A	U
903-34664	06-12-66	A	U	Ebjedik I., E. Kwajalein, Marshall Is.	06-21-67	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
903-45621	06-12-66	A	U	Kure Atoll	06-14-67	A	U (nesting)
903-50101	06-13-66	A	U	Kure Atoll	06-12-67	A	U (nesting)

Appendix Table 4-8a. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
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
903-61956	06-13-66	A	U	Johnston Atoll	07-10-66	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
903-64636	06-14-66	A	U	East I., French Frigate Shoals	05-28-67	A	U
903-65555	06-14-66	A	U	Johnston Atoll	07-25-67	A	U
903-82859	06-15-66	A	U	Johnston Atoll	05-23-69	A	U (on egg)
993-45954	06-07-67	A	U	Johnston Atoll	08-07-67	A	U

*Blood sampled.

**Caught by a native hunter.

Appendix Table 4-8b. Movements of Sooty Terns to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
French Frigate Shoals							
723-62369	06-09-63	A	U	Laysan I.	08-05-65	A	U
863-26728	08-25-65	A	U	Laysan I.	06-10-67	A	U (with downy chick)
863-26796	08-25-65	A	U	Laysan I.	06-10-67	A	U (on nest)

Appendix Table 4-8b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Johnston Atoll							
753-14254	08-02-63	A	U	Laysan I.	06-10-67	A	U
753-20707	08-26-63	A	U	Laysan I.	07-19-65*	A	U
753-20853	08-26-63	A	U	Laysan I.	06-10-67	A	U
753-20889	08-26-63	A	U	Laysan I.	06-15-66*	A	U
753-21404	08-31-63	A	U	Laysan I.	09-17-64*	A	U
753-21699	09-01-63	A	U	Laysan I.**	06-14-66*	A	U
753-23285	09-06-63	A	U	Laysan I.	07-19-65*	A	U
753-23432	09-09-63	A	U	Laysan I.	06-15-66*	A	U
753-23733	09-10-63	A	U	Laysan I.	08-08-65*	A	U
753-24138	09-15-63	A	U	Laysan I.	06-10-67	A	U
				Laysan I.	06-08-67	A	U
753-24227	09-15-63	A	U	Laysan I.	06-10-67	A	U
753-24423	09-17-63	A	U	Laysan I.	06-15-66	A	U
753-82465	05-14-64	L	U	Laysan I.	07-18-65	A	U
843-78332	07-17-65	A	U	Laysan I.	08-10-65*	A	U
843-78822	07-18-65	A	U	Laysan I.	08-08-65*	A	U
843-78978	07-18-65	A	U	Laysan I.	06-10-66*	A	U
843-82173	07-22-65	A	U	Laysan I.	06-07-67	A	U
843-82822	07-22-65	A	U	Laysan I.	08-08-65*	A	U
843-83669	07-24-65	A	U	Laysan I.	06-11-66*	A	U
843-83987	07-24-65	A	U	Laysan I.**	06-10-66*	A	U
843-85955	07-26-65	A	U	Laysan I.	08-05-65*	A	U

Appendix Table 4-8b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Johnston Atoll (continued)							
843-91342	08-06-65	A	U	Laysan I.	08-10-65*	A	U
843-99861	08-22-65	A	U	Laysan I.	06-11-67	A	U
Kure Atoll							
773-19689	05-20-64	A	U	Laysan I.	06-20-66	A	U (breeding)
813-91288	08-27-64	A	U	Laysan I.	06-20-66	A	U
Lisianski I.							
823-19014	07-16-65	A	U	Laysan I.	06-12-66	A	U
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
				Laysan I.	06-13-66	A	U
903-90422	06-16-66	A	U	Laysan I.	06-10-67	A	U (nesting)
903-96566	06-16-66	A	U	Laysan I.	06-10-67	A	U (nesting)
903-98068	06-16-66	A	U	Laysan I.	06-10-67	A	U (nesting)
943-14501	06-18-66	A	U	Laysan I.	06-11-67	A	U (breeding)
943-17848	06-18-66	A	U	Laysan I.	06-11-67	A	U (breeding)
943-18114	06-??-66	A	U	Laysan I.	06-11-67	A	U

Appendix Table 4-8b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Midway Atoll, Eastern I.							
903-00280	08-28-65	A	U	Laysan I.	06-10-67	A	U
903-02280	08-29-65	A	U	Laysan I.	06-11-67	U	U

*Marked with orange leg streamer.

**Bird collected.

Appendix Table 4-9a. Movements of Black Noddies from Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
723-60413	02-12-63	A	U	Trig I., French Frigate Shoals	06-24-68	A	U
723-60424	02-12-63	A	U	Whale-Skate I., French Frigate Shoals	08-30-65	A	U
723-60435	02-12-63	A	U	Southeast I., Pearl and Hermes Reef	05-30-67	A	U
723-60446	02-12-63	A	U	Whale-Skate I., French Frigate Shoals	08-15-65	A	U
712-00697	10-22-66	U	U	Lisianski I.	09-02-67	A	U

Appendix Table 4-9b. Movements of Black Noddies to Laysan.

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Whale-Skate I., French Frigate Shoals							
863-23696	08-15-65	A	U	Laysan I.	03-18-68	A	U

Appendix Table 4-9b. (continued)

Original Banding Data				Recapture Data			
Band Number	Date	Age	Sex	Where Recaptured	Date	Age	Sex
Whale-Skate I., French Frigate Shoals (continued)							
712-01740	08-16-65	A	U	Laysan I.	09-10-67	A	U
712-01782	08-16-65	A	U	Laysan I.	03-17-68	A	U
712-01362	08-29-65	A	U	Laysan I.	10-22-66	A	U
712-01477	08-29-65	A	U	Laysan I.	10-20-66	A	U
863-27548	08-29-65	A	U	Laysan I.	03-18-68 (with egg)	A	U
712-58324	06-26-66	A	U	Laysan I.	03-18-68 (with egg)	A	U
Midway Atoll, Sand I.							
542-77233	08-10-62*	U	U	Laysan I.	09-07-67	A	U

*Banded by BSFW.

Appendix Table 5. Distribution of Laysan bird skins and mounts.

More specimens have been taken at Laysan over a longer period of time than at any other locality in the Northwestern Hawaiian Islands. Most of the many specimens collected at Laysan are now in major American museums; others were exchanged to foreign museums and an unknown number are in private collections or small museums. The following listing was completed through an examination of museum catalogues and (usually) skins present in the following museums:

AMNH American Museum of Natural History, New York
BMNH British Museum (Natural History), London
BPBM Bernice P. Bishop Museum, Honolulu
CMNH Chicago Natural History Museum, Chicago
DMNH Denver Museum of Natural History, Denver
JEL Law and Bailey collections, presently at Rockbridge Alum Springs, Virginia
MCZ Museum of Comparative Zoology, Cambridge
PANS Academy of Natural Sciences of Philadelphia
SUI State University of Iowa, Iowa City

Appendix Table 5. (continued)

UMMZ University of Michigan Museum of Zoology, Ann Arbor
USNM United States National Museum, Washington D.C.

(Also included are a few specimens from the D.R. Dickey (DRD) collection, now at the University of California, Los Angeles (?)).

This listing includes all major Laysan collections but time did not permit the checking of all individual Laysan specimens. Whenever possible, museum catalogues were checked against specimens present in the collections. In appendix tables specimens are listed under the museum where catalogued. Coverage of various museums is uneven: AMNH was covered in much better depth than was MCZ; data from AMNH and USNM are more accurate than those at BPBM where duplications and errors are known. Despite errors, this listing should be of value to anyone working with the Hawaiian area and the central Pacific. Hopefully, others using this listing will make appropriate corrections when errors are found.

Appendix Table 5-1. Laysan specimens in major museums.

Species	AMNH	BPBM	CMNH	DMNH	MCZ	Misc.	SUI	UMMZ	USNM	Totals
Black-footed Albatross	12	12	6	7	2	3	12	4	24	82
Laysan Albatross	26	15	8	7	4	3	34	7	32	136
Hybrid Albatross		1	1						1	3
Bonin Petrel	21	20	6		8	2	4	8	52	121
Bulwer's Petrel	12	3	1	6	12		8		29	71
Sooty Shearwater		1								1
Wedge-tailed Shearwater	12	18		2	1		5	1	33	72
Christmas Shearwater	15	11	4	4	5	1	4	4	40	88
Sooty Storm Petrel	7	6	3			2	1	10	17	46
Red-tailed Tropicbird	24	12	6	8	7		6	13	16	92
Blue-faced Booby	16	10	3	2			9	1	13	54
Brown Booby	1	2								3
Red-footed Booby	11	7	3	2	4		9	2	15	53
Great Frigatebird	14	9	6	4	4	4	14	3	29	87
Mallard									2	2
Laysan Teal	22	16		2	6		2		13	61
Pintail		1								1
Bufflehead									1	1
Harlequin Duck		1								1
Laysan Rail	46	28	4	3	3	2	3	16	35	140
Semipalmated Plover									1	1
Golden Plover	10	3	2	1		2	4	18	13	53
Black-bellied Plover									1	1
Ruddy Turnstone	8	5	2		6	2	3	6	25	57
Bristle-thighed Curlew	12	8	7	6	15	2	2	7	18	77
Wandering Tattler	8	2					2	5	4	21
Greater Yellowlegs									1	1

Appendix Table 5-1. (continued)

Species	AMNH	BPBM	CMNH	DMNH	MCZ	Misc.	SUI	UMMZ	USNM	Totals
Lesser Yellowlegs									2	2
Sharp-tailed Sandpiper									1	1
Pectoral Sandpiper									2	2
Baird's Sandpiper									2	2
Dunlin									1	1
Marbled Godwit									1	1
Bar-tailed Godwit	1									1
Sanderling									1	1
Red Phalarope			1						1	2
Northern Phalarope									2	2
Glaucous Gull		1								1
Herring Gull		1							2	3
Bonaparte's Gull									1	1
Black-legged Kittiwake		1								1
Sooty Tern	17	6	2	12	4		27	3	36	107
Gray-backed Tern	23	14	2	9	11	2	16	8	36	121
Brown Noddy	14	5	3	7	7	1	13	6	36	92
Black Noddy	22	15	5	8	6	2	19	5	49	131
White Tern	22	17	2	3	4		7	3	19	77
Laysan Miller-bird	22	25	2	2	9	4	3	4	11	82
Laysan Honey-eater	16	23	2	2	12	2	4	8	21	90
Laysan Finch	45	42	2	2	9	2	5	14	77	198
Totals	459	341	83	99	139	36	216	156	716	2,245

Appendix Table 5-2. Laysan specimens at the American Museum of Natural History (includes mounts).

Species	Bailey	Bryan	Coultas	Dill	Hall	Misc.	Rothschild	Schauinsland	Schlemmer	Totals
Black-footed Albatross		2	6				4			12
Laysan Albatross			6	1		2	7	9	1	26
Bonin Petrel	3	1	3		1		2	11		21
Bulwer's Petrel							2	10		12
Wedge-tailed Shearwater		1	1				2	8		12
Christmas Shearwater		1					2	12		15
Sooty Storm Petrel	3	3	1							7
Red-tailed Tropicbird					2	7	3	12		24
Blue-faced Booby			4				1	11		16
Brown Booby								1		1
Red-footed Booby								11		11
Great Frigatebird							3	11		14

Appendix Table 5-2. (continued)

Species	Bailey	Bryan	Coultas	Dill	Hall	Misc.	Rothschild	Schauinsland	Schlemmer	Totals
Laysan Teal		3	2				6	10	1	22
Laysan Rail		4		1			29	12		46
Golden Plover								10		10
Ruddy Turnstone								8		8
Bristle-thighed Curlew		1	1		1		1	8		12
Wandering Tattler								8		8
Bar-tailed Godwit								1		1
Sooty Tern	1				1		2	13		17
Gray-backed Tern	2	1					9	11		23
Brown Noddy	1							13		14
Black Noddy	2		5				1	14		22
White Tern		2					8	12		22
Laysan Miller-bird		3		1			7	10	1	22
Laysan Honey-eater		3		1			5	7		16
Laysan Finch		4	10	2		1	9	19		45
Totals	12	29	39	6	5	10	103	252	3	459

Appendix Table 5-3. Laysan specimens at the Bernice P. Bishop Museum (includes mounts).

Species	Bryan	Hall	Misc.	Rothschild	Schauinsland	Wetmore	Total
Black-footed Albatross	7					5	12
Laysan Albatross	11		1	1		2	15
Hybrid Albatross			1				1
Bonin Petrel	9	2	1	5		3	20
Bulwer's Petrel	2			1			3
Sooty Shearwater			1				1
Wedge-tailed Shearwater	6	1	5	2	2	2	18
Christmas Shearwater	1		2	1		7	11
Sooty Storm Petrel	6						6
Red-tailed Tropicbird			7	1		4	12
Blue-faced Booby			2	1		7	10
Brown Booby	1		1				2
Red-footed Booby	2		1			4	7
Great Frigatebird	1	3	3	2			9

Appendix Table 5-3. (continued)

Species	Bryan	Hall	Misc.	Rothschild	Schauinsland	Wetmore	Total
Laysan Teal	12	1	1	2			16
Pintail	1						1
Harlequin Duck			1				1
Laysan Rail	15		8	5			28
Golden Plover	2				1		3
Ruddy Turnstone			1		4		5
Bristle-thighed Curlew	2	2	2		2		8
Wandering Tattler			1		1		2
Glaucous Gull			1				1
Herring Gull			1				1
Black-legged Kittiwake			1				1
Sooty Tern		3	2	1			6
Gray-backed Tern	4		2	1		7	14
Brown Noddy	1	1	3				5
Black Noddy	13		1		1		15
White Tern	6	3	5	2		1	17
Laysan Miller-bird	21			4			25
Laysan Honey-eater	19		1	2	1		23
Laysan Finch	24		12	3	3		42
Totals	166	16	68	34	15	42	341

Appendix Table 5-4. Laysan specimens at the Chicago Museum of Natural History (includes mounts).

Species	Bailey	Dill	Schlemmer	Misc.	Totals
Black-footed Albatross	2	4			6
Laysan Albatross	4	4			8
Hybrid Albatross	1				1
Bonin Petrel	4	2			6
Bulwer's Petrel		1			1
Christmas Shearwater	2	2			4
Sooty Storm Petrel	3				3
Red-tailed Tropicbird	2	1		3*	6
Blue-faced Booby	2	1			3
Red-footed Booby	2	1			3
Great Frigatebird	3	2	1		6
Laysan Rail	2	1		1**	4
Golden Plover	2				2
Ruddy Turnstone	2				2
Bristle-thighed Curlew	7				7
Red Phalarope	1				1
Sooty Tern	2				2

Appendix Table 5-4. (continued)

Species	Bailey	Dill	Schlemmer	Misc.	Totals
Gray-backed Tern	2				2
Brown Noddy	2	1			3
Black Noddy	2	3			5
White Tern	2				2
Laysan Miller-bird	2				2
Laysan Honey-eater	2				2
Laysan Finch	2				2
Totals	55	23	1	4	83

*Japanese hunters, 1909-1910.

**Townsend (captive in Honolulu).

Appendix Table 5-5. Laysan specimens at the Denver Museum of Natural History (includes mounts).

Species	Bailey	BSFW	Dill	Misc.	Wetmore	Totals
Black-footed Albatross			1		6	7
Laysan Albatross			7			7
Bulwer's Petrel			4		2	6
Wedge-tailed Shearwater					2	2
Christmas Shearwater			2		2	4
Red-tailed Tropicbird	4		2	2*		8
Blue-faced Booby	2					2
Red-footed Booby			2			2
Great Frigatebird			4			4
Laysan Teal		2				2
Laysan Rail			3			3
Golden Plover	1					1
Bristle-thighed Curlew	2		4			6
Sooty Tern	7		4	1*		12
Gray-backed Tern	2		6	1*		9
Brown Noddy	5		2			7
Black Noddy	2		4		2	8
White Tern			2	1*		3
Laysan Miller-bird			2			2
Laysan Honey-eater	1		1			2
Laysan Finch			2			2
Totals	26	2	52	5	14	99

*Japanese hunters, 1909-1910.

Appendix Table 5-6. Laysan specimens at the Museum of Comparative Zoology.

Species	Schlemmer	Bailey	Misc.	Totals
Black-footed Albatross	2			2
Laysan Albatross	4			4
Bonin Petrel	8			8
Bulwer's Petrel	12			12
Wedge-tailed Shearwater	1			1
Christmas Shearwater	5			5
Red-tailed Tropicbird	7			7
Red-footed Booby	4			4
Great Frigatebird	4			4
Laysan Teal	6			6
Laysan Rail	2	1		3
Ruddy Turnstone	6			6
Bristle-thighed Curlew	15			15
Sooty Tern	4			4
Gray-backed Tern	11			11
Brown Noddy	7			7
Black Noddy	6			6
White Tern	4			4
Laysan Miller-bird	7	1	1*	9
Laysan Honey-eater	10	1	1*	12
Laysan Finch	6	1	2*	9
Totals	131	4	4	139

*From Flood brothers.

Appendix Table 5-7. Laysan specimens at the State University of Iowa (includes 106 mounts).

Species	Albatross	Bailey	Dill	Totals
Black-footed Albatross			12	12
Laysan Albatross			34	34
Bonin Petrel			4	4
Bulwer's Petrel			8	8
Wedge-tailed Shearwater			5	5
Christmas Shearwater	2		2	4
Sooty Storm Petrel			1	1
Red-tailed Tropicbird	1		5	6
Blue-faced Booby			9	9
Red-footed Booby	1		8	9
Great Frigatebird	1	2	11	14
Laysan Teal			2	2
Laysan Rail			3	3
Golden Plover			4	4
Ruddy Turnstone			3	3
Bristle-thighed Curlew			2	2
Wandering Tattler			2	2

Appendix Table 5-7. (continued)

Species	Albatross	Bailey	Dill	Totals
Sooty Tern	2		25	27
Gray-backed Tern	1		15	16
Brown Noddy			13	13
Black Noddy	1		18	19
White Tern	3		4	7
Laysan Miller-bird			3	3
Laysan Honey-eater	1		3	4
Laysan Finch			5	5
Totals	13	2	201	216

Appendix Table 5-8. Laysan specimens at the University of Michigan Museum of Zoology.

Species	Bailey	Dill	Misc.	Totals
Black-footed Albatross	4			4
Laysan Albatross	6	1		7
Bonin Petrel	8			8
Wedge-tailed Shearwater	1			1
Christmas Shearwater	3	1		4
Sooty Storm Petrel	10			10
Red-tailed Tropicbird	2		11*	13
Blue-faced Booby	1			1
Red-footed Booby	1	1		2
Great Frigatebird	2	1		3
Laysan Rail	14		2	16
Golden Plover	18			18
Ruddy Turnstone	6			6
Bristle-thighed Curlew	7			7
Wandering Tattler	5			5
Sooty Tern	3			3
Gray-backed Tern	8			8
Brown Noddy	6			6
Black Noddy	5			5
White Tern	1		2*	3
Laysan Miller-bird	3		1	4
Laysan Honey-eater	7		1	8
Laysan Finch	12		2	14
Totals	133	4	19	156

*Japanese hunters, 1909-1910.

Appendix Table 5-9. Laysan specimens at the U.S. National Museum (includes mounts).

Species	Albatross	Bailey	BSFW	Dill	Misc.	POBSP	Wetmore	Totals
Black-footed Albatross	2	6		4			12	24
Laysan Albatross	4	8		6			14	32
Hybrid Albatross						1		1
Bonin Petrel	3	26	2	4		16	1	52
Bulwer's Petrel				6		3	20	29
Wedge-tailed Shear-water			1	2			30	33
Christmas Shearwater	2	15	1	4		1	17	40
Sooty Storm Petrel	1	11		1		4		17
Red-tailed Tropicbird	1	3		5			7	16
Blue-faced Booby				4			9	13
Red-footed Booby				4			11	15
Great Frigatebird		5		5			19	29
Mallard		2						2
Laysan Teal	3		3	1			6	13
Bufflehead		1						1
Laysan Rail	7	26		2				35
Semipalmated Plover						1		1
Golden Plover	2	1		1		5	4	13
Black-bellied Plover		1						1
Ruddy Turnstone	1		1	2		11	10	25
Bristle-thighed Curlew		3		5			10	18
Wandering Tattler			1			1	2	4
Greater Yellowlegs						1		1
Lesser Yellowlegs						2		2
Sharp-tailed Sandpiper						1		1
Pectoral Sandpiper						2		2
Baird's Sandpiper						2		2
Dunlin		1						1
Marbled Godwit						1		1
Sanderling		1						1
Red Phalarope		1						1
Northern Phalarope						2		2
Herring Gull		1				1		2
Bonaparte's Gull		1						1
Sooty Tern	2	9	1	2		4	18	36
Gray-backed Tern	3	9	2	2			20	36
Brown Noddy	1	15		6			14	36
Black Noddy	3	14	1	2		13	16	49
White Tern	6			1			12	19
Laysan Miller-bird	6			2	3			11
Laysan Honey-eater	6	10		2	3			21
Laysan Finch	12	13	35	2		4	11	77
Totals	65	183	48	75	6	76	263	716

Appendix Table 5-10. Minor Laysan holdings.

British Museum (Natural History)

Species	Rothschild	Schauinsland	Wetmore	Totals
Laysan Albatross	1			1
Bonin Petrel			1	1
Great Frigatebird		4		4
Totals	1	4	1	6

D.R. Dickey Collection

Black-footed Albatross	2	2

J.E. Law Collection

Species	Bailey	Total
Black-footed Albatross	1	1
Laysan Albatross	1	1
Bonin Petrel	1	1
Christmas Shearwater	1	1
Sooty Storm Petrel	2	2
Laysan Rail	2	2
Golden Plover	2	2
Ruddy Turnstone	2	2
Bristle-thighed Curlew	2	2
Gray-backed Tern	2	2
Brown Noddy	1	1
Black Noddy	2	2
Laysan Miller-bird	2	2
Laysan Honey-eater	2	2
Laysan Finch	2	2
Totals	25	25

Academy of Natural Sciences of Philadelphia

Species	Dill	Rothschild	Schlemmer	Totals
Laysan Albatross	1			1
Laysan Miller-bird		1	1	2
Totals	1	1	1	3

Appendix Table 5-11. Present deposition of specimens from major expeditions.

Expedition	AMNH	BPBM	BMNH	CMNH	DMNH	DRD	JEL	MCZ	SUI	PANS	UMMZ	USNM	Totals
Albatross									13			65	78
Bailey	12			55	26		25	4	2		133	183	440*
Bryan	29	166											195
Coultas	39												39
Dill	6			23	52				201	1	4	75	362
Hall	5	16											21
Misc.	10	68		4	5			4			19	6	116
Rothschild	103	34	1							1			139**
Schauinsland	252	15	4										271**
Schlemmer	3			1				131		1			136
Wetmore		42	1		14	2						263	322
POBSP												76	76
BSFW					2							48	50
Totals	459	341	6	83	99	2	25	139	216	3	156	716	2,245

*A number of specimens were scattered among private collections.

**An unknown number are in other European museums.

Appendix Table 5-12. Laysan specimens by expedition.

Species	Albatross	Bailey	Bryan	BSFW	Coultas	Dill	Hall	Misc.	POBSP	Rothschild	Schauinsland	Schlemmer	Wetmore	Totals
Black-footed Albatross	2	13	9		6	21				4		2	25	82
Laysan Albatross	4	19	11		6	54		3		9	9	5	16	136
Hybrid Albatross		1						1	1					3
Bonin Petrel	3	42	10	2	3	10	3	1	16	7	11	8	5	121
Bulwer's Petrel			2			19			3	3	10	12	22	71
Sooty Shearwater								1						1
Wedge-tailed Shearwater		1	7	1	1	7	1	5		4	10	1	34	72
Christmas Shearwater	4	21	2	1		11		2	1	3	12	5	26	88
Sooty Storm Petrel	1	29	9		1	2			4					46
Red-tailed Tropicbird	2	11				13	2	30		4	12	7	11	92

Appendix Table 5-12. (continued)

Species	Albatross	Bailey	Bryan	BSFW	Coultas	Dill	Hall	Misc.	POBSP	Rothschild	Schauinsland	Schlemmer	Wetmore	Totals
Blue-faced Booby		5			4	14		2		2	11		16	54
Brown Booby			1					1			1			3
Red-footed Booby	1	3	2			16		1			11	4	15	53
Great Frigatebird	1	12	1			23	3	3		5	15	5	19	87
Mallard		2												2
Laysan Teal	3		15	5	2	3	1	1		8	10	7	6	61
Pintail			1											1
Bufflehead		1												1
Harlequin Duck								1						1
Laysan Rail	7	45	19			10		11		34	12	2		140
Semipalmated Plover									1					1
Golden Plover	2	24	2			5			5		11		4	53
Black-bellied Plover		1												1
Ruddy Turnstone	1	10		1		5		1	11		12	6	10	57
Bristle-thighed Curlew		21	3		1	11	3	2		1	10	15	10	77
Wandering Tattler		5		1		2		1	1		9		2	21
Greater Yellowlegs									1					1
Lesser Yellowlegs									2					2
Sharp-tailed Sandpiper									1					1
Pectoral Sandpiper									2					2
Baird's Sandpiper									2					2
Dunlin		1												1
Marbled Godwit									1					1
Bar-tailed Godwit											1			1
Sanderling		1												1
Red Phalarope		2												2
Northern Phalarope									2					2
Glaucous Gull								1						1
Herring Gull		1						1	1					3
Bonaparte's Gull		1												1
Black-legged Kittiwake								1						1
Sooty Tern	4	22		1		31	4	3	4	3	13	4	18	107
Gray-backed Tern	4	25	5	2		23		3		10	11	11	27	121
Brown Noddy	1	30	1			22	1	3			13	7	14	92
Black Noddy	4	27	13	1	5	27		1	13	1	15	6	18	131
White Tern	9	3	8			7	3	8		10	12	4	13	77
Laysan Miller-bird	6	8	24			8		5		12	10	9		82
Laysan Honey-eater	7	23	22			7		6		7	8	10		90
Laysan Finch	12	30	28	35	10	11		17	4	12	22	6	11	198
Totals	78	440	195	50	39	362	21	116	76	139	271	136	322	2,245

* U. S. GOVERNMENT PRINTING OFFICE : 1973 O - 519-527