

all

ATOLL RESEARCH BULLETIN

174. *The Natural History of Pearl
and Hermes Reef, Northwest-
ern Hawaiian Islands*

by *A. Binion Amerson, Jr., Roger B.
Clapp, and William O. Wirtz, II*



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

ATOLL RESEARCH BULLETIN

NO. 174

**THE NATURAL HISTORY OF PEARL AND HERMES REEF,
NORTHWESTERN HAWAIIAN ISLANDS**

**by A. Binion Amerson, Jr., Roger C. Clapp,
and William O. Wirtz, II**

**Issued by
THE SMITHSONIAN INSTITUTION
with the assistance of
The Bureau of Sport Fisheries and Wildlife
U.S. Department of the Interior
Washington, D.C., U.S.A.**

December 31, 1974

ACKNOWLEDGMENT

The Atoll Research Bulletin is issued by the Smithsonian Institution as a part of its Tropical Biology Program. It is co-sponsored by the Museum of Natural History, the Office of Environmental Sciences, and the Smithsonian Press. The Press supports and handles production and distribution. The editing is done by the Tropical Biology staff, Botany Department, Museum of Natural History.

The Bulletin was founded and the first 117 numbers issued by the Pacific Science Board, National Academy of Sciences, with financial support from the Office of Naval Research. Its pages were largely devoted to reports resulting from the Pacific Science Board's Coral Atoll Program.

The sole responsibility for all statements made by authors of papers in the Atoll Research Bulletin rests with them, and statements made in the Bulletin do not necessarily represent the views of the Smithsonian nor those of the editors of the Bulletin.

Editors

F. R. Fosberg
M.-H. Sachet

Smithsonian Institution
Washington, D. C. 20560

D. R. Stoddart

Department of Geography
University of Cambridge
Downing Place
Cambridge, England

TABLE OF CONTENTS

	<u>Page</u>
LIST OF FIGURES.....	iii
LIST OF TABLES.....	viii
LIST OF APPENDIX TABLES.....	xiii
INTRODUCTION.....	1
DESCRIPTION.....	3
GEOLOGY.....	17
CLIMATE.....	22
HISTORY.....	26
SCIENTIFIC VISITS.....	34
VEGETATION.....	38
Vascular Plants.....	38
Grass Island.....	39
Little North Island.....	42
North Island.....	42
Seal Island.....	46
Southeast Island.....	46
Other Islands.....	58
REPTILES.....	58
<u>Chelonia agassizi</u>	61
BIRDS.....	67
Introduction.....	68
Resident Seabirds.....	69
Migrant Shorebirds.....	70
Vagrant, Accidental, and Introduced Birds.....	70
Annual Cycles.....	70
Seabird Breeding Cycles.....	71
Winter and Spring Breeders.....	71
Spring and Summer Breeders.....	71
Summer and Fall Breeders.....	71
Fall and Winter Breeders.....	71
Land Bird Breeding Cycles.....	71
Population Cycles.....	73
Resident Species.....	73
Non-resident Species.....	73
Introduced Birds.....	74
Ecological Distribution Within the Atoll.....	74
Resident Seabirds.....	75
Migrant Shorebirds.....	75
Vagrant, Accidental, and Introduced Birds.....	75
Island Accounts.....	75
Bird Island.....	77
Grass Island.....	77
Kittery Island.....	82
Little North Island.....	82
North Island.....	86
Planetree Island.....	86
Sand Island.....	89
Seal Island.....	89
Southeast Island.....	89

	<u>Page</u>
Banding and Movement.....	97
Banding.....	97
Movement.....	107
Species Accounts.....	107
<u>Diomedea nigripes</u>	111
<u>Diomedea immutabilis</u>	118
<u>Pterodroma hypoleuca</u>	127
<u>Bulweria bulwerii</u>	133
<u>Puffinus pacificus</u>	134
<u>Puffinus nativitatus</u>	139
<u>Oceanodroma tristrami</u>	143
<u>Phaethon rubricauda</u>	147
<u>Sula dactylatra</u>	152
<u>Sula sula</u>	162
<u>Sula leucogaster</u>	169
<u>Fregata minor</u>	174
<u>Anas acuta</u>	182
<u>Anas laysanensis</u>	182
<u>Porzanula palmeri</u>	184
<u>Pluvialis dominica</u>	185
<u>Numenius tahitiensis</u>	190
<u>Heteroscelus incanum</u>	193
<u>Arenaria interpres</u>	196
<u>Capella species</u>	201
<u>Calidris canutus</u>	202
<u>Crocethia alba</u>	202
<u>Erolia acuminata</u>	205
<u>Erolia alpina sakhalina</u>	205
<u>Philomachus pugnax</u>	206
<u>Phalaropus fulicarius</u>	206
<u>Larus delawarensis</u>	207
<u>Larus argentatus vegae</u>	207
<u>Larus glaucescens</u>	208
<u>Rissa tridactyla</u>	208
<u>Sterna lunata</u>	209
<u>Sterna fuscata</u>	215
<u>Anous stolidus</u>	220
<u>Anous tenuirostris</u>	227
<u>Gygis alba</u>	234
<u>Fratercula corniculata</u>	237
<u>Psittirostra cantans cantans</u>	238
MAMMALS.....	240
<u>Stenella roseiventris</u>	240
<u>Tursiops truncatus</u>	240
<u>Monachus schauinslandi</u>	241
<u>Oryctolagus cuniculus</u>	252
SUMMARY.....	253
ACKNOWLEDGMENTS.....	254
LITERATURE CITED.....	256
APPENDIX TABLES.....	268

LIST OF FIGURES

	<u>Page</u>
1. The Hawaiian Islands.	2
2. Map of Pearl and Hermes Reef. Redrawn from U.S. Coast and Geodetic Survey chart 4175.	4
3. Early map of Pearl and Hermes Reef. Unpublished 1859 map by N.C. Brooks showing track of <u>Gambia</u> and wrecks of <u>Pearl</u> and <u>Hermes</u> (U.S. Nat. Archives, Cartogr. Div., R.G. 37).	5
4. Map of Pearl and Hermes Reef, 1867. Redrawn from U.S. Naval Hydrographic Office chart 4, 1868.	6
5. Map of Pearl and Hermes Reef, 1924. Redrawn from U.S. Naval Hydrographic Office chart 4, reissued 1924.	6
6. Aerial view of Grass Island, 5 June 1962. Official U.S. Navy photograph.	9
7. Map of Grass Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.	9
8. Map of Kittery Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.	10
9. Aerial view of Little North Island, 5 June 1962. Official U.S. Navy photograph.	10
10. Aerial view of North Island, 5 June 1962. Official U.S. Navy photograph.	12
11. Map of North Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.	12
12. Aerial view of Seal Island, 5 June 1962. Official U.S. Navy photograph.	13
13. Map of Seal Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.	13
14. Aerial view of Southeast Island, 5 June 1962; a small-boat channel through the reef occurs just out of view on the right. Official U.S. Navy photograph.	15
15. Map of Southeast Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.	15
16. Aerial view of main ship channel between Sand and Bird Islands, 5 June 1962. Official U.S. Navy photograph.	18

17. Aerial view of small-boat channel between Bird and Planetree Islands, 5 June 1962. Official U.S. Navy photograph. 18
18. Chart showing distribution of temperature and salinity within the lagoon, July - August 1930. Reproduced with permission from Galtsoff (1933: figure 4, opposite p. 24). 21
19. Monthly temperature means and their maximum and minimum ranges for a 10-year period, 1953 to 1963, at Midway Atoll. 23
20. Mean number of days with measurable precipitation for Midway Atoll, 1953 to 1963. 24
21. Mean monthly precipitation in inches for Midway Atoll, 1953 to 1963. 24
22. Wind direction and speed at Midway Atoll from 1953 to 1963. Length of directional line indicates percent of observations from that direction; figure at end of directional line is mean wind speed in knots. 25
23. Fishing camp of the Hawaiian Sea Products Company at Southeast Island, summer 1930. Photograph by P.S. Galtsoff. 30
24. One of three buildings at Southeast Island constructed by the Hawaiian Sea Products Company, summer 1930. Photograph by P.S. Galtsoff. 30
25. Drawing of U.S. Navy base camp at Southeast Island, drawn 6 August 1936. Official U.S. Navy photograph no. 80-CF-79797-3 in the U.S. National Archives. 32
26. Chart of tender anchorages, plane moorings, and base camp for U.S. Navy exercise, 1 October 1937. Official U.S. Navy photograph no. 80-CF-79797-4 in the U.S. National Archives. 32
27. Aerial view of Southeast Island from 300 feet showing details of base camp, probably October 1937. Official U.S. Navy photograph no. 80-G-11878 in the U.S. National Archives. 33
28. Vegetation map of Grass Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II. 40
29. Grass Island covered with dense Eragrostis, 27 April 1923. Photograph by A. Wetmore. 41
30. Interior of Grass Island, 27 June 1963. Laysan Albatross chicks (foreground) in area of Setaria, Boerhavia and Tribulus; Great Frigatebirds nesting in Solanum. POBSP photograph by A.B. Amerson, Jr. 41
31. Vegetation map of Little North Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II. 43

32. Sparse vegetation at Little North Island, looking southeast (print reversed), 29 August 1967. POBSP photograph by C.A. Ely. 44
33. Scant vegetation at Little North Island, looking northwest (print reversed); North Island in background, 29 August 1967. POBSP photograph by C.A. Ely. 44
34. Vegetation map of North Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II. 45
35. Low vegetation at North Island, from west-center looking north (print reversed), 29 August 1967. POBSP photograph by C.A. Ely. 47
36. Creepers and a few patches of grass dominate the vegetation at North Island, from west-center looking east (print reversed), 29 August 1967. POBSP photograph by C.A. Ely. 47
37. Extreme low vegetation at North Island, from west-center looking north, 24 June 1963. POBSP photograph by A.B. Amerson, Jr. 48
38. Extreme low vegetation at North Island, from west-center looking south, 24 June 1963. POBSP photograph by A.B. Amerson, Jr. 48
39. Vegetation map of Seal Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II. 49
40. Sicyos, Solanum, and Eragrostis cover the interior of Seal Island, view looking south, 14 March 1964; Laysan Albatross adults and chicks. POBSP photograph by A.B. Amerson, Jr. 50
41. Transition zone of Tribulus, Boerhavia, Lepturus, and Eragrostis between dense interior and beach at Seal Island, view looking southeast, 14 March 1964. POBSP photograph by A.B. Amerson, Jr. 50
42. Grasses and low shrubs cover the crest of Seal Island on 27 April 1923; albatross chicks in foreground, Great Frigatebirds in flight. Photograph by A. Wetmore. 51
43. Seals and albatrosses among scattered clumps of grass at Seal Island, 27 April 1923. Photograph by A. Wetmore. 51
44. Vegetation map of Southeast Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II. 52
45. Laysan and Black-footed Albatrosses nesting among Solanum, Coronopus, Boerhavia, and Tribulus on western section at Southeast Island, view looking southwest, 13 March 1964; USCGC Planetree in left background. POBSP photograph by A.B. Amerson, Jr. 54

46. Low vegetation on western section at Southeast Island, view looking southeast across interior toward reef-rock area, 13 March 1964. POBSP photograph by A.B. Amerson, Jr. 54
47. Eragrostis, Coronopus, Tribulus, and Boerhavia growing in the west-central portion of the eastern section at Southeast Island, view looking west, June 1967; Laysan Albatross adults and chicks and Sooty Tern adults; U.S. Navy-built tower in center background. POBSP photograph by R.L. DeLong. 55
48. Tribulus and Sicyos in the west-central portion of the eastern section of Southeast Island, 13 March 1964. POBSP photograph by A.B. Amerson, Jr. 55
49. Black Noddies roosting in stunted Scaevola bushes on the south shore of the western portion of the eastern section at Southeast Island, view looking northwest, 28-30 August 1967. POBSP photograph by R.B. Clapp. 56
50. Tall bunchgrass, presumably Eragrostis, growing on the crest of Southeast Island, December 1912; Hawaiian Monk Seal foreground, Black-footed Albatross nesting below crest. Photograph by W.F. Frear courtesy of Virginia Frear Wild. 57
51. Open cover of Eragrostis at Southeast Island, 26 April 1923. Photograph by A. Wetmore. 57
52. Bureau of Fisheries personnel inspect Sooty Tern colony in dense Eragrostis of the eastern section at Southeast Island, summer 1930. Photograph by P.S. Galtsoff. 59
53. Boerhavia and Lepturus growing on the western section at Southeast Island, view looking south, summer 1930. Photograph by P.S. Galtsoff. 59
54. Creepers and low shrubs cover most of the eastern section at Southeast Island, view from U.S. Navy-built tower looking east, 14 March 1964. POBSP photograph by A.B. Amerson, Jr. 60
55. Dense creepers, low shrubs, and some grasses cover most of the central portion of the eastern section at Southeast Island, view from tower looking east-northeast, 14 March 1964. POBSP photograph by A.B. Amerson, Jr. 60
56. The southeast beach-cove area at North Island is a popular place for sea turtles to bask in the sun, 29 August 1967 (print reversed). POBSP photograph by C.A. Ely. 66
57. Black Turtle sun basking on north beach at Southeast Island, June 1967. POBSP photograph by R.L. DeLong. 66
58. Breeding cycles of seabirds at Pearl and Hermes Reef; stippled areas represent eggs, barred areas young, and black dots non-breeding birds. 72

	<u>Page</u>
59. Wirtz (l.) and Stadel (r.) count Black-footed Albatross chicks along the upper beach crest and on the perimeter of the vegetated west portion at Grass Island, June 1967; Hawaiian Monk Seals in foreground. POBSP photograph by R.L. DeLong.	81
60. Great Frigatebirds (l.) and a Red-footed Booby (r.) nesting in low-growing <u>Solanum</u> at Grass Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.	81
61. Three species, Laysan and Black-footed Albatrosses and Blue-faced Boobies, nest on Kittery Island, view from southeast beach crest looking northwest, 26 June 1963. POBSP photograph by A.B. Amerson, Jr.	84
62. Laysan Albatross (l.) and Black-footed Albatross (r.) chicks on the perimeter of the vegetated portion at Seal Island, view looking west, 26 June 1963. POBSP photograph by A.B. Amerson, Jr.	93
63. Black-footed Albatross prefer to nest on the vegetation perimeter, whereas Laysan Albatross prefer the interior, Southeast Island 13 March 1964. POBSP photograph by A.B. Amerson, Jr.	98
64. Laysan Albatross predominantly nest inland; however, an occasional Black-footed Albatross nests here, Southeast Island 13 March 1964. POBSP photograph by A.B. Amerson, Jr.	98
65. Wedge-tailed Shearwaters by their nest burrows in <u>Sesuvium</u> at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.	99
66. Young Red-tailed Tropicbird at entrance to nest among oil drums at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.	99
67. Brown Booby with two young--a rare occurrence for normally only one survives--on coral-rock ledge at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.	100
68. Blue-faced Booby adult with young (foreground) on rock ledge at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.	100
69. Red-footed Booby on nest in low-growing <u>Solanum</u> at Southeast Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.	101
70. Great Frigatebirds, male (l.) and female (r.) on nests in low <u>Solanum</u> at Southeast Island, 13 March 1964. POBSP photograph by A.B. Amerson, Jr.	101
71. Nesting Sooty Terns at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.	102

	<u>Page</u>
72. Sooty Tern adult with recently hatched young at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.	102
73. Brown Noddy nest showing egg and nest material at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.	103
74. Black Noddy on nest placed in <u>Eragrostis</u> at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.	103
75. An introduced, banded Laysan Finch in <u>Sesuvium</u> and <u>Tribulus</u> at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.	104
76. Laysan Finch nest with two eggs in <u>Eragrostis</u> at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.	104
77. Sanderling (center front), Ruddy Turnstones (center rear), and Wandering Tattler (r.) on beach at Southeast Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.	105
78. Bristle-thighed Curlews on coral-rock ledges at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.	105
79. Yearling Hawaiian Monk Seal on lagoon beach at Southeast Island, March 1963. POBSP photograph by W.O. Wirtz, II.	250
80. Adult Hawaiian Monk Seals basking in the sun on the vegetated portion at Southeast Island, 28 August 1967. POBSP photograph by D.I. Hoff.	250

LIST OF TABLES

1. POBSP and BSFW survey dates of islands at Pearl and Hermes Reef.	36
2. Vascular plant distribution at Pearl and Hermes Reef.	39
3. Black Turtle observations at Pearl and Hermes Reef.	61
4. Maximum breeding periods of Pearl and Hermes Reef resident seabirds.	73
5. Monthly occurrence of non-resident birds at Pearl and Hermes Reef.	74
6. Status of the birds on Pearl and Hermes Reef.	76
7. Status, recent population, and habitat of Bird Island birds.	78
8. Status, recent population, and habitat of Grass Island birds.	79

	<u>Page</u>
9. Status, recent population, and habitat of Kittery Island birds.	83
10. Status, recent population, and habitat of Little North Island birds.	85
11. Status, recent population, and habitat of North Island birds.	87
12. Status, recent population, and habitat of Sand Island birds.	90
13. Status, recent population, and habitat of Seal Island birds.	91
14. Status, recent population, and habitat of Southeast Island birds.	94
15. POBSP and BSWF yearly banding totals of Pearl and Hermes Reef avifauna.	106
16. Recaptures of Pearl and Hermes-banded birds on the atoll.	108
17. Interisland movement of banded birds involving Pearl and Hermes Reef.	109
18. Summary of POBSP records of birds from Pearl and Hermes Reef.	110
19. Observations of Black-footed Albatross at Bird Island.	113
20. Observations of Black-footed Albatross at Grass Island.	114
21. Observations of Black-footed Albatross at Kittery Island.	115
22. Observations of Black-footed Albatross at Little North Island.	115
23. Observations of Black-footed Albatross at North Island.	116
24. Observations of Black-footed Albatross at Seal Island.	116
25. Observations of Black-footed Albatross at Southeast Island.	117
26. Black-footed Albatross banded at Pearl and Hermes Reef.	119
27. Observations of Laysan Albatross at Grass Island.	122
28. Observations of Laysan Albatross at Kittery Island.	123
29. Observations of Laysan Albatross at North Island.	123
30. Observations of Laysan Albatross at Seal Island.	124
31. Observations of Laysan Albatross at Southeast Island.	125
32. Laysan Albatross banded at Pearl and Hermes Reef.	128

	<u>Page</u>
33. Observations of Bonin Petrels at Grass Island.	129
34. Observations of Bonin Petrels at North Island.	130
35. Observations of Bonin Petrels at Seal Island.	131
36. Observations of Bonin Petrels at Southeast Island.	132
37. Observations of Wedge-tailed Shearwaters at Grass Island.	136
38. Observations of Wedge-tailed Shearwaters at North Island.	137
39. Observations of Wedge-tailed Shearwaters at Seal Island.	137
40. Observations of Wedge-tailed Shearwaters at Southeast Island.	138
41. Adult Wedge-tailed Shearwaters banded at Pearl and Hermes Reef by the POBSP.	140
42. Observations of Christmas Shearwaters at Southeast Island.	142
43. Observations of Sooty Storm Petrels at Southeast Island.	144
44. Sooty Storm Petrels banded at Pearl and Hermes Reef.	146
45. Observations of Red-tailed Tropicbirds at Grass Island.	148
46. Observations of Red-tailed Tropicbirds at North Island.	149
47. Observations of Red-tailed Tropicbirds at Seal Island.	150
48. Observations of Red-tailed Tropicbirds at Southeast Island.	150
49. Red-tailed Tropicbirds banded at Pearl and Hermes Reef by the POBSP.	153
50. Observations of Blue-faced Boobies at Grass Island.	155
51. Observations of Blue-faced Boobies at Kittery Island.	156
52. Observations of Blue-faced Boobies at Little North Island.	157
53. Observations of Blue-faced Boobies at North Island.	158
54. Observations of Blue-faced Boobies at Seal Island.	159
55. Observations of Blue-faced Boobies at Southeast Island.	160
56. Observations of Blue-faced Boobies on other islands at Pearl and Hermes Reef.	162

	<u>Page</u>
57. Blue-faced Boobies banded at Pearl and Hermes Reef.	163
58. Observations of Red-footed Boobies at Grass Island.	165
59. Observations of Red-footed Boobies at North Island.	166
60. Observations of Red-footed Boobies at Seal Island.	166
61. Observations of Red-footed Boobies at Southeast Island.	167
62. Red-footed Boobies banded at Pearl and Hermes Reef.	170
63. Observations of Brown Boobies at Southeast Island.	171
64. Observations of Brown Boobies on other islands at Pearl and Hermes Reef.	173
65. Brown Boobies banded at Pearl and Hermes Reef.	175
66. Observations of Great Frigatebirds at Grass Island.	178
67. Observations of Great Frigatebirds at North Island.	179
68. Observations of Great Frigatebirds at Seal Island.	180
69. Observations of Great Frigatebirds at Southeast Island.	180
70. Great Frigatebirds banded at Pearl and Hermes Reef.	183
71. Observations of Golden Plovers at Grass Island.	186
72. Observations of Golden Plovers at North Island.	187
73. Observations of Golden Plovers at Seal Island.	187
74. Observations of Golden Plovers at Southeast Island.	188
75. Observations of Bristle-thighed Curlews at Southeast Island.	191
76. Observations of Bristle-thighed Curlews on other islands at Pearl and Hermes Reef.	192
77. Observations of Wandering Tattlers at Southeast Island.	194
78. Observations of Wandering Tattlers on other islands at Pearl and Hermes Reef.	195
79. Observations of Ruddy Turnstones at Grass Island.	197
80. Observations of Ruddy Turnstones at North Island.	198

	<u>Page</u>
81. Observations of Ruddy Turnstones at Seal Island.	199
82. Observations of Ruddy Turnstones at Southeast Island.	199
83. Observations of Ruddy Turnstones on other islands at Pearl and Hermes Reef.	201
84. Observations of Sanderlings at Grass Island.	203
85. Observations of Sanderlings at Southeast Island.	204
86. Observations of Sanderlings on other islands at Pearl and Hermes Reef.	205
87. Observations of Gray-backed Terns at Seal Island.	211
88. Observations of Gray-backed Terns at Southeast Island.	211
89. Observations of Gray-backed Terns on other islands at Pearl and Hermes Reef.	213
90. Gray-backed Terns banded at Pearl and Hermes Reef.	214
91. Observations of Sooty Terns at Seal Island.	216
92. Observations of Sooty Terns at Southeast Island.	217
93. Observations of Sooty Terns on other islands at Pearl and Hermes Reef.	219
94. Density and status of subpopulations of Sooty Terns on Southeast Island, 28, 30 May-1 June 1967.	219
95. Sooty Terns banded at Pearl and Hermes Reef by the POBSP.	220
96. Observations of Brown Noddies at Grass Island.	223
97. Observations of Brown Noddies at North Island.	224
98. Observations of Brown Noddies at Seal Island.	224
99. Observations of Brown Noddies at Southeast Island.	225
100. Nest material used by Brown Noddies at Southeast Island, 28, 30 May-1 June 1967.	227
101. Brown Noddies banded at Pearl and Hermes Reef.	228
102. Observations of Black Noddies at Grass Island.	230
103. Observations of Black Noddies at North Island.	231

	<u>Page</u>
104. Observations of Black Noddies at Seal Island.	231
105. Observations of Black Noddies at Southeast Island.	232
106. Black Noddies banded at Pearl and Hermes Reef.	235
107. Observations of White Terns on islands at Pearl and Hermes Reef.	236
108. Observations of Laysan Finches at Southeast Island.	239
109. Observations of Hawaiian Monk Seals at Grass Island.	243
110. Observations of Hawaiian Monk Seals at Kittery Island.	245
111. Observations of Hawaiian Monk Seals at Little North Island.	245
112. Observations of Hawaiian Monk Seals at North Island.	246
113. Observations of Hawaiian Monk Seals at Seal Island.	247
114. Observations of Hawaiian Monk Seals at Southeast Island.	248
115. Observations of Hawaiian Monk Seals on other islands at Pearl and Hermes Reef.	251

LIST OF APPENDIX TABLES

1. Scientific visits to Pearl and Hermes Reef, 1857-1969.	268
2. Publications and manuscripts on collections and studies made on Pearl and Hermes Reef.	272
3. Annotated list of vascular plants from Pearl and Hermes Reef. Specimens are found in the herbaria of the National Museum of Natural History (USNM), the Bernice P. Bishop Museum (BPBM), and the University of Hawaii (UH).	281
4a. Movements of Black-footed Albatross from Pearl and Hermes Reef.	284
4b. Movements of Black-footed Albatross to Pearl and Hermes Reef.	289
5. Movements of Laysan Albatross from Pearl and Hermes Reef.	291
6a. Movements of Bonin Petrels from Pearl and Hermes Reef.	293
6b. Movements of Bonin Petrels to Pearl and Hermes Reef.	293
7a. Movements of Blue-faced Boobies from Pearl and Hermes Reef.	294

	<u>Page</u>
7b. Movements of Blue-faced Boobies to Pearl and Hermes Reef.	295
8a. Movements of Red-footed Boobies from Pearl and Hermes Reef.	296
8b. Movements of Red-footed Boobies to Pearl and Hermes Reef.	297
9a. Movements of Brown Boobies from Pearl and Hermes Reef.	298
9b. Movements of Brown Boobies to Pearl and Hermes Reef.	299
10. Movements of Great Frigatebirds from Pearl and Hermes Reef.	299
11. Movements of Ruddy Turnstones to Pearl and Hermes Reef.	303
12a. Movements of Sooty Terns from Pearl and Hermes Reef.	303
12b. Movements of Sooty Terns to Pearl and Hermes Reef.	304
13a. Movements of Black Noddies from Pearl and Hermes Reef.	305
13b. Movements of Black Noddies to Pearl and Hermes Reef.	306

THE NATURAL HISTORY OF PEARL AND HERMES REEF, NORTHWESTERN HAWAIIAN ISLANDS¹

by A. Binion Amerson, Jr.,^{2/} Roger B. Clapp,^{3/}
and William O. Wirtz, II^{4/}

INTRODUCTION

Pearl and Hermes Reef is a low coral atoll situated toward the northwestern end of the Hawaiian archipelago (Figure 1). It is approximately 1,200 statute miles northwest of Honolulu, and 100 statute miles east-southeast of Midway Atoll. Of the nine small islands in the lagoon, most of which are located along its southern edge, only five are vegetated; the remaining four are sand bars.

Thirty-seven bird species have been recorded from the atoll. Seventeen seabird species are known to breed there and five migratory shorebird species have been regularly recorded. There are no terrestrial mammals or reptiles, but sea turtles are frequently seen and there are resident Hawaiian Monk Seals. Marine life is abundant, but terrestrial invertebrate life is limited to insects and a few arachnids. Wildlife is protected as Pearl and Hermes is part of the Hawaiian Islands National Wildlife Refuge administered by the Bureau of Sport Fisheries and Wildlife (hereafter referred to as BSWF) of the U.S. Department of the Interior.

In 1963 the Smithsonian Institution's Pacific Ocean Biological Survey Program (hereafter called POBSP) began an extensive program of biological research in the Central Pacific. Between February 1963 and March 1968 POBSP personnel spent a total of 52 days at Pearl and Hermes Reef on 12 different trips. The initial results of the investigations of the POBSP

^{1/} Paper Number 78, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

^{2/} Present address: Department of Systematics and Ecology, University of Kansas, Lawrence, Kansas 66044.

^{3/} Present address: National Fish and Wildlife Laboratory, Bureau of Sport Fisheries and Wildlife, Smithsonian Institution, Washington, D. C. 20560.

^{4/} Present address: Department of Zoology, Pomona College, Claremont, California 91711

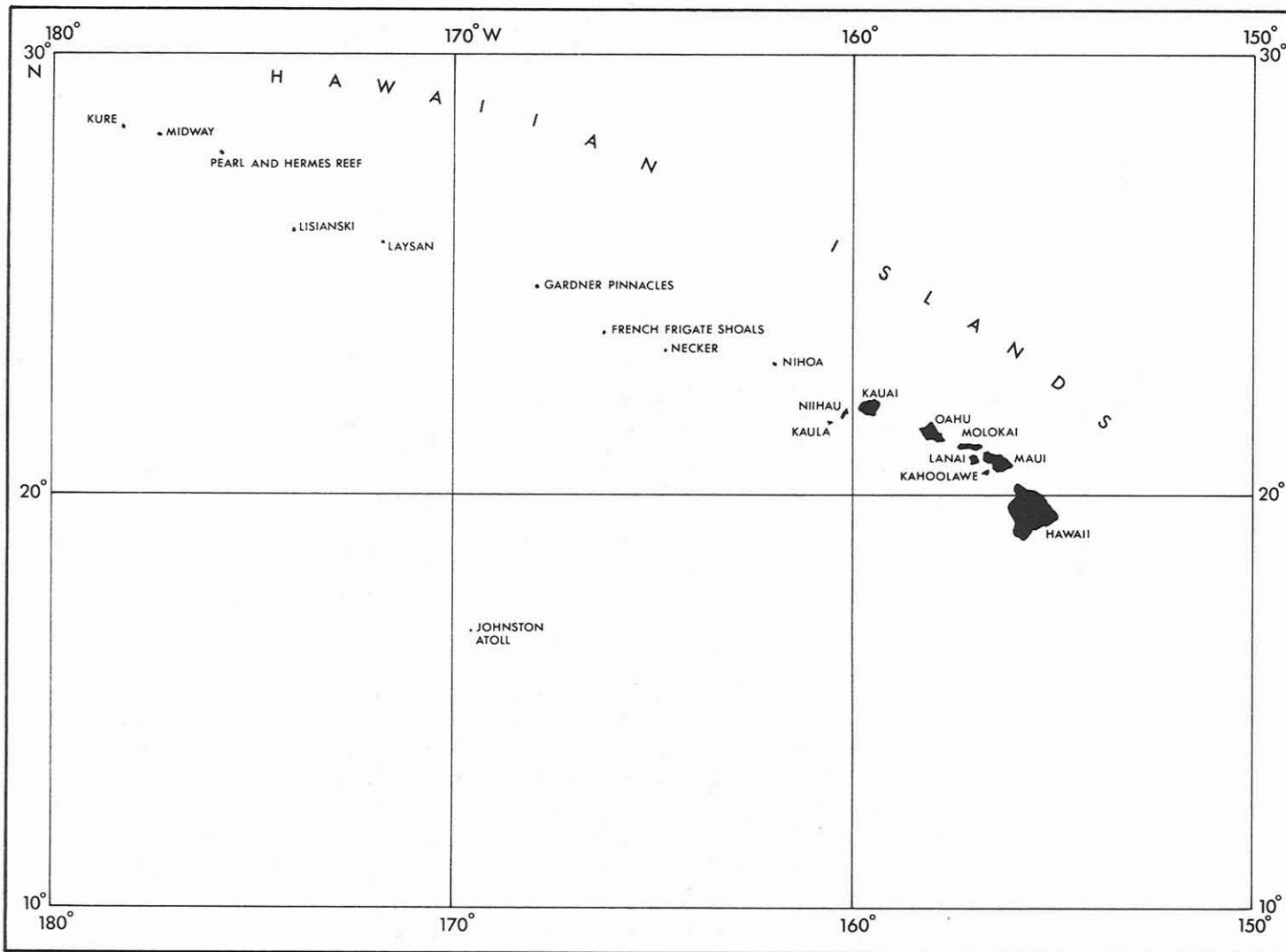


Figure 1. The Hawaiian Islands.

and BSWF through 1969, as well as previously published material, are discussed herein; special emphasis is placed on the vertebrate terrestrial fauna and the vascular flora.

DESCRIPTION

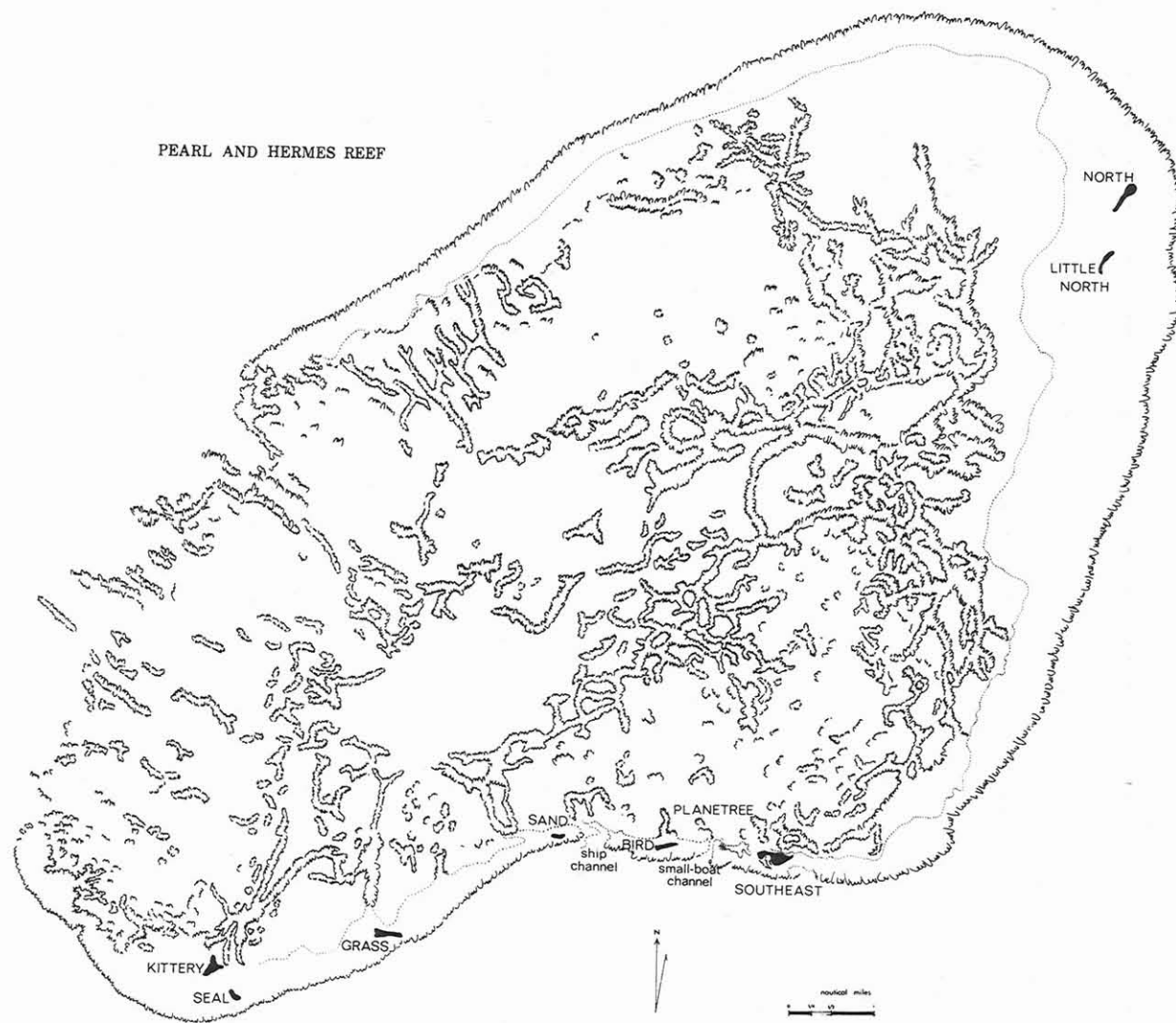
Pearl and Hermes Reef, lying between the latitudes of 27°44'46" and 27°57'10" North and the longitudes of 175°43'11" and 175°59'08" West (USCGS chart 4175), is given an official location of 27°55' N x 175°45' W by the U.S. Department of the Interior (Office of Geography, 1956: 66). This true atoll has been known as Pearl and Hermes Reef since the two ships of corresponding names wrecked there in 1822. In October 1968, however, the State of Hawaii Department of Planning and Economic Development approved the name Pearl and Hermes Atoll (Tomich, 1969: 120); this name was subsequently adopted by the U.S. Board of Geographic Names. We, nonetheless, chose to use the conventional and well-known name, Pearl and Hermes Reef, throughout this paper.

The fringing reef, as described by Thorp (1936: 109), is roughly 43 miles in circumference and open to the west. The enclosed elliptical area, whose long axis lies in a northeasterly direction, is approximately 17 x 10 nautical miles at its broadest points (Fig. 2). The area within the reef covers 143 square miles (Gross *et al.*, 1969: 21). POBSP personnel found nine islands, covering 85 acres,¹ within the reef; 12 were reported in 1859 by Brooks (1860: 502). Four of the islands--Grass, North, Seal, and Southeast--have established vegetation. Little North Island has continued to emerge since it was first reported in 1937 as a sandbar awash at high tide (USCGS chart 4175) and presently has a limited flora. One low island, Kittery, is subject to occasional inundation, and supports no vegetation in spite of its size and relative permanency. The remaining three islands--Bird, Planetree, and Sand--are continually shifting sandbars.

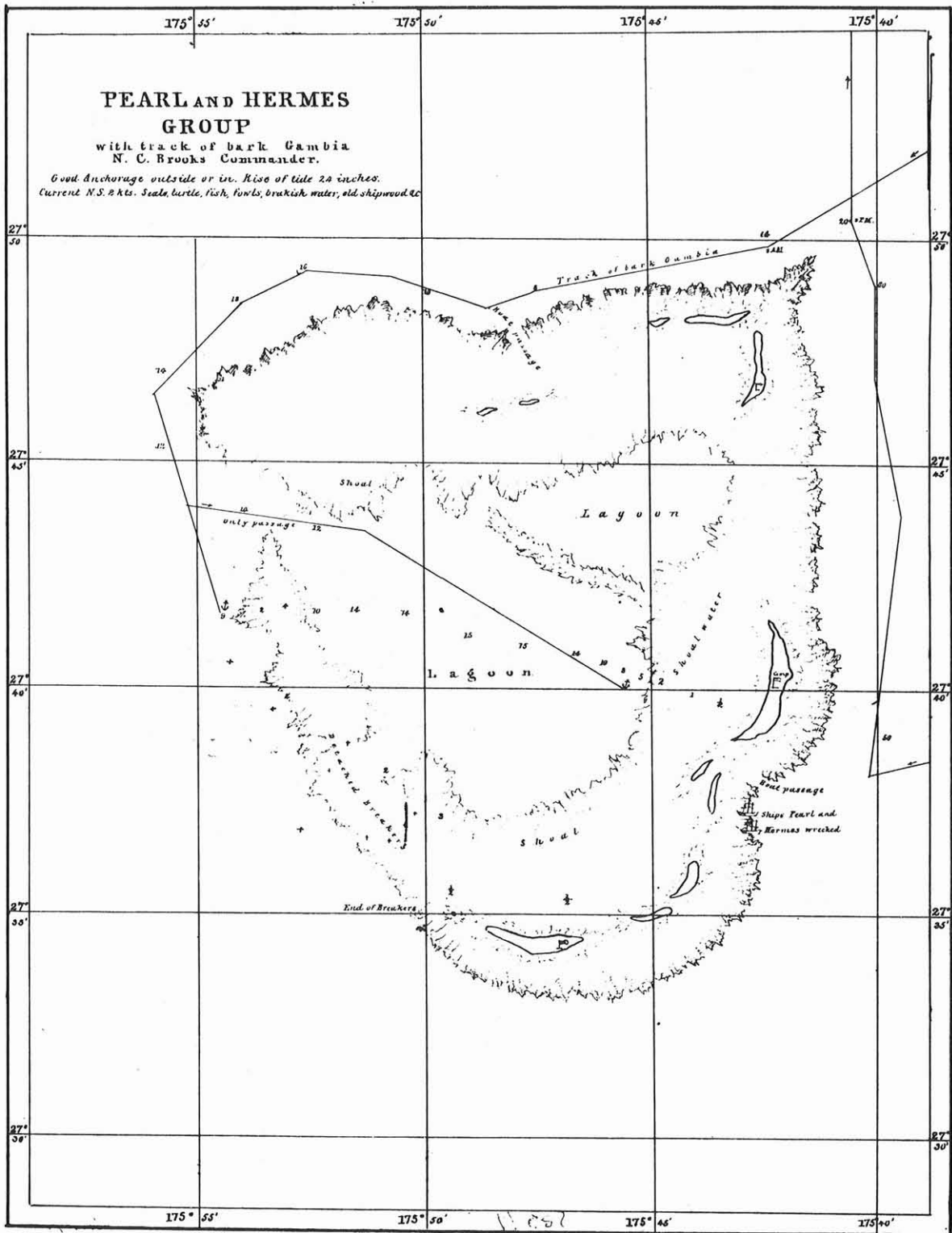
The shifting, splitting, and reforming of sandspits along the southern and northeastern reefs account for the 12 islands Brooks (1860: 502) reported in July 1859 (Fig. 3). Five definite islands are indicated on the chart (Fig. 4) made by the USS Lackawanna in August 1867 (USNHO chart 4, January 1868). Four of the areas indicated are much larger than any present-day islands, but are in the positions of the islands now known as Grass, North, Seal, and Southeast; another large land area is southwest of North Island. It is difficult to ascertain whether these areas were vegetated, but by comparing the original chart with others made by the Lackawanna at the same time, it appears that only Southeast Island had vegetation (U.S. Nat. Archives, Cartog. Div., R.G. 37).

Elschner (1915: 59-62), who visited Pearl and Hermes in September 1914, altered the Lackawanna's chart slightly. Six islands are shown, two of which ("Southeast Island and Sand [North] Island") supported vegetation.

¹Gross *et al.*, (1969: 21) reported the land area to be 493 acres, a figure we consider to be much too high.

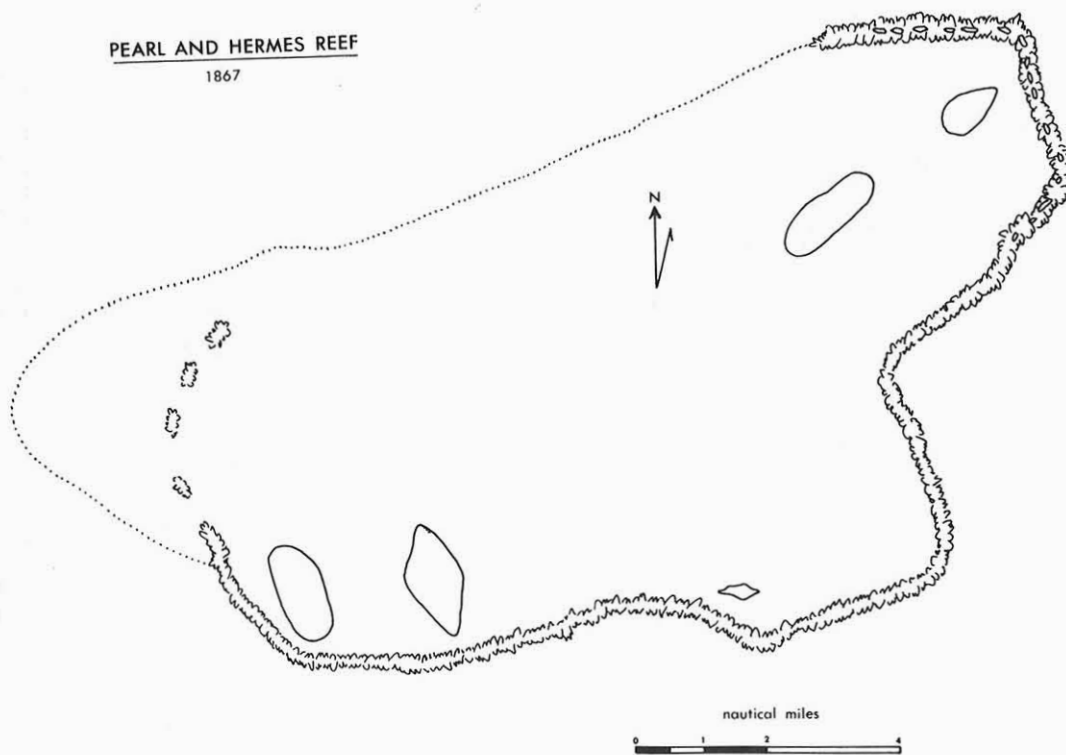


2. Map of Pearl and Hermes Reef. Redrawn from U.S. Coast and Geodetic Survey chart 4175.



3. Early map of Pearl and Hermes Reef. Unpublished 1859 map by N.C. Brooks showing track of Gambia and wrecks of Pearl and Hermes (U.S. Nat. Archives, Cartogr. Div., R.G. 37).

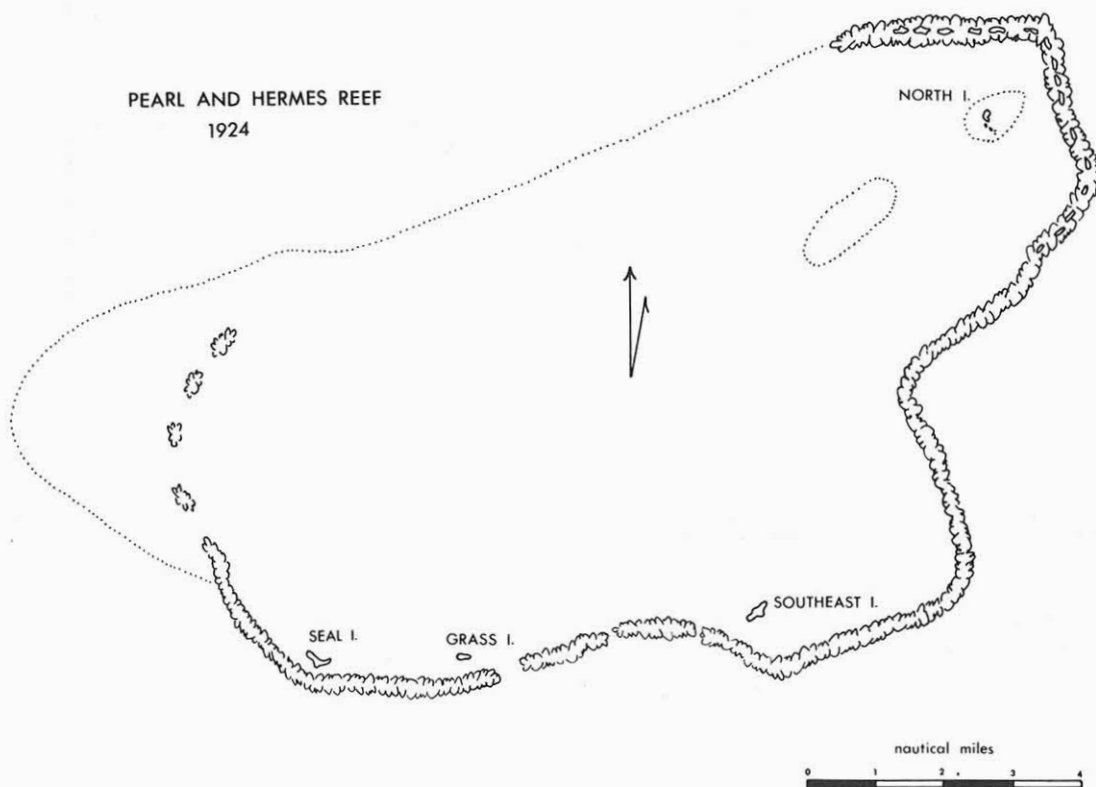
PEARL AND HERMES REEF
1867



4. Map of Pearl and Hermes Reef, 1867. Redrawn from U.S. Naval Hydrographic Office chart 4, 1868.

5. Map of Pearl and Hermes Reef, 1924. Redrawn from U.S. Naval Hydrographic Office chart 4, reissued 1924.

PEARL AND HERMES REEF
1924



U.S. Naval Hydrographic Office chart 4 was reissued in August 1924 when additions and corrections made by the April 1923 Tanager Expedition were added. The western islands of Seal and Grass were named by the leader of that expedition, Alexander Wetmore (ms.), and Gregory (1924: 21) notes the naming of the two "hitherto uncharted" islands. This reissued version (Fig. 5) still indicated a land area southwest of North, but the four named islands had been reduced in size to their approximate present-day dimensions. No sandspits are indicated between Grass Island and Southeast Island although Wetmore (ms.) investigated this area by small boat. Tanager Expedition maps located in the Bishop Museum, Honolulu, show a small sandbar 500 yards northwest of Seal Island; this may have been the beginning of Kittery Island.

The atoll was not charted again until 1930 (Galtsoff, 1933: 8). In addition to Grass, North, Seal, and Southeast Islands, Galtsoff's chart indicated two sandbars due south of North Island, three small sandbars due west of Southeast, and a small island about a half mile northwest of Seal in the position of what is now Kittery Island.

U.S. Naval Hydrographic Office (USNHO) chart 5647,¹ made from U.S. Navy hydrographic and topographic surveys in 1936, names Kittery Island and locates it in the position given by Galtsoff (1933: 8). Chart 5647 shows one island where Galtsoff indicated three sandspits and names it Bird. Another small island, Sand, is added west of Bird in an area where Galtsoff only indicated very shallow water. In the northeastern section, chart 5647 notes only one sandbar, awash at high tide, south of North Island. About three miles west of North, in roughly the position indicated as land by USNHO chart 4, is the notation, "sand bars awash at HW [High Water]."

In 1963, when the POBSP first visited Pearl and Hermes, the sandbar south of North Island was at least 5 feet above sea level and 1,000 feet long. Four plant species were found, and a few albatrosses and Blue-faced Boobies were nesting.

These data suggest that considerable changes have occurred in the topography of Pearl and Hermes Reef in the past one hundred years, and that minor changes are still occurring (see Geology section). Photographs taken by Walter F. Frear, former Governor of the Territory of Hawaii, and kindly lent to the POBSP by his daughter, and those lent by Alexander Wetmore and Paul S. Galtsoff support this hypothesis of change and provide further material for a discussion of vegetation changes in a following section. The photographs taken by Governor Frear in December 1912, though unlabeled, are probably all of Southeast Island. Wetmore has photographs of Grass, Seal, and Southeast Islands taken in April 1923; Galtsoff's photographs are mainly of Southeast Island in the summer of 1930.

¹USNHO chart 5647 was published in February 1947; it is superseded by USCG chart 4175.

Grass Island

Grass Island (Fig. 6), at 27°46' N x 175°54' W is just inside the reef on the southern side of the lagoon 4.7 miles west of Southeast Island. It is 1,800 feet east to west, and only 400 feet wide at its broadest, near the western end. It has an area of 11 acres. A spur of reef rock extends westward from the eastern tip for 400 feet along the southern side of the island, but does not touch the beach. In 1965 the western end was being eroded by the sea, leaving a vertical drop of 5 feet to the water at that end of the island. Only a portion of the western end, less than 700 feet long east to west, is vegetated. The dominant plant species is the woody Solanum which grows in a dense mat to a height of about a foot in the central 400 feet of this area. Other herbs and grasses grow sparsely in the transition zone of coral rubble between the matted area and the sand beach. The rest of the island is composed of coarse to fine sand, with an area of coral rubble in the center of the eastern portion.

In 1923 Wetmore (ms.), who named this island, noted that "it is about 450 yards long by 100 yards wide, 15 feet high, surrounded by a beach of coral sand." The crest of the island was covered with bunch grass and a few of the shrubs recorded on Southeast. Cmdr. S.W. King sketched Grass Island in 1923 (Fig. 7).

Kittery Island

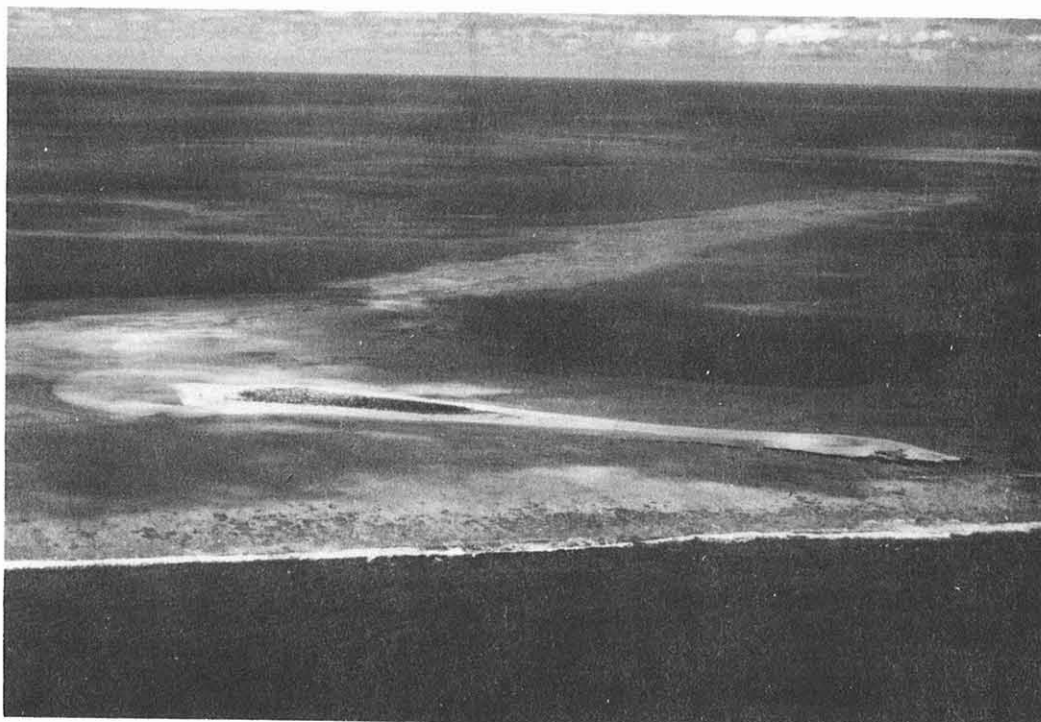
Kittery Island (Fig. 8), at 27°45' N x 175°56' W, is a low sand and coral rubble triangle less than half a mile northwest of Seal Island. It has no vegetation. Troughs eroded in the sand of the island's interior suggest that it is periodically inundated during severe weather. The island covers 11.9 acres, and its longest north-south and east-west axes are about 1,100 feet. The northwestern side is highest, about 5 feet above sea level, and the interior, southern, and eastern portions are just barely above normal high-water level.

This island existed only as a small sandbar in 1923, was present in 1930 (Galtsoff, 1933: 8), and was finally named by the U.S. Navy survey in 1936.

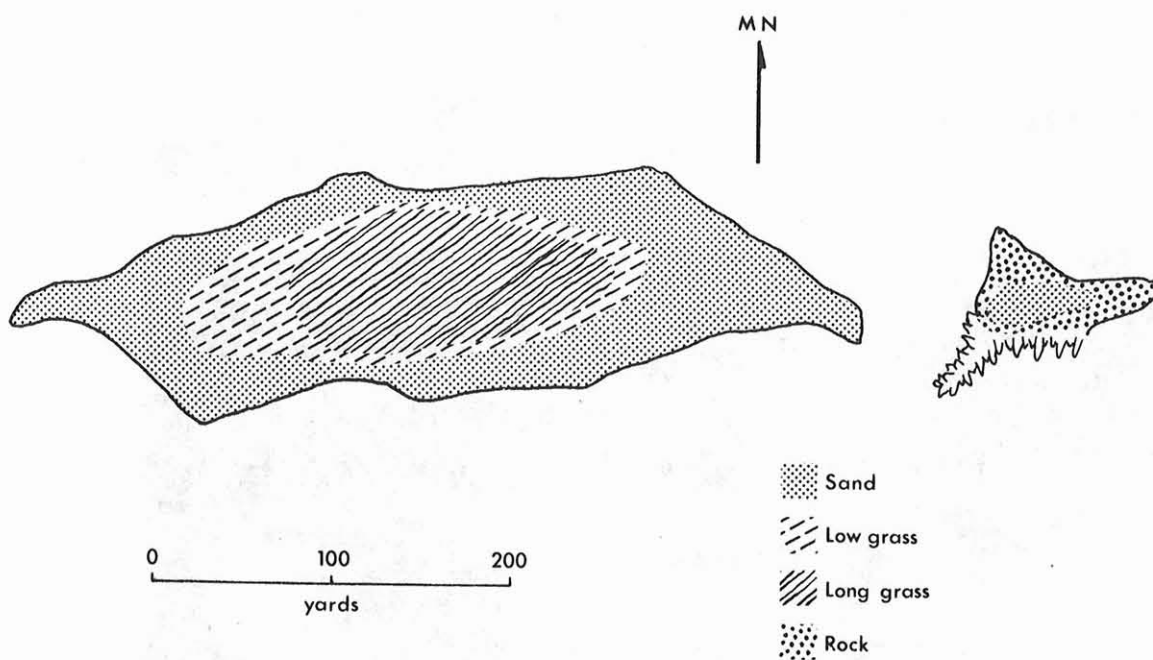
Little North Island

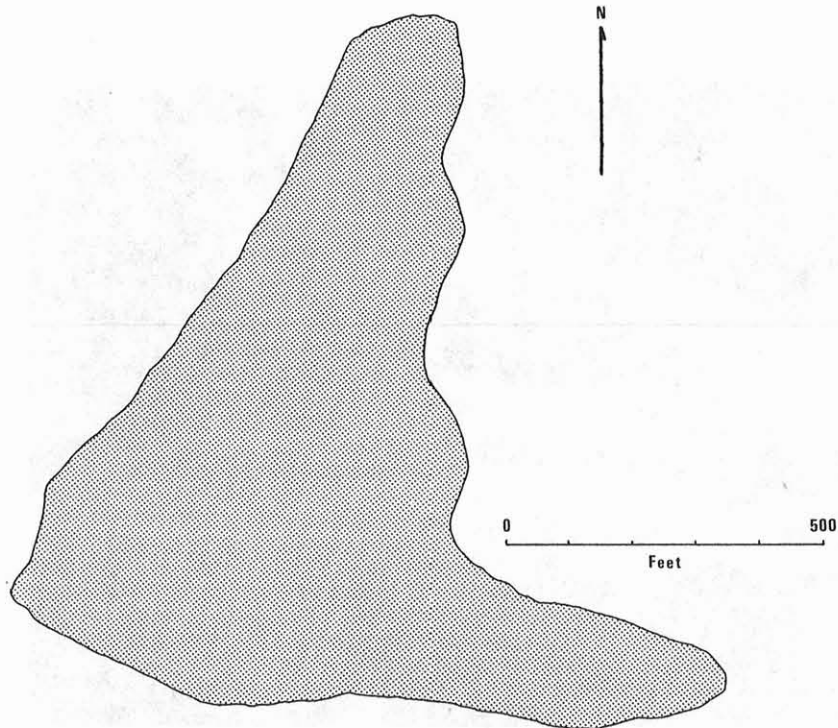
Little North Island (Fig. 9), at 27°54' N x 175°44' W, is a half mile south of North Island. Its name was officially recognized 11 February 1969 by the U.S. Board of Geographic Names. Until then it had been nameless but was referred to by Clapp and Woodward (1968: 19-27) and Standen (1967: 29, 38) as Humphrey Island (after Philip S. Humphrey, Director of the POBSP).

At low tide, it is presently less than 200 feet wide and is about 1,100 feet long in a north-south direction. The central portion of the main island, 400 feet long and 1.4 acres in area, is 6 to 10 feet above sea level, and has a meager flora of 4 species of grass and herbs. The long, low sandspit at its southern end appears to be extending itself southward and curving to the



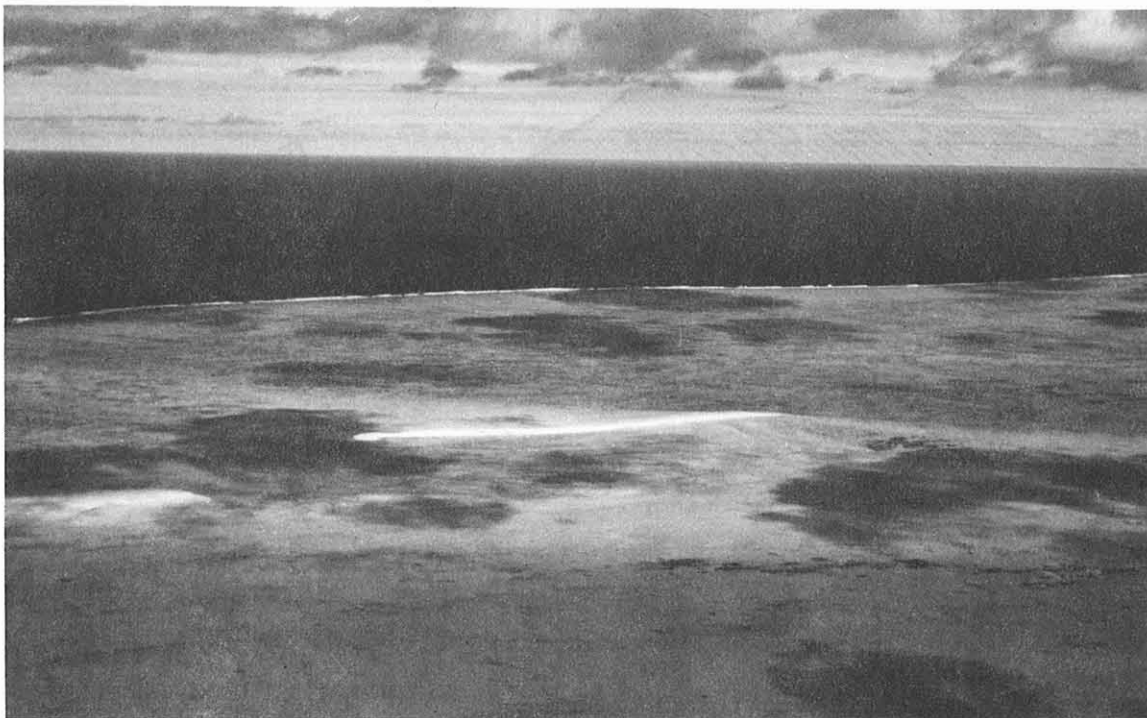
6. Aerial view of Grass Island, 5 June 1962. Official U.S. Navy photograph.
7. Map of Grass Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.





8. Map of Kittery Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.

9. Aerial view of Little North Island, 5 June 1962. Official U.S. Navy photograph.



west; three small disconnected sandbars, presently just above high-tide level, extend the length of the island another 500 feet. Six to eight hundred feet west of the island is another series of sandbars which has not quite broken the surface of the water. The island may change from year to year or seasonally; however, recent observations indicate that the area is building up.

North Island

North Island (Fig. 10) lies in the northeastern corner of the lagoon at $27^{\circ}56' N \times 175^{\circ}44' W$, and is 10 miles north-northeast of Southeast. It is polliwog-shaped, with the tail extending southward. It has an area of 15.9 acres.

The body is about 1,000 feet long north to south, and 800 feet wide; it is 10 feet above sea level. It has a steep narrow beach on its east, north, and west sides. The center of the body has a dense flora of herbs, and the remainder is a mixture of herbs and grasses, with some grasses growing among the coral rubble between the interior and the beach. There are some rotting timbers along the west side, and a few pilings in the lagoon to the southeast which were probably left by the mother-of-pearl oyster fisheries venture in the late 1920's.

The tail extends southward from the body for 1,000 feet, and is about 100 feet wide throughout its length. Its proximal portion is 5 feet above sea level for 500 feet, and its distal portion is a low, shifting sandspit.

One of the few previous descriptions of the island is that of Willett (*in* Bailey, 1956: 32), who mentions that in 1913 the island was "topped with a scanty growth of tough grasses." Elschner (1915: 62, 64) mapped it in 1914 and noted that it was "overgrown with high grass." Commander S.W. King of the Tanager Expedition also charted it (Fig. 11) in 1923.

Seal Island

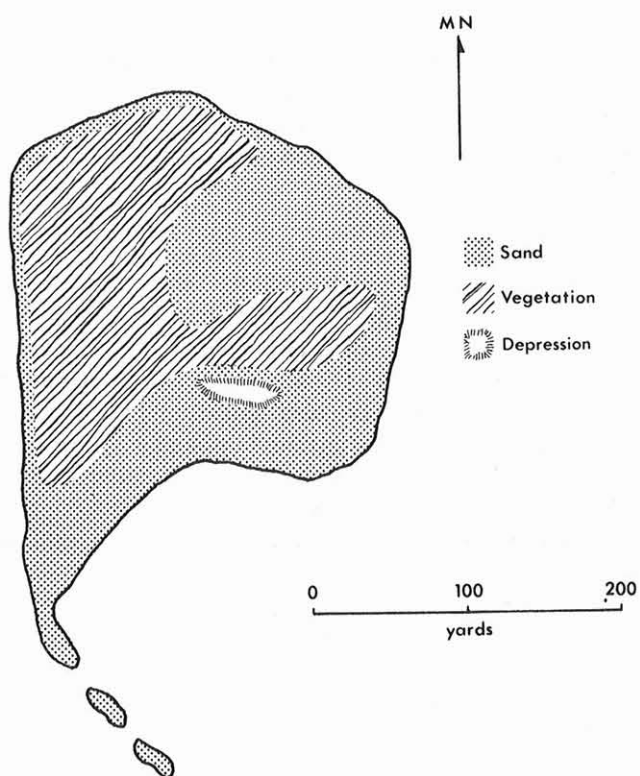
Seal Island (Fig. 12) also lies just inside the reef, in the southwestern section of the lagoon at $27^{\circ}45' N \times 175^{\circ}56' W$. It is 2 miles west-southwest of Grass Island. Seal is 1,400 feet from east to west, and 300 feet wide at its broadest point, with an area of 10.6 acres. The eastern half is composed of coral rubble and sand, with rocky ledges and reef sections on the southern side. Succulent plants grow sparsely throughout the area. This entire half is broken by numerous tidal pools and cuts in the rock. The intertidal zone on the northern side is of fine sand. A solid ledge of rock forms a northeast to southwest line across this half.

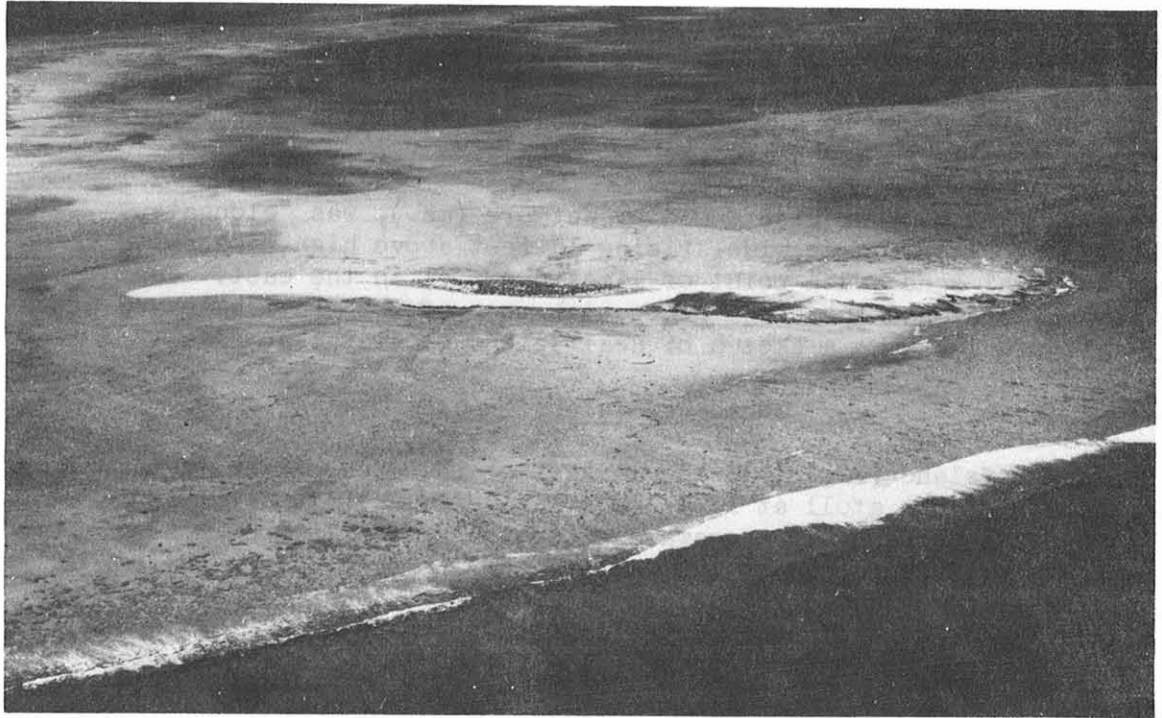
The western half has a wide, sandy beach on the south, a narrow coarse rubble beach on the north, and a point of coarse coral rubble and sand curving to the north at its western end. An area of the western half, measuring 600 feet east to west, and less than 150 feet wide, is about 6 feet above sea level. Almost all of the island's vegetation is confined to this area.



10. Aerial view of North Island, 5 June 1962. Official U.S. Navy photograph.

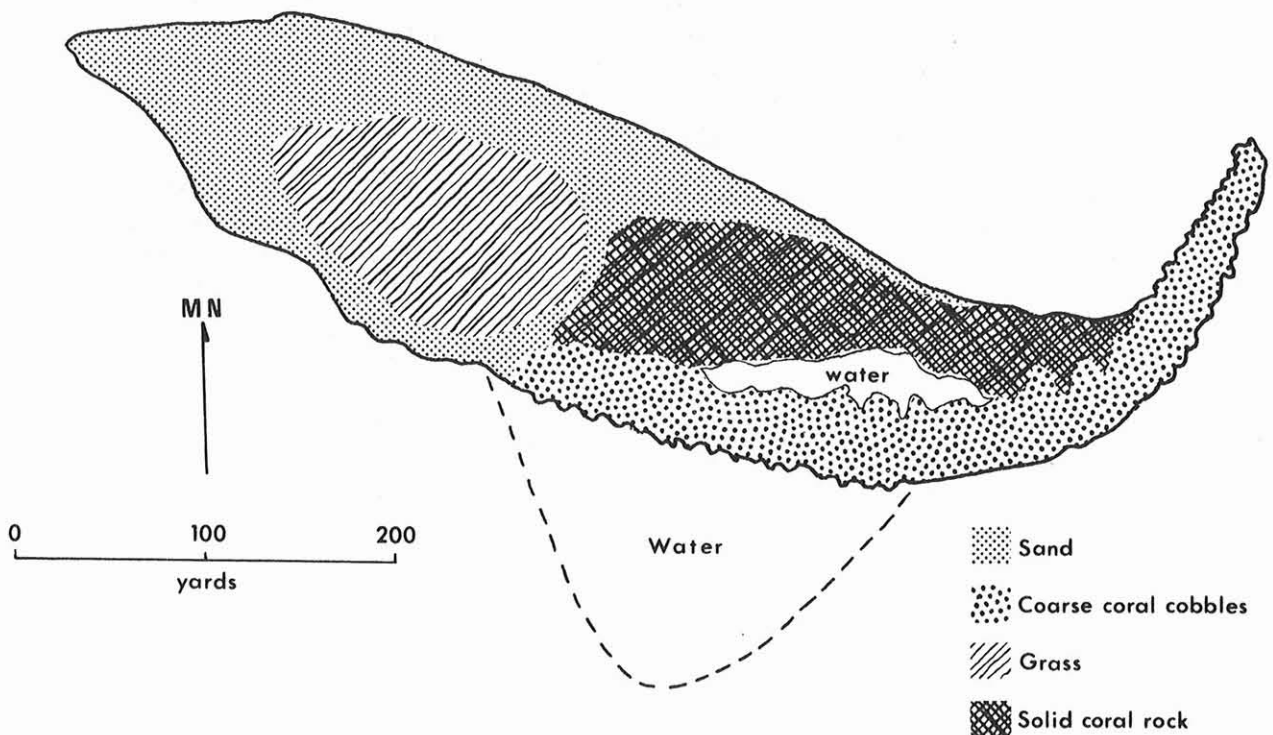
11. Map of North Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.





12. Aerial view of Seal Island, 5 June 1962. Official U.S. Navy photograph.

13. Map of Seal Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.



The dominant plant forms are vines and grasses. The central portion is fairly lush, giving way to a sparsely vegetated transition zone in coral rubble, and finally to beach sand.

In 1923 this island, also named by Wetmore (ms.), was "elongate, 600 yards long by 300 yards wide, rising 15 feet above high tide, with a beach of coral sand and a point of limestone rock in the east. The crest was covered with the bunch grass with much of the grayish leaved shrub." Figure 13 shows a sketch of Seal Island made at that time.

Southeast Island

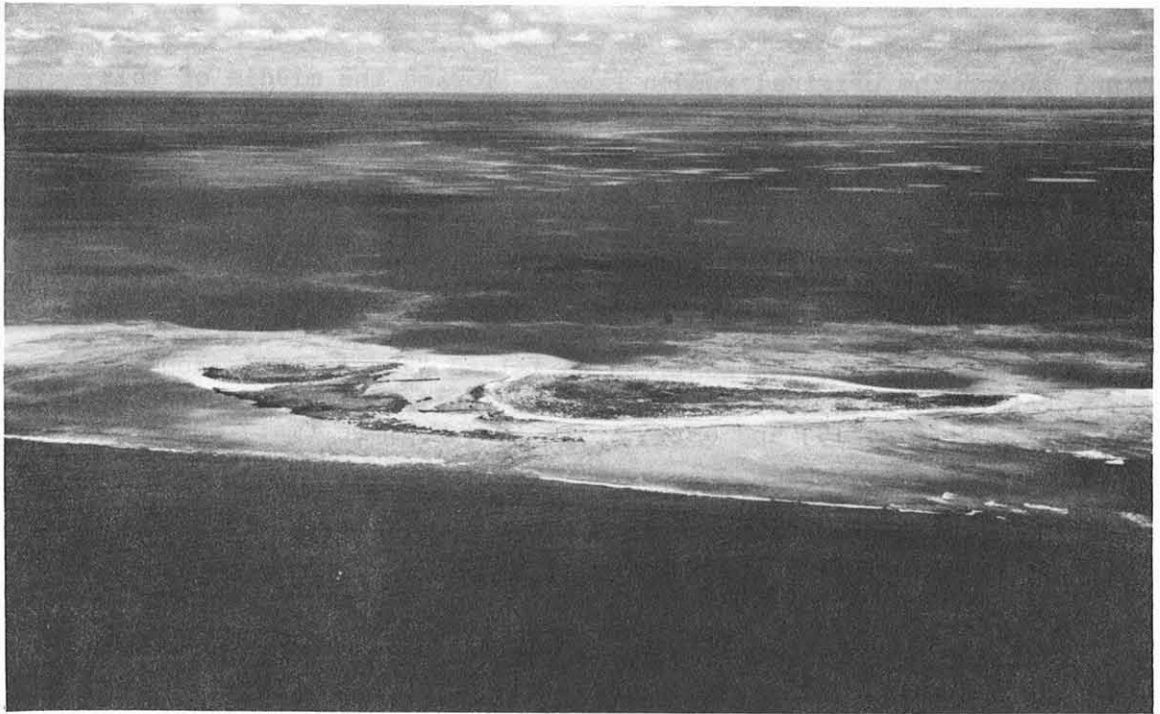
Southeast Island (Fig. 14), the largest of the group, lies in the eastern corner of the atoll at 27°47' N x 175°48' W. It is nearly cut into two unequal portions by a seaward extension of the lagoon. The smaller western section is connected to the eastern section by a narrow sandbar on its northern side.¹ The entire island is 2,600 feet long east to west. Excluding a large ledge of reef rock along its southern side, the island has a maximum north to south width of 1,100 feet. It has a land area of 34 acres.

The western section has a kidney-shaped central area 700 by 400 feet on which grows a sparse flora of grasses, decumbent herbs, and vines. A low flat shelf, or ledge, of reef rock, supporting a thick growth of a succulent herb, extends eastward from the southeastern corner of this section, and partially along the southern side of the large eastern portion of the island. A steep, narrow beach extends around the western and northern perimeters of the western section. A U.S. Coast and Geodetic Survey marker placed at the northwestern corner of the island in 1937 was toppled into the water in 1965 by erosion from the west. The larger eastern section is 1,800 feet from northeast to southwest, and is roughly triangular. There are up to three tidal pools, depending on tide and season, in the eastern half of this section; the depth of the brackish water rises and falls with the tide. The area in and around these pools is dominated by the succulent herb Sesuvium.

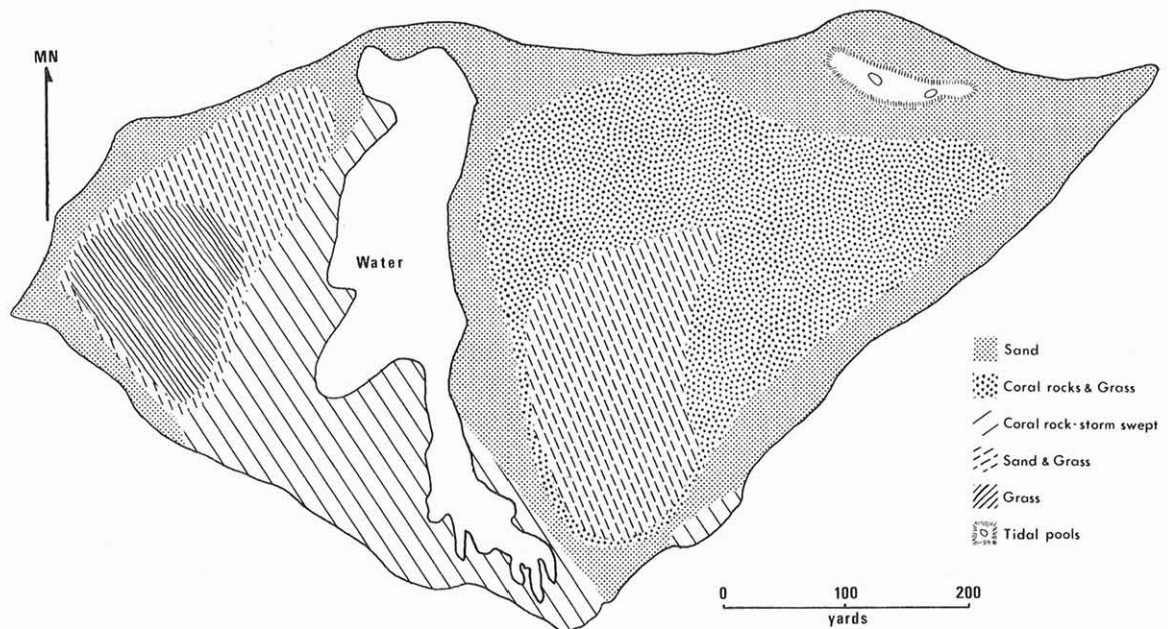
To the west of the pools are patches of grasses and decumbent herbs, almost completely surrounded by a large area of introduced mustard plant. From this central vegetated area to the beaches is relatively open coral sand and rock rubble with a sparse and patchy flora. The extent of these patches varies with location and season. A few small Scaevola bushes grow along the southwestern edge and a narrow sandy beach surrounds the entire section.

A 15-foot-high steel frame tower near the lagoon side of the eastern section was built by U.S. Navy personnel in 1961, but by 1969 was badly

¹Although narrow and low, this sandbar has always been present. Bad storms from a northerly direction might, however, destroy it; northwesterly and northeasterly winds, on the other hand, would keep it intact.



14. Aerial view of Southeast Island, 5 June 1962; a small-boat channel through the reef occurs just out of view on the right. Official U.S. Navy photograph.
15. Map of Southeast Island, May 1923. Redrawn from B.P. Bishop Museum map by Cmdr. S.W. King.



rusted and lacked the original wooden floor. Toward the middle of this section are two piles of rusting 55-gallon drums, and on the southwestern shore of the eastern portion is a large steel tank, the latter apparently washed up on the island by severe storms.

There are little available data on early vegetative and physiographic changes on this, or any other, island of Pearl and Hermes Reef. There are apparently no notes from the ship wrecks of 1822. Brooks (1860: 502) reported that "the largest islands were covered with coarse grass and trees"¹ in May 1859. Munro (1942: 12) mentions an island "about a mile long, with some low vegetation" seen during his visit in 1891. The Tanager Expedition mapped the island (Fig. 15) and on 26 April 1923 Wetmore (ms.) recorded that:

the island is elongate, about 900-1000 yards long by 500 yards wide, rising 15 feet above high water. Along the western portion, the beach is of coral sand. Somewhat west of the center there is a tiny, irregular lagoon. A band of blackened and eroded limestone forms the southern shore here and extends out in a broad hook to the eastward. The island rises between 10 and 18 feet at the highest point. Two ridges are covered with clumps of bunch grass one to two feet tall, and a sprawling shrub with thick rounded hirsute leaves of grayish-green color [Solanum] is abundant. There is a low spot with blackish soil on the eastern portion of the north side that evidently holds water after rains. It was now dry. Near this we found remains of an old camp. Upright sticks had apparently been used to support shelters of canvas, and some rubbish, iron cans, etc., lay about. Indications were that it was a camp of Japanese, perhaps from a wrecked sampan.

The physiography of the island has not changed significantly in the 40 years since that description, but the vegetation has been considerably altered. There is no sign of the camp mentioned by Wetmore, though there are still traces of the brief stay of the mother-of-pearl oyster fisheries --some rotting timbers, rusty corrugated roofing, and a pile of oyster shells.

In calm weather, small boats can safely land on the island's southeast beach by way of a small-boat channel through the reef (see Fig. 14). The bottom near the beach in this area is coral-rock, not sand.

Other Islands

Bird Island (27°47' N x 175°50' W), Planetree Island² (27°47' N x 175°49' W), and Sand Island (27°47' N x 175°52' W) are, though relatively

¹Probably refers to Scaevola.

²Planetree Island was named by the crew of the U.S. Coast Guard buoy tender of that name in March 1964; it is not an official name recognized by the U.S. Board of Geographic Names.

constant in position, continually changing sandspits along the inner margin of the southern reef between Southeast and Grass Islands. Rice (ms., a) described them as "merely part of a three-mile chain of shifting sandspits just inside the south reef." On various aerial surveys in the fall and winter of 1956-57 and 1957-58 he found their number ranged from 4 to 12. They are presently nowhere wider than 100 feet, and vary in length, depending on winds and tide, from 500 to 1,500 feet in an east to west direction. POBSP personnel found no vegetation on them.

A narrow, ship channel (Fig. 16) exists between Sand and Bird Islands (see also Fig. 2); its minimum depth is only 2 fathoms. A small-boat channel (Fig. 17) occurs between Bird and Planetree Islands; its minimum depth is 1.5 fathoms.

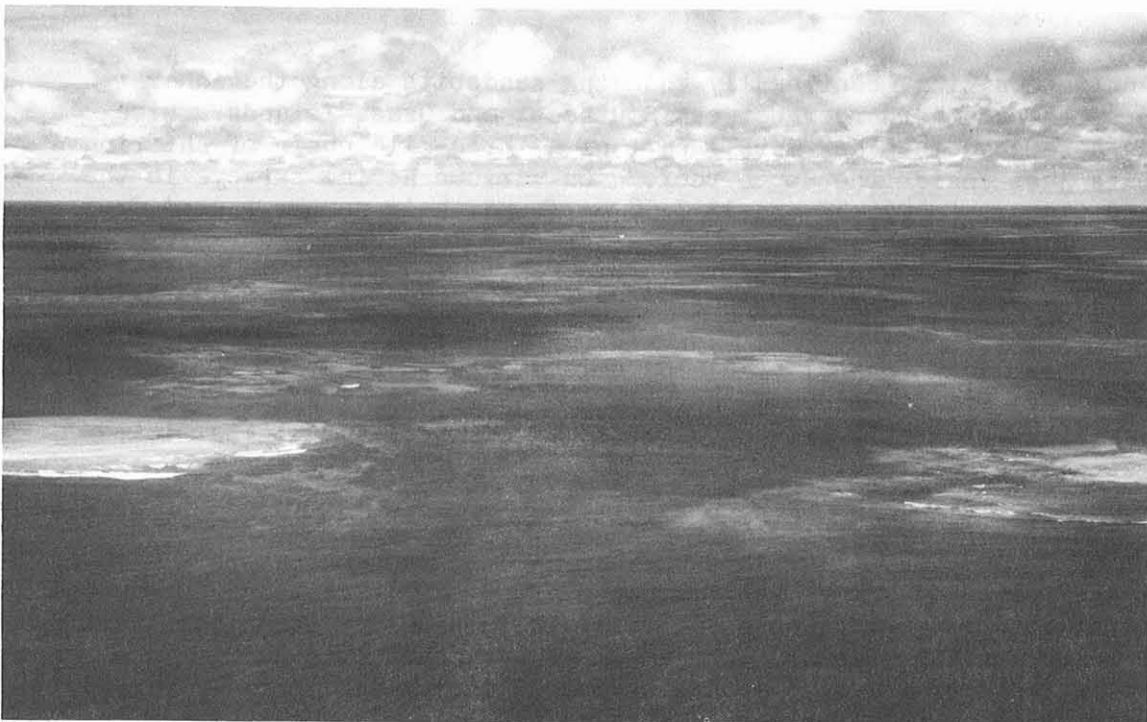
GEOLOGY

Today Pearl and Hermes Reef is but a group of tiny islands surrounded by a coral rim protruding above the water in the Pacific Ocean northwest of the Main Hawaiian Islands. The atoll is a remnant of a summit in a 2,000-mile range of volcanic mountains formed during the Tertiary Period. Erosion by wind, waves, and rain destroyed the volcanic domes, which in turn provided a suitable environment for the growth of coral. At equilibrium, a rim of coral remained, enclosing a lagoon on top of the peak (Stearns, 1966: 217-219; Wiens, 1962: 85-135).

Gravity investigations to find the magnetic center of each of the Northwestern Hawaiian Islands by Kroenke and Woollard (1965: 363) show a +276 mgal Bouguer anomaly value on the southeast reef at Southeast Island. Gravity gradient values increase, at an average rate of 5 mgal per mile southwestward, to +285 mgal at Kittery Island. These gravity contours indicate that the highest reading, or the atoll's magnetic center, should be to the north and west of Kittery, with maximum Bouguer anomaly values possibly as high as +305 mgal.

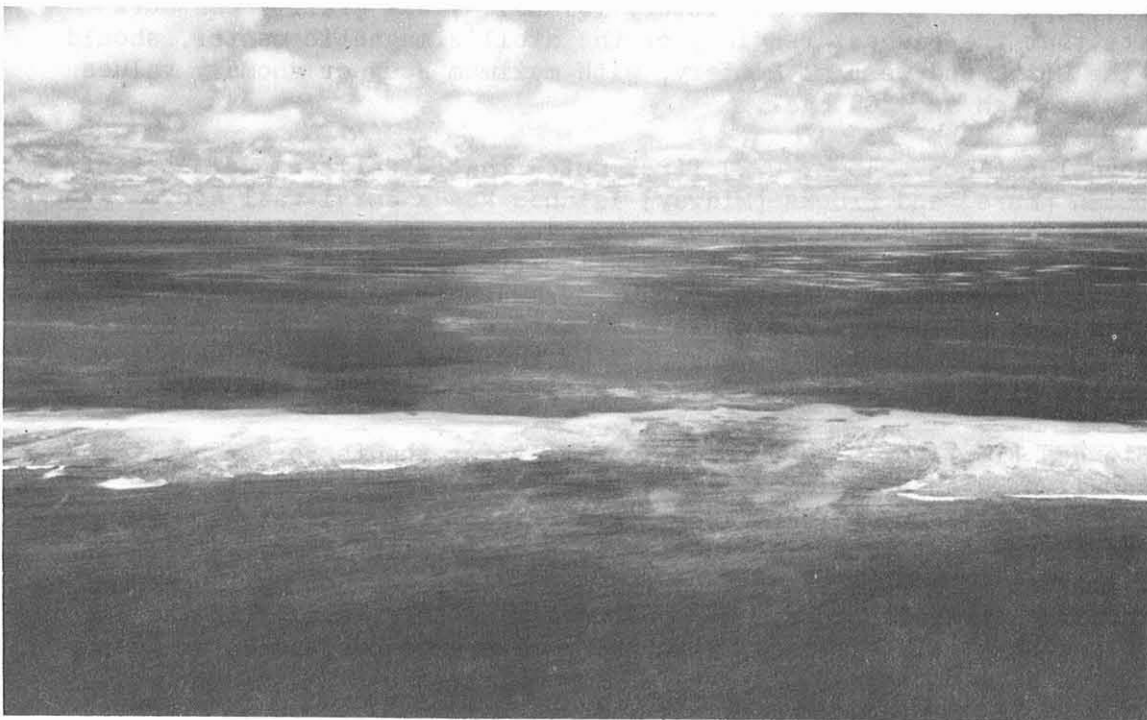
Reynolds (Anon., 1868: 272) first noted that "Pearl and Hermes Reef, like Ocean [Kure] and Brooks [Midway] Islands has a coral wall above water at its N.W. extreme." The reefs of all three are open only on the extreme west side. These features, as Standen (1967: 27-28) points out, are consistent with the theory of Wiens (1959: 39-40), who contends that reef growth is best where wave action is most active. Here on the northeast sector of the reef the trade winds produce the most persistent wave activity; the western side is in the lee of this activity.

Standen (1967: 8, 87-89) points out that for the three northwesternmost Hawaiian Islands, which includes Pearl and Hermes, land distribution within the atoll is 99 percent in the southern half of the atoll. Furthermore, he claims that land distribution is greatly affected by infrequent winter storms, with high winds from the northwest, and not by the normal summer northeast trade winds. He concludes that this land is in the lee of such northwest winter winds, with their main axis perpendicular to the winds.



16. Aerial view of main ship channel between Sand and Bird Islands, 5 June 1962. Official U.S. Navy photograph.

17. Aerial view of small-boat channel between Bird and Planetree Islands, 5 June 1962. Official U.S. Navy photograph.



Standen (1967: 80-86) believes that "the shapes of the permanent islands are mere magnifications of smaller sand bars," and that "larger sections of land added...as sand spits during years with mild winters may become covered with vegetation and thus become part of the permanent island." Because of the atoll's large lagoon size, he suggests "that large [lagoon] waves breaking entirely over the small islets of Pearl and Hermes have hindered the growth of islands of substantial size." Standen further suggests that the small tidal lagoon in the depressed eastern section of Southeast Island may be an intermediate stage in the development of the island, and that eventually it will fill with debris and dry up. Similar dried areas are found at Green Island, Kure Atoll, and Eastern Island, Midway Atoll.

Standen (1967: 71) analyzed the beach sand and found it to be composed of broken coral and sea shells; he noted that 86 percent of the particles had a diameter of from 0.5 to 4.0 mm. POBSP observers found that the soils ranged from pure coral sand and gravel on the beaches, through coarse coral rock rubble to mixtures of coral sand and some humus in the vegetated areas. The atoll does not appear to have any phosphatic guano deposits (Hutchinson, 1950: 207).

Bryan (1942: 198) mentions that brackish water can be obtained by digging shallow wells. The efforts of Galtsoff (1933: 13) to find a fresh water-bearing stratum at Southeast Island were fruitless, although he found the slight depression in the eastern section briefly retained fresh water after a rain. It did not remain because of the porosity of the ground.

Galtsoff (1933: 14) found that the depth of the lagoon varies from 1 to 104 feet, and at the western opening from 1 to 90 feet. Many small coral growths and reefs, all with a shallow central portion surrounded by a fringe of living coral, occur in the lagoon. Their center varies in depth from 3 to 8 feet and the bottom is covered with soft coral sand. The outer slope of the reefs supports living coral to a depth of 50 to 60 feet; past this depth coral growth is smothered by a very fine, sticky mud, with very few bottom organisms except foraminifera.

Galtsoff (1933: 14) divided the lagoon into two sections on the basis of the prevailing character of the bottom; the central and northern parts are predominantly occupied by coral reefs, and the eastern and southern parts have predominantly sandy bottoms.

Gross *et al.* (1969: 17-21) reported that the shallow (<5 meters deep) sediment-built lagoon terrace (Galtsoff's sandy bottom) occupies only 14 percent of the total lagoon. They suggest that this lagoon terrace has built leeward from the windward reef (northeastern side) and is encroaching upon the deeper parts of the lagoon.

Thorp (1936: 109-118) studied the lagoon bottom samples collected in 1930 by Galtsoff. He found the four major constituents to be calcareous algae (48.5 percent), mollusks (17.8 percent), madreporarian corals (16.6

percent), and foraminifera (6.3 percent); the other organic groups, and minerals, silt, and clay contribute only 10.8 percent. A few volcanic rocks were mingled with the calcareous sediments. The larger of these fragments, Thorp believed, were derived from below the reef and show that the reef structure rests on a volcanic basement.¹

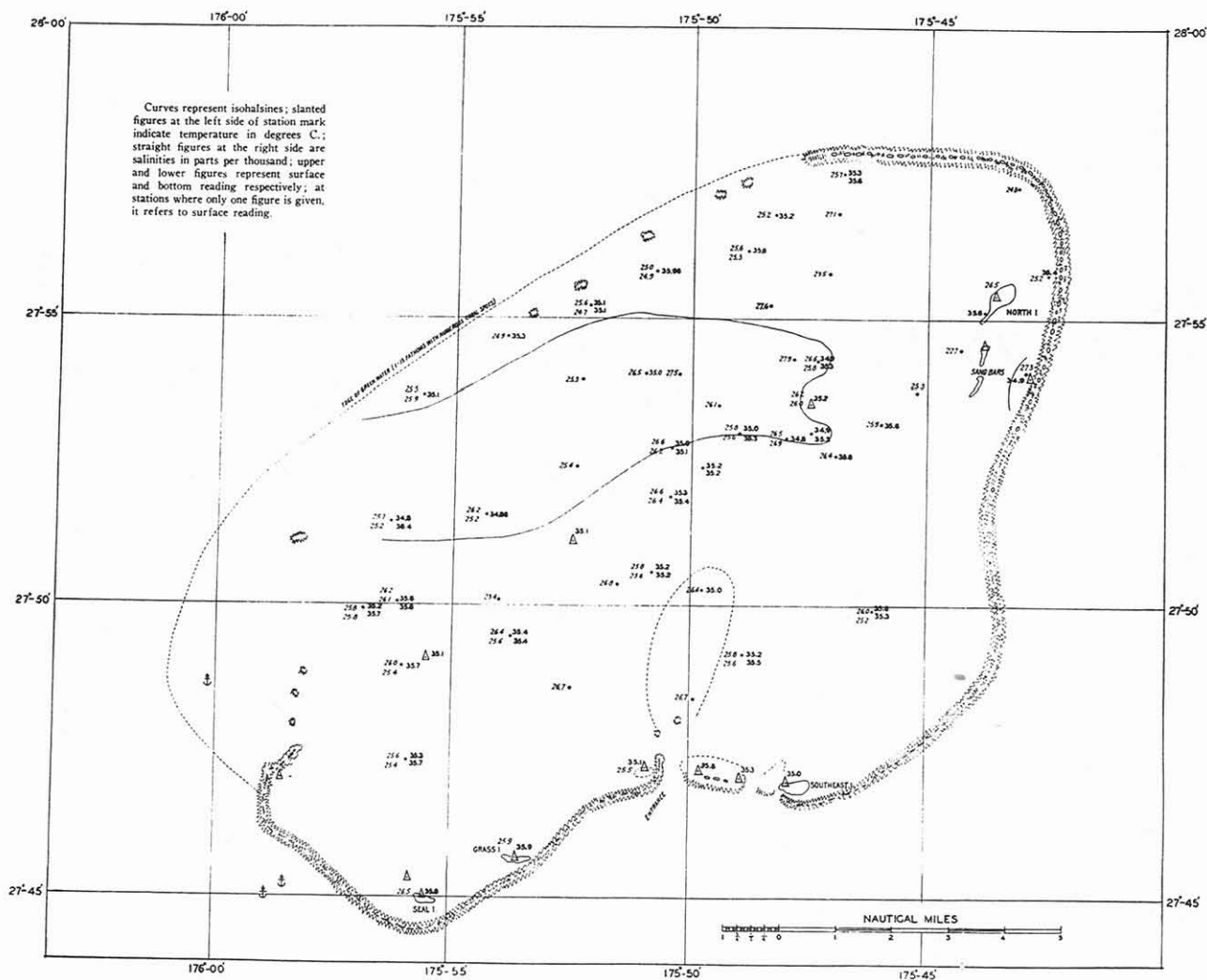
Galtsoff (1933: 15) found the rocks in the northeastern section of the lagoon, several of which were 5 feet above water, to be of coral limestone, greatly resembling the fringing reef, but, as they were separated by several hundred yards, the formation suggested an elevation of the reef or minor changes in sea level during their formation. The outer reef is composed of large coral colonies and also solidified limestone rock.² Spaces between and around the coral colonies are reinforced by lime deposited by the coralline algae, so that the entire structure is permeated and covered with a thick layer of lime. The reef is slightly above sea level, and is covered by barnacles in places.

Galtsoff (1933: 20-25) obtained temperature and salinity data from 22 July to 23 August 1930 (Fig. 18). His observations showed a gradual upward trend of surface water temperature from about 25° C. in July to about 26.5° C. by the end of August; the extremes were 22.7° C. and 27.9° C. The temperature at the bottom differed only slightly from that at the surface; it was usually less than one degree Centigrade cooler (the difference at 90 feet was 1.6° C.). In comparison, Galtsoff pointed out that at-sea temperatures taken near Midway, 90 miles to the west-northwest, over a 10-year period varied from 18° C. in March to 25.1° C. in September, and that Honolulu fluctuations were from 22.5° C. to 25.2° C. He recorded no apparent trend in lagoon salinity; readings varied from 35.6 to 36.6 parts per thousand, but were usually closer to 36.0. His salinity distribution suggested that ocean water enters the lagoon primarily through the opening on the northwestern corner of the reef and the boat channel on the south side. Thorp (1936: 115) interpreted Galtsoff's data differently and wrote "apparently ocean water enters the lagoon principally through the southern boat channel and escapes through the open northwest side." Gross *et al.* (1969: 18, 24) examined a photograph of the area taken 9 December 1965 from the Gemini VII spacecraft and noted distinct plumes of discolored, presumably turbid, water flowing westward out of Pearl and Hermes Reef and Midway Atoll. They suggest that the turbidity of the escaping water may be caused by suspended, silt-sized particles being carried out of both atolls. This recent finding thus supports Thorp's 1936 theory.

Galtsoff (1933: 24-25) reported that the tidal range is about two feet and that the tide sets north and south with a velocity of two knots. The direction of tidal currents at specific localities within the reef is complex, and depends upon the configuration of the reef.

¹Ladd, Tracey, and Gross (1957: 1088-1094) found a volcanic base on Midway using cone drillings.

²Gross *et al.* (1969: 22) found the carbon-14 age of the emergent reef rocks at Midway to range from 1,230 ± 250 to 2,420 ± 300 years.



18. Chart showing distribution of temperature and salinity within the lagoon, July - August 1930. Reproduced with permission from Galtsoff (1933: figure 4, opposite p. 24).

CLIMATE

Climatic data for this area are available only from Midway Naval Station. There is no significant difference between the general weather conditions of the two areas. The following information is derived from a summary of the years 1953-1963 (Air Weather Service [MATS] Climatic Center USAF).

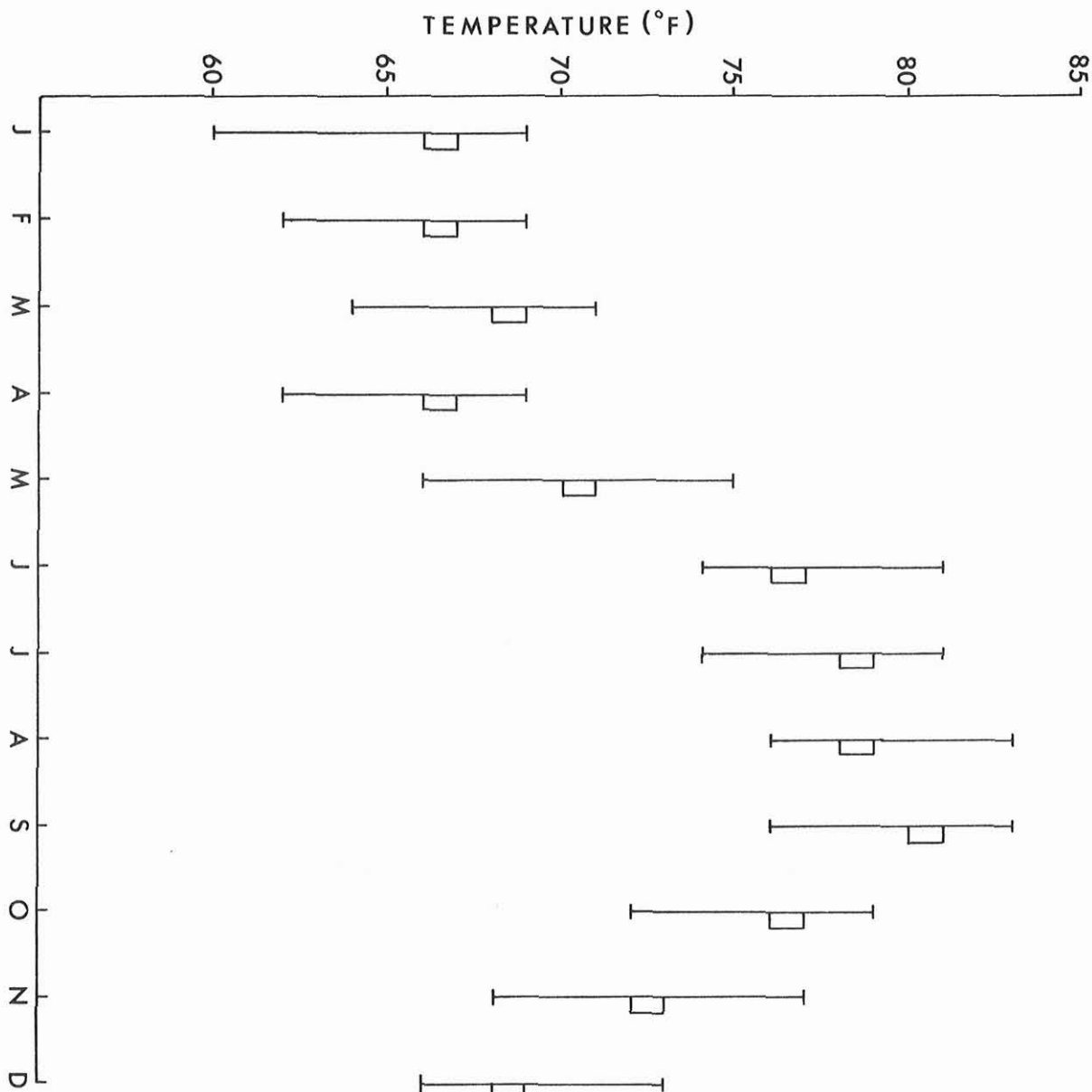
The climate is marine, influenced by marine tropical or marine Pacific air masses depending upon the season. During the summer the Pacific High becomes dominant, with the ridge line extending across the Pacific north of Kure and Midway. This places the region under the influence of easterlies with marine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

The monthly temperature means for the 10-year period and the range of the maximum and minimum temperatures for each month are shown in Figure 19. The temperature variation shown is indicative of a marine environment. The mean annual range is 16° F. From December through April the means are between 66° F. and 69° F., and during the remainder of the year between 70° F. and 81° F., the warmest months being July, August, and September, and the coolest January, February, and April. A 37-degree difference exists between the absolute high of 89° F. and the absolute low of 52° F.

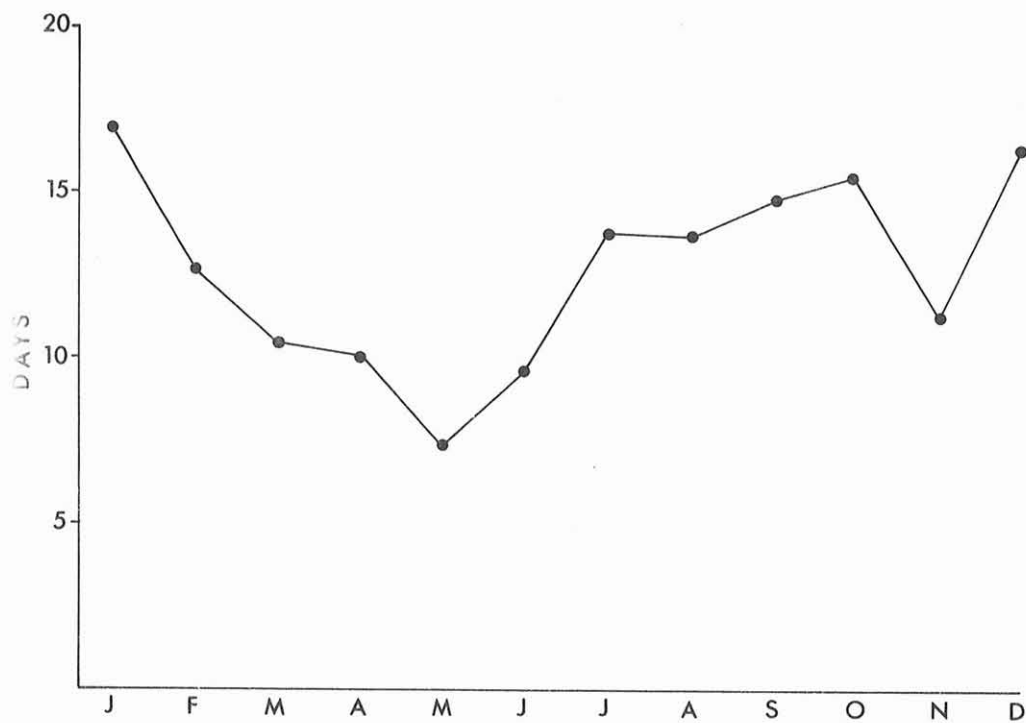
Mean number of days with measurable precipitation and the mean monthly precipitation in inches are indicated in Figures 20 and 21. Rain or drizzle most frequently occur from July through February, and least frequently in May and June. The mean annual precipitation for the period is 42.59 inches, with a maximum of 5.07 inches occurring in January and August, and a minimum of 2.03 inches in November. A secondary high of 4.92 inches occurs in October. Combining amount of precipitation and days with measurable precipitation shows May and June to be the driest months of the year. During the remaining months measurable rain falls on from 10 to 17 days. Thunderstorms have been recorded in all months except February, March, and April but peak activity seems to occur during August, September, and November. The annual average relative humidity is 76 percent, with a high monthly mean of 89 percent and a low of 62 percent.

During the periods for which data are available, no tropical storm or typhoon passed through the area. Winter storms, however, are common, causing a noticeable increase in precipitation and winds, especially from September to December.

Surface windspeeds and directions are shown in Figure 22. The prevailing wind direction 10 months of the year is easterly, and during December and January westerly. The annual mean windspeed is 10 knots, with

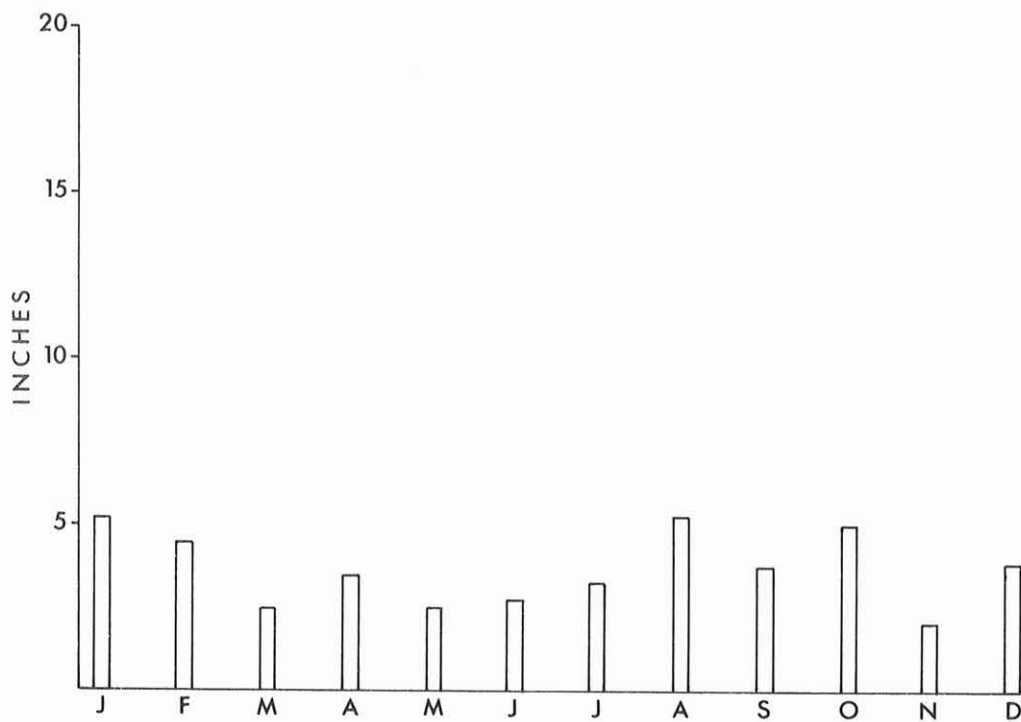


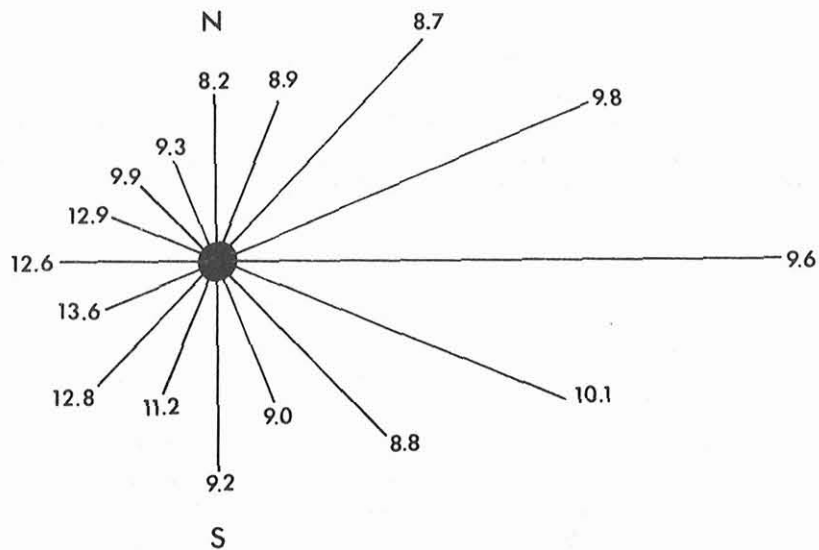
19. Monthly temperature means and their maximum and minimum ranges for a 10-year period, 1953 to 1963, at Midway Atoll.



20. Mean number of days with measurable precipitation for Midway Atoll, 1953 to 1963.

21. Mean monthly precipitation in inches for Midway Atoll, 1953 to 1963.





22. Wind direction and speed at Midway Atoll from 1953 to 1963. Length of directional line indicates percent of observations from that direction; figure at end of directional line is mean wind speed in knots.

a range of 5 knots. Maximum winds occur generally from the east from July through October, and from the west during the remainder of the year. From May through August peaks range from 35 to 41 knots and in the remaining months from 42 to 55 knots. Peak gusts of 77 and 67 knots have been recorded in December and January, respectively.

The mean tenths of total sky cover is fairly uniform throughout the year, ranging from a low of 5.3 in August to a high of 7.3 in March. The yearly mean is 6.2. The occurrence of fog and haze is negligible, but highest in January and March. Minimum visibility caused by rain of less than 1 mile occurs rarely, most often from December through April.

HISTORY

The atoll derives its name from those of two English whaling vessels, the Pearl and the Hermes, which ran aground at nearly the same time on the then unknown reef during the night of 25 April 1822. No lives were lost and provisions and timber were salvaged and used to sustain the crews for two months during which they built a schooner from the salvaged timbers. Shortly before the crews were ready to launch their new schooner, named the Deliverance, another ship--the Thames--was saved from disaster on the reef. Captain Phillips of the Hermes was able to warn her captain in time. While most of the two crews were safely taken off the reef by the Thames, 12 elected to sail the Deliverance into Honolulu (Hawaiian Mission Children's Society Library, Missionary Letters; Bryan, 1942: 197).

The next recorded visit was that of Captain Benjamin Morrell, Jr., from 8 to 10 July 1825, who wrote of seeing "pearl-oysters and biuche de mer" as well as green turtles, seal elephants and sea leopards (Morrell, 1832: 217-218).

Twenty-five years later Albert G. Osburn, aboard the brig Rodolph, visited the atoll on 11 August 1850 in search of sea turtles. Captain Perry and three crewmen landed on a "small island not 1 mile in circumference." They found the island covered with grass and a vine; nesting birds, seals, one small turtle, fish, and shell were noted. After killing 10 or 12 seal for food, they departed (Kemble, 1966: 154-156).

Captain John Paty of the Hawaiian schooner Manokawai stopped at Pearl and Hermes in May 1857 to determine its position and map the islands (Paty, 1857: 2-3; Bryan, 1942: 197). In 1859 Captain N.C. Brooks sailed the Hawaiian bark Gambia there and on 5 July took possession, probably in the name of Hawaii; he reported 12 islands (see Fig. 3), 6 more than Captain Paty observed (Brooks, 1860: 502-503; U.S. Nat. Archives, Frear to Sec. Interior Dept. letter of 30 April 1909, R.G. 48). U.S. Naval Hydrographic Office chart 4 (see Fig. 4) which resulted from the USS Lackawanna's hydrographic observations in August 1867, Captain William Reynolds commanding,

shows the position of just five islands (U.S. Nat. Archives, Cartogr. Div., R.G. 37), not two as reported by Bryan (1937: 30; 1942: 197). Reynolds also took possession of the atoll for the United States.¹

During the off season of sea otter hunting, the Japanese schooner Ada was chartered by an American, George Mansfield, and his friends. They sailed from Yokohama, Japan, on 10 December 1881, bound first for the Bonin Islands and thence to the Northwestern Hawaiians hoping for a cargo of fish, shark, turtle and bêche-de-mer. On 19 January 1882 the Ada, commanded by Harry Hardy, anchored off Pearl and Hermes Reef and in the next two days her crew of 17 killed 28 turtles and collected 54 beche-de-mer and 43 pounds of albatross down. The down was obtained by killing the chicks, dipping them in boiling water, and then stripping off the feathers; petrels, boobies, and frigates were treated in like fashion. The Ada visited the remaining islands down to French Frigate Shoals and stopped a second time at Midway in May 1882 to reprovision before returning to Japan (Hornell, 1934: 426-432).

On 6-7 July 1891, Henry C. Palmer and George C. Munro, who were employed by the Honorable Walter Rothschild of England, the former as his bird collector, anchored off the Reef on the refitted schooner Kaalokai, Captain F.D. Walker in command. They did not land because of "submerged coral patches and sandbars" but described the largest island and the birds sighted (Munro, 1942: 12).

Sometime during the late 1880's or early 1890's John Cameron reported pitching a tent on Pearl and Hermes, but did not remain long (Farrell, 1928: 415).

During this entire period there was little political interest in Pearl and Hermes Reef. In fact, its name was omitted in various official listings of the Hawaiian Islands (Galtsoff, 1933: 11-12). On 15 February 1894, however, an indenture was entered into between J.A. King, Minister of the Interior for the Provisional Hawaiian Government, and a Hawaiian company then known as The North Pacific Phosphate and Fertilizer Company,² for the

¹The question of who possessed Pearl and Hermes was resolved when Hawaii became a United States territory on 30 April 1900. The atoll became part of the State of Hawaii when the Territory of Hawaii was admitted as the 50th State in the Union on 21 August 1959 (Pearcy, 1959; U.S. Dept. of State, 1965). Presently, the City and County of Honolulu hold jurisdiction over Pearl and Hermes Reef by virtue of Section 1717 of Chapter 118 in the Revised Laws of Hawaii dated 1925 (Morris, 1934).

²The name changed to The Pacific Guano and Fertilizer Company in April 1894, but until its sale in 1904 the only island worked appears to have been Laysan (Anon., 1939: 2-22).

lease of Morrell, Ocean, Pearl and Hermes Reef, Midway, and French Frigate Shoals for 25 years at \$1.00 per year. This company, which had been bringing guano into Hawaii from Laysan since 1891 (Anon., 1939: 2-22), was granted the exclusive right to remove guano, phosphate, fertilizers and other material, a royalty of 50 cents for each ton to be paid to the Hawaiian government semi-annually (U.S. Nat. Archives, King - Glade and Hackfeld indenture dated 15 Feb. 1894, R.G. 126).

Beginning in 1902, Japanese feather poachers visited the Northwestern Hawaiian Islands and killed thousands of albatrosses but the extent of their poaching at Pearl and Hermes is not known. The USS Iroquois under Captain Niblack sailed past the atoll on 29 September 1904 and noted "wreckage...but no signs of human beings" (Wilder, 1905: 393). Three Japanese were left there in July 1908 by a Japanese schooner; they were rescued in January 1909 by the schooner Florence Ward (Thrum, 1909: 176). By Executive Order No. 1019, Theodore Roosevelt made Pearl and Hermes a part of the Hawaiian Islands Reservation in February 1909, and placed it under the jurisdiction of the Bureau of Biological Survey, Department of Agriculture.¹

During the years 1910 to 1916 the U.S. Revenue Cutter Thetis visited Pearl and Hermes numerous times, sometimes landing, other times merely sailing around it. After arresting Japanese plumage hunters at both Laysan and Lisianski on 17 and 20 January 1910, Commander Jacobs proceeded to Pearl and Hermes but found "no evidence of it having been visited in recent times." On 24 December 1912 the Thetis returned and Commodore Salisbury visited "the sand islands inside the reef." In addition, Hawaii Governor W.F. Frear landed on one of the islands to take photographs (U.S. Nat. Archives, Thetis logs, R.G. 26).

On 15 March 1913, the Thetis landed Alfred M. Bailey and George Willett at the northern island. In September of the following year Carl Elschner, a chemical engineer, although unable to land on the southwest island, visited the northeast island and found it "overgrown with high grass which offers attractive breeding places for the numerous Terns and Boobies." He also observed other birds, seals, and turtles and made geological observations (U.S. Nat. Archives, Thetis logs, R.G. 26; Elschner, 1915: 59-60; Bailey, 1956: 30-31).

In March 1915 and in February 1916 the Thetis checked the atoll for feather poachers but found none. During the latter visit, W.H. Munter reported birds, seals, turtles, and, on Southeast Island, rabbits. He also indicated that Southeast Island had "been recently visited by man; probably within a year and a half, judging by the conditions of the remains of a crude shelter that had been constructed on the north side of the island near its eastern end. They were Japanese fishermen most likely,

¹In 1940, the preserve was transferred to the Department of the Interior.

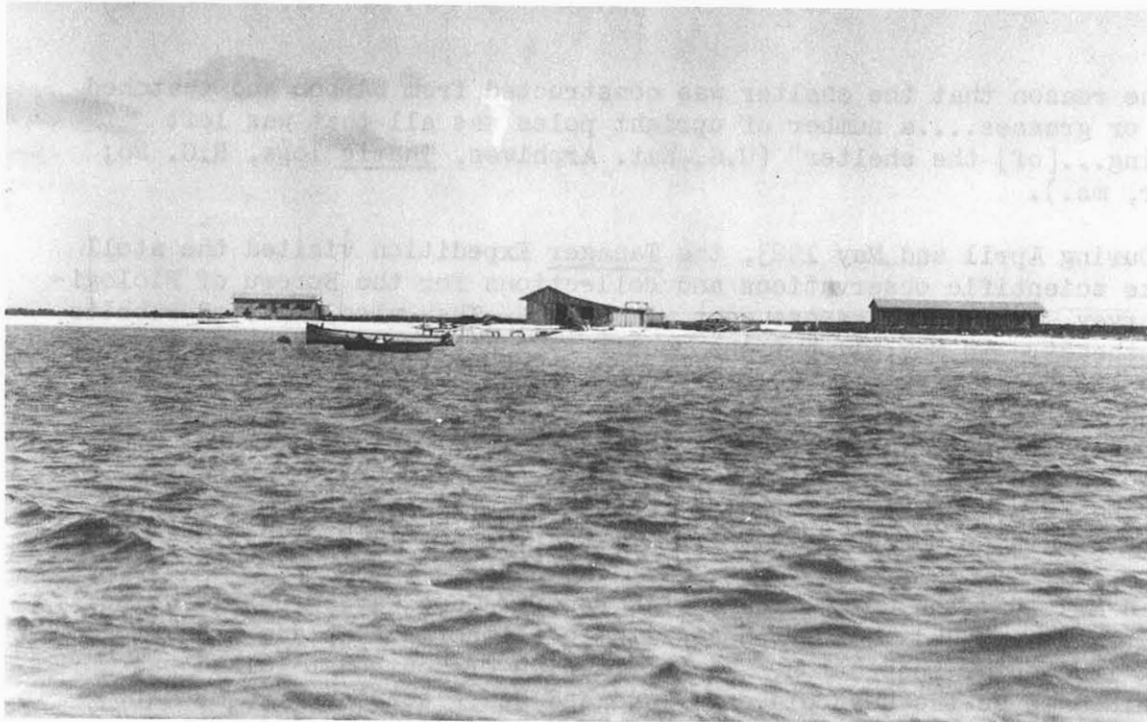
for the reason that the shelter was constructed from bamboo and thatched straw or grasses....a number of upright poles was all that was left standing...[of] the shelter" (U.S. Nat. Archives, Thetis logs, R.G. 26; Munter, ms.).

During April and May 1923, the Tanager Expedition visited the atoll to make scientific observations and collections for the Bureau of Biological Survey. The old Japanese camp was noted. They also reported rabbits on Southeast. In May all but one rabbit were killed and several kinds of plants and trees were planted. Two new islands, Grass and Seal, were charted in the lagoon (Gregory, 1924: 20-21; Wetmore, ms.) and the results of the expedition's observations were incorporated into U.S. Naval Hydrographic Office chart 4, revised August 1924 (see Fig. 5). Marine life at Pearl and Hermes was again studied in 1928 by Victor Pietschmann, a Bernice P. Bishop Museum fellow from Vienna (Bryan, 1942: 198).

In May 1924 the USS Pelican, with Federal Game Warden Gerrit Wilder aboard, surveyed and photographed--with the aid of a seaplane--the atoll during its annual inspection. The north side of Southeast Island was determined to be the best place to land and beach seaplanes (U.S. Nat. Archives, Pelican log, R.G. 24; also USNHO corresp., R.G. 37).

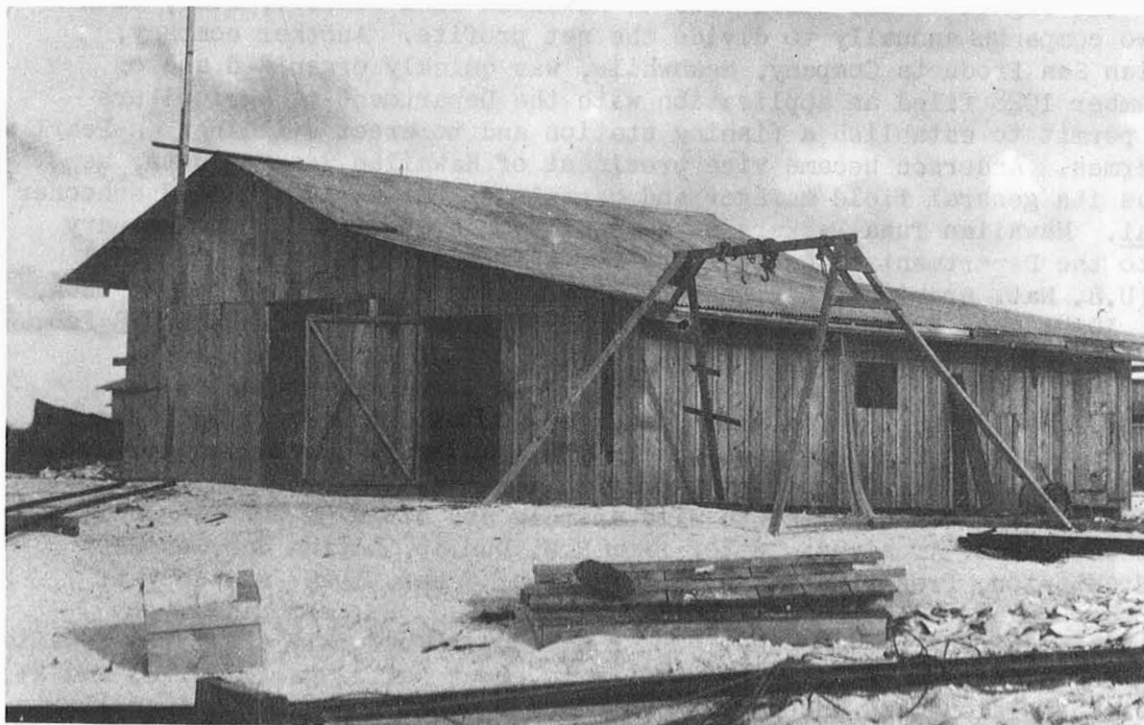
From 1926 to 1930 fishing operations became important in the history of the Reef. The Lanikai Fishing Company, Ltd., operated during 1926 and 1927 but by December 1928 had failed financially. Pearl oysters, which yield mother-of-pearl shell, had been discovered in May 1928 by Captain William B. Anderson who commanded the schooner Lanikai for the Lanikai Fishing Company. Because of its financial difficulties, the company transferred its rights to the pearl beds to Hawaiian Tuna Packers, Ltd., with the two companies annually to divide the net profits. Another company, Hawaiian Sea Products Company, meanwhile, was quickly organized and on 3 December 1928 filed an application with the Department of Agriculture for a permit to establish a fishing station and to erect buildings on Pearl and Hermes. Anderson became vice president of Hawaiian Sea Products, as well as its general field manager and captain of the newly acquired schooner Lanikai. Hawaiian Tuna Packers subsequently made application in February 1929 to the Department of Agriculture for a license to develop the pearl beds (U.S. Nat. Archives, application of Hawaiian Sea Products Co. to USDA, 3 Dec. 1928; and letter from Hawaiian Tuna Packers to Sec. of USDA, 13 Feb. 1929, R.G. 22).

The Department of Agriculture declined jurisdiction over the fisheries in waters adjacent to reefs and authority was given to the Governor of Hawaii to grant use and occupation permits for the fishing operations, provided protection was accorded to wild animals and birds on the National Refuge (U.S. Nat. Archives, letter from R.W. Dunlap, Acting Sec. of USDA to E.C. Winston, Pres., Hawaiian Tuna Packers, 2 Mar. 1929; and copy of USDA Order signed by R.W. Dunlap, 15 May 1929; R.G. 22; memorandum on Administrative Control, 18 June 1929, R.G. 126). The newly organized Hawaiian Sea Products Company received permission to erect buildings (Figs. 23 and 24) on Southeast Island and subsequently brought several tons of pearl shells to Honolulu. They later sold them to San Francisco and New York button manufacturers (Bryan, 1942: 196).



23. Fishing camp of the Hawaiian Sea Products Company at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.

24. One of three buildings at Southeast Island constructed by the Hawaiian Sea Products Company, summer 1930. Photograph by P.S. Galtsoff.



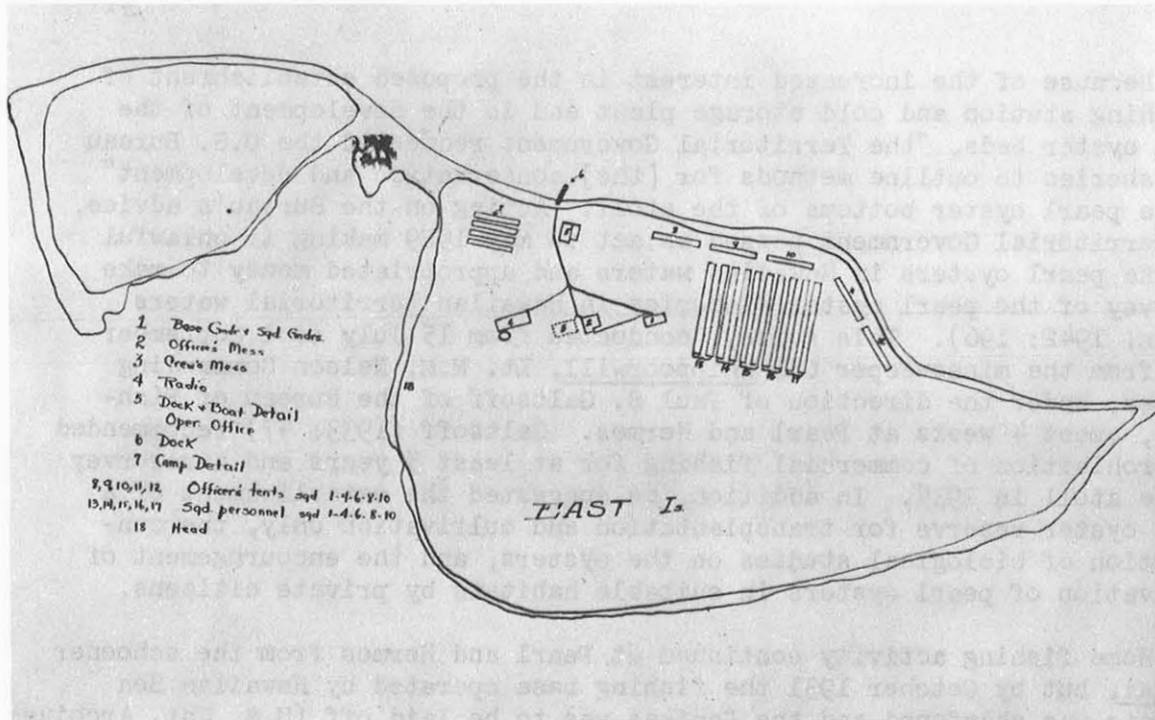
Because of the increased interest in the proposed establishment of a fishing station and cold storage plant and in the development of the pearl oyster beds, "the Territorial Government requested the U.S. Bureau of Fisheries to outline methods for [the] conservation and development" of the pearl oyster bottoms of the atoll. Acting on the Bureau's advice, the Territorial Government passed an act in May 1929 making it unlawful to take pearl oysters in Hawaiian waters and appropriated money to make a survey of the pearl oyster fisheries in Hawaiian territorial waters (Bryan, 1942: 196). This survey, conducted from 15 July to 1 September 1930 from the minesweeper USS Whippoorwill, Lt. M.M. Nelson Commanding Officer, under the direction of Paul S. Galtsoff of the Bureau of Fisheries, spent 4 weeks at Pearl and Hermes. Galtsoff (1933: 47) recommended the prohibition of commercial fishing for at least 5 years and a resurvey of the atoll in 1935. In addition, he suggested the establishment of a pearl oyster reserve for transplantation and cultivation only, the continuation of biological studies on the oysters, and the encouragement of cultivation of pearl oysters in suitable habitats by private citizens.

Some fishing activity continued at Pearl and Hermes from the schooner Lanikai, but by October 1931 the fishing base operated by Hawaiian Sea Products was abandoned and the Lanikai was to be laid off (U.S. Nat. Archives, letter from F.L. Earnshaw to G.P. Wilder, 28 Oct. 1931, R.G. 22).

During the mid-1930's regular inspection cruises, such as that of the USCGC Itasca in June 1934, were made to the Northwestern Hawaiians. In May 1935 the USS Lark, taking part in U.S. Naval war games, anchored at Pearl and Hermes on 15 May; she departed the next day. A hydrographic survey of the atoll was made in April 1935 by the USS Avocet, in company with the USS Quail, Tanager and Oglala. This resulted in the production of a modern chart of the atoll, but because of the political turmoil in the Pacific it was not officially published as USNHO chart 5647 until February 1947. In October 1937, another U.S. Navy exercise involved the USS Swan at Pearl and Hermes (Figs. 25, 26, and 27). Her log for the 26th records that 12 planes of Patrol Squadron 8 from French Frigate Shoals landed and tied up at temporary moorings in the lagoon; later in the day the planes returned to French Frigate. Ten planes of Patrol Squadron 4 also made a round trip visit from French Frigate Shoals that same day (U.S. Nat. Archives, Itasca log, R.G. 26; logs of the Avocet, Lark, and Swan, R.G. 24).

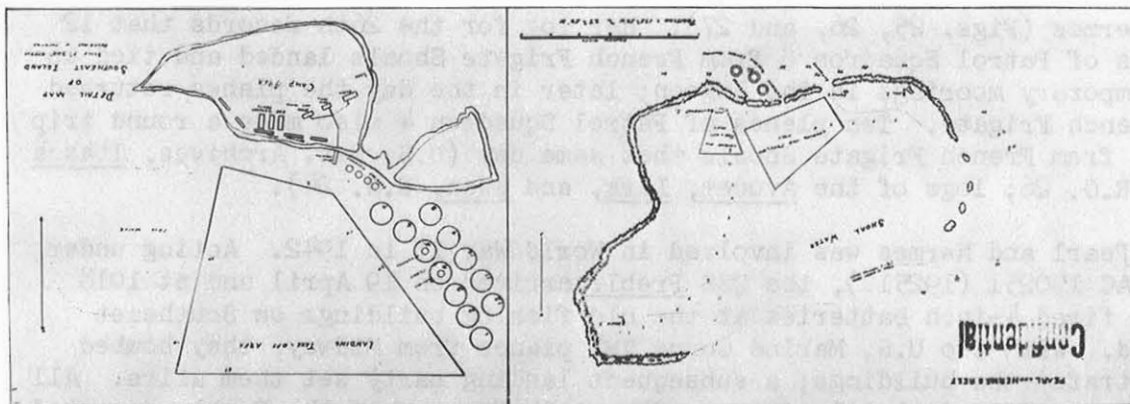
Pearl and Hermes was involved in World War II in 1942. Acting under CINEPAC 190251 (19251?), the USS Preble arrived on 19 April and at 1018 hours fired 4-inch batteries at the old fishing buildings on Southeast Island. With two U.S. Marine Corps VMF planes from Midway, they bombed and strafed the buildings; a subsequent landing party set them afire. All buildings were completely destroyed by 1408 hours when the Preble departed for Midway. No evidence was found on the island of recent habitation or landing (U.S. Nat. Archives, Preble log, R.G. 24; U.S. Navy, Class. Oper. Archives, Preble war diary).

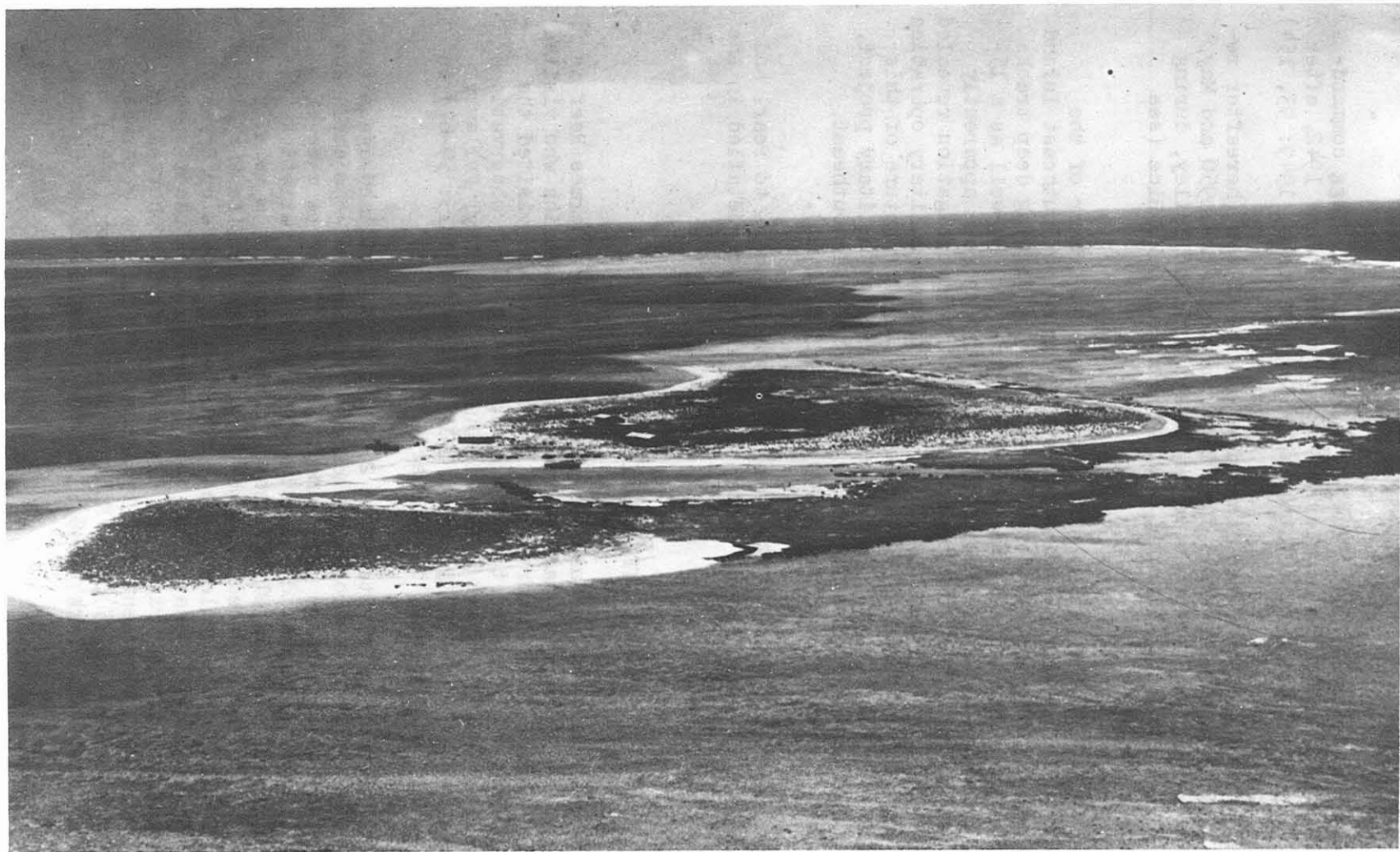
In defense of Midway Island during May and June 1942, the oiler USS Kaloli, the civilian yacht Crystal, and the minesweeper USS Vireo were



25. Drawing of U.S. Navy base camp at Southeast Island, drawn 6 August 1936. Official U.S. Navy photograph no. 80-CF-79797-3 in the U.S. National Archives.

26. Chart of tender anchorages, plane moorings, and base camp for U.S. Navy exercise, 1 October 1937. Official U.S. Navy photograph no. 80-CF-79797-4 in the U.S. National Archives.





27. Aerial view of Southeast Island from 300 feet showing details of base camp, probably October 1937. Official U.S. Navy photograph no. 80-G-11878 in the U.S. National Archives.

deployed to Pearl and Hermes Reef. The Vireo, Lt. James C. Legg commanding, was the first to reach the carrier USS Yorktown on 5 June 1942, after it was severely damaged during the Battle of Midway (Morison, 1949: 93, 154).

Personnel of the Pacific Ocean Fisheries Investigations (hereafter referred to as POFI) visited the atoll five times between June 1950 and May 1956. Aerial surveys were conducted in May 1949 by Alfred Bailey, during the 1950's by A.F. Carr, J.W. Aldrich, K.W. Kenyon, and D.W. Rice (see Scientific Visits section).

On 12 March 1961, David H. Woodside and Raymond J. Kramer of the Division of Fish and Game of the State of Hawaii landed on Southeast Island and made general wildlife observations. They reported finding deep tracks made on the beach landing point by an amphibious tractor, as well as a 15-foot "steel observation tower...several 55 gallon drums, some apparently full of fuel...[and] hollow tile blocks." Subsequent investigation revealed these items had been left in 1960 by LORAC, an amphibious military operation from Midway which occupied the island without permit. The nature of this project is unknown. Also in 1961, personnel from another military project, HIRAN, which was engaged in plotting the exact location of Southeast, "landed by helicopter and camped for a few days" (HDFG, 1961).

Beginning in February 1963 POBSP personnel made 12 trips to Pearl and Hermes Reef; BSWF personnel made 12 other trips. These are detailed in the Scientific Visits section.

SCIENTIFIC VISITS

Early information on the natural history of Pearl and Hermes Reef is available only from the reports made by various ships' captains who visited or were wrecked there. Even observations by scientists who visited the atoll prior to 1923 were limited to a few hours. Such early observations were made by Munro (1942: 12) and Palmer in July 1891, Bailey, Fullaway and Willett (Bailey 1956: 30-32) in March 1913, Elschner (1915: 59-67) in September 1914, and Munter (ms.) in February 1916.

The Tanager Expedition visited from 26 through 28 April and again from 17 through 19 May in 1923. Hydrographic charts were made of the atoll and two previously uncharted islands were named. Collections were made of birds, mammals, insects, arachnids, plants, fish, and many varieties of marine invertebrates. In all, 21 species of birds including a mummified gull (Wetmore, ms.) were recorded, and the bird and mammal life was discussed by Wetmore (1925). Insects collected were reported in papers by Bryan et al. (1926), and Zimmerman (1948a, b, c, d). Eleven growing plant species and two represented in beach drift were discussed by Christophersen and Caum (1931). Myriapods were mentioned by Attems (1938). The Crustacea were treated by Edmondson (1925), the Echinodermata by Fisher (1925), and H.L. Clark (1925) and A.H. Clark (1949), and the Foraminifera by Cushman (1925).

Collections of marine fauna were made between 1927 and 1930 by Captain Anderson and his associates, by Victor Pietschmann in 1928, and by Paul S. Galtsoff in 1930. Fish collections of the Tanager Expedition, as well as those of Anderson and Pietschmann, were treated by Pietschmann (1930 and 1938), Fowler and Ball (1925),¹ and Fowler (1927, 1928, 1931, 1934, and 1949). Echinoderms collected from 1923 through 1930 were discussed by Holly (1932). Galtsoff (1933), who directed the studies of the pearl oyster fisheries in 1930, published identifications of several groups of marine invertebrates including Porifera, Coelenterata, Echinodermata, Mollusca, and Crustacea, as well as fishes. His paper also discussed the oceanography of the lagoon and adjacent waters.

An aerial seal survey was conducted by Alfred Bailey (1952: 16) in May 1949. Additional seal data were taken by Vernon Brock, who visited the atoll on a POFI survey in June 1950; other POFI surveys were made in May 1951,² January 1955, March 1956, and May 1956 (Ikehara, 1953; June and Reintjes, 1953; POFI, 1950, 1951, 1955, 1956a, b).

Southeast Island was visited briefly in March 1961 by David H. Woodside and Raymond J. Kramer of the Division of Fish and Game of the State of Hawaii (HDFG, 1961). They made general observations on the wildlife, established photographic stations, and set up refuge signs. In addition to these landings, several aerial surveys have been made by the following personnel of the Bureau of Sport Fisheries and Wildlife: John W. Aldrich in December 1956; Karl W. Kenyon and Dale W. Rice in December 1956, January, April, and May 1957; and Dale W. Rice in October and January 1957, and January, April, May, and June 1958. Their observations were reported in three unpublished memoranda (Aldrich, Robbins, and Rice, ms.; Rice, ms. a and b) and papers on the monk seal (Kenyon and Rice, 1959; Rice, 1960a) and the albatrosses (Rice and Kenyon, 1962). An aerial turtle survey was conducted by Archie F. Carr (in litt.) in January 1962.

POBSP personnel spent 52 days at Pearl and Hermes Reef on 12 separate trips beginning in February 1963. BSWF and HDFG personnel were present on five of these. BSWF personnel spent at least an additional 43 days on 12 other trips. Dates and islands visited for each trip are listed in Table 1. Personnel for these surveys, as well as all others, are presented in Appendix Table 1.

POBSP and BSWF personnel banded thousands of birds and obtained many recaptures through 1969. Wildlife population estimates and notes on breeding status are available from each trip; all islands were not visited on each trip and on some islands no nocturnal activities of the avifauna were

¹Tanager collection only.

²The George Vanderbilt Pacific Equatorial Expedition, concerned primarily with marine life, did not stop briefly at the Reef in 1951 as implied by Bailey (1952).

Table 1. POBSP and BSFW survey dates of islands at Pearl and Hermes Reef

36

Year	Survey Party	Southeast	Grass	Seal	Kittery	North	Little North	Sand	Bird	Planetree
1963	POBSP	26 Feb.- 8 Mar.	5 Mar.	5 Mar.	5 Mar.	6 Mar.	6 Mar.	5 Mar.	5 Mar.	
	POBSP	18-23, 25 June	26-27 June	26 June	26 June	23-25 June	23-25 June			
1964	BSFW, POBSP	13-14 Mar.	14 Mar.	14 Mar.	14 Mar.			14 Mar.	14 Mar.	14 Mar.
	POBSP	16-19 Aug.	18 Aug.	18 Aug.	18 Aug.*	19-20 Aug.	19 Aug.	18 Aug.	18 Aug.	18 Aug.
	BSFW, POBSP	16 Sept.				17 Sept.	17 Sept.			
1965	POBSP	15-19 Mar.	19 Mar.	18-19 Mar.	18 Mar.	17-18 Mar.	18 Mar.			
	BSFW, POBSP	21-22 Mar.	22 Mar.	22 Mar.	22 Mar.			22 Mar.	22 Mar.	22 Mar.
1966	BSFW	1 Apr.								
	BSFW	20-26 Sept.	21 Sept.	21 Sept.	21 Sept.	22 Sept.	22 Sept.	21 Sept.		21 Sept.*
	POBSP	25-27 Sept.								
1967	BSFW	17 Mar.				16-17 Mar.				
	BSFW, POBSP	21-23 Mar.	22 Mar.	22 Mar.	22 Mar.					

Table 1. (continued)

Year	Survey Party	Southeast	Grass	Seal	Kittery	North	Little North	Sand	Bird	Planetree
1967	POBSP	28,30 May- 1 June	31 May	31 May	31 May			31 May	31 May	
	BSFW	3-9 July	8 July	6 July	9 July					
	POBSP	28-30 Aug.	29 Aug.	29 Aug.	29 Aug.	29-30 Aug.	29 Aug.	29 Aug.*	29 Aug.*	29 Aug.
	BSFW	27-29 Sept.	28 Sept.	28 Sept.	28 Sept.	27 Sept.	27 Sept.	28 Sept.	28 Sept.	
1968	BSFW, POBSP	22-24 Mar.	24 Mar.	24 Mar.	24 Mar.					
	BSFW	8 Aug.								
1969	BSFW	10-12 Feb.		10-12 Feb.	10-12 Feb.	10-12 Feb.	10-12 Feb.			
	BSFW	31 Mar.- 2 Apr.				31 Mar.	31 Mar.			
	BSFW	26-31 May	26 May	26 May	26 May	26 May	26 May			
	BSFW	5 June								
	BSFW	28 July								
	BSFW	10-19 Sept.	11 Sept.	11 Sept.	11 Sept.	12 Sept.	12 Sept.		11 Sept.	

*Offshore observation only.

observed. All of the islands were mapped and color and black and white photographs were taken showing the appearance of each. Papers resulting from POBSP activities at Pearl and Hermes Reef were published by Amerson (1968); Amerson and Emerson (1971); Brennan (1965); Clapp and Woodward (1968); Kohls (1966); Kohls and Clifford (1967); Kohls, Sonnenshine, and Clifford (1965); Maa (1968); Sibley and McFarlane (1968); Standen (1967); Tsuda (1966); and Yocom (1965).

In all, 106 scientific publications and manuscripts have resulted from the various surveys to Pearl and Hermes Reef. An annotated list of these is presented in Appendix Table 2.

VEGETATION

Osborn first recorded vegetation in August 1850; he noted an island "covered with coarse grass & a vine bearing prickly pod" (Kemble, 1966: 155). Brooks (1860: 500) next recorded vegetation in July 1859; he found the largest islands covered with coarse grass and trees. Bitter (1900) identified two species--Eragrostis hawaiiensis [=variabilis], and Solanum laysanense [=nelsoni]--from photographs taken by Walker in 1899.

The vegetation was first detailed in a report by Christophersen and Caum (1931: 15-16, 20-41), who discussed the 11 species of vascular plants found growing by the Tanager Expedition in April 1923, and two species represented by seeds found in beach litter. More specimens were collected by Galtsoff in 1930. Photographs by Frear, Wetmore, and Galtsoff make it possible to reconstruct the vegetative history of the atoll in the present century.

Vascular plant specimens were collected by Sibley in June 1963 and by Long in September 1964; other POBSP personnel have taken notes and photographs on most visits. The islands and their major vegetation associations were mapped in March 1965. Specimens have also been collected by Charles H. Lamoureux (date unknown) and Allen H. Young (August 1964) of the University of Hawaii, POBSP cooperators in botany. Lamoureux and Long prepared the basis for the annotated list of species presented in Appendix Table 3. Plant specimens may be found in the herbaria of the National Museum of Natural History (USNM), the Bernice P. Bishop Museum (BPBM), and the University of Hawaii (UH).

Vascular Plants

In all, 25 species of vascular plants, representing 17 families, have been recorded from 5 islands (Table 2 and Appendix Table 3). One species, Sicyos caunii, is endemic (St. John, 1970: 448-451). The following discussion of the flora is based on all previous botanical accounts, as well as the data of the POBSP. Wherever plant associations are discussed, the species are listed in the order of decreasing abundance. Islands are listed in alphabetical order.

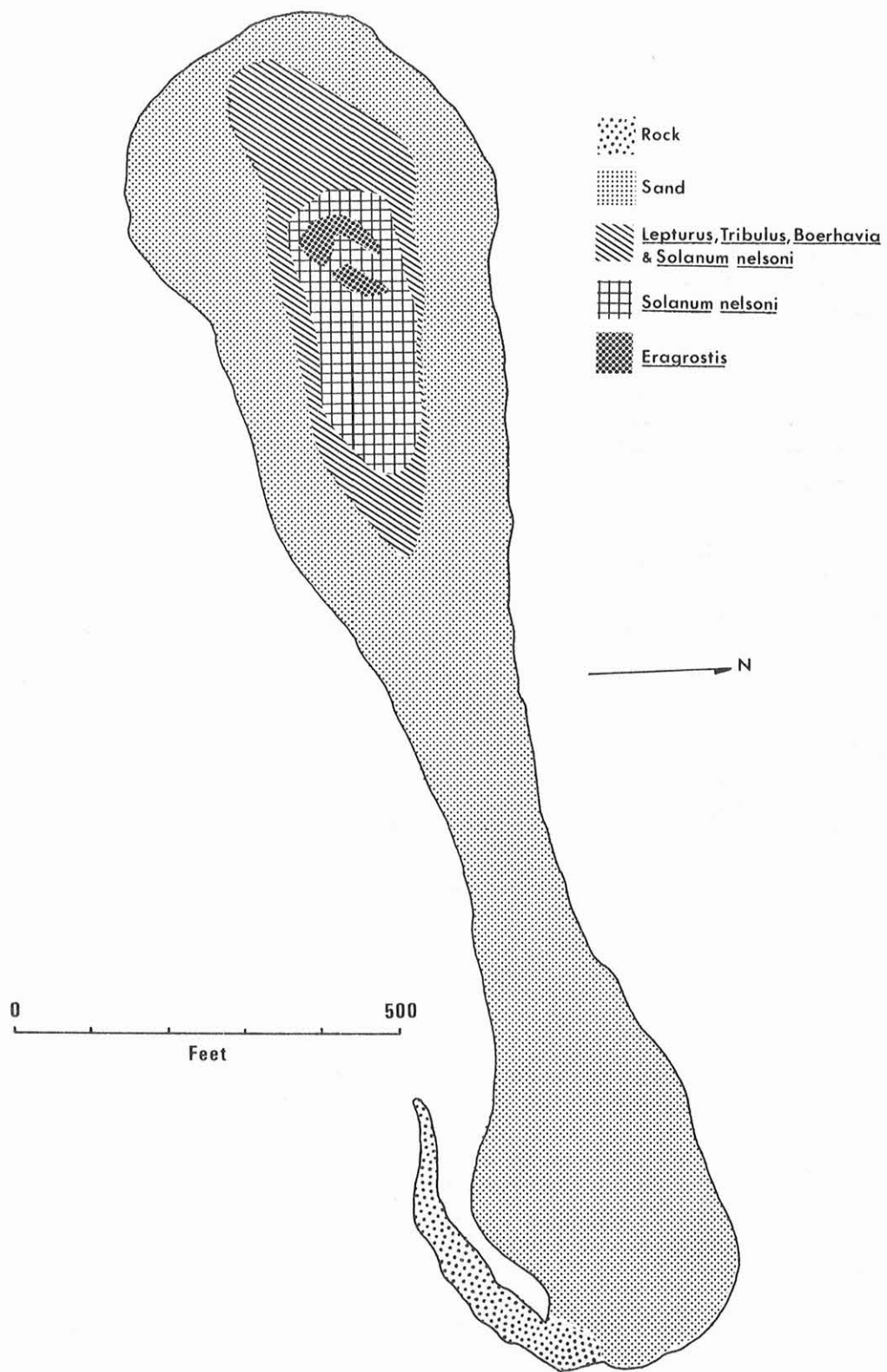
Table 2. Vascular plant distribution at Pearl and Hermes Reef

Species	Southeast	North	Grass	Seal	Little North
<u>Cynodon dactylon</u>	x				
N <u>Eragrostis variabilis</u>	x	x	x	x	
N <u>Lepturus repens</u>	x	x	x	x	x
<u>Setaria verticellata</u>	x		x		
<u>Allium</u> sp.	x				
<u>Cocos</u> sp.	x				
<u>Pritchardia pacifica</u>	x				
<u>Casuarina equisetifolia</u>	x				
N <u>Achyranthes splendens</u>		x	x	x	
N <u>Boerhavia repens</u>	x	x	x	x	x
N <u>Sesuvium portulacastrum</u>	x			x	
N <u>Portulaca lutea</u>	x	x			
N <u>Capparis sandwichiana</u>				x	
<u>Brassica campestris</u>	x	x			
<u>Coronopus didymus</u>	x				
N <u>Lepidium bidentatum</u>	x	x	x	x	
N <u>Tribulus cistoides</u>	x	x	x	x	x
<u>Malvastrum coromandelianum</u>	x				
N <u>Hibiscus tiliaceus</u>	x				
<u>Tournefortia argentea</u>		x	x		x
N <u>Solanum nelsoni</u>	x	x	x	x	
N <u>Solanum nigrum</u>	x		x		
N <u>Sicyos caunii</u>	x	x		x	
N <u>Scaevola taccada</u>	x	x	x	x	
<u>Sonchus oleraceus</u>	x				
Total	22	12	11	11	4

Grass Island

Eleven species of vascular plants have been recorded from Grass Island (Table 2). Only a portion of the western end, 2.6 acres, is vegetated (Fig. 28). The interior of this vegetated portion is a dense patch of Solanum nelsoni about 400 feet long east to west, and 100 feet wide which grows to the height of a foot. Between the Solanum and the sandy beach is a sparsely vegetated area of Lepturus repens, Tribulus cistoides, Boerhavia repens, and S. nelsoni. About a dozen clumps of Eragrostis variabilis grow among the Solanum.

An April 1923 photograph by Wetmore shows primarily dense Eragrostis (Fig. 29). Wetmore (ms.) noted that "the crest of the island was covered with bunch grass and a few of the shrubs recorded on Southeast Island." Eight species were recorded by Christophersen and Caum (1931: 15-16). The vegetation was dominated by Eragrostis, which was restricted to the central parts. Lepturus grew in a fringe around the Eragrostis. Two plants of



28. Vegetation map of Grass Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.



29. Grass Island covered with dense Eragrostis, 27 April 1923.
Photograph by A. Wetmore.

30. Interior of Grass Island, 27 June 1963. Laysan Albatross
chicks (foreground) in area of Setaria, Boerhavia and
Tribulus; Great Frigatebirds nesting in Solanum. POBSP
photograph by A.B. Amerson, Jr.



Achyranthes splendens were found. Boerhavia and Tribulus were present, but not abundant, and Lepidium o-waihiense [= bidentatum] was rare. A few small Scaevola taccada and Tournefortia argentea bushes were present. Solanum laysanense [= nelsoni] was present though not abundant.

In 1963, the interior (Fig. 30) was covered by a dense mat of Solanum nelsoni. Lepturus formed a thick cover on the west end of the vegetated area, Lepidium was found along the southern side of the island, and Solanum nigrum was common. In all, 20 to 30 clumps of Eragrostis were found, and Boerhavia and Tribulus were widespread. Scattered clumps of Setaria verticellata were noted and there were no longer any plants of Scaevola or Achyranthes. In 1965 the Setaria was not found and the number of Eragrostis clumps had been reduced to 14.

The change from grasses to herbaceous creepers is, thus, well-documented. The vegetation change has brought about a change in the bird nesting colony as well. For example, in April 1923 the Great Frigatebird (Fregata minor) was not breeding (Wetmore, ms.); in recent years 300 to 350 Great Frigatebirds roost in the Solanum, and 75 to 100 nest there.

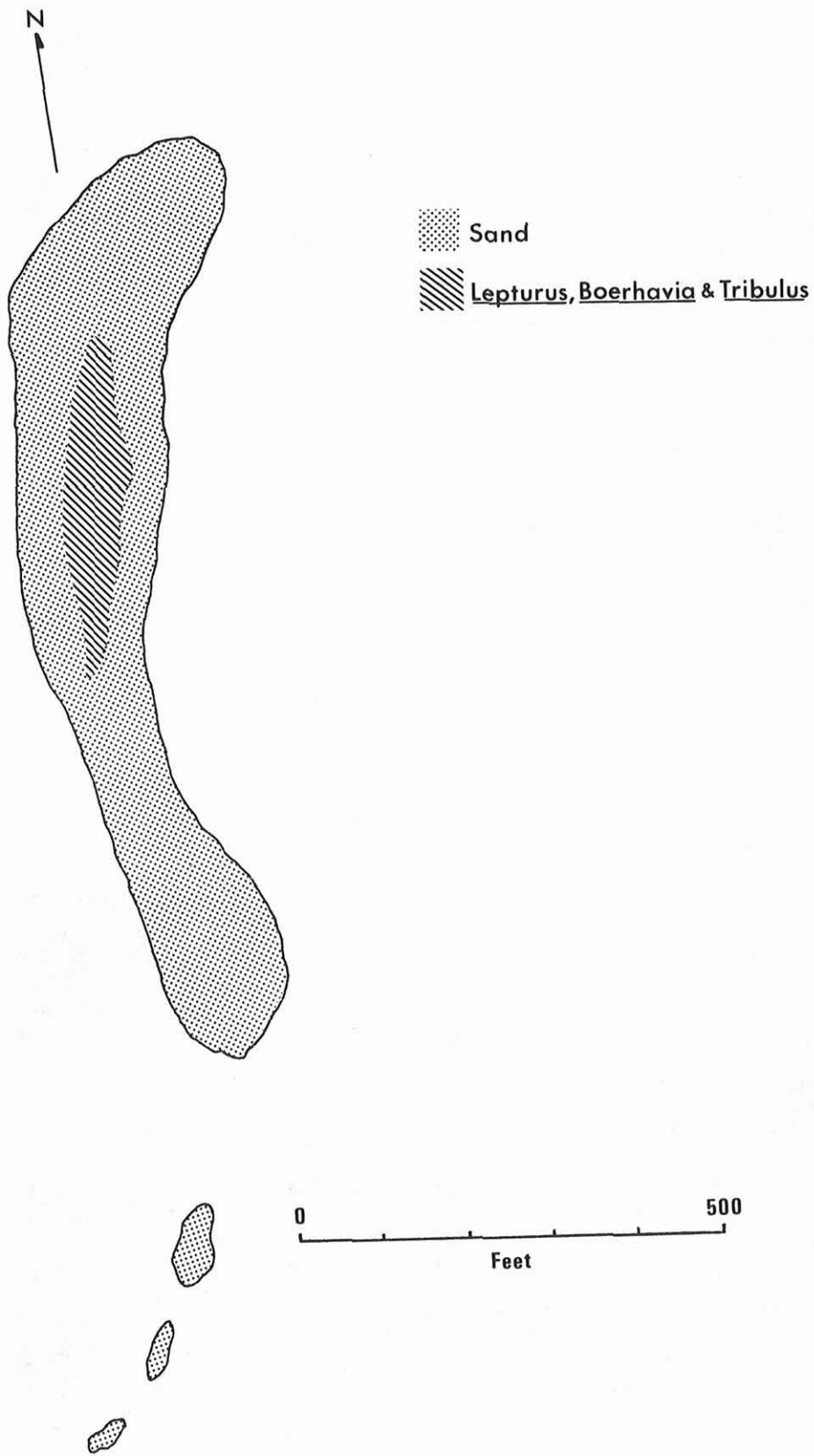
Little North Island

Only four vascular plant species are known (Table 2); 0.5 acre is vegetated. The raised central portion, about 400 feet long north to south, presently supports a meager growth of one grass and two prostrate herbs (Fig. 31). Lepturus repens is represented by several clumps, small seedlings of Boerhavia repens were found, as were a few sprigs of Tribulus cistoides. Small Tournefortia argentea plants were noted in June 1963, but were not found in March 1965. Three species were still present in August 1967 (Figs. 32 and 33).

North Island

Twelve species of vascular plants have been recorded (Table 2); 7.1 acres are vegetated. The center of the island is presently dominated by a lush growth of Sicyos caumii (Fig. 34). Some Boerhavia repens and Tribulus cistoides also grow in this area. At the northern perimeter is a nearly solid growth of Solanum nelsoni. East of this growth is an area of mixed Tribulus, Boerhavia, and S. nelsoni. At the northeast corner is a nearly pure stand of Eragrostis variabilis about 100 by 200 feet. The remainder of the vegetated area is a sparse mixture of Lepidium bidentatum, S. nelsoni, Sicyos, Tribulus, and Boerhavia, except for a nearly pure stand of Lepidium along the western side. Plant density decreases from the interior to the beaches, and Lepidium is the last species to be found in the coral rubble closest to the beaches and part way south on the southern tip. Several stunted and nearly dead Tournefortia argentea bushes were found along the southwestern edge of the island in March 1965. Several areas of Brassica campestris were found in August 1967. Other plants recorded in small numbers are Lepturus repens, Portulaca lutea, and Scaevola taccada.

In March 1913 Willett (Bailey, 1956: 32) stated that "tussocks of bunch grass...covers [sic] the northern end of the island." Christophersen



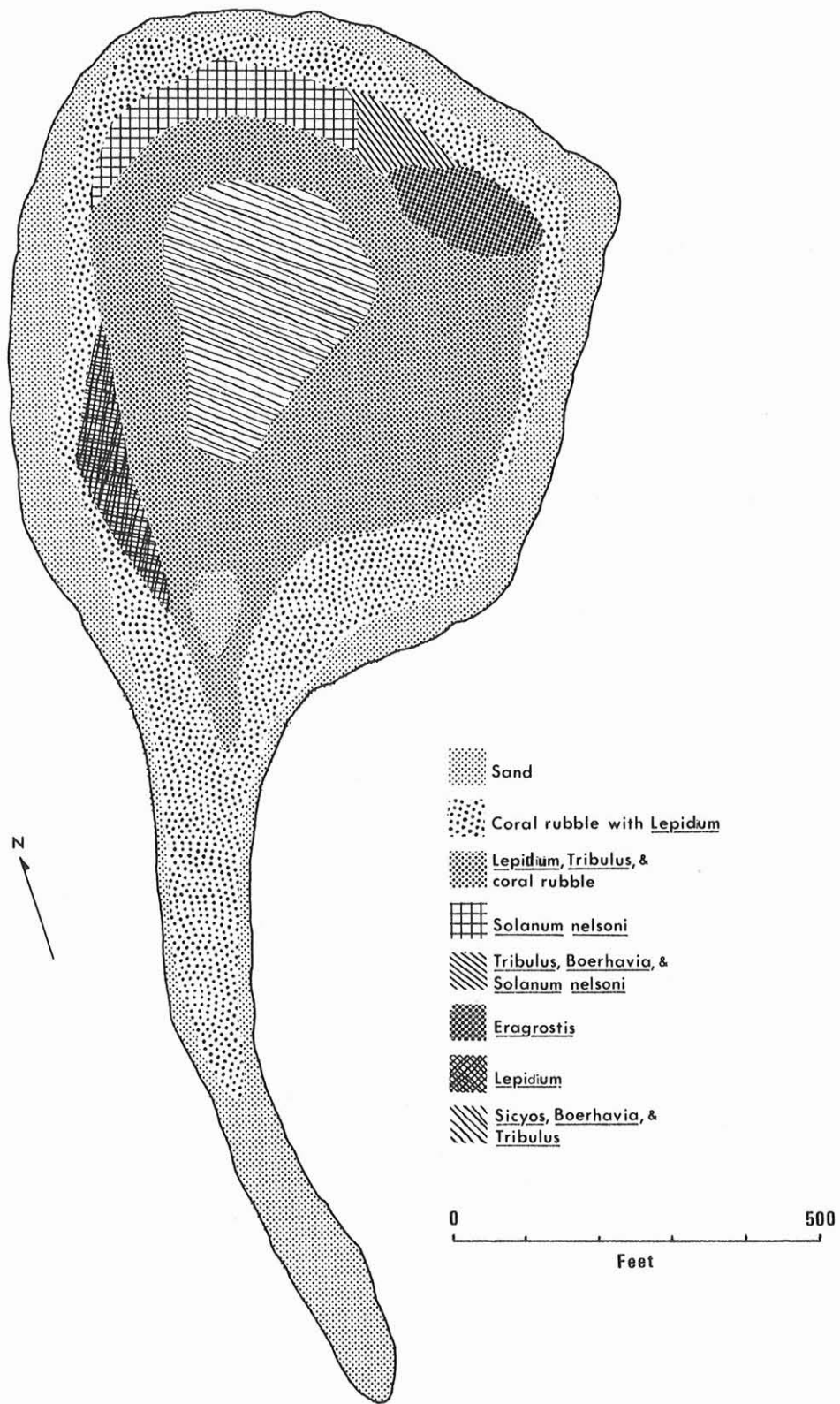
31. Vegetation map of Little North Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.



32. Sparse vegetation at Little North Island, looking southeast (print reversed), 29 August 1967. POBSP photograph by C.A. Ely.

33. Scant vegetation at Little North Island, looking northwest (print reversed); North Island in background, 29 August 1967. POBSP photograph by C.A. Ely.





34. Vegetation map of North Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.

and Caum (1931: 15-16) report that the Tanager Expedition collected Achyranthes splendens and Tribulus in 1923.

As there are only a few patches of grass at present, with several species of creepers dominating the flora, apparently this island has undergone the same type of successional changes as those on Grass and Southeast Islands. Seasonal changes also occur; the vegetation, in general, was more lush in August 1967 (Figs. 35 and 36) than in June 1963 (Figs. 37 and 38).

Seal Island

Eleven species of vascular plants have been recorded (Table 2); 2.5 acres are vegetated. The central portion of the western half, about 600 feet east to west and 150 feet wide, contains most of the vegetation (Fig. 39). The interior of this vegetated area is primarily Sicyos caumii, Solanum nelsoni, and Eragrostis variabilis (Fig. 40). Between the densely vegetated area and the beach is a transition zone of Tribulus cistoides, Boerhavia repens, Lepturus repens, and Eragrostis (Fig. 41). Growth of all but the Eragrostis extends out among the beach rubble. One clump of Achyranthes splendens grows at the eastern border of this vegetated area. Small Sesuvium portulacastrum plants are scattered on the rocky ledges of the eastern half.

In April 1923 Wetmore (ms.) noted that "the crest was covered with the bunch grass and much of the grayish leaved shrub" (Fig. 42). Christophersen and Caum (1931: 15-16) reported 11 species in 1923. Eragrostis and Lepturus were distributed indiscriminately (Fig. 43), Achyranthes was common, and Boerhavia and Tribulus were present. Large flourishing plants of Sicyos grew on the eastern half of the western section (see also St. John, 1970: 450). Solanum nelsoni was present, though not abundant, and Lepidium o-waihiense [= bidentatum] was rare. Sesuvium grew on the raised reef and low wet flats of the eastern portion. Capparis sandwichiana was scattered over much of the island except for beach and reef. A few small Scaevola taccada bushes were also found.

The same 11 species were present in 1963. Only one clump of Capparis and one Scaevola bush were found. Tribulus and Boerhavia were widespread, and Lepidium was common in the transition zone from bunchgrass to beach. There were 40 to 50 clumps of Eragrostis, Lepturus and Solanum nelsoni were common, and Sicyos was present. Sesuvium still occurred on the rocky and wet areas of the eastern portion. About five plants of Achyranthes were noted.

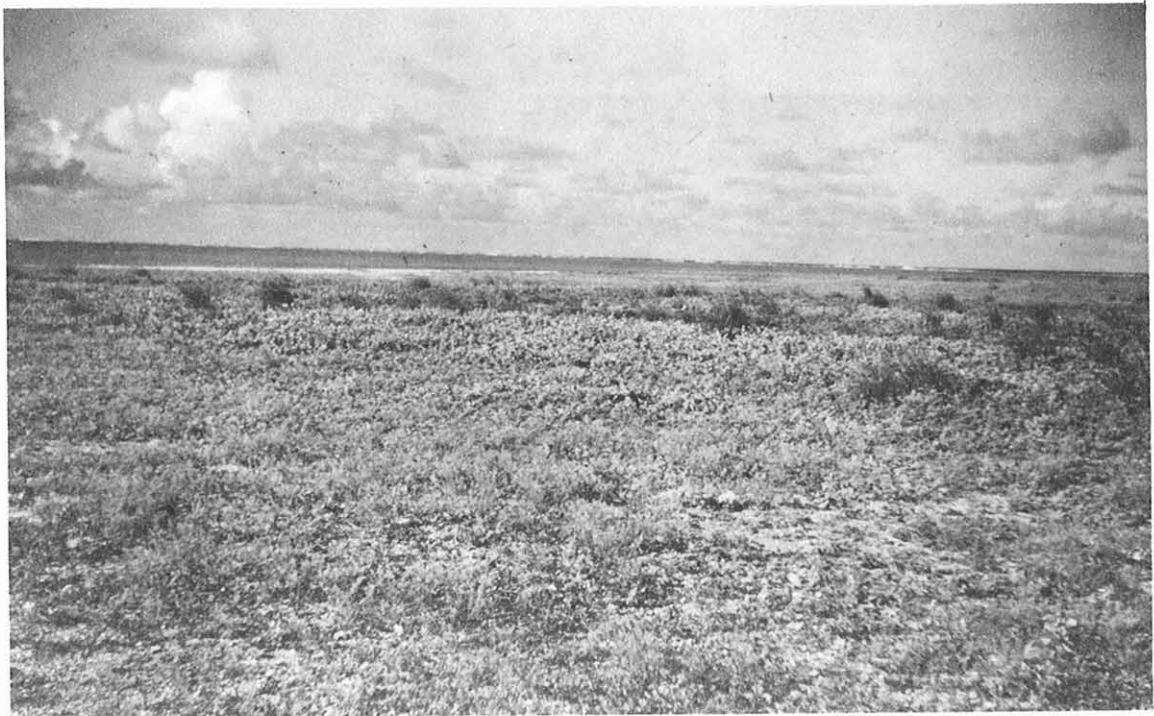
Southeast Island

Twenty-two vascular plants are known from Southeast Island (Table 2); 27.2 acres are vegetated. The vegetation is presently dominated by 10 species, two of which were introduced (Fig. 44). Eighteen species, including an onion (Allium sp.) growing on the refuse heap which was eradicated in March 1963, have been found by the POBSP.



35. Low vegetation at North Island, from west-center looking north (print reversed), 29 August 1967. POBSP photograph by C.A. Ely.

36. Creepers and a few patches of grass dominate the vegetation at North Island, from west-center looking east (print reversed), 29 August 1967. POBSP photograph by C.A. Ely.

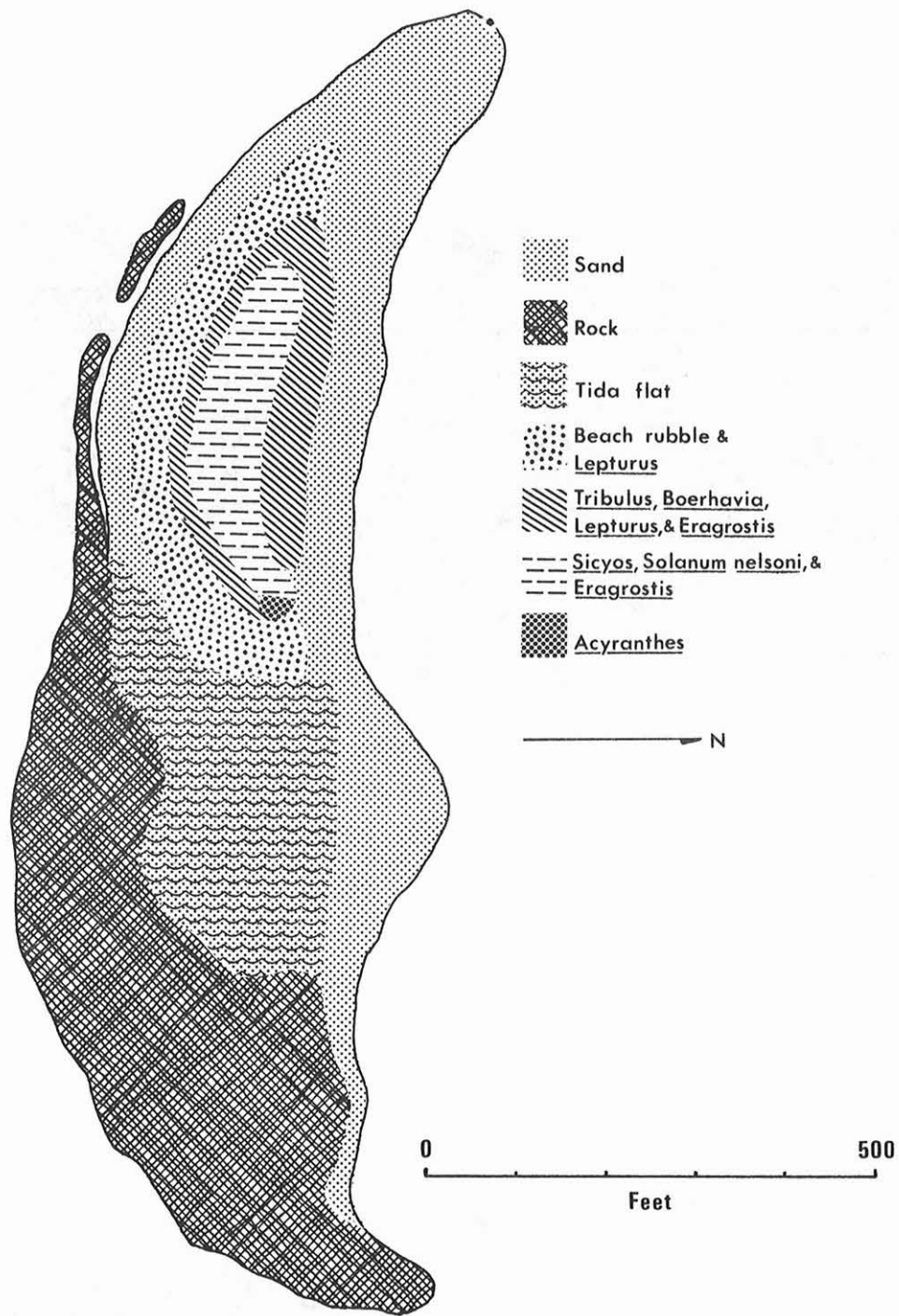




37. Extreme low vegetation at North Island, from west-center looking north, 24 June 1963. POBSP photograph by A.B. Amerson, Jr.

38. Extreme low vegetation at North Island, from west-center looking south, 24 June 1963. POBSP photograph by A.B. Amerson, Jr.





39. Vegetation map of Seal Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.



40. Sicyos, Solanum, and Eragrostis cover the interior of Seal Island, view looking south, 14 March 1964; Laysan Albatross adults and chicks. POBSP photograph by A.B. Amerson, Jr.

41. Transition zone of Tribulus, Boerhavia, Lepturus, and Eragrostis between dense interior and beach at Seal Island, view looking southeast, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.

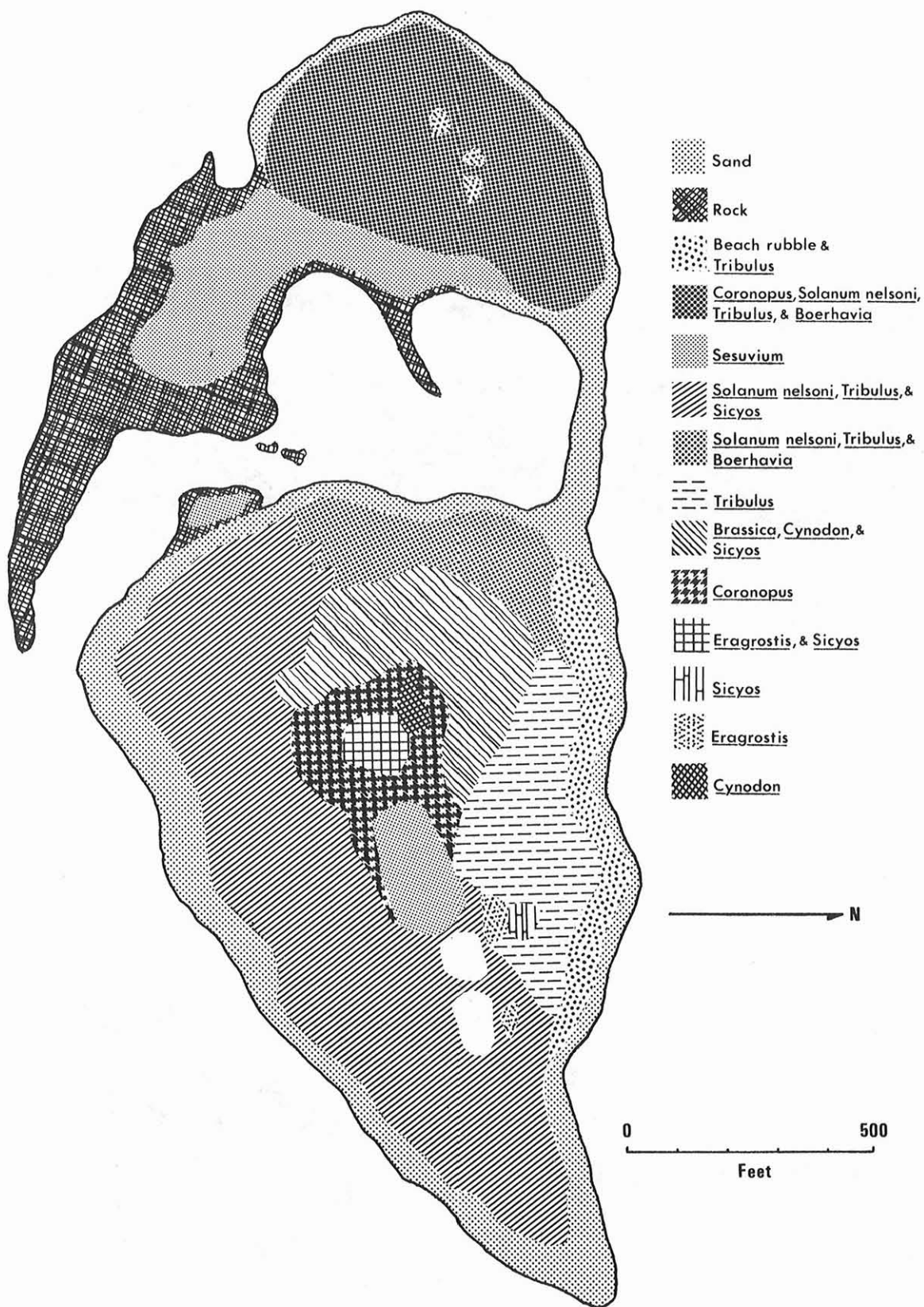




42. Grasses and low shrubs cover the crest of Seal Island on 27 April 1923; albatross chicks in foreground, Great Frigatebirds in flight. Photograph by A. Wetmore.

43. Seals and albatrosses among scattered clumps of grass at Seal Island, 27 April 1923. Photograph by A. Wetmore.





44. Vegetation map of Southeast Island, March 1965. Redrawn from POBSP map by W.O. Wirtz, II.

The central portion of the western section (Figs. 45 and 46) has a sparse vegetation of Solanum nelsoni, Coronopus didymus, Boerhavia repens, Tribulus cistoides, and Lepidium bidentatum. Several clumps of Eragrostis variabilis grow to a height of about three feet near the center of this area.

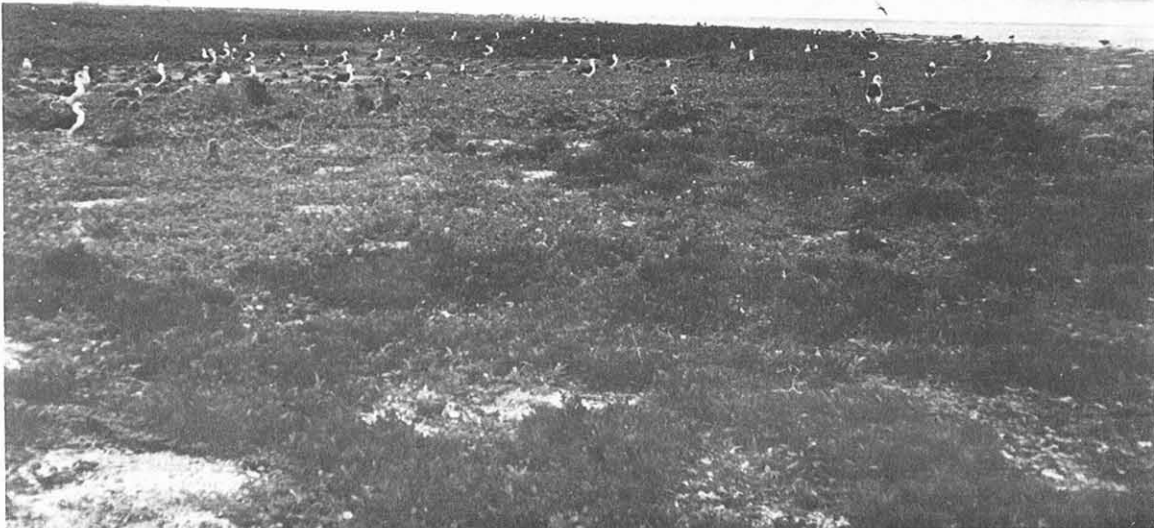
The ledge of reef rock extending southeastward from the western section has a large patch of Sesuvium portulacastrum in its interior. A patch of Sesuvium also grows on the reef rock extension at the southeastern corner of the eastern section.

The area in and adjacent to the tidal pools in the eastern half of the eastern section is dominated by a lush growth of Sesuvium. West of these pools is a large area dominated by Coronopus. A large patch of Eragrostis and a smaller one of Cynodon dactylon, presumably introduced, grow adjacent to each other in the center of the Coronopus area. A few plants of Sonchus oleraceus and Solanum nigrum grow among the Cynodon and Coronopus.

Surrounding the Coronopus area on the north and west is a steadily expanding area dominated by an introduced mustard, Brassica campestris. The area also has some Cynodon and some Sicyos caunii. From this central, heavily-vegetated area out to the beaches is a relatively open coral sand and rubble region with patches (Fig. 47) of Solanum nelsoni, Tribulus, Boerhavia, and Sicyos. The extent of these patches varies with location and season. Solanum nelsoni is especially dominant on the southern side and Tribulus on the north. Tribulus and Sicyos (Fig. 48) are mixed with Solanum nelsoni on the southern two-thirds, and Tribulus and Boerhavia are mixed with S. nelsoni on the northwestern side. A northern area dominated by Tribulus has one patch of pure Sicyos and a larger patch of Eragrostis. A second clump of this grass grows further east in the S. nelsoni-Tribulus-Sicyos association. Several very stunted Scaevola taccada bushes grow along the margin between the vegetated area and the beach on the southwestern and southern sides of the eastern section.

Other plant species recorded in small numbers are Setaria verticillata, evidently introduced in 1961 (HDFG, 1961); Lepturus repens; Portulaca lutea; Malvastrum coromandelianum; and Casuarina equisetifolia, introduced in 1963, mostly dead in 1965, and absent in 1969.

The photographs by Frear, taken in December 1912, indicate that the flora was chiefly tall bunchgrass, presumably Eragrostis (Fig. 50). Eleven years later, in April 1923, the photographs of Wetmore show the island to have a moderate, open cover of Eragrostis (Fig. 51). Sesuvium grew abundantly on the large reef rock ledge. The Tanager Expedition collected six species (Christophersen and Caum, 1931: 15-16). Eragrostis and Lepturus were distributed indiscriminately on the island. Sesuvium grew on the reef rock areas and in the mud flats around the ponds at the eastern end of the island. Boerhavia was present, but not abundant, and Tribulus was present. Sicyos was represented by a few plants (see also St. John, 1970: 451). One seed each of Mucuna gigantea and M. urens was found on the beaches.

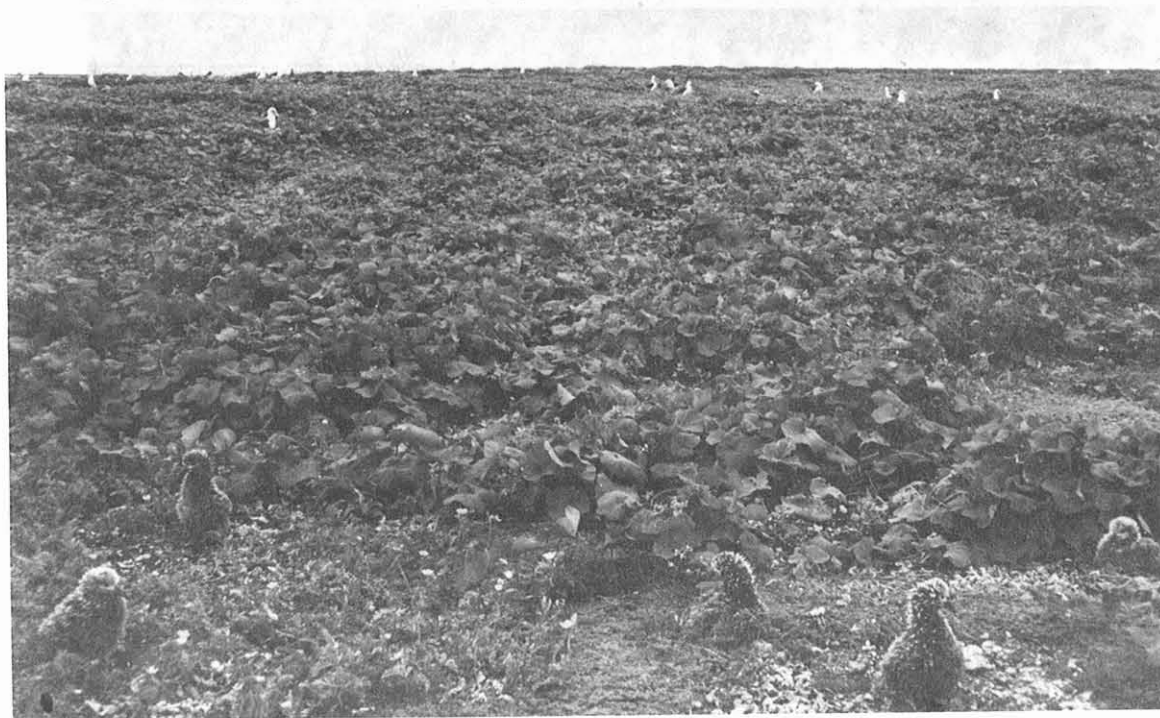


45. Laysan and Black-footed Albatrosses nesting among Solanum, Coronopus, Boerhavia, and Tribulus on western section at Southeast Island, view looking southwest, 13 March 1964; USCGC Planetree in left background. POBSP photograph by A.B. Amerson, Jr.
46. Low vegetation on western section at Southeast Island, view looking southeast across interior toward reef-rock area, 13 March 1964. POBSP photograph by A.B. Amerson, Jr.





47. Eragrostis, Coronopus, Tribulus, and Boerhavia growing in the west-central portion of the eastern section at Southeast Island, view looking west, June 1967; Laysan Albatross adults and chicks and Sooty Tern adults; U.S. Navy-built tower in center background. POBSP photograph by R.L. DeLong.
48. Tribulus and Sicyos in the west-central portion of the eastern section of Southeast Island, 13 March 1964. POBSP photograph by A.B. Amerson, Jr.





49. Black Noddies roosting in stunted Scaevola bushes on the south shore of the western portion of the eastern section at Southeast Island, view looking northwest, 28-30 August 1967. POBSP photograph by R.B. Clapp.



50. Tall bunchgrass, presumably Eragrostis, growing on the crest of Southeast Island, December 1912; Hawaiian Monk Seal foreground, Black-footed Albatross nesting below crest. Photograph by W.F. Frear courtesy of Virginia Frear Wild.
51. Open cover of Eragrostis at Southeast Island, 26 April 1923. Photograph by A. Wetmore.



In May 1923 the Tanager Expedition planted hau, Hibiscus tiliacea, and palm trees, Pritchardia pacifica, and scattered seeds (Gregory, 1924: 21; Wetmore, ms.). Though no record remains of what seeds were scattered, Wetmore has a list of the species given the expedition by the Territory of Hawaii and the Department of Agriculture for planting on the Reservation to replace vegetation destroyed by rabbits. With the exception of Scaevola none of the species on this list is presently growing on Southeast Island.

Photographs taken by Galtsoff in 1930 show that the eastern section was primarily dense Eragrostis (Fig. 52) with some areas of Lepturus and Boerhavia. A photograph of the buildings of the pearl fisheries venture shows a Casuarina about five feet tall, many plants of Sonchus, and an unidentifiable composite which is apparently no longer present. One view of the western section (Fig. 53) shows a flora of scattered Boerhavia and very sparse Lepturus. Galtsoff (1933: 16) mentions the planting of Casuarina and Cocos sp. in 1928, but further states that they were all dead or dying by 1930.

Woodside and Kramer (HDFG, 1961) reported finding introduced Setaria verticillata in March 1961. Ironwood (Casuarina) trees were planted by the U.S. Navy sometime in 1963 to increase the islands' visibility from the ocean. As this was in violation of Refuge regulations, all trees which were not already dead were destroyed in 1964. Setaria was reintroduced with the ironwoods in 1963.

A significant change has occurred in the flora since it was first described in 1923 and 1930 (Figs. 54 and 55). Eragrostis has been reduced from the status of a major plant cover to one of insignificance. Only a few isolated clumps remain on the eastern section, which in 1930 was nearly solid grass. Possibly the major vegetation change occurred in late 1930 when George Kaufman reported no live vegetation, only tall clumps of dead bunchgrass, after a severe storm (Fisher and Baldwin, 1945: 11). As information on plant succession in the Northwestern Hawaiian Islands is very limited, it is not known whether the floral change observed, from grasses to herbs and vines, is a result of natural succession or caused by some edaphic catastrophe.

Other Islands

POBSP and BSWF personnel found no plants on Bird, Kittery, Planetree, or Sand Islands on visits between 1963 and 1969, nor was vegetation listed for these islands in earlier reports (Wetmore, ms.; Galtsoff, 1933: 13-14; Christophersen and Caum, 1931: 15-16, 20-41).

REPTILES

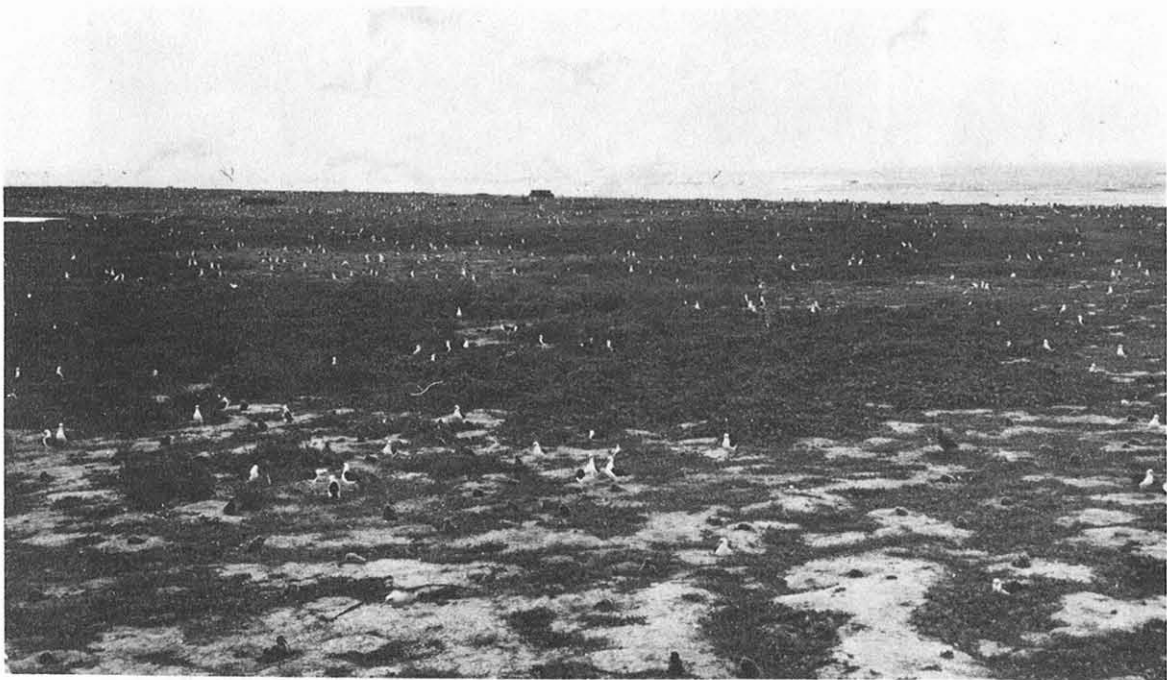
Only one reptile--the Black Turtle of the Pacific (Chelonia agassizi)--has been recorded. Perhaps the Pacific Hawksbill Turtle (Eretmochelys imbricata), an uncommon species in the Hawaiian Islands, has visited the atoll, but no substantiated record exists of its occurrence. Common and scientific names follow Carr (1972).



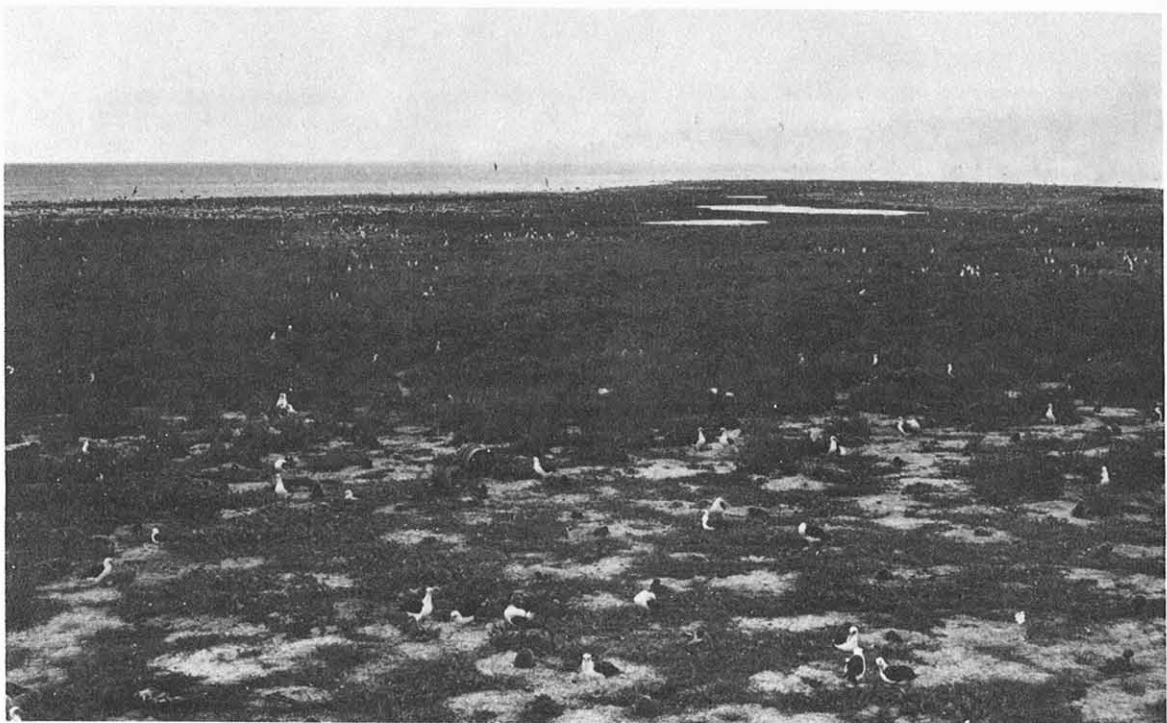
52. Bureau of Fisheries personnel inspect Sooty Tern colony in dense Eragrostis of the eastern section at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.

53. Boerhavia and Lepturus growing on the western section at Southeast Island, view looking south, summer 1930. Photograph by P.S. Galtsoff.





54. Creepers and low shrubs cover most of the eastern section at Southeast Island, view from U.S. Navy-built tower looking east, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.
55. Dense creepers, low shrubs, and some grasses cover most of the central portion of the eastern section at Southeast Island, view from tower looking east-northeast, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.



BLACK TURTLE

Chelonia agassiziStatus

Uncommon resident breeder; a few probably present year-round; frequents Little North, North, and Southeast Islands. Maximum recent POBSP and BSWF population estimate 55 in September 1966.

Observations

Morrell (1832: 218) first recorded sea turtles in 1825; he wrote that "great numbers of green turtles are found on the sand-beaches, where they come to deposit their eggs." He further noted that "the hawk's-bill turtle, also, sometimes visits this place, but in small numbers." Osburn (Kemble, 1966: 155) in August 1850 caught one small sea turtle on the reef, but saw "no Turtle nor the signs of any" on shore.

Turtles were next recorded in 1857 by Paty (1857: 2-3) who wrote that the lagoon "seemed to abound with...turtle." Two years later Brooks (1860: 502) noted "plenty of...turtle," and in 1882 the crew of the Japanese schooner Ada killed 28 (Hornell, 1934: 432). Turtles were also reported to be plentiful in 1913 (Bailey, 1956: 30) and 1914 (Elschner, 1915: 60). Munter (ms.) noted eight on the beach in February 1916. Wetmore (ms.), however, did not observe them in April 1923.

POBSP and BSWF personnel recorded turtles on most survey trips since early 1963. All turtle observations are summarized in Table 3.

Table 3. Black Turtle observations at Pearl and Hermes Reef

Date of Survey	Island	Population		Breeding Status, Remarks, References
		Estimate		
1825	8-11 July	?	great numbers	On beaches; notes eggs (Morrell, 1832: 218).
1850	11 Aug.	Southeast?	0	Saw "no Turtle nor the signs of any" on the island but caught "one small Green Turtle on the reef" (Kemble, 1966: 155).
1857	19-20 May	?	?	Lagoon abounded with turtle (Paty, 1857: 2-3).
1859	5 July	?	?	Plenty of turtle (Brooks, 1860: 502).
1882	19-21 Jan.	?	28	Killed by crew of schooner <u>Ada</u> (Hornell, 1934: 432).
1913	15 Mar.	North	?	Many large Green Turtles (Bailey, 1956: 30).

Table 3. (continued)

Date of Survey	Island	Population Estimate	Breeding Status, Remarks, References
1914 Sept.	North	?	Good many turtles (Elschner, 1915: 60).
1916 4 Feb.	Southeast	8	Hauled out on beach (Munter, ms.).
1923 26-28 Apr.	?	0	Did not record turtles (Wetmore, ms.).
1930 22 July- 23 Aug.	?	?	Notes presence of large amount of algae (<u>Codium</u>) in turtle stomachs (Galtsoff, 1933: 16).
1950 27 June	Southeast	12	Tagged (POFI, 1950).
1956 22 Mar.	Southeast	44	Counted (POFI, 1956a).
26 May	Southeast	3	(POFI, 1956b).
26 May	North	1	Digging nest (POFI, 1956b).
1957 ?	Southeast	20-50	Basking on north beach (Parsons, 1962: 69-70).
?	North	10-20	Basking on south beach (Parsons, 1962: 69-70).
1958 ?	Southeast	20-50	Basking on north beach (Parsons, 1962: 69-70).
?	North	10-20	Basking on south beach (Parsons, 1962: 69-70).
1961 12 Mar.	Southeast	4	Adults; copulation observed in shallow water; no sign of egg laying (HDFG, 1961).
1962 Jan.*	Bird and Sand	30	Seen from aerial survey; 8 ♀ basking (Carr, <u>in litt.</u>).
1963 26 Feb.- 8 Mar.	Southeast	15	On beaches, mostly at night (POBSP, 1964d).
6 Mar.	North	7	On east beach cove (POBSP, 1964d).

*Between 14 and 28 January.

Table 3. (continued)

Date of Survey		Island	Population Estimate	Breeding Status, Remarks, References
1963	18-23, 25 June	Southeast	20	On beaches, mostly nocturnal (POBSP, 1963).
	23-25 June	North	9	On beaches (POBSP, 1963).
	23, 25 June	Little North	2	On beaches, 1 15" yearling caught (POBSP, 1963).
1964	13-14 Mar.	Southeast	8	Adults; 2 ♂ and 5 ♀ tagged (BSFW, 1964a; POBSP, 1964b).
	16-19 Aug.	Southeast	12	Nocturnally (POBSP, 1964a).
	19-20 Aug.	North	10	Nocturnally (POBSP, 1964a).
	16 Sept.	Southeast	31	Adults; 5 ♂ and 14 ♀ tagged; nest pits, but no eggs (BSFW, 1964b; POBSP, 1964c).
	17 Sept.	North	2	Small 2' x 2' turtles; 8-10 pits, no eggs, 1 3" mummified young (BSFW, 1964b; POBSP, 1964c).
	17 Sept.	Little North	2	Adults; 1 ♀ on beach (BSFW, 1964b).
1965	15-19 Mar.	Southeast	12	Counted on 15th (POBSP, 1965b).
	17-18 Mar.	North	5	Counted on 17th; 1 mummified hatchling (POBSP, 1965b).
	21-22 Mar.	Southeast	5	1 ♂ and 1 ♀ tagged; 1 recaptured (BSFW, 1965; POBSP, 1965a).
1966	1 Apr.	Southeast	12	3 ♂ and 6 ♀ tagged (BSFW, 1966a).
	20-26 Sept.	Southeast	50	44 tagged, 6 recaptured (BSFW, 1966b).
	22 Sept.	North	2	Adults, 1 ♂ and 1 ♀ tagged (BSFW, 1966b).
	22 Sept.	Little North	3	Adults, 2 ♂ and 1 ♀ tagged (BSFW, 1966b).
1967	16-17 Mar.	North	9	Counted on 16th (BSFW, 1967d).

Table 3. (continued)

Date of Survey	Island	Population Estimate	Breeding Status, Remarks, References
1967 17 Mar.	Southeast	8	Counted (BSFW, 1967d).
21-23 Mar.	Southeast	17	1 ♂ and 10 ♀ tagged; 1 ♂ and 5 ♀ recaptured (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	Southeast	5	4 large, 1 small; copulation in water (POBSP, 1967b).
28-30 Aug.	Southeast	?	Present (POBSP, 1967a).
29-30 Aug.	North	3-5	(POBSP, 1967a).
29 Aug.	Little North	1	Counted (POBSP, 1967a).
27-29 Sept.	Southeast	19	3 ♂ and 1 ♀ tagged at dusk (BSFW, 1967c).
1968 22-24 Mar.	Southeast	22	10 tagged, 12 recaptured (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	Southeast	2	Unknown sex (BSFW, 1969a).
10-12 Feb.	North	11	6 ♂, 1 ♀, 4 unknown (BSFW, 1969a).
10-12 Feb.	Little North	2	Unknown sex (BSFW, 1969a).
31 Mar.- 2 Apr.	Southeast	11	2 ♀ tagged, 9 recaptured (BSFW, 1969b).
31 Mar.	North	7	5 ♂ and 2 ♀ tagged (BSFW, 1969b).
31 Mar.	Little North	3	1 ♂ and 2 ♀ tagged (BSFW, 1969b).
26-31 May	Southeast	8	2 tagged, 6 recaptured (BSFW, 1969c).
26 May	North	6	Counted (BSFW, 1969c).
10-19 Sept.	Southeast	27	Counted on the 10th; 3 ♂ and 9 ♀ tagged; 3 ♂, 3 ♀ and 2 unknown recaptured; 10 nest pits on west portion, no eggs (BSFW, 1969d).

Annual Cycle

Black Turtles have been observed in small numbers during most months of the year. Recent March population counts for the atoll range from 17 to 21. May and June counts range from 14 to 31, while September counts range from 35 to 55.

Although turtles have been observed copulating in March, May and June, no egg laying has been observed. Small numbers of egg pits were recorded in September, but no eggs were found by digging. Mummified hatchlings were found in March and September. Turtles on other Northwestern Hawaiian Islands lay their eggs in the summer months with young hatching by late summer and fall.

Ecological Distribution

Turtles are attracted to the atoll for food and for breeding purposes. Adults and yearlings feed on algae growing in the lagoon. Tsuda (1966: 39) recorded 39 species of marine benthic algae from the lagoon. At least one of these, Codium arabicum, is frequently used as food by adult sea turtles.

Turtles are known only from Bird, Little North, North, Sand, and Southeast Islands; nesting occurs solely on North and Southeast Islands. None has been observed on the other islands.

Little North Island: Turtles have been recorded on six occasions (Table 3). The population, regardless of month, was always low and ranged from 1 to 3.

North Island: Turtles have been observed on 16 surveys (Table 3). Population estimates have averaged 7 for all 11 recent surveys, and have ranged from 2 to 11. The southeast beach cove area is popular day and night with basking turtles (Fig. 56). In September 1964, 8 to 10 turtle nest pits were noted but digging produced no eggs; a mummified 3-inch hatchling was also found nearby. Another mummified hatchling was found in March 1965.

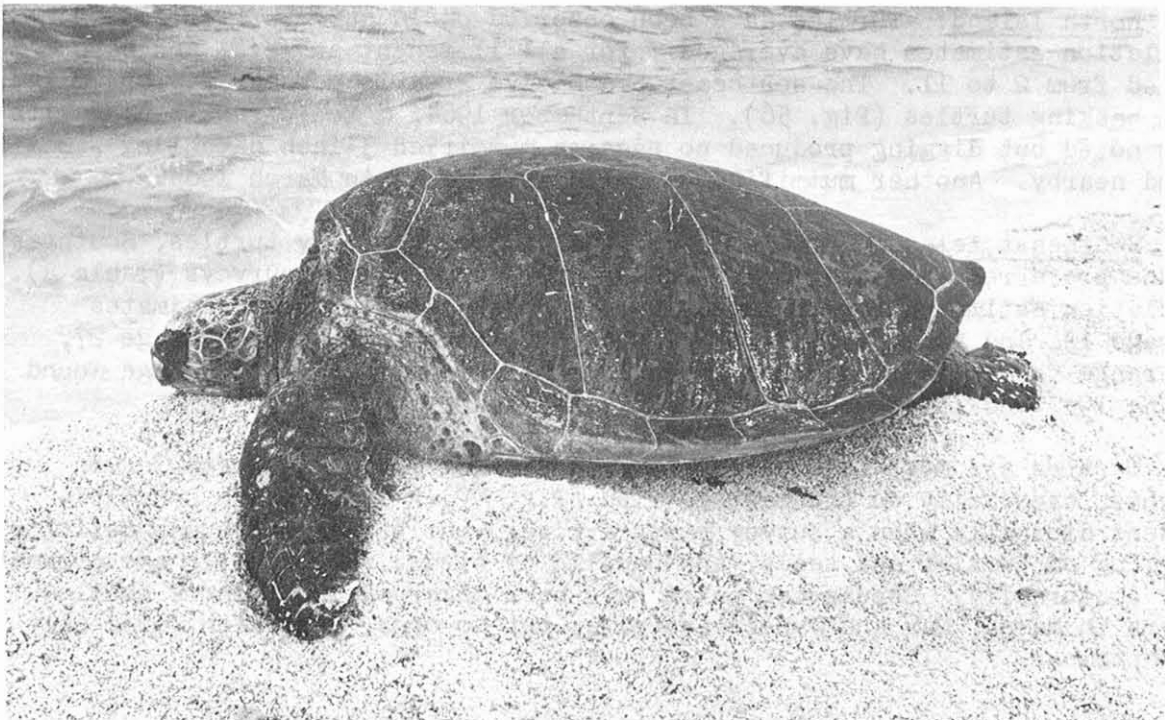
Southeast Island: Of the three islands frequented by turtles, Southeast is the preferred. Turtles have been recorded there on 24 surveys (Table 3). Population estimates for 17 recent surveys average 15. March estimates average 13, and range from 8 to 22, while September estimates average 27, and range from 13 to 50. This range is similar to the 20 to 50 range found during 1957 and 1958 by Kenyon and Rice (Parsons, 1962: 69-70).

Turtles are most frequently observed basking along the north lagoon beaches, especially on the east portion (Fig. 57). Turtles are usually present diurnally when a survey party arrives, but because of human activity (tagging of turtles and seals, and banding of birds) subsequently are present only nocturnally. Copulating pairs have been observed in offshore shallow waters in March, May and June; nest pits, but no eggs, have been found only in September.



56. The southeast beach-cove area at North Island is a popular place for sea turtles to bask in the sun, 29 August 1967 (print reversed). POBSP photograph by C.A. Ely.

57. Black Turtle sun basking on north beach at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.



Other Islands: Carr (in litt.) noted about 30 on Bird and Sand Islands in January 1962. None has been observed there since.

Tagging and Movement

Since 1964 BSWF personnel have tagged at least 137 Black Turtles (Table 3) with numbered Monel metal tags, usually placed in the trailing edge of the right front flipper. Of these, 122 were used at Southeast, 9 on North, and 6 on Little North Islands. Tagged individuals included 28 males and 55 females.

Of the 137, 46 were recaptured on Southeast Island (Table 3). In addition, two females tagged at Whale-Skate Island, French Frigate Shoals, some 600 miles to the southeast, were recaptured at Southeast Island. Another turtle tagged at Southeast Island was captured at Whale-Skate Island, French Frigate Shoals. These data are being further analyzed by BSWF personnel.

Amerson (1971: 80) noted that the French Frigate Shoals turtle population is the largest in the Hawaiian Islands. Hendrickson (1969: 94) theorized that "a double population nests" there. He suggested that the extreme Northwestern Hawaiian Islands may be the feeding ground for one group and that the other migrates eastward to feeding grounds around the inhabited islands. Early tag analysis seems to verify this theory (see also Amerson, 1971: 91-92).

Carr (1964: 51-52) in January 1962¹ found the Pearl and Hermes Reef and French Frigate Shoals turtle populations to be predominantly dark and high-shelled despite single light-colored, flat yearlings at each atoll. He was unable to determine whether these individuals were variants of the local dark stock or visitors from some distant, genetically different, population.

Carr (1972: 24-26) uses the name Chelonia agassizi for the mid-Pacific turtles, thus separating them taxonomically from the Atlantic green turtle, Chelonia mydas. C. agassizi also occurs in the eastern Pacific and in parts of the Indian Ocean. Carr suggests that "with its range extending through so much territory, ... the name ... surely covers a number of hitherto unnamed races." He also notes that "some Pacific colonies that are obviously not C. agassizi ... have to be grouped with the Atlantic green turtle as C. mydas."

BIRDS

Several sources were used in assembling the common and scientific names of the birds occurring at Pearl and Hermes Reef. The names used in the American Ornithologists' Union's Check list of North American Birds, 1957, 5th edition, were followed for species occurring in North America. In the

¹Not August 1956 as noted by Amerson (1971: 61, 92, 340).

interest of consistency, seabird names agree with those which appear in Watson's Smithsonian Identification Manual: Seabirds of the Tropical Atlantic Ocean, and King's Smithsonian Identification Manual: Seabirds of the Tropical Pacific Ocean. Taxonomic order follows that of Peter's Check-list of Birds of the World, volumes I, II, and III, with the exception of the Procellariiformes, which follow Alexander et al. (1965), the Anseriformes, which follow Delacour (1954, 1959), and the Charadriiformes, which follow Bock (1958).

Introduction

The 37 bird species recorded belong to 6 orders, 14 families, and 27 genera. In the following checklist, resident birds are unmarked, non-resident birds are marked with an *, and birds introduced by man are marked with a #.

Order Procellariiformes

Family Diomedidae

Diomedea nigripes

Black-footed Albatross

Diomedea immutabilis

Laysan Albatross

Family Procellariidae

Pterodroma hypoleuca

Bonin Petrel

Bulweria bulwerii

Bulwer's Petrel

Puffinus pacificus

Wedge-tailed Shearwater

Puffinus nativitatus

Christmas Shearwater

Family Hydrobatidae

Oceanodroma tristrami

Sooty Storm Petrel

Order Pelecaniformes

Family Phaethontidae

Phaethon rubricauda

Red-tailed Tropicbird

Family Sulidae

Sula dactylatra

Blue-faced Booby

Sula sula

Red-footed Booby

Sula leucogaster

Brown Booby

Family Fregatidae

Fregata minor

Great Frigatebird

Order Anseriformes

Family Anatidae

Anas acuta*

Pintail

Anas laysanensis #

Laysan Teal

Order Gruiformes

Family Rallidae

Porzanula palmeri #

Laysan Rail

Order Charadriiformes

Family Charadriidae

Pluvialis dominica*

Golden Plover

Family Scolopacidae	
<u>Numenius tahitiensis*</u>	Bristle-thighed Curlew
<u>Heteroscelus incanum*</u>	Wandering Tattler
<u>Arenaria interpres*</u>	Ruddy Turnstone
<u>Capella sp.*</u>	Snipe species
<u>Calidris canutus*</u>	Knot
<u>Crocethia alba*</u>	Sanderling
<u>Erolia acuminata*</u>	Sharp-tailed Sandpiper
<u>Erolia alpina*</u>	Dunlin
<u>Philomachus pugnax*</u>	Ruff
Family Phalaropodidae	
<u>Phalaropus fulicarius*</u>	Red Phalarope
Family Laridae	
<u>Larus delawarensis*</u>	Ring-billed Gull
<u>Larus argentatus vegae*</u>	Herring Gull
<u>Larus glaucescens*</u>	Glaucous-winged Gull
<u>Rissa tridactyla*</u>	Black-legged Kittiwake
<u>Sterna lunata</u>	Gray-backed Tern
<u>Sterna fuscata</u>	Sooty Tern
<u>Anous stolidus</u>	Brown Noddy
<u>Anous tenuirostris</u>	Black Noddy
<u>Gygis alba</u>	White Tern
Family Alcidea	
<u>Fratercula corniculata*</u>	Horned Puffin
Order Passeriformes	
Family Drepaniidae	
<u>Psittirostra cantans</u> <u>cantans#</u>	Laysan Finch

There are 17 species of resident seabirds, 5 regular migrant shorebirds, and 15 vagrant, accidental, and introduced birds.

Resident Seabirds

The 17 resident seabird species belong to 7 families--Diomedidae, Procellariidae, Hydrobatidae, Phaethontidae, Sulidae, Fregatidae, and Laridae.

These species all breed in the Hawaiian Islands. The Laysan Albatross breeds solely in the Hawaiian Islands. The Black-footed Albatross, Bonin Petrel, and Sooty Storm Petrel breed only in the Hawaiian and Bonin-Volcano Islands. The remaining species--Bulwer's Petrel, Wedge-tailed Shearwater, Christmas Shearwater, Red-tailed Tropicbird, Blue-faced Booby, Red-footed Booby, Brown Booby, Great Frigatebird, Gray-backed Tern, Sooty Tern, Brown Noddy, Black Noddy, and White Tern--breed in the Hawaiian Islands and other parts of the tropical Pacific.

Migrant Shorebirds

Although over 30 shorebird species have been recorded from the Northwestern Hawaiian Islands (Bryan, 1958; Udvardy, 1961; Clapp, 1968; Clapp and Woodward, 1968; unpubl. POBSP data), only Golden Plover, Bristle-thighed Curlew, Wandering Tattler, Ruddy Turnstone, and Sanderling are considered regular migrants. They breed during the summer in the Northern Hemisphere and migrate south for the winter; some use Pearl and Hermes for a "wintering ground."

Vagrant, Accidental, and Introduced Birds

Fifteen species have been recorded, including four accidental gull species--Ring-billed, Herring, Glaucous-winged, and Black-legged Kittiwake. In general, Glaucous-winged Gulls breed in the area surrounding the extreme North Pacific, while Black-legged Kittiwakes breed circumpolarly in the Northern Hemisphere. The Herring Gull subspecies breeds in Siberia and the Ring-billed Gulls breed throughout most of northern North America.

One vagrant alcid species, Horned Puffin, has been recorded. This species breeds in the area surrounding the extreme North Pacific.

Six shorebird species--Snipe species, Knot, Sharp-tailed Sandpiper, Dunlin, Ruff, and Red Phalarope--are accidental visitors. The tidal pools on Southeast Island and the proximity to Midway Atoll, with its fresh-water puddles and large land area, may attract accidental shorebirds.

The three introduced species all come from Laysan Island. The Laysan Rail, introduced in 1928, and the Laysan Teal, introduced in 1967, did not survive for long, but the Laysan Finch, also introduced in 1967, has survived and is breeding very successfully.

One accidental duck species, the Pintail, has been recorded. This species is a fairly regular migrant to the Main Hawaiian Islands which occasionally migrates to the Northwestern Hawaiian Islands.

The shallow waters around Pearl and Hermes Reef offer an excellent feeding area for many seabirds, those which use, or breed on, the atoll as well as those which seldom occur there. The latter group includes both species which breed in the Hawaiian area (i.e., White-tailed Tropicbird) and pelagic birds which breed in other areas of the Pacific and migrate into or through the area during their non-breeding season. King (1967) records 50 seabird species classified as regular migrants, rare migrants, or vagrants to the Hawaiian area. Normally all of these birds stay at sea, but, because of sickness or bad weather, any could alight on the islands; none has been recorded at Pearl and Hermes to date.

Annual Cycles

Among the bird species annual population cycles and annual breeding cycles vary. These variations are discussed below.

Seabird Breeding Cycles

Seabirds breed here during all seasons of the year (Fig. 58). Most have distinct breeding periods; some have extended breeding cycles. The 17 breeding seabird species are grouped, based on maximum breeding periods, as follows: 4 are winter and spring breeders, 11 are spring and summer breeders, and 2 are summer and fall breeders; none is a fall and winter breeder (Table 4). Of these, the cycles of only six agree with those suggested by Richardson (1957: 30).

Winter and Spring Breeders: The four species are procellariiforms. The Black-footed and Laysan Albatrosses commence to nest in late fall, and the Sooty Storm Petrel and Bonin Petrel commence in early and mid-winter, respectively. The Albatrosses have usually fledged by late July. Sooty Storm Petrel and Bonin Petrel fledge in late spring and early summer, respectively.

Spring and Summer Breeders: Of the 11 species, 1 is a procellariiform, 5 are pelecaniforms, and 5 are charadriiforms. Six species (55 percent), the Christmas Shearwater, Red-tailed Tropicbird, Gray-backed Tern, Sooty Tern, Black Noddy, and White Tern, commence laying during the spring months. Individual birds of the remaining five species (45 percent) start laying during the winter months: the Brown Noddy as early as December, the Red-footed and Brown Boobies in early January, and the Blue-faced Booby and Great Frigatebird in February. All young usually commence fledging in the summer and continue into the fall. Fledging of the Christmas Shearwater, Sooty Tern, and probably White Tern extends into early fall; of the Red-tailed Tropicbird, Blue-faced Booby, Red-footed Booby, Great Frigatebird, Gray-backed Tern, Brown Noddy, and Black Noddy into late fall; and of the Brown Booby even into early winter.

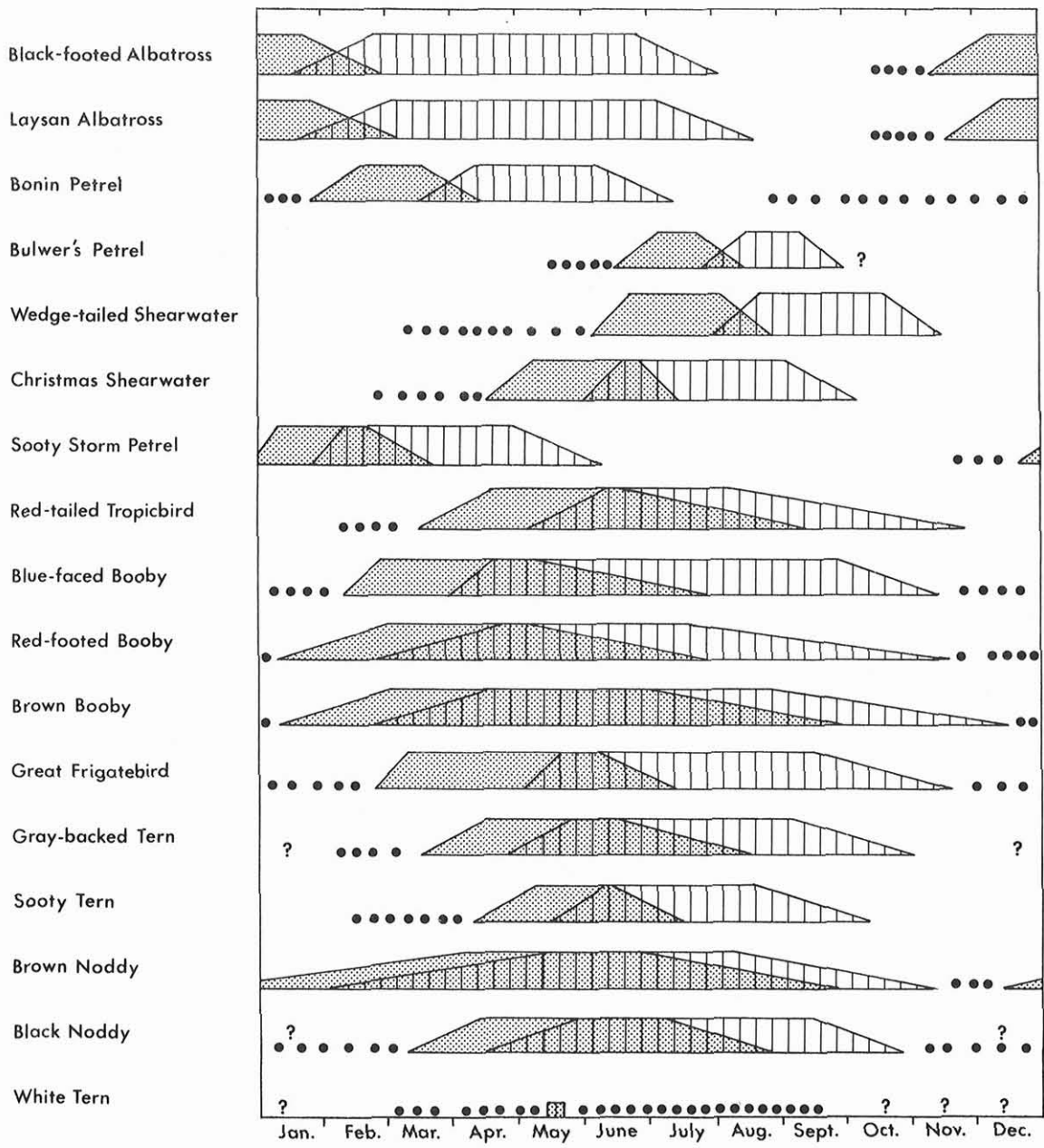
Summer and Fall Breeders: Two procellariiforms, Bulwer's Petrel and Wedge-tailed Shearwater, start laying in early summer and usually finish fledging by mid- or late fall.

Fall and Winter Breeders: Although no fall-winter breeders are known, virtually no late fall and early winter visits have been made. The Black Noddy, a fall-winter breeder on other Northwestern Hawaiian Islands, may breed during this period.

Although all breeding seabird species have a breeding peak, four, the Blue-faced Booby, Red-footed Booby, Brown Booby, and Brown Noddy, have an extended breeding season with egg laying extending over three seasons.

Land Bird Breeding Cycles

The introduced Laysan Finch appears to have a winter and spring breeding cycle. Eggs and young are now known from February to May. Because of its recent introduction, however, the cycle may be erratic. The unsuccessfully introduced Laysan Teal did not survive long enough to establish an annual breeding cycle. One pair, however, attempted to nest in mid-fall.



58. Breeding cycles of seabirds at Pearl and Hermes Reef; stippled areas represent eggs, barred areas young, and black dots non-breeding birds.

Table 4. Maximum breeding periods of Pearl and Hermes Reef resident seabirds

Winter-Spring	Spring-Summer	Summer-Fall	Fall-Winter
Black-footed Albatross	Christmas Shearwater*	Bulwer's Petrel	None
Laysan Albatross	Red-tailed Tropicbird*	Wedge-tailed Shearwater*	
Bonin Petrel			
Sooty Storm Petrel	Blue-faced Booby*		
	Red-footed Booby*		
	Brown Booby		
	Great Frigatebird*		
	Gray-backed Tern*		
	Sooty Tern*		
	Brown Noddy		
	Black Noddy		
	White Tern		

*Breeding period agrees with that suggested by Richardson (1957: 30).

Population Cycles

Perusal of the subsequent species accounts and inspection of Figure 58 and Table 5 reveal that many resident and non-resident species leave the atoll during part of each year. Even those that stay year-round have a population buildup sometime during the year.

Resident Species: Of the resident seabird breeding species, 7 remain on the atoll year round: Blue-faced Booby, Red-footed Booby, Brown Booby, Great Frigatebird, Brown Noddy, Black Noddy, and probably White Tern. Their populations decrease during the non-breeding seasons in the late fall and early winter.

The 10 resident seabird breeding species which do not stay on the atoll year-round leave just before or just after their young fledge. Some remain at sea in the general area of the Hawaiian Islands; others leave the area entirely and migrate to distant areas. The Black-footed Albatross, Laysan Albatross, Bonin Petrel, Red-tailed Tropicbird, and Gray-backed Tern are only away for two to three months. The Bulwer's Petrel, Wedge-tailed Shearwater, Christmas Shearwater, Sooty Storm Petrel, and Sooty Tern spend from 4 to 7 months away (Fig. 58).

Non-resident Species: The monthly occurrence of the 17 non-residents--regular migrant shorebirds, and vagrant and accidental species--is presented in Table 5. Some species occur year-round, while others occur infrequently.

The five regular migrant shorebird species are known from all seasons of the year. The six shorebirds classed as accidentals and vagrants are found irregularly during the year. The four gulls and the alcid are known from late winter or spring months. The accidental duck is known only from September.

Introduced Birds: Of the three introduced bird species, only the Laysan Finch remains. It is found year-round on the atoll.

Table 5. Monthly occurrence of the non-resident birds at Pearl and Hermes Reef *

Species	February	March	April	May	June	August	September
Pintail							x
Golden Plover	x	x	x	x	x	x	x
Bristle-thighed Curlew	x	x	x	x	x	x	x
Wandering Tattler	x	x	x	x	x	x	x
Ruddy Turnstone	x	x	x	x	x	x	x
Snipe species		x					
Knot		x					
Sanderling	x	x				x	x
Sharp-tailed Sand- piper							x
Dunlin		x					
Ruff						x	
Red Phalarope		X					
Ring-billed Gull		x					
Herring Gull	x	x					
Glaucous-winged Gull	x	x	X				
Black-legged Kittiwake		X					
Horned Puffin		X					

*No ground observations January, July, October, November, and December.

x = birds found alive, X = birds found dead.

Ecological Distribution Within the Atoll

Suitable habitat for bird species varies on the islands. The nine named islands differ slightly in size, height, soil, vegetation, fresh-

water supply, and degree of human disturbance. Major differences in avifaunal distribution are found between vegetated and non-vegetated islands (Table 6).

The major islands--Grass, North, Seal, and Southeast--are all rather large and well-vegetated. All bird species are known from at least one. Southeast Island, with the greatest number of recorded species and the highest population count, is the largest island in the atoll, with 34 acres; it has more vegetation, tidal pools, and a larger rocky seaward ledge than the other islands. It is the only island that has been affected by human habitation. Grass, North, and Seal Islands vary slightly in size (10 to 16 acres); Grass and Seal have rocky portions, Seal has a tidal pool, and North has more vegetation than the other two.

The remaining five low, sandy islands have little or no vegetation; only 17 bird species have been recorded on them. Little North Island supports four plant species, but is not large, while Kittery Island is large but has no vegetation; Bird Island has no vegetation but is usually above high tide. Sand and Planetree are vegetationless, low, and awash at high tide.

Resident Seabirds

Only three of the 17 breeding species nest on both vegetated and non-vegetated islands; none nests exclusively on the non-vegetated islands (Table 6).

Migrant Shorebirds

The regular migrant shorebirds are all known from the four major islands and all except the Bristle-thighed Curlew have been recorded on two or more of the five lesser islands (Table 6).

Vagrant, Accidental, and Introduced Birds

All four gull species are known from Southeast, two are known from Little North and one each from Grass, Kittery, North and Seal. The alcid is known from Grass and North. The six accidental shorebirds were all observed at Southeast. The accidental duck species was also recorded at Southeast. Both the accidental shorebirds and the duck were probably attracted to Southeast because of its central tidal pools.

Of the birds introduced to Southeast, only the Laysan Finch remains. It presently breeds there and has been observed at Grass.

Island Accounts

Avifaunal components are discussed in the following section. Islands are listed alphabetically.

Table 6. Status of the birds on Pearl and Hermes Reef

Species	Vegetated				Non-vegetated				
	South- east	Grass	North	Seal	Little- North	Kittery	Bird	Sand	Plane- tree
Black-footed Albatross	B	B	B	B	B	B	B		
Laysan Albatross	B	B	B	B	B	B	B		
Bonin Petrel	B	B	bP	B					
Bulwer's Petrel	B								
Wedge-tailed Shearwater	B	B	B	B					
Christmas Shearwater	B		P						
Sooty Storm Petrel	B	P	B	B					
Red-tailed Tropicbird	B	B	B	B	O				
Blue-faced Booby	B	B	B	B	B	B	B	P	P
Red-footed Booby	B	B	B	P					
Brown Booby	B	P	P	P		P			
Great Frigatebird	B	B	B	bp		P			
Pintail	A								
Laysan Teal	IB			I*					
Laysan Rail	i								
Golden Plover	P	P	P	P	P	P			
Bristle-thighed Curlew	P	P	P	P					
Wandering Tattler	P	P	P	P	P	P	P		
Ruddy Turnstone	P	P	P	P	P	P	P	P	P
Snipe sp.	A								
Knot	A								
Sanderling	P	P	P	P	P	P			
Sharp-tailed Sandpiper	A								
Dunlin	A								
Ruff	A								
Red Phalarope	A								
Ring-billed Gull	A				A				
Herring Gull	A					A			
Glaucous-winged Gull	A		A	A	A				
Black-legged Kittiwake	A	A							
Gray-backed Tern	B	B	O	B		P	P		
Sooty Tern	B	O	O	B					
Brown Noddy	B	B	B	B	O	P		P	
Black Noddy	B	bP	B	bP			p	P	p
White Tern	B	P	P	P	P				
Horned Puffin		A	A						
Laysan Finch	IB	I*							
Total Species	36	23	23	22	12	12	7	4	3
Breeding Species	19	11	11	12	3	3	3	0	0

B = Breeding; P = Present; O = Overflier; A = Accidental; I = Introduced.
Capital letters indicate status 1960-1969; lower case letters indicate
status 1891-1959, if different than present.

*Occurrence by natural dispersal from Southeast.

Bird Island

Seven bird species have been recorded (Table 7). The absence of species records prior to 1935 and the low population and breeding numbers recorded since are due primarily to the island's small size and its lack of vegetation. This sandy island is low and during extremely bad weather its location is such that wave action could destroy nests.

Recent total daytime populations (breeders 48, non-breeders 5) are small; populations probably increase at night.

The three species--Black-footed Albatross, Laysan Albatross, and Blue-faced Booby--presently nesting nest on the raised central portion. The Black Noddy was observed roosting in 1957 by Rice (ms. a); the Gray-backed Tern was observed there in recent years.

Low numbers of Wandering Tattlers and Ruddy Turnstones have been recorded on the beaches. No other shorebird species have been recorded.

Grass Island

Twenty-three species have been observed (Table 8). The sudden decrease in the number of species between 1935 and 1959 reflects a decrease in number of observations rather than a change in the bird life.

Recent total maximum populations on Grass are greater than on Seal, but not as large as on Southeast and North. The Black-footed Albatross, Laysan Albatross, Wedge-tailed Shearwater, and Brown Noddy, in that order, are the most numerous breeding species. The Black Noddy, which nested prior to 1935, has the largest population of any present-day non-breeding species.

The 11 breeding species nest on all portions of Grass. The Black-footed Albatross and Blue-faced Booby are found mainly along the upper beach crest and on the perimeter of the vegetated west portion (Fig. 59). The Laysan Albatross nests mainly on the bare spots in the vegetated portion. Burrows of Bonin Petrels and Wedge-tailed Shearwaters can be found only in the vegetated portion. Red-tailed Tropicbirds nest under thick vegetation, especially Eragrostis. Red-footed Boobies and Great Frigatebirds nest on the dense Solanum (Fig. 60). The Gray-backed Terns and Brown Noddies nest on the ground in areas of low vegetation. The Black Noddy, which nested formerly, now only roosts on the vegetated portion. Most non-nesting individuals of breeding species roost very close to their nesting counterparts.

Sooty Storm Petrels roost only in the vegetated area; Brown Boobies roost on the beach. Sooty Terns and White Terns occasionally fly over the island; the latter species has roosted on the rocks of the nearby reef.

The five species of regular migrant shorebirds occur over most of the island. The Golden Plover, Ruddy Turnstone, and Sanderling are most frequently seen on the beaches. The Bristle-thighed Curlew and Wandering Tattler may also be found on the east reef rock extension.

Table 7. Status, recent populations, and habitat of Bird Island birds

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross		B	B	38	?	Nests on island crest.
Laysan Albatross			B	2	?	Nest placed on island crest.
Blue-faced Booby		P	B	8	?	Nests on island crest.
Wandering Tattler			P		1	Beach.
Ruddy Turnstone			P		3	Beach.
Gray-backed Tern			P		1	
Black Noddy [?]		P				Roosting (Rice, ms. a).
Total				48	5	

B = Breeding; P - Present.

Table 8. Status, recent population, and habitat of Grass Island birds

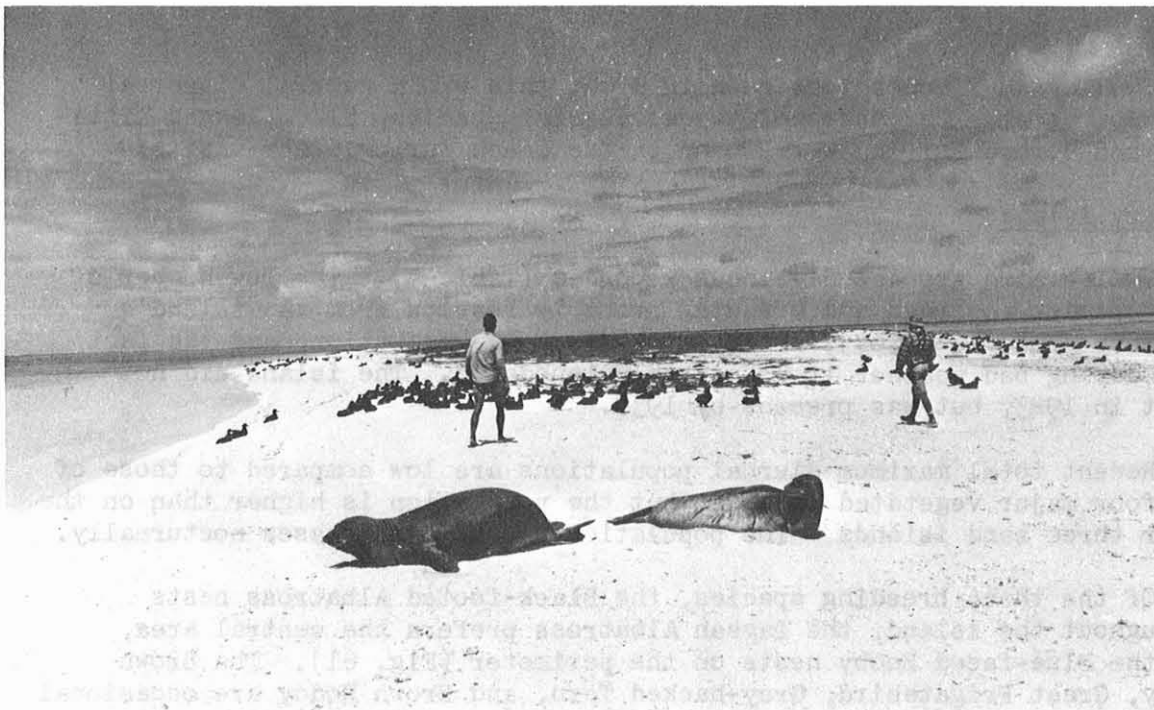
Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross	B	B	B	2,934	?	Nests on perimeter.
Laysan Albatross	B	B	B	2,240	?	Nests on inland vegetated areas and beaches.
Bonin Petrel	P		B	few	200	Nests in vegetated portion.
Wedge-tailed Shearwater	P		B	1,000	?	Nests placed in vegetated area.
Sooty Storm Petrel			P	?	?	Presence noted.
Red-tailed Tropicbird	B		B	4	4	Nests under thick vegetation, especially <u>Eragrostis</u> .
Blue-faced Booby	P	P	B	12	16	Nests on upper sand beaches.
Red-footed Booby			B	8	7	Nests on <u>Solanum</u> .
Brown Booby			P		1	Roosting on sand.
Great Frigatebird	P	P	B	226	24	Nests on dense <u>Solanum</u> .
Golden Plover	P		P		5	Beaches.
Bristle-thighed Curlew	P		P		3	Rocky ledges.
Wandering Tattler	P		P		1	Beaches and rock ledges.
Ruddy Turnstone	P		P		100	Beaches.

Table 8. (continued)

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Sanderling			P		3	Beaches.
Black-legged Kittiwake			A		1	Beach carcass.
Gray-backed Tern			B	2	8	Nests in low vegetated area.
Sooty Tern			O		20	Overhead and offshore.
Brown Noddy	B		B	400	3,000	Nests in low vegetated area.
Black Noddy	B		P		400	Roosting on vegetated portion.
White Tern			P		5	Roosting on reef.
Horned Puffin			A		1	Beach carcass.
Laysan Finch			I*		2	<u>Lepturus</u> and <u>Eragrostis</u> .
Total				6,826	3,801	

B = Breeding; P = Present; O = Overflier; A = Accidental; I = Introduced.

*Natural dispersal from Southeast.



59. Wirtz (l.) and Stadel (r.) count Black-footed Albatross chicks along the upper beach crest and on the perimeter of the vegetated west portion at Grass Island, June 1967; Hawaiian Monk Seals in foreground. POBSP photograph by R.L. DeLong.
60. Great Frigatebirds (l.) and a Red-footed Booby (r.) nesting in low-growing Solanum at Grass Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.



Two Laysan Finches were seen in 1968; this was a natural dispersal from Southeast. Carcasses of two accidental species, Black-legged Kittiwake and Horned Puffin, were found on the beach during other visits.

Kittery Island

Twelve bird species have been recorded (Table 9). The low number of bird species recorded and breeding probably results from the island's moderate size (12 acres), its complete lack of vegetation, and the fact that during bad weather it is probably inundated. The island did not exist in 1923, but was present by 1936.

Recent total maximum diurnal populations are low compared to those of the four major vegetated islands, but the population is higher than on the other three sand islands. The population probably increases nocturnally.

Of the three breeding species, the Black-footed Albatross nests throughout the island, the Laysan Albatross prefers the central area, and the Blue-faced Booby nests on the perimeter (Fig. 61). The Brown Booby, Great Frigatebird, Gray-backed Tern, and Brown Noddy are occasional visitors and roost on the crest or beach areas. The one accidental, the Herring Gull, was found on the beach.

Low numbers of Golden Plovers, Wandering Tattlers, Ruddy Turnstones, and Sanderlings have been observed on the beaches.

Little North Island

Twelve bird species have been recorded (Table 10). The increase in the number of recorded species, as well as in the number of nesting species, since 1959 is due to an increase in number of observations, and to the recent permanent status of the island itself. A 1937 hydrographic chart showed only a sandbar awash at high tide. Today, four plant species can be found on Little North.

Recent total diurnal populations rank last among the vegetated islands; they are even below those of non-vegetated Kittery. These low populations reflect the island's small size (1.4 acres). The island's population probably increases nocturnally.

The three nesting seabird species nest on the raised central portion. Red-tailed Tropicbirds have been recorded flying low over the island, but no nests have been found in the bunch grass. Brown Noddies and White Terns occasionally roost on the island.

Two accidental gulls have been collected from the beaches, where four migrant shorebirds have also been recorded. No accidental shorebirds have been observed.

Table 9. Status, recent population, and habitat of Kittery Island birds

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross		B	B	706	?	Nests throughout the island.
Laysan Albatross			B	104	?	Nests in central area.
Blue-faced Booby			B	64	16	Nests primarily on island perimeter.
Brown Booby			P		1	Roosting on sand.
Great Frigatebird			P		1	Roosts on BSFW sign.
Golden Plover			P		2	Beach.
Wandering Tattler			P		1	Beach.
Ruddy Turnstone			P		30	Beach.
Sanderling			P		1	Beach.
Herring Gull			A		1	Beach.
Gray-backed Tern			P		1	
Brown Noddy			P		10	Beach.
Total				874	64	

B = Breeding; P = Present; A = Accidental.



61. Three species, Laysan and Black-footed Albatrosses and Blue-faced Boobies, nest on Kittery Island, view from southeast beach crest looking northwest, 26 June 1963. POBSP photograph by A.B. Amerson, Jr.

Table 10. Status, recent population, and habitat of Little North Island birds

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross		B	B	128	?	Nests on raised central portion.
Laysan Albatross			B	40	?	Nests on raised central portion.
Red-tailed Tropicbird			O	0	2	Over island.
Blue-faced Booby		P	B	58	150	Nests on raised central portion.
Golden Plover			P		1	Beach.
Wandering Tattler			P		1	Beach.
Ruddy Turnstone			P		15	Beach.
Sanderling			P		1	Beach.
Ring-billed Gull			A		1	Beach.
Glaucous-winged Gull			A		2	Beach.
Brown Noddy			O		3	
White Tern			P		3	Roosting on small central rock.
Total				226	179	

B = Breeding; P = Present; O = Overflier; A = Accidental.

North Island

Twenty-three bird species have been observed (Table 11). The sudden decrease in number of recorded and breeding species from 1935 through 1959 reflects the low number of observations made. The only surveys during that period were aerial.

Recent populations are extremely low compared to those of Southeast Island, but they are the second highest in the atoll. The Wedge-tailed Shearwater, Black-footed Albatross, Laysan Albatross, and Brown Noddy, in that order, are the most numerous breeding species. The breeding populations of the remaining nesting species are 150 or lower. The Bonin Petrel, which nested prior to 1935, is present today only in very small numbers.

All areas are utilized by the species now nesting; seven species nest on or under the ground and three nest in bushes or low vegetation. Black-footed Albatross nest around the entire periphery of the island, but especially on the east and west beach crests (see Figs. 37 and 38). Blue-faced Boobies nest mainly on the upper beach crests. Laysan Albatross nest primarily in the vegetated northern portion. Wedge-tailed Shearwaters and Sooty Storm Petrels dig burrows under most of the vegetated portion. Red-tailed Tropicbirds nest under Eragrostis and Solanum. Red-footed Boobies and Great Frigatebirds built their nests on Solanum; the former also nests on Scaevola. Brown Noddy nests are scattered over the ground throughout the vegetated portion and Black Noddies nest in clumps of Eragrostis. Roosting individuals of these breeding species usually utilize the same general areas as the nesters.

Non-nesting seabird species can be found in the vegetated portion (Bonin Petrel, Christmas Shearwater), on the beach (Brown Booby, White Tern), and occasionally flying over the island (Gray-backed Tern, Sooty Tern, White Tern).

The migrant shorebirds are found over most of North Island. Wandering Tattler, Ruddy Turnstone, and Sanderling are common on the beaches, while Golden Plover and Bristle-thighed Curlew frequent both the beaches and the vegetated areas.

Two accidental bird species have been recorded from the beaches. No accidental shorebirds have been observed.

Planetree Island

Three bird species have been recorded from Planetree. The island was not present when Tanager personnel visited the atoll in 1923. Rice (ms., a) observed roosting Black Noddies from an aerial survey in October 1957. Two additional species--a single roosting Blue-faced Booby and a single Ruddy Turnstone--have been recorded by POBSP, BSFW, and HDFG personnel since 1959. The island is continually awash and therefore changing shape, thus few birds frequent it.

Table 11. Status, recent population, and habitat of North Island birds.

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross	B	B	B	2,400	?	Nests on east and west beaches.
Laysan Albatross	B	B	B	1,500	500	Nests in vegetated northern portion.
Bonin Petrel	B		P	0	10	Vegetated area.
Wedge-tailed Shearwater			B	4,000	2,000	Nests in vegetated northern portion.
Christmas Shearwater			P	0	5	Vegetated area.
Sooty Storm Petrel	B		B	150	50	Nests in vegetated area.
Red-tailed Tropicbird			B	38	22	Nests under <u>Eragrostis</u> and <u>Solanum</u> .
Blue-faced Booby	B	P	B	58	117	Nests on upper beach crests.
Red-footed Booby		P	B	12	26	Nests on <u>Solanum</u> and <u>Scaevola</u> .
Brown Booby	P		P		24	Roosting on sand.
Great Frigatebird	B	P	B	124	206	Nests and roosts on <u>Solanum</u> .
Golden Plover	P		P		70	Primarily on beaches.
Bristle-thighed Curlew	P		P		4	Beach and vegetated areas.
Wandering Tattler			P		3	Beaches.
Ruddy Turnstone	P		P		100	Beaches.

Table 11. (continued)

Species	Status			Recent Maximum Population		Habitat
	pre- 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Sanderling			P		1	Beach.
Glaucous-winged Gull			A		2	Beach.
Gray-backed Tern			O		6	
Sooty Tern	P		O		2	
Brown Noddy	B		B	600	1,850	Nests scattered over vegetated area.
Black Noddy	B		B	6	1,100	Nests in <u>Eragrostis</u> ; roosts on beaches.
White Tern	P		P		10	Flying over and roosting on beach.
Horned Puffin			A		<u>1</u>	Beach carcass.
Total				8,888	6,109	

B = Breeder; P = Present; O = Overflier; A = Accidental.

Sand Island

Four bird species have been recorded (Table 12). This island was not in existence in 1923. Rice (ms. a) recorded one bird species from "south sand spits" in October 1957. POBSP and BSFW personnel have recorded three seabird and one shorebird species since 1963; no birds were nesting.

Sand Island's location, small size, low height, and lack of vegetation have all played a major role in limiting the number of birds as waves continually change its shape.

Seal Island

In all, 22 bird species have been recorded (Table 13). Two species that nested prior to 1935 no longer nest on Seal; one present nester was not known to breed prior to 1960.

The sharp decrease in number of recorded and breeding species from 1935 through 1959 reflects the low number of observations made during that period; surveys were only taken from airplanes.

Recent maximum population estimates are low compared to those for the other three major vegetated islands. Seal's population is, however, higher than that on Little North and the non-vegetated islands.

Ten seabird species presently nest. The Black-footed Albatross nests mainly on the outer perimeter; the Blue-faced Booby nests on the beach crest and east rock ledges. Laysan Albatross nest on open areas in the vegetated west portion (Fig. 62). Bonin Petrels, Wedge-tailed Shearwaters, and Sooty Storm Petrels dig their nest burrows in the vegetated west portion. Red-tailed Tropicbirds nest under dense clumps of Eragrostis. Gray-backed Terns, Sooty Terns, and Brown Noddies nest among the low vegetation; the Gray-backed Tern also nests on the rocky ledges. Visiting seabirds roost on the vegetation (Red-footed Booby, Great Frigatebird), on the beaches (Brown Booby, Black Noddy), and on the rock ledges (White Tern).

All the migrant shorebird species utilize the entire island. Golden Plovers, Ruddy Turnstones, and Sanderlings are most common on the beaches and around the tidal pools. Bristle-thighed Curlews and Wandering Tattlers frequent the rocky ledges.

An introduced Laysan Teal was seen on a nearby sandspit, and is considered to be a natural dispersal from Southeast. The carcass of one accidental species was found on the beach. No accidental shorebird species have been found.

Southeast Island

Thirty-six of the 37 bird species are known from Southeast Island (Table 14). The decrease in number of recorded and breeding species from

Table 12. Status, recent population, and habitat of Sand Island birds

Species	Status			Recent Maximum Population		Habitat
	pre- 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Blue-faced Booby			P		9	Roosting on sand beach.
Ruddy Turnstone			P		4	Beach.
Brown Noddy		P	P		20	Roosting on sand.
Black Noddy		P	P		<u>100</u>	Roosting on sand.
Total					133	

P = Present.

Table 13. Status, recent population, and habitat of Seal Island birds

Species	Status			Recent Maximum Population		Habitat
	pre- 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross	B	B	B	650	?	Nests mainly on perimeter.
Laysan Albatross	B	B	B	798	?	Nests in vegetated west portion.
Bonin Petrel	B		B	?	50	Nests in vegetated area.
Wedge-tailed Shearwater	P		B	1,000	200	Nests in vegetated portion.
Sooty Storm Petrel	B		B	few	15	Nests in vegetated portion.
Red-tailed Tropicbird	B		B	12	8	Nests under <u>Eragrostis</u> clumps.
Blue-faced Booby	B		B	106	?	Nests on upper beach crest and rock ledges.
Red-footed Booby			P		19	Roosts on vegetation.
Brown Booby		P	P		35	Roosting on sand.
Great Frigatebird	B		B		75	Roosting on vegetation.
Laysan Teal			I*		1	On a nearby sand spit.
Golden Plover	P		P		200	Numerous around tidal pools.
Bristle-thighed Curlew	P		P		16	Rocky ledges.
Wandering Tattler	P		P		6	Beach and rock ledges.
Ruddy Turnstone	P		P		65	Beaches and tidal pools.

Table 13. (continued)

Species	Status			Recent Maximum Population		Habitat
	pre- 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Sanderling			P		2	Beaches and tidal pools.
Glaucous-winged Gull			A		1	Beach.
Gray-backed Tern	B		B	350	?	Nests on rocky and vegetated portions.
Sooty Tern	B		B	18	1,500	Nests among low vegetation.
Brown Noddy	B		B	400	1,500	Nests among low vegetation; roosts on beaches and rocky ledges.
Black Noddy	B		P		700	Roosting on beaches.
White Tern			P		3	Roosts on rocks.
Total				3,334	4,396	

B = Breeding; P = Present; A = Accidental; I = Introduced.

*Natural dispersal from Southeast.



62. Laysan Albatross (l.) and Black-footed Albatross (r.) chicks on the perimeter of the vegetated portion at Seal Island, view looking west, 26 June 1963. POBSP photograph by A.B. Amerson, Jr.

Table 14. Status, recent population, and habitat of Southeast Island birds

46

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Black-footed Albatross	B	B	B	5,000	1,000	Nests mainly on perimeter.
Laysan Albatross	B	B	B	22,538	?	Nests on interior of island.
Bonin Petrel	B?		B	200	800	Nests on east vegetated portion.
Bulwer's Petrel			B	6	9	Nests on east portion under boards and tin.
Wedge-tailed Shearwater	P		B	10,000	4,000	Nests over entire island.
Christmas Shearwater	P		B	6	44	Nests under <u>Scaevola</u> and boards.
Sooty Storm Petrel	B		B	400	7,100	Nests abundant in <u>Cynodon</u> area.
Red-tailed Tropicbird	B		B	58	7	Nests under <u>Eragrostis</u> and <u>Scaevola</u> .
Blue-faced Booby	B	P	B	78	?	Nests on sand beaches and rock ledges.
Red-footed Booby	B	P	B	96	103	Nests on <u>Scaevola</u> , <u>Solanum</u> , <u>Tribulus</u> and <u>Sicyos</u> .
Brown Booby	B		B	144	?	Nests on inland grassy or coral rubble areas.
Great Frigatebird	B	P	B	242	?	Nests in <u>Solanum</u> ; roosts in vegetation, on the tower and oil drums.
Pintail			A		1	

Table 14. (continued)

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Laysan Teal			IB	2	10	Introduced 18 March 1967; last 2 seen 29 September 1967.
Laysan Rail	I*					14 introduced June 1929; not present summer 1930.
Golden Plover	P		P	.	175	Beaches and rock ledges.
Bristle-thighed Curlew	P		P		30	Rock ledges and tidal pools.
Wandering Tattler	P		P		25	Beaches and rocky ledges.
Ruddy Turnstone	P		P		500	Beaches, rocky ledges, and tidal pools.
Snipe sp.			A		1	
Knot			A		1	Edge of tidal pools.
Sanderling			P		3	Beaches and tidal pools.
Sharp-tailed Sandpiper			A		2	Tidal pools.
Dunlin			A		1	Tidal pools.
Ruff			A		1	Tidal pools.
Red Phalarope			A		1	Interior <u>Brassica</u> area.
Ring-billed Gull			A		1	Offshore.

Table 14. (continued)

96

Species	Status			Recent Maximum Population		Habitat
	pre 1935	1935- 1959	1960- 1969	Breeding	Non- breeding	
Herring Gull			A		1	Beach.
Glaucous-winged Gull			A		1	Beach.
Black-legged Kittiwake			A		2	Beach.
Gray-backed Tern	B		B	1,000	500	Nests scattered over entire island.
Sooty Tern	B		B	77,400	2,600	Nests scattered over entire island.
Brown Noddy	B		B	1,600	400	Nests scattered over entire island.
Black Noddy	B		B	100	2,900	Nests placed in <u>Eragrostis</u> and <u>Solanum</u> ; roosts in low vegetation.
White Tern	P		B	2	5	Nest placed on coral rock; usually flying over.
Laysan Finch			IB	34	130 [±]	Nests in <u>Eragrostis</u> and <u>Solanum</u> .
Total				118,906	20,350	

B = Breeder; P = Present; A = Accidental; I = Introduced.

1935 through 1959 reflects few observations. No ground surveys are known; aerial surveys were made in the fall and winter of 1956-57 and 1957-58 only.

Recent maximum populations on Southeast are the highest among all islands of the atoll. The Sooty Tern, when present, is by far the most numerous of the island's avifauna. Other species with high populations are, in order, Laysan Albatross, Wedge-tailed Shearwater, and Black-footed Albatross.

All areas are utilized by the nesting seabird species. Fourteen species nest on or under the ground; an additional three species nest in low vegetation or bushes. Black-footed Albatross nest on the island's perimeter (Fig. 63) except for the west rock ledge area. Laysan Albatross nest in the interior of the island (Fig. 64). Bonin Petrels dig their nest burrows only on the eastern half, while Wedge-tailed Shearwaters dig their nest burrows (Fig. 65) on both halves of the island. Christmas Shearwaters nest under Scaevola and boards and Bulwer's Petrels nest under boards and tin sheeting; both nest nowhere else on the atoll. Sooty Storm Petrels dig their nest burrows primarily in the Cynodon area of the eastern half. Red-tailed Tropicbirds nest under dense vegetation, especially Eragrostis and Scaevola, and also among the oil drums (Fig. 66). Brown Boobies nest on grassy and coral-rubble areas (Fig. 67), while Blue-faced Boobies nest on the upper sand beaches and west rock ledges (Fig. 68). Red-footed Boobies build their nests on low Scaevola, Solanum, and Sicyos (Fig. 69). Nests of Great Frigatebirds are placed in low-growing Solanum (Fig. 70). Gray-backed Tern, Sooty Tern, and Brown Noddy nests are scattered over the entire island (Figs. 71-73). Black Noddies build their nests in Eragrostis (Fig. 74) and Solanum. The one White Tern egg found was on a low coral rock. Roosting individuals of these breeding species usually utilize the same areas as the nesters.

Of the introduced species, only the Laysan Finch has survived; it nests only at Southeast in Eragrostis (Figs. 75 and 76) and (rarely) Solanum. One pair of Laysan Teal attempted unsuccessfully to nest. The Laysan Rail, presumed to have been introduced on Southeast in 1929, was not found in summer 1930.

The regular migrant shorebirds are found over most of Southeast Island, especially on beaches, in central tidal pools, and on the western rock ledges (Figs. 77 and 78). The accidental shorebirds have been recorded from the central tidal pools. The Pintail, an accidental fresh-water bird, and the four accidental gull species have been recorded on the beach.

Banding and Movement

Banding

A total of 31,661 birds of 22 species was banded with U.S. Fish and Wildlife Service metal bands by POBSP and BSFW personnel from early 1963 through 1969 (Table 15). Slightly over 14,000 birds were banded in 1963 alone; smaller numbers were banded in subsequent years.



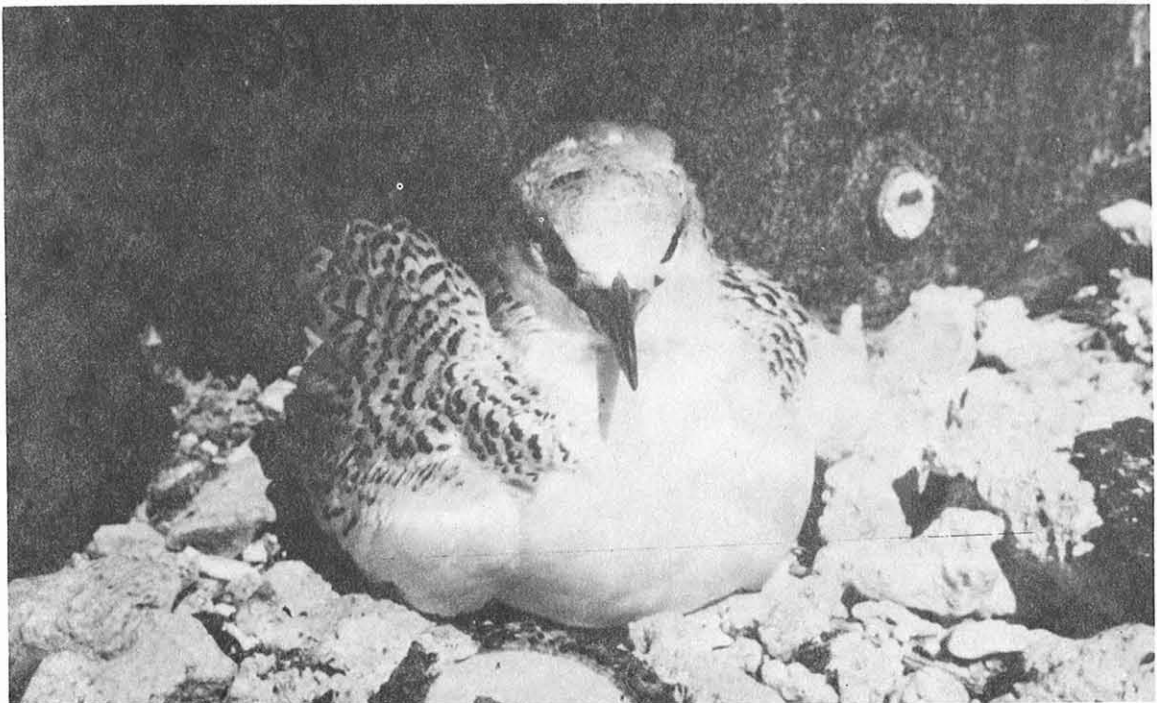
63. Black-footed Albatross prefer to nest on the vegetation perimeter, whereas Laysan Albatross prefer the interior, Southeast Island 13 March 1964. POBSP photograph by A.B. Amerson, Jr.
64. Laysan Albatross predominantly nest inland; however, an occasional Black-footed Albatross nests here, Southeast Island 13 March 1964. POBSP photograph by A.B. Amerson, Jr.

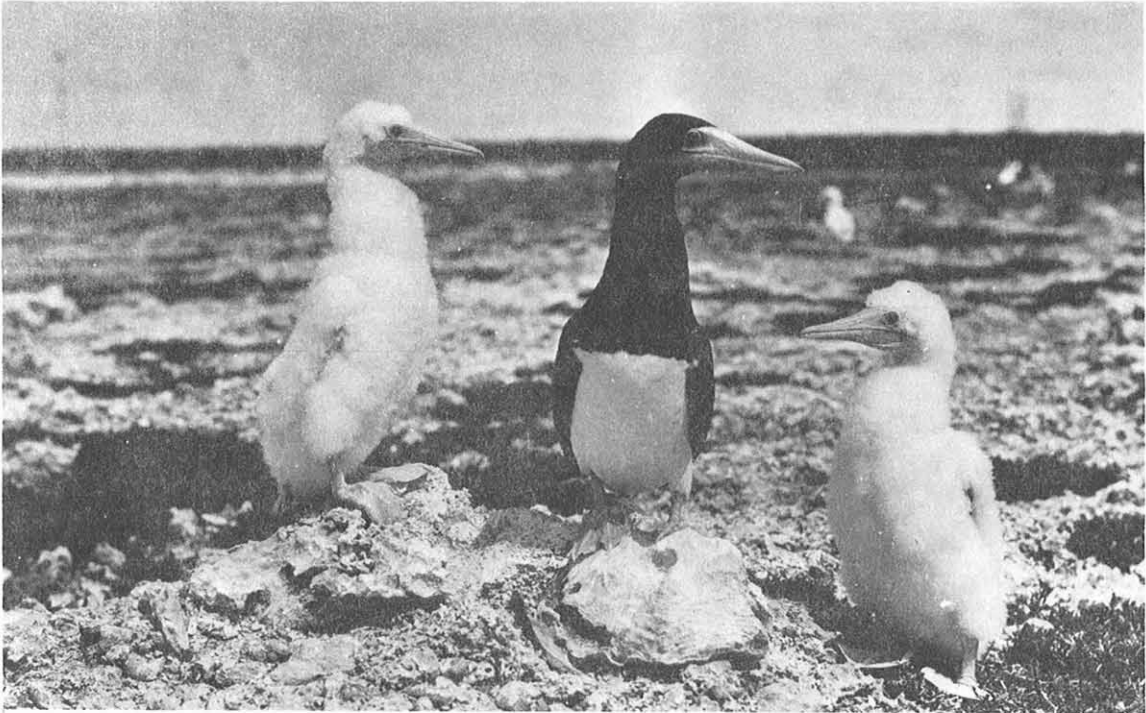




65. Wedge-tailed Shearwaters by their nest burrows in Sesuvium at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.

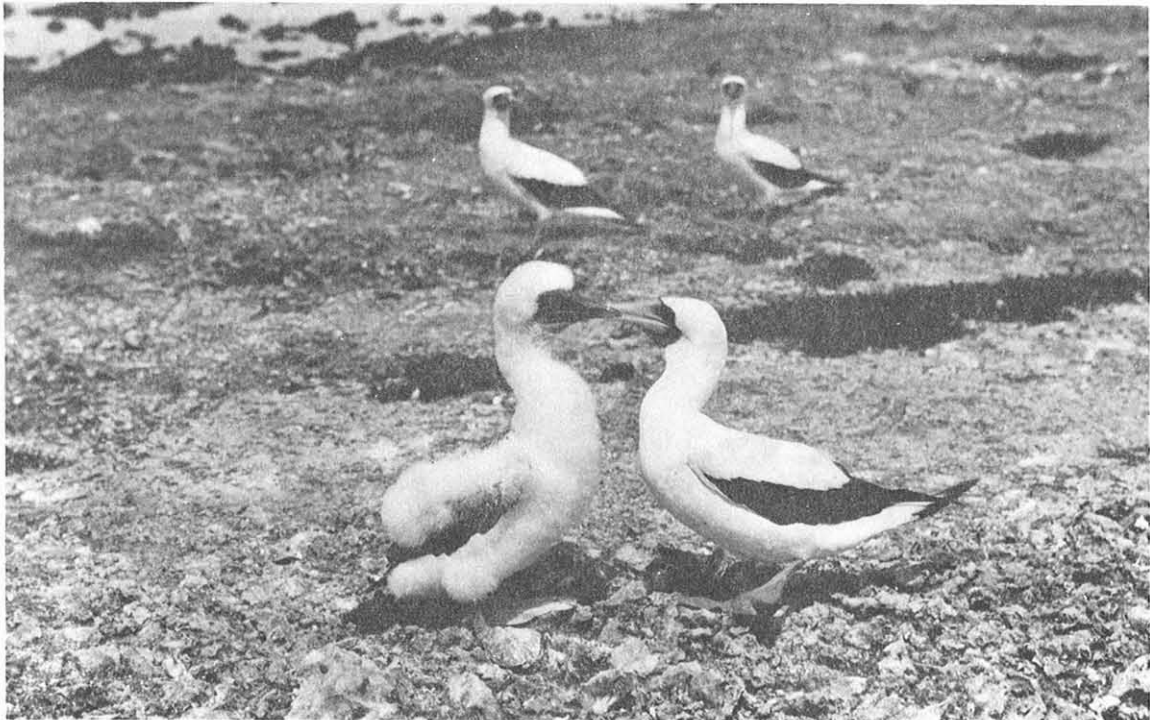
66. Young Red-tailed Tropicbird at entrance to nest among oil drums at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.





67. Brown Booby with two young--a rare occurrence for normally only one survives--on coral-rock ledge at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.

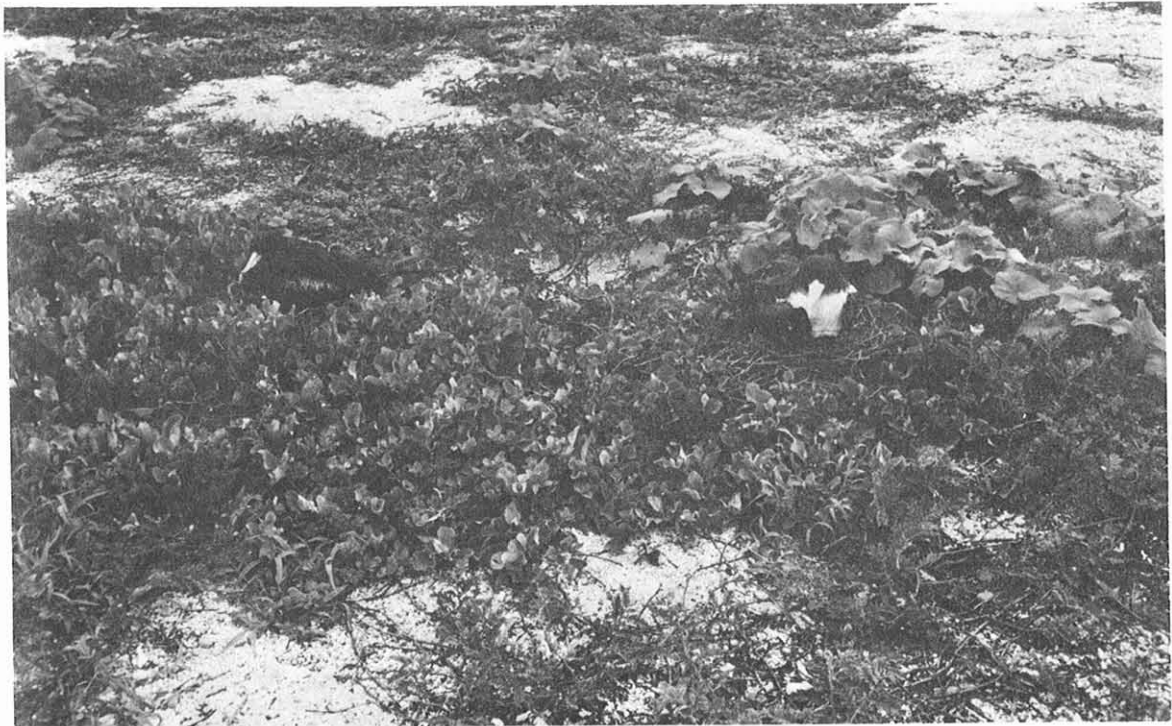
68. Blue-faced Booby adult with young (foreground) on rock ledge at Southeast Island, summer 1930. Photograph by P.S. Galtsoff.





69. Red-footed Booby on nest in low-growing Solanum at Southeast Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.

70. Great Frigatebirds, male (l.) and female (r.) on nests in low Solanum at Southeast Island, 13 March 1964. POBSP photograph by A.B. Amerson, Jr.





71. Nesting Sooty Terns at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.

72. Sooty Tern adult with recently hatched young at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.





73. Brown Noddy nest showing egg and nest material at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.

74. Black Noddy on nest placed in Eragrostis at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.





75. An introduced, banded Laysan Finch in Sesuvium and Tribulus at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.

76. Laysan Finch nest with two eggs in Eragrostis at Southeast Island, June 1967. POBSP photograph by R.L. DeLong.





77. Sanderling (center front), Ruddy Turnstones (center rear), and Wandering Tattler (r.) on beach at Southeast Island, 14 March 1964. POBSP photograph by A.B. Amerson, Jr.

78. Bristle-thighed Curlews on coral-rock ledges at Southeast Island, 28-30 August 1967. POBSP photograph by R.B. Clapp.

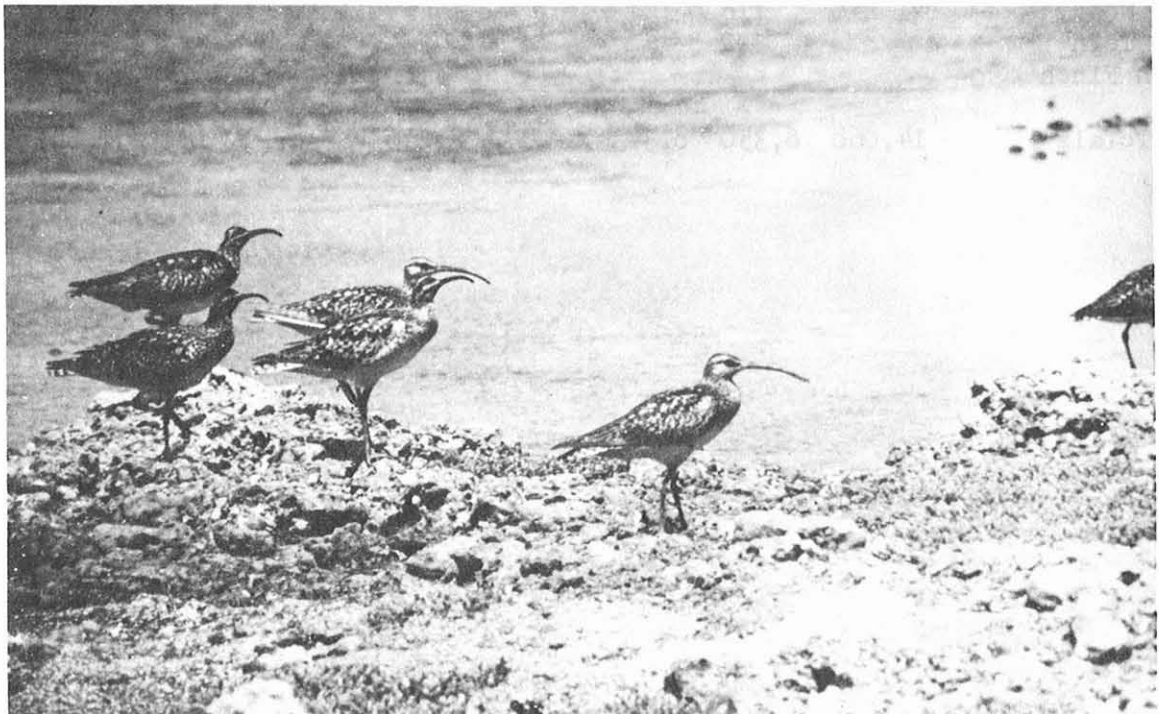


Table 15. POBSP and BSFW yearly banding totals of Pearl and Hermes Reef avifauna

Species	1963	1964	1965	1966	1967	1968	1969	Total
Black-footed Albatross	5,956	200	2,217		635			9,008
Laysan Albatross	3,378	348	5,600		1,049			10,375
Bonin Petrel	276	5	58	26				365
Bulwer's Petrel	6	3						9
Wedge-tailed Shearwater	702	2,186	80	247	56			3,271
Christmas Shearwater				1				1
Sooty Storm Petrel	438	34	202		2	19	93	788
Red-tailed Tropicbird	76	36	5		54			171
Blue-faced Booby	440	37	68	4	34	10		593
Red-footed Booby	145	16	6	6	25	2		200
Brown Booby	144	61	3	31	44	30		313
Great Frigatebird	268	126	17	59	69			539
Laysan Teal					14			14
Golden Plover	2	1	1				1	5
Bristle-thighed Curlew	1		2		1			4
Ruddy Turnstone	26	1	5			9	5	46
Gray-backed Tern	214	72	52					338
Sooty Tern	1,300	3,000	2		25			4,327
Brown Noddy	448	106	12		129			695
Black Noddy	248	116	13					377
White Tern		2						2
Laysan Finch					109	17	94	220
Totals	14,068	6,350	8,343	374	2,246	87	193	31,661

These birds were banded on the seven islands on which breeding occurs, the majority on the four major islands. An island and age-class breakdown of birds banded is presented under each species account.

Movement

POBSP and BSWF personnel recaptured 1,790 of 18 species on the atoll (Table 16). Also, 70 birds of 12 species originating from other Central Pacific atolls have been captured at Pearl and Hermes Reef. These birds were originally banded on all the Northwestern Hawaiian Islands except Nihoa and Necker, and on Johnston Atoll, Wake Island, the Pribilofs, and at sea (Table 17). Most came from Kure (36 percent), followed by Midway (24 percent), and Johnston (16 percent).

In addition, 211 birds of 13 species originally banded at Pearl and Hermes have been captured on all the Northwestern Hawaiian Islands except Necker and Nihoa, and on Oahu, Johnston Atoll, Wake Island, the Ellice Islands, the Philippine Islands, Japan, the Pribilofs, the California-Washington area, and at sea (Table 17). More birds (48 percent) traveled to Kure than to any other locality. At-sea recaptures accounted for 19 percent, and 8 percent were recaptured on Johnston Atoll.

The number of birds involved in interisland movement, both to and from the atoll, totals 281. Kure, at-sea, Johnston, and Midway, in that order, are the localities most frequently involved.

Species Accounts

Prior to the first POBSP survey in February 1963, 37 specimens of 16 bird species were known from Pearl and Hermes Reef. POBSP personnel collected 31 specimens of 18 species. These 68 specimens of 26 species are in the collection of the National Museum of Natural History (USNM), Washington, D.C.

Seventeen new species distributional records--14 first specimen records and 3 first sight records--and four new species breeding records are reported herein. In addition to these records, POBSP personnel previously reported 17 species distributional records from the atoll (Clapp and Woodward, 1968: 34-35; Sibley and MacFarlane, 1968: 318). Table 18 summarizes these specimen and distributional records. We agree with Clapp and Woodward (1968: 3-6) that these records fall into two categories, one composed of species that regularly occur in the Hawaiian area but which cannot be considered unusual and another composed of species of uncommon or seldom documented occurrence in the Northwestern Hawaiian Islands.

For descriptions and illustrations of the bird species recorded herein, the reader is referred to the ornithological sources cited previously, especially King (1967).

Tables are in alphabetical order by island following each species account; when few observations have been made on some islands, they are grouped in the final table.

Table 16. Recaptures of Pearl and Hermes-banded birds on the atoll

Species	1963	1964	1965	1966	1967	1968	1969	Total
Black-footed Albatross	43	110	118		18		77	366
Laysan Albatross	97	21	2		37	21	18	196
Bonin Petrel		3	8	1	2	1		15
Bulwer's Petrel		3						3
Wedge-tailed Shearwater	1	84	6	24	32		1	148
Sooty Storm Petrel		9	8			1	2	20
Red-tailed Tropicbird	2	36	1		15	2		56
Blue-faced Booby	48	30	65	2	58	32	14	249
Red-footed Booby	41	8	9	8	34	7	11	118
Brown Booby	27	20	17	6	30	31	14	145
Great Frigatebird	1	1	35	2	12		2	53
Laysan Teal					2			2
Ruddy Turnstone			1		2			3
Gray-backed Tern		8	3					11
Sooty Tern		11	1		292	1	38	343
Brown Noddy		1	2		6		8	17
Black Noddy	1	4	5		5	2	3	20
Laysan Finch					1		24	25
Totals	261	349	281	43	546	98	212	1,790

Table 17. Interisland movement of banded birds involving Pearl and Hermes Reef

To Pearl and Hermes Reef from:	Oahu	French Frigate Shoals	Laysan	Lisianski	Midway	Kure	Wake	Johnston	At Sea	Ellice	Philippines	Japan	Pribilof	California-Washington	Total
Black-footed Albatross		1			14	6			3						24
Bonin Petrel						3									3
Wedge-tailed Shearwater						1									1
Blue-faced Booby		1				2									3
Red-footed Booby		2	1		1	4		2							10
Brown Booby			1			2	1								4
Great Frigatebird						1		1							2
Golden Plover				1		1									2
Ruddy Turnstone													3		3
Sooty Tern				1	1	5		7							14
Brown Noddy								1							1
Black Noddy		1	1		1										3
Total (To)		5	3	2	17	25	1	11	3				3		70
From Pearl and Hermes Reef to:															
Black-footed Albatross		2			1	17			34			1		12	67
Laysan Albatross			2		1	20			6						29
Bonin Petrel			1			2									3
Wedge-tailed Shearwater	1					1									2
Red-tailed Tropicbird								1							1
Blue-faced Booby		1	3	2		5		1							12
Red-footed Booby		2		4	1	5		8							20
Brown Booby			1			4	1			1					7
Great Frigatebird		1		1		4		3			3				50
Bristle-thighed Curlew			1												1
Sooty Tern				2	2	2		2							8
Brown Noddy								2							2
Black Noddy		3		2	1	3									9
Total (From)	1	9	8	11	6	101	1	17	40	1	3	1		12	211
Grand Total	1	14	11	13	23	126	2	28	43	1	3	1	3	12	281

Table 18. Summary of POBSP records of birds from Pearl and Hermes Reef

Species	Specimens		POBSP Records		
	Pre- POBSP	POBSP	This Paper	Clapp and Woodward, 1968	Sibley and MacFarlane, 1968
Black-footed Albatross	2				
Laysan Albatross	2				
Bonin Petrel	4		sr		
Bulwer's Petrel				r	
Wedge-tailed Shearwater		1	sr		
Christmas Shearwater		2		sr	
Sooty Storm Petrel	6	3	sr		
Red-tailed Tropicbird	3		sr	r	
Blue-faced Booby	3		sr		
Brown Booby	1	1	sr,br		
Great Frigatebird	1	1	sr		
Pintail			r		
Laysan Teal*			r,br		
Golden Plover				r	
Bristle-thighed Curlew	1		sr		
Wandering Tattler	2		sr	r	
Ruddy Turnstone	1	2		sr	
Snipe sp.			r		
Knot		1		SR	
Sanderling				r	
Sharp-tailed Sandpiper		2		sr	
Dunlin		1		sr	
Ruff		1	sr		
Red Phalarope		1		sr	
Ring-billed Gull		1		sr	sr
Herring Gull		2		sr	sr
Glaucous-winged Gull	1	3		sr	sr
Black-legged Kittiwake		3		sr	sr
Gray-backed Tern	4		sr	r	
Sooty Tern	2	1	sr		
Brown Noddy	2	1	sr		
Black Noddy	2	4	sr		
White Tern			br		
Horned Puffin		2**		r	
Laysan Finch*			br		
Total Specimens	37	31			
Total POBSP Records			21	17	4

br = first breeding record; r = first sight record; sr = first specimen record; SR = first specimen confirmation of a species previously known only from sight records for both the main Hawaiian and Northwestern Hawaiian Islands.

*Introduced.

**Specimens not preserved.

BLACK-FOOTED ALBATROSS

Diomedea nigripesStatus

Common breeding species; present from late October into July; occurs and nests on all islands except Planetree and Sand. Maximum recent population estimate 13,948 in March 1967.

Observations

Nesting Black-footed Albatross were first recorded in March 1913 (Bailey, 1956: 32; and Willett, ms.). Munter (ms.) found them again in 1916 and Wetmore (ms.) observed them in 1923. We have no data for the 1930's and 1940's. Richardson (1957: 16) noted that it "is abundant," but gave no data. Rice and Kenyon (1962: 369) reported this species concentrated mainly at Grass, North and Southeast Islands during the 1956-67 and 1957-58 breeding seasons. POBSP and BSFW personnel observed this species on all major islands except Planetree and Sand. All observations are presented in Tables 19 to 25.

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Adults arrive in early October and depart in late June or July; numbers increase in November and decline in late spring. The population fluctuation coincides with breeding: most eggs are undoubtedly laid in mid- or late November and begin to hatch by late January or early February. Fledging occurs in late June and July.

Rice and Kenyon (1962: 369) reported some 15,000 breeding Black-footed Albatross in December 1956 and 1957. No comparable data exist for recent Decembers. March surveys for 1963 to 1968 show an average of 7,900 breeding birds (range 6,600 to 8,900).

Ecological Distribution

The Black-footed Albatross nests on Bird, Grass, Kittery, Little North, North, Seal, and Southeast Islands. It has not been recorded at Planetree and Sand, both of which are small islands and awash at high tide.

Bird Island: Rice and Kenyon (1962: 369) reported 126 breeding birds on "south sandspits," presumably Bird, during December 1956 and 1957. POBSP and BSFW personnel found this species nesting in small numbers (less than 20) only in 1964 and 1967 (Table 19). Nests are all in bare sand as there is no vegetation on the island.

Grass Island: Munter (ms.) found nesting Black-footed Albatross very plentiful on Grass Island in February 1916.

POBSP and BSFW personnel have recorded Black-footed Albatross each year since 1963 except 1966 when no spring visit was made (Table 20); from 300 to 1,466 young have been recorded in March.

This species nests mainly on the perimeter of the vegetated area; some nest in a sparsely vegetated area at the western end of the island.

Kittery Island: Black-footed Albatross were first recorded by Rice and Kenyon (1962: 369), who counted 900 breeders from aerial photographic surveys in December 1956 and 1957. The breeding population has been smaller in recent years. POBSP and BSFW figures based on the number of young present during March surveys ranged from 252 to 456 breeders between 1963 and 1968 (Table 21).

Black-footed Albatross nest in bare sand as the island is unvegetated.

Little North Island: Rice and Kenyon (1962: 369) in December 1956 and 1957 recorded the first Black-footed Albatross from Little North Island, then referred to as "north sandspits." Their estimate of 240 breeders has not been equaled in recent years.

POBSP and BSFW personnel recorded this species only in 1963 and 1965 (Table 22). The nests were all in the raised central portion.

North Island: Black-footed Albatross were first observed at North Island in March 1913 (Bailey, 1956: 32; and Willett, ms.). Rice and Kenyon (1962: 369) estimated 3,800 breeders in December 1956 and 1957.

POBSP and BSFW personnel recorded this species nesting on all surveys (Table 23). March counts on young ranged from 500 to 1,200.

Nests are concentrated on the east and west beaches, at the base of the southern tip, and on the raised middle portion of this elongated tip.

Seal Island: Munter (ms.) first observed this species in February 1916. Wetmore (ms.) estimated 1,200 pairs in April 1923.

With the exception of 1966 when no spring visits were made, POBSP and BSFW personnel recorded Black-footed Albatross each year since 1963 (Table 24). March counts of young range from 42 to 325.

Nests are placed at the perimeter of the vegetated area with the exception of a few placed in a depressed area on the eastern section.

Southeast Island: Munter (ms.) recorded the first Black-footed Albatross in February 1916, and Wetmore (ms.) found it nesting in April 1923. Rice and Kenyon (1962: 369) estimated 4,600 breeding adults in December 1956 and 1957.

POBSP and BSFW personnel recorded this species nesting each year from 1963 to 1969 (Table 25). March counts of young range from 1,560 to 2,500.

Black-footed Albatross nest around the perimeter of the east and west sections, and on the coral rubble transition zone between the vegetated interior and the sand beach. They seldom nest in heavily vegetated areas.

Banding and Movements

POBSP and BSWF personnel banded 9,008 Black-footed Albatross on six islands (Table 26). Of this total, 6,673 were banded by the POBSP and 2,335 were banded by the BSWF.

POBSP and BSWF personnel have captured 390 previously banded Black-footed Albatross here. Three hundred and sixty-six were originally banded on the atoll; 24 originated elsewhere: Midway (14), Kure (6), at sea (3), and French Frigate Shoals (1). In addition, 55 birds originating at Pearl and Hermes have been captured elsewhere: at sea (34), Kure (17), French Frigate Shoals (2), and Midway and Japan (1 each). These movements are presented in Appendix Tables 4a and 4b.

Specimens

Non-POBSP: USNM 300815 and 300833, ♂♂, collected 27 April 1923 by Wetmore.

Table 19. Observations of Black-footed Albatross at Bird Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1956 10 Dec.	168	126 breeders, 42 non-breeders (Rice and Kenyon, 1962: 369).*
1957 14 Oct.	200	Aerial survey (Rice, ms. a).
18 Dec.	168	126 breeders, 42 non-breeders (Rice and Kenyon, 1962: 369).*
1963 5 Mar.	40-50	Roosting, none nesting (POBSP, 1964d).
1964 14 Mar.	43	30 adults, 13 live young counted; 1 dead (BSFW, 1964a; POBSP, 1964b).
1965 22 Mar.	5	Roosting, none nesting (POBSP, 1965a).
1967 31 May	19	Young counted (POBSP, 1967b).

*Locality listed as "south sandspits."

Table 20. Observations of Black-footed Albatross at Grass Island

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1916	4 Feb.	very plentiful	Adults with eggs and young birds; <u>ca.</u> half as numerous as Laysan Albatross (Munter, ms.).
1923	27 Apr.	1,600	<u>Ca.</u> 800 pairs (Wetmore, ms.).
1956	10 Dec.	5,100	3,800 breeders, 1,300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957	14 Oct.	4,500	Aerial survey (Rice, ms. a).
	18 Dec.	5,100	3,800 breeders, 1,300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963	5 Mar.	?	Nesting; <u>ca.</u> twice as numerous as Laysan Albatross (POBSP, 1964d).
	26-27 June	263	Young counted (POBSP, 1963).
1964	14 Mar.	4,275	3,000 adults, 1,275 young (BSFW, 1964a; POBSP, 1964b).
1965	19 Mar.	1,100-1,400	800-1,000 adults, 300-400 young (POBSP, 1965b).
	22 Mar.	1,280	800 adults, 480 young (BSFW, 1965; POBSP, 1965a).
1966	21 Sept.	0	None seen; no dead young (BSFW, 1966b).
1967	22 Mar.	4,398 [±]	1,466 downy young counted; low mortality although 37 dead young counted (BSFW, 1967a; POBSP, 1967d).
	31 May	1,175	Young counted (POBSP, 1967b).
1968	24 Mar.	3,570	2,380 breeders, 1,190 young counted (BSFW, 1968; POBSP, 1968).

Table 21. Observations of Black-footed Albatross at Kittery Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1956 10 Dec.	1,200	900 breeders, 300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957 14 Oct.	1,100	Aerial survey (Rice, ms. a).
18 Dec.	1,200	900 breeders, 300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963 5 Mar.	several hundred	Nesting (POBSP, 1964d).
26 June	248	124 young counted (POBSP, 1963).
1964 14 Mar.	426	300 adults, 126 young counted (BSFW, 1964a; POBSP, 1964b).
1965 18 Mar.	600-725	400-500 adults, 200-225 young (POBSP, 1965b).
22 Mar.	385	Ca. 205 adults, 180 young; 30 eggs in a windrow in east central area (BSFW, 1965; POBSP, 1965a).
1967 31 May	353	Young counted (POBSP, 1967b).
1968 24 Mar.	684	228 young counted (BSFW, 1968; POBSP, 1968).

Table 22. Observations of Black-footed Albatross at Little North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1956 10 Dec.	320	240 breeders, 80 non-breeders (Rice and Kenyon, 1962: 369).*
1957 14 Oct.	0	Aerial survey (Rice, ms. a).
18 Dec.	320	240 breeders, 80 non-breeders (Rice and Kenyon, 1962: 369).*
1963 6 Mar.	100 [±]	Ca. 50 pairs nesting (POBSP, 1964d).
23, 25 June	64+	Young counted (POBSP, 1963).
1965 18 Mar.	56-66	40-50 adults, 16 young counted (POBSP, 1965b).
1969 26 May	0	None observed (BSFW, 1969c).

*Locality listed as "north sandspits."

Table 23. Observations of Black-footed Albatross at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	900-1,050	Ca. 300-350 nestlings (Bailey, 1956: 32); 300 pairs (Willetts, ms.).
1956 10 Dec.	5,060	3,800 breeders, 1,260 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957 14 Oct.	4,500	Aerial survey (Rice, ms. a).
18 Dec.	5,060	3,800 breeders, 1,260 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963 6 Mar.	100 [±]	Nestlings (POBSP, 1964d).
23-25 June	751	1,500 adults, 751 young counted (POBSP, 1963).
1965 17 Mar.	1,500-2,100	1,000-1,500 adults, 500-600 young 1/4 to 1/3 grown (POBSP, 1965b).
1967 16-17 Mar.	3,450 [±]	1,150 [±] 50 chicks counted (BSFW, 1967d).
1969 31 Mar.	?	Nesting (BSFW, 1969c).

Table 24. Observations of Black-footed Albatross at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	thickly populated	Eggs and young birds (Munter, ms.).
1923 27 Apr.	2,400	About 1,200 pairs (Wetmore, ms.).
1956 10 Dec.	990	740 breeders, 250 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957 14 Oct.	900	Aerial survey (Rice, ms. a).
18 Dec.	990	740 breeders, 250 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963 5 Mar.	?	Nesting in somewhat greater numbers than the Laysan Albatross (POBSP, 1964d).

Table 24. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 26 June	97	Young counted (POBSP, 1963).
1964 14 Mar.	825	265 young counted; also 10 dead young (BSFW, 1964a; POBSP, 1964b).
1965 18-19 Mar.	150-250	100-200 adults, 42 young 1/4 to 1/3 grown counted (POBSP, 1965b).
22 Mar.	185	144 adults, 41 young counted (BSFW, 1965; POBSP, 1965a).
1967 22 Mar.	990	325 young counted, also 4 dead young (BSFW, 1967a; POBSP, 1967d).
31 May	310	Young counted (POBSP, 1967b).
1968 24 Mar.	660 [±]	439 breeders, 219 young counted (BSFW, 1968; POBSP, 1968).

Table 25. Observations of Black-footed Albatross at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	thickly settled	Eggs and very young birds present; less numerous than Laysan Albatross (Munter, ms.).
1923 26-28 Apr.	2,000+	Adults; some young with developing breast feathers (Wetmore, ms.).
1956 10 Dec.	6,100	Aerial survey estimated data: 4,600 breeding adults, 1,500 non-breeding adults (Rice and Kenyon, 1962: 369).
1957 14 Oct.	5,600	Aerial survey (Rice, ms. a).
18 Dec.	6,100	Aerial survey estimated data: 4,600 breeding adults, 1,500 non-breeding adults (Rice and Kenyon, 1962: 369).
1961 12 Mar.	?	Young present; much more abundant than Laysan Albatross (HDFG, 1961).
1963 26 Feb.- 8 Mar.	5,000	Adults, all with young (POBSP, 1964d).

Table 25. (continued)

<u>Date of Survey</u>		<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963	18-23, 25 June	1,200+	Few adults, 1,200 young counted (POBSP, 1963).
1964	13-14 Mar.	8,500	5,000 breeders, 1,000 non-breeders; 2,500 young, many dead young (BSFW, 1964a; POBSP, 1964b).
1965	15-19 Mar.	6,000- 7,000	4,000-5,000 adults, 2,000 young (POBSP, 1965b).
	21-22 Mar.	3,250	2,000 adults, 1,250 young, low mortality (BSFW, 1965; POBSP, 1965a).
1966	1 Apr.	many	Nesting (BSFW, 1966a).
1967	21-23 Mar.	4,710	1,560 young counted (BSFW, 1967a; POBSP, 1967d).
	28, 30 May- 1 June	2,021	50 adults, 1,971 fully grown young counted (POBSP, 1967b).
1968	22-24 Mar.	6,000+	4,000+ breeders, 2,002 young counted: 1,696 on eastern part and 306 on western part (BSFW, 1968; POBSP, 1968).
1969	10-12 Feb.	11,000	Most young less than 2 weeks old, few eggs (BSFW, 1969a).
	31 Mar.- 2 Apr.	4,435	1,478 young; little mortality (BSFW, 1969b).
	26-31 May	1,964+	Young counted (1,598 on eastern half, 366 on western half); little mortality (BSFW, 1969c).

LAYSAN ALBATROSS

Diomedea immutabilisStatus

Abundant breeding species; present from early October to late July, a few stragglers into early August; absent during rest of year. Nests on all islands except Planetree and Sand. Maximum POBSP and BSFW population estimate 45,000 in February 1969.

Table 26. Black-footed Albatross banded at Pearl and Hermes Reef

Island	Bander: Age- Class	POBSP	POBSP	1963 Total	BSFW	POBSP	BSFW	1965 Total	BSFW	Totals
		Feb.- Mar. 1963	June 1963		Mar. 1964	Mar. 1965	Mar. 1965		Mar. 1967	
Southeast	Adult	3,300	0	3,300	0	0	500	500	0	3,800
	Young	1,200	159	1,359	200	0	800	800	100	2,459
	Total:	4,500	159	4,659	200	0	1,300	1,300	100	6,259
Grass	Adult	0	0	0	0	39	0	39	0	39
	Young	—	263	263	—	150	200	350	—	613
	Total:	0	263	263	0	189	200	389	0	652
Seal	Adult	0	0	0	0	0	0	0	0	0
	Young	—	96	96	—	9	—	9	—	105
	Total:	0	96	96	0	9	0	9	0	105
Kittery	Young	0	124	124	0	77	0	77	0	201
North	Young	0	750	750		396		396	535	1,681
Little North	Young	0	64	64		46		46		110
Total	Adult	3,300	0	3,300	0	39	500	539	0	3,839
	Young	1,200	1,456	2,656	200	678	1,000	1,678	635	5,169
	Total:	4,500	1,456	5,956	200	717	1,500	2,217	635	9,008

Observations

Nesting Laysan Albatross were recorded at Pearl and Hermes Reef as early as March 1913 (Bailey, 1956: 32; Willett, ms.). Anderson (1954: 84) saw this species in the late 1920's. Galtsoff (1933: 19) is credited, however, with the first published record from the atoll; he observed several hundred abandoned young at Southeast Island in summer 1930. Richardson (1957: 16) noted that it "breeds abundantly," but gives no data.

POBSP and BSFW personnel found this species nesting each year from 1963 to 1969. All observations are shown in Tables 27 to 31.

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Birds arrive in early October and egg-laying commences about early November. Hatching occurs in early and mid-January. Young begin to fledge in mid-June and have departed by late August. Adults commence to leave in late May and June and all have left by September.

The Laysan Albatross population is the second highest in the atoll. Total young counts for five recent March visits average 7,872 and range from 5,802 to 12,840. Total POBSP and BSFW population estimates have been highest during February visits even though only Southeast Island was visited. The Rice and Kenyon (1962: 369) estimates for December 1956 and 1957 were higher for the entire atoll but lower for Southeast.

Ecological Distribution

Laysan Albatross nest on Bird, Grass, Kittery, Little North, North, Seal, and Southeast Islands; none is known from Planetree and Sand.

Bird Island: Three or four adult roosting Laysan Albatross were observed by POBSP personnel in March 1963. None was found during two visits (March and August) in 1964 and one visit in 1965 (March). One chick was counted 31 May 1967 by POBSP personnel; this is the only nesting record.

Grass Island: Munter (ms.) was the first to observe Laysan Albatross in early February 1916. All visitors since noted them. POBSP and BSFW personnel found Laysan Albatross nesting each year from 1963 to 1968 except in 1966 when the island was not visited during the albatross season (Table 27). Data for 1969 are unavailable. Recent March counts of young average 649, and range from 350 to 1,120.

Laysan Albatross nest along both beaches but prefer the inland vegetated area.

Kittery Island: POBSP personnel first recorded nesting Laysan Albatross in March 1963, and, except for 1966 and 1969 when no data are

available, the species has been recorded nesting ever since (Table 28). March population estimates for young average 28, and range from 4 to 52.

At vegetationless Kittery, Laysan Albatross nest in the center portion of the island.

Little North Island: The first few nesting Laysan Albatross were found on 6 March 1963 by POBSP personnel. Twenty young were counted when they next visited the island on 23 and 25 June 1963. On 18 March 1965, 8 to 10 adults and 4 young were counted on the crest of the island. The island was not visited during this species' breeding season in 1964, 1966-68. BSWF personnel visited Little North on 31 March 1969; however, population data are not available.

North Island: Bailey (1956: 32) and Willett (ms.) reported nesting Laysan Albatross in March 1913. It has been recorded breeding on all subsequent visits (Table 29).

Available data from two recent March population counts show 750 young in 1965 and ca. 525 in 1967. Nests are predominately located in the vegetated northern portion.

Seal Island: Munter (ms.) found Seal Island thickly populated with nesting Laysan Albatross in February 1916, and Wetmore (ms.) found 150 pairs in August 1923. Rice and Kenyon (1962: 369), however, first published their occurrence from aerial observations in 1956 and 1957. POBSP and BSWF personnel have recorded them nesting on all subsequent visits for which we have data (Table 30).

Four recent March population counts show an average number of 151 young, and range from 40 to 399. Nests are located mainly in the vegetated western portion of the island.

Southeast Island: Nesting Laysan Albatross were first observed by Munter (ms.) in February 1916. Galtsoff (1933: 19) first reported them after noting them in summer 1930. POBSP, BSWF, and HDFG personnel have collected breeding data for each year from 1961 to 1969, except in 1962 when the atoll was not visited (Table 31).

Recent March population estimates of young average 6,950 and range from 4,600 to 11,269. Laysan Albatross utilize the interior for nesting. Most prefer the eastern half of the island; in March 1968, 87 percent favored this half.

Banding and Movements

The POBSP and BSWF banded 10,375 Laysan Albatross on six islands since 1963, 9,625 by the POBSP and 750 by the BSWF (Table 32).

POBSP and BSWF personnel have recaptured 196 Laysan Albatross, all originally banded on the atoll. In addition, 29 banded at Pearl and Hermes

have been captured elsewhere: 20 at Kure, 6 at sea, 2 at Laysan and 1 at Midway (see Appendix Table 5).

Specimens

Non-POBSP: USNM 300856, ♂, collected 26 April 1923 by Wetmore; USNM 289167, skull, collected 28 April 1923 by Wetmore.

Table 27. Observations of Laysan Albatross at Grass Island

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1916	4 Feb.	very plentiful	Eggs and quite young birds; twice as numerous as Black-footed Albatross (Munter, ms.).
1923	27 Apr.	200	100 pairs (Wetmore, ms.).
1956	10 Dec.	3,200	2,400 breeders, 800 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957	14 Oct.	2,800	Observed from aerial survey (Rice, ms. a).
	18 Dec.	3,200	2,400 breeders, 800 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963	5 Mar.	?	Two-thirds as numerous as Black-footed Albatross; breeding (POBSP, 1964d).
	26-27 June	607	Young counted (POBSP, 1963).
1964	14 Mar.	2,750	2,000 adults, 750 young estimated (BSFW, 1964a; POBSP, 1964b).
	18 Aug.	3	Young counted; no adults (POBSP, 1964a).
1965	19 Mar.	1,025-1,250	700-900 adults, 325-350 young (POBSP, 1965b).
	22 Mar.	1,100+	850 adults, 250-260 young (BSFW, 1965; POBSP, 1965a).
1967	22 Mar.	660	220 young counted; 375 nests counted previously destroyed (BSFW, 1967a; POBSP, 1967d).
	31 May	127	Young counted (POBSP, 1967b).

Table 27. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1967 8 July	96	Young counted (BSFW, 1967b).
1968 24 Mar.	3,360	2,240 breeders, 1,120 young counted (BSFW, 1968; POBSP, 1968).

Table 28. Observations of Laysan Albatross at Kittery Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1956 10 Dec.	none	(Rice and Kenyon, 1962: 369).
1957 18 Dec.	none	(Rice and Kenyon, 1962: 369).
1963 5 Mar.	few pairs	Nesting (POBSP, 1964d).
26 June	27	Young counted (POBSP, 1963).
1964 14 Mar.	14-19	10-15 adults; 4 young counted (POBSP, 1964b).
1965 18 Mar.	17-27	10-20 adults; 7 young counted (POBSP, 1965b).
22 Mar.	44	37 adults; 7 young counted (BSFW, 1965; POBSP, 1965a).
1967 22 Mar.	144	48 young counted (BSFW, 1967a; POBSP, 1967d).
31 May	30	Young counted (POBSP, 1967b).
1968 24 Mar.	156	52 young counted (BSFW, 1968; POBSP, 1968).

Table 29. Observations of Laysan Albatross at North Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1913 15 Mar.	900-1,030	Ca. 300-350 nests with young (Bailey, 1956: 32); about 300 pairs (Willetts, ms.).
1956 10 Dec.	5,600	4,200 breeders, 1,400 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).

Table 29. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1957 14 Oct.	4,800	Observed from aerial survey (Rice, ms. a).
18 Dec.	5,600	4,200 breeders, 1,400 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963 6 Mar.	few	Nesting (POBSP, 1964d).
23-25 June	384	Young, all banded (POBSP, 1963).
1964 19-20 Aug.	9	8 large young, 1 flying immature (POBSP, 1964a).
17 Sept.	0	10 long dead almost fully grown young (BSFW, 1964b; POBSP, 1964c).
1965 17 Mar.	2,250-2,750	1,500-2,000 adults, 750 young (POBSP, 1965b).
1967 16-17 Mar.	1,575-1,625	525 ± 25 chicks counted (BSFW, 1967d).
29-30 Aug.	1	Starving young banded in March, no adults (POBSP, 1967a).
1969 31 Mar.	?	Nesting (BSFW, 1969b).

Table 30. Observations of Laysan Albatross at Seal Island.

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	thickly populated	Eggs and young birds (Munter, ms.).
1923 27 Apr.	300	150 pairs (Wetmore, ms.).
1956 10 Dec.	1,200	900 breeders, 300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1957 14 Oct.	1,000	Observed from aerial survey (Rice, ms. a).
18 Dec.	1,200	900 breeders, 300 non-breeders; based on aerial survey (Rice and Kenyon, 1962: 369).
1963 5 Mar.	?	Nesting (POBSP, 1964d).

Table 30. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 26 June	186	Young counted (POBSP, 1963).
1964 14 Mar.	320-370	250-300 adults, 70 live young, 5 dead young (BSFW, 1964a; POBSP, 1964b).
18 Aug.	1	Young (POBSP, 1964a).
1965 18-19 Mar.	191-241	100-150 adults; 91 1/4 to 1/3 grown young counted (POBSP, 1965b).
22 Mar.	300	138 adults; 100 young (BSFW, 1965; POBSP, 1965a).
1967 22 Mar.	102+	34 live and 6 dead young counted; 175 \pm additional nests previously destroyed (BSFW, 1967a; POBSP, 1967d).
31 May	27	Young counted (POBSP, 1967b).
6 July	23+	Few adults, 23 near-fledging young counted, also 1 dead chick (BSFW, 1967b).
1968 24 Mar.	1,197	798 breeders, 399 young counted (BSFW, 1968; POBSP, 1968).

Table 31. Observations of Laysan Albatross at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	thickly settled	Eggs and very young birds present; more abundant than Black-footed Albatross (Munter, ms.).
1923 26-28 Apr.	600	Adults; <u>ca.</u> 300 pairs on Southeast (Wetmore, ms.).
1930 23 July-Aug.	several hundred	Abandoned young, all died (Galtsoff, 1933: 19).
1956 10 Dec.	37,300	Aerial survey estimated data: 28,000 breeding adults; 9,300 non-breeding adults (Rice and Kenyon, 1962: 369).
1957 14 Oct.	33,200	Observed from aerial survey (Rice, ms. a).

Table 31. (continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1957	18 Dec.	37,300	Aerial survey estimated data: 28,000 breeding adults, 9,300 non-breeding adults (Rice and Kenyon, 1962: 369).
1961	12 Mar.	?	With young; much more abundant than Laysan Albatross (HDFG, 1961).
1963	28 Feb.- 8 Mar.	35,000	All breeding birds with young (POBSP, 1964d).
	18-23, 25 June	8,000- 10,000	Young (POBSP, 1963).
1964	13-14 Mar.	24,500	15,000-15,500 breeders, 1,000-1,500 non-breeders, 7,500 young (BSFW, 1964a; POBSP, 1964b).
	16-19 Aug.	39	Large young counted; 600-800 carcasses; no adults (POBSP, 1964a).
1965	15-19 Mar.	15,000 [±]	9,200 breeders, 800-1,800 non-breeders, 4,600* young: 1/4 to 1/3 grown (POBSP, 1965b).
	21-22 Mar.	14,500 [±]	9,000-10,000 adults, 4,500 young (BSFW, 1965; POBSP, 1965a).
1966	1 Apr.	many	Nesting (BSFW, 1966a).
	20-26 Sept.	0	450-500 large immatures had died (Kenyon and Kridler, 1969: 339).
1967	21-23 Mar.	15,900 [±]	5,300 young counted (Kenyon and Kridler, 1969: 340); heavy mortality (BSFW, 1967a).
	28, 30 May- 1 June	4,000 [±]	500 [±] adults, 3,473 young counted (POBSP, 1967b).
	3-9 July	several hundred	Few adults, several hundred young; 426 dead chicks (BSFW, 1967b).
1968	22-24 Mar.	33,800	11,269 young counted (Kenyon and Kridler, 1969: 340); 9,573 on the eastern part of the island and 1,696 on the western part (BSFW, 1968; POBSP, 1968).

Table 31. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 10-12 Feb.	45,000	Most eggs hatched (BSFW, 1969a).
31 Mar.- 2 Apr.	18,200 [±]	6,075 young (BSFW, 1969b).
26-31 May	5,763	Young counted, 5,109 on the eastern part and 654 on the western part; little mortality noted (BSFW, 1969c).

*Kenyon and Kridler (1969: 340) give a figure of 5,000 young for this visit.

BONIN PETREL

Pterodroma hypoleuca

Status

Common breeding species; present from late August to late June; absent during rest of year. Nests on the four major vegetated islands. Maximum POBSP and BSFW population estimate 1,000 in August 1967 and February 1969.

Observations

Bonin Petrels, with nests, were first observed in 1913 (Bailey, 1956: 32; Willett, ms.). POBSP and BSFW personnel have recorded them each year since 1963 (Tables 33 to 36).

Annual Cycle

Figure 58 presents the local annual breeding cycle. Adults are believed to arrive in late August; egg-laying possibly commences as early as January. Eggs were known to occur as late as mid-March in 1964 and 1965. Hatching was recorded by mid-March in 1965. Large, fully-feathered juveniles were recorded in early June 1967 and late June 1963; all young fledge by early July. Adults are probably absent during July and most of August.

In recent years, approximately 1,000 Bonin Petrels are estimated to inhabit Pearl and Hermes.

Ecological Distribution

Bonin Petrels nest at Grass, North, Seal, and Southeast Islands.

Grass Island: Munter (ms.) probably observed burrows of this species in February 1916. Wetmore (ms.) saw one individual in April 1923. POBSP

Table 32. Laysan Albatross banded at Pearl and Hermes Reef

128

Island	Age- Class	Bander: POBSP			BSFW			POBSP			Totals	
		Feb.- Mar. 1963	June 1963	1963 Total	Mar. 1964	Aug. 1964	1964 Total	Mar. 1965	Mar. 1967	May 1967		1967 Total
Southeast	Adult	1,000	0	1,000	0	0	0	0	0	99	99	1,099
	Young	0	961	961	300	37	337	4,500	0	500	500	6,298
	Total:	1,000	961	1,961	300	37	337	4,500	0	599	599	7,397
Grass	Young	0	602	602	0	3	3	300	0	0	0	905
Seal	Young	0	186	186	0	1	1	39	0	0	0	226
Kittery	Young	0	27	27	0	0	0	7	0	0	0	34
North	Young	0	582	582		7	7	700	450		450	1,739
Little North	Young	0	20	20		0	0	54			0	74
Total	Adult	1,000	0	1,000	0	0	0	0	0	99	99	1,099
	Young	0	2,378	2,378	300	48	348	5,600	450	500	950	9,276
	Total:	1,000	2,378	3,378	300	48	348	5,600	450	599	1,049	10,375

and BSWF personnel have recorded small numbers nesting in most years since 1963 (Table 33). Burrows are located in the vegetated portion.

North Island: Bonin Petrels nested in large numbers in March 1913 (Bailey, 1956: 32; Willett, ms.). In recent years (Table 34), POBSP and BSWF personnel observed this species in very small numbers only three times; none was nesting.

Seal Island: Wetmore (ms.) found 1 adult and 2 young in April 1923. POBSP and BSWF personnel found it nesting in 1963 and 1965. It was present in 1969, and may have been overlooked in other years because of diurnal surveys (Table 35).

Southeast Island: Munter (ms.) probably found a Bonin Petrel egg in February 1916 at Southeast. Wetmore noted the presence of Bonins in April 1923. POBSP and BSWF personnel recorded burrows of this species each year since 1963 (Table 36). The highest populations (1,000) occurred in August 1967 and February 1969.

Nest burrows are found only on the east portion in, south, and west of the west-central Eragrostis area. Burrow length is approximately 3 feet and only one-half to one foot beneath the ground surface.

Banding and Movements

The POBSP banded 365 adult Bonin Petrels; 33 were banded on Seal Island in March 1965 and 332 were banded on Southeast Island (276 in February and March 1963, 5 in September 1964, 25 in March 1965, and 26 in September 1966).

POBSP and BSWF personnel captured 15 Bonin Petrels at Pearl and Hermes Reef; 12 were originally banded on the atoll; 3 were originally from Kure. In addition, 2 originating at Pearl and Hermes moved to Kure and another moved to Laysan. These data are presented in Appendix Tables 6a and 6b.

Specimens

Non-POBSP: USNM 300667-69, ♀, ♀, ♂, collected 27 April 1923 by Wetmore; USNM 289189, skull, collected 27 April 1923 by Wetmore. These are first specimen records.

Table 33. Observations of Bonin Petrels at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	?	"Island honeycombed with...petrel holes" (Munter, ms.).
1923 27 Apr.	1	(Wetmore, ms.).

Table 33. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 5 Mar.	4	At least 2 nests with eggs found (POBSP, 1964d).
26-27 June	1	Near-fledging young (POBSP, 1963).
1964 14 Mar.	1-2	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	0	(POBSP, 1964a).
1965 19 Mar.	100-200	Few nests contained eggs or small chicks (POBSP, 1965b).
22 Mar.	?	Some burrows with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966a).
1967 22 Mar.	?	None seen during brief diurnal visit (BSFW, 1967a; POBSP, 1967d).
31 May	2	Young (POBSP, 1967b).
29 Aug.	0	(POBSP, 1967a).
1968 24 Mar.	?	None seen during brief diurnal visit (BSFW, 1968; POBSP, 1968).

Table 34. Observations of Bonin Petrels at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	3,000	Nesting abundantly (Bailey, 1956: 32; Willett, ms.).
1963 6 Mar.	0	(POBSP, 1964d).
23-25 June	0	(POBSP, 1963).
1964 19-20 Aug.	0	(POBSP, 1964a).
17 Sept.	0	(BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	few	No burrows examined (POBSP, 1965b).
1966 22 Sept.	0	(BSFW, 1966b).

Table 34. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 16-17 Mar.	5	Minimum number present (BSFW, 1967d).
29-30 Aug.	0	(POBSP, 1967a).
1969 12 Sept.	10	(BSFW, 1969d).

Table 35. Observations of Bonin Petrels at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 27 Apr.	3	1 adult, 2 young (Wetmore, ms.).
1963 5 Mar.	?	Nesting (POBSP, 1964d).
26 June	0	None seen during diurnal survey (POBSP, 1963).
1964 14 Mar.	?	Burrows (BSFW, 1964a; POBSP, 1964b).
18 Aug.	?	None seen during diurnal survey (POBSP, 1964a).
1965 18-19 Mar.	30-50	Heavily incubated to pipped eggs found; some small young may have been present (POBSP, 1965b).
22 Mar.	34	Adults handled; 1 hatching egg (BSFW, 1965; POBSP, 1965a).
1967 22 Mar.	?	None observed on diurnal survey; no fresh burrows (BSFW, 1967a; POBSP, 1967d).
31 May	?	None seen during diurnal survey (POBSP, 1967b).
28 Aug.	?	None seen during diurnal survey (POBSP, 1967a).
1968 24 Mar.	?	None seen during diurnal survey (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	5	(BSFW, 1969d).

Table 36. Observations of Bonin Petrels at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	?	Fresh egg found in "Wedge-tailed Shearwater burrows" (Munter, ms.). [Probably Bonin egg and burrow].
1923 26-28 Apr.	?	Presence noted (Wetmore, ms.).
1961 12 Mar.	?	None seen but "most likely they are present in small numbers" (HDFG, 1961).
1963 26 Feb.- 8 Mar.	800	All active burrows observed contained young (POBSP, 1964d).
1964 13-14 Mar.	150-200	Adults; 100 nests estimated, some birds incubating eggs, no young seen (BSFW, 1964a; POBSP, 1964b).
16 Sept.	25	6 adults seen (BSFW, 1964a; POBSP 1964b).
1965 15-19 Mar.	100-300	Nests with either well-incubated eggs or small downy young (POBSP, 1965b).
21-22 Mar.	200	No eggs seen (BSFW, 1965; POBSP, 1965a).
1966 20-26 Sept.	400+	Nocturnal adults; no eggs or young (BSFW, 1966b).
25-27 Sept.	200	Adults digging burrows; no eggs (POBSP, 1966).
1967 21-23 Mar.	150	Nocturnal adults; many burrows inspected but none contained eggs or young (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	5	Large, fully-feathered juveniles (POBSP, 1967b).
28-30 Aug.	1,000 [±]	No eggs or young; most birds sitting quietly on ground surface (POBSP, 1967a).
1968 22-24 Mar.	25-50	Burrows not checked for contents (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	1,000	Nocturnal adults; burrows present, but no eggs or young (BSFW, 1969a).
10-19 Sept.	300	Adults (BSFW, 1969d).

BULWER'S PETREL

Bulweria bulweriiStatus

Uncommon breeding species; recorded only on Southeast Island during summer. Maximum POBSP population estimate 15 in June 1963.

Observations

Bulwer's Petrels were tentatively recorded 12 March 1961 when HDFG personnel found remains of several petrels on Southeast Island; these, however, were very likely Sooty Storm Petrels.

A few nesting Bulwer's Petrels, with eggs, were found on Southeast by POBSP personnel in June 1963; several were observed in empty burrows in August 1964; an adult and one young bird were found in September 1966 (Clapp and Woodward, 1968: 7-8). None has been seen since.

Annual Cycle

The only positive evidence of breeding--eggs in June 1963 and a near-fledging young in September 1966--indicate that the Bulwer's Petrel may follow a spring and summer breeding season (see Fig. 58) as do other populations in the Northwestern Hawaiian Islands.

The lack of observations from four fall-winter surveys and seven early spring surveys indicates these petrels are absent from October through March. The three positive observations suggest that the population is extremely small. These low numbers and the absence of Bulwer's during the May to June 1967 and 1969 surveys when breeding should have occurred may indicate that the local population is gradually becoming extirpated.

Ecological Distribution

Bulwer's Petrels have been recorded only from Southeast Island. Because of its small population and the few nocturnal surveys of islands other than Southeast, the species may have been overlooked on Grass, North and Seal Islands.

Southeast Island: POBSP personnel observed 15 Bulwer's Petrels and three nests with eggs at Southeast 18 to 23 and 25 June 1963. Five petrels were found in empty burrows 16 to 19 August 1964. An adult and a young bird, with only a trace of down on its nape, were observed by BSFW and POBSP personnel 20 to 27 September 1966.

Most Bulwer's Petrels have been found near the south shore. The three nests containing eggs were observed under boards, and the fourth, containing a young bird, was found under a piece of corrugated tin. Other petrels have been observed in burrows beneath vegetation, and in one instance, beneath a Red-footed Booby nest in Solanum.

Banding and Movements

Nine adult Bulwer's Petrels were banded on Southeast Island, 6 in June 1963 and 3 in August 1964. Three of the 6 banded in June 1963 were recaptured locally in August 1964. None has been recaptured elsewhere.

WEDGE-TAILED SHEARWATER

Puffinus pacificusStatus

Common breeding species; present usually from March to November. Nests and occurs only on the four major vegetated islands. Recent POBSP and BSFW maximum population estimate 26,500 in August 1964.

Observations

Munro (1942: 12) saw "numbers of Wedge-tailed Shearwaters" before sailing into the lagoon on 6 July 1891. No landing was made; he left early on the 7th. Munter (ms.) in February 1916 observed a fresh egg in a "Wedge-tailed Shearwater burrow." This observation is probably erroneous; this species consistently returns in March and lays eggs in June; the burrow was probably that of a Bonin Petrel. Wetmore (ms.) found adults, but no eggs in April 1923. Galtsoff (1933: 19) published the first observation from the atoll after finding them in large numbers in summer 1930. Richardson (1957: 16) noted that it breeds here. POBSP, BSFW, and HDFG personnel observed their presence on the atoll in 1961, and 1963 to 1969 (Tables 37 to 40).

Annual Cycle

Wedge-tailed Shearwaters at Pearl and Hermes are summer-fall breeders (see Fig. 58). Recent data show adult birds arrive in small numbers normally during early March. By mid- or late March the nocturnal population increases and some diurnal activity occurs. Egg laying begins in early June and most eggs are laid by late June. Hatching commences in late July and most eggs are hatched by mid-August. Young birds probably remain until mid-October and a few into early November. Adults more than likely start leaving in early October, prior to the departure of their young. The population is composed mainly of white-phased individuals.

Ecological Distribution

Wedge-tailed Shearwaters nest on Grass, North, Seal and Southeast Islands.

Grass Island: Wetmore (ms.) first observed Wedge-tailed Shearwaters in April 1923. POBSP and BSFW personnel found them present in all years (Table 37).

Population estimates for most recent visits are lacking because of the diurnal nature of the visits and shortness of the surveys. An estimated

1,000+ adults and 500 nest burrows with eggs, however, were recorded by POBSP personnel in June 1963. Nests were found only in the vegetated western part.

North Island: POBSP personnel first observed nesting Wedge-tailed Shearwaters in June 1963, and found them on most subsequent visits (Table 38). Summer estimates of nests with eggs or young ranged from 1,000 to 2,000.

Nest burrows were in the vegetated northern portion. Individual nest burrows were under dense Solanum, Sicyos, and Eragrostis.

Seal Island: Wetmore (ms.) noted Wedge-tailed Shearwaters in April 1923. POBSP and BSFW personnel observed them on most recent visits (Table 39). The only breeding population estimate is of 500 nests with eggs.

This species nests in burrows in the vegetated portion.

Southeast Island: In April 1923 Wetmore (ms.) found Wedge-tailed Shearwaters to be fairly common. Galtsoff (1933: 19) wrote of seeing large numbers in summer 1930. All recent visitors have recorded them during their spring-summer breeding season (Table 40). Fall estimates of adults and young range from 3,000 and 800 respectively to 14,000 and 5,000.

The population is distributed over the entire island, but is most numerous in the area of high grass in the northwest sector of the eastern portion. In areas of scant vegetation, the lack of extensive root systems causes loose sand; consequently, burrows frequently collapse. In June 1967 one percent of the population was estimated to be dark-phased individuals.

Banding and Movements

POBSP personnel banded 3,271 adults on North, Seal, and Southeast Islands (Table 41). Of these, 148 have been recaptured on the atoll (Table 16). In addition, one adult (USFW band no. 605-12758) banded on Kure 12 March 1964 was captured on Southeast one day later. An adult (615-16431) banded 17 August 1964 on Southeast was found injured at Kure 23 September 1964. Another adult (615-17584) banded on Southeast 18 August 1964 was captured on Manana Island, Oahu 2 June 1966.

Specimens

POBSP: USNM 492958, ♂, collected 7 March 1963 on Southeast by Amerson. This is a first specimen record.

Table 37. Observations of Wedge-tailed Shearwaters at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Island honeycombed with shearwater* and petrel holes (Munter, ms.).
1923 27 Apr.	100	(Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26-27 June	1,000+	An estimated 500 nest burrows with eggs (POBSP, 1963).
1964 14 Mar.	2	No evidence of nesting (BSFW, 1964a; POBSP, 1964b).
18 Aug.	?	Adults with eggs and nestlings in burrows (POBSP, 1964a).
1965 19 Mar.	100-200	A pair seen; no active burrows (POBSP, 1965b).
22 Mar.	20	Many burrows observed; only 1 pair seen during diurnal survey (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	?	Active burrows (BSFW, 1966b).
1967 22 Mar.	?	None seen during brief diurnal visit; no fresh burrow digging (BSFW, 1967a; POBSP, 1967d).
31 May	200	Diurnal survey (POBSP, 1967b).
29 Aug.	?	1 adult seen during diurnal survey; of 25 nests examined none was active (POBSP, 1967a).
1968 24 Mar.	?	1 adult seen on brief diurnal visit (BSFW, 1968; POBSP, 1968).

*Probably Bonin Petrel burrows.

Table 38. Observations of Wedge-tailed Shearwaters at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 6 Mar.	0	(POBSP, 1964d).
23-25 June	5,000	Adults; 2,000± burrows with eggs (POBSP, 1963).
1964 19-20 Aug.	7,500	Adults; 1,000 burrows with eggs, and 1,500 with very small nestlings (POBSP, 1964a).
17 Sept.	1,000-1,500	Burrows contained downy young (BSFW, 1964b; POBSP, 1964c).
1965 17 Mar.	100-200	No eggs or young (POBSP, 1965b).
1966 22 Sept.	0	(BSFW, 1966b).
1967 16-17 Mar.	0	(BSFW, 1967d).
29-30 Aug.	7,000-8,000	1,000-2,000 medium-sized downy young (POBSP, 1967a).
1969 12 Sept.	10	(BSFW, 1969d).

Table 39. Observations of Wedge-tailed Shearwaters at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	?	"Shearwater holes were found thickly scattered about the island" (Munter, ms.).*
1923 27 Apr.	600	300 pairs (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	1,200	Adults, 500 nest burrows with eggs (POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	?	Adults with nestlings and eggs in burrows (POBSP, 1964a).
1965 18-19 Mar.	10-15	Adults; no eggs or young (POBSP, 1965b).
22 Mar.	5	Only 1 pair (BSFW, 1965; POBSP, 1965a).

Table 39. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1967 22 Mar.	?	None seen on diurnal survey; burrows showed no signs of fresh digging (BSFW, 1967a; POBSP, 1967d).
31 May	200	Diurnal survey (POBSP, 1967b).
29 Aug.	?	None seen during diurnal visit; 5 or 6 burrows investigated were inactive (POBSP, 1967a).
1968 24 Mar.	0	Diurnal survey (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	Diurnal survey (BSFW, 1969d).

*Probably Bonin Petrel burrows.

Table 40. Observations of Wedge-tailed Shearwaters at Southeast Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	?	Fresh egg found in a "Wedge-tailed Shearwater burrow" (Munter, ms.). [Observation probably erroneous; possibly refers to Bonin Petrel].
1923 26-28 Apr.	fairly common	Evidently no eggs laid (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 26 Feb.- 8 Mar.	5	First observed 6 March; no more than 3 nightly (POBSP, 1964d).
18-23, 25 June	5,000+	Almost all nesting, with fresh or nearly fresh eggs (POBSP, 1963).
1964 13-14 Mar.	200-300	Nocturnal, only 40 [±] diurnal; some birds paired, some excavating burrows (BSFW, 1964a; POBSP, 1964b).

Table 40. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1964 16-19 Aug.	19,000	14,000 adults, 5,000 young; almost all active burrows contained young chicks; only 2 nests with eggs found (POBSP, 1964a).
16 Sept.	3,500	Downy young (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	100-300	No active burrows (POBSP, 1965b).
21-22 Mar.	700	No nests, most birds apparently paired (BSFW, 1965; POBSP, 1965a).
1966 20-26 Sept.	450-500	Young in late downy stages (BSFW, 1966b).
25-27 Sept.	3,800	3,000 adults, 800 mostly large downy young (POBSP, 1966).
1967 21-23 Mar.	40-50	Nocturnal; few paired, no active burrows (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	1,400- 2,600	Adults; some copulating and others digging burrows; neither eggs nor young found (POBSP, 1967b).
28-30 Aug.	9,000	8,000 adults, less than 1,000 young; all active burrows with medium-sized downy chicks (POBSP, 1967b).
1968 22-24 Mar.	50	Scattered individuals roosting quietly on surface of ground; no breeding activity (BSFW, 1968; POBSP, 1968).
1969 31 Mar.- 2 Apr.	1,000	(BSFW, 1969b).
26-31 May	?	Adults calling and digging burrows; no evidence of egg-laying (BSFW, 1969c).
10-19 Sept.	4	Adults (BSFW, 1969d).

CHRISTMAS SHEARWATER

Puffinus nativitatusStatus

Uncommon breeding species; present from late February until late September and early October. Nests at Southeast Island; occurs at North

Table 41. Adult Wedge-tailed Shearwaters banded at Pearl and Hermes Reef by the POBSP *

<u>Island</u>	1963			1964			1965-1967			<u>Totals</u>
	<u>Mar.</u> 1963	<u>June</u> 1963	<u>1963</u> Total	<u>Aug.</u> 1964	<u>Sept.</u> 1964	<u>1964</u> Total	<u>Mar.</u> 1965	<u>Sept.</u> 1966	<u>Aug.</u> 1967	
Southeast	2	500	502	1,500	286	1,786	43	247	56	2,634
Seal	0	0	0	0	0	0	1		0	1
North	0	200	200	400	0	400	36		0	636
Total	2	700	702	1,900	286	2,186	80	247	56	3,271

*No young were banded.

Island. POBSP and BSFW maximum population estimate 50 in March 1965 and 1968.

Observations

Wetmore (ms.) had a Christmas Shearwater reported to him in April 1923. Clapp and Woodward (1968: 8-9) published the first atoll record from early POBSP data. POBSP, BSFW, and HDFG have noted its presence in small numbers each year since 1963 except 1969 (Table 42).

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Adults begin arriving by late February; egg laying probably begins in mid- or late April. Young usually hatch early in June with some eggs probably remaining until early July. Young probably fledge in late August and September. None occurs in late fall and early winter. March populations ranged from 0 to 50.

Ecological Distribution

Christmas Shearwaters nest only at Southeast Island; adults are known from North Island.

North Island: Five adults were recorded by BSFW personnel 17 September 1964. This species may nest here.

Southeast Island: Although Wetmore (ms.) recorded the first Christmas Shearwater in 1923, Clapp and Woodward (1968: 8-9) first published its occurrence from 1963 to 1966 POBSP data. POBSP and BSFW personnel have since recorded it in 1967 and 1968 (Table 42). The population is small with a maximum estimate of 50.

Nests have been found under Scaevola and boards. Individuals have been sighted on open ground and in thick Solanum and Eragrostis. The species has been recorded from both the east and west portions of the island.

Banding and Movement

One adult was banded by POBSP personnel at Southeast in September 1966; no interisland movement exists for this species.

Specimen Records

POBSP: USNM 492965, ♂, collected on Southeast Island 7 March 1963, POBSP collector unknown; USNM 492966, ♂, collected on Southeast Island 26 February 1963, POBSP collector unknown.

Table 42. Observations of Christmas Shearwaters at Southeast Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	1	Reported to, but not seen by, Wetmore (ms.).
1930 23 July-Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	?	Presence noted (HDFG, 1961).
1963 26 Feb.- 8 Mar.	5	No nests (Clapp and Woodward, 1968: 8-9; POBSP, 1964d).
18-23, 25 June	5-10	Adults, 1 nest with egg (Clapp and Woodward, 1968: 8-9; POBSP, 1963).
1964 13-14 Mar.	12-15	2 diurnal, 15 nocturnal; no nests (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	10	Adults; only 2 found in a burrow which contained neither egg nor young (POBSP, 1964a).
16 Sept.	15-25	No evidence of nesting; 5 birds actually seen (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15-20	Adults sitting in pairs; no nests found (POBSP, 1965b).
21-22 Mar.	50	No active nests; 12 adults actually observed (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	-	Not mentioned in notes (BSFW, 1966b).
25-27 Sept.	20	3 large young (+21 days); only a few birds seen at sunset (Clapp and Woodward, 1968: 8-9; POBSP, 1966).
1967 21-23 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	<50	4 breeders: 2 nests with eggs (POBSP, 1967b).
28-30 Aug.	20	Adults found in pairs near empty burrows (POBSP, 1967a).

Table 42. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1968 22-24 Mar.	50	Ca. 5 pairs actually seen; no evidence of nesting (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	0	(BSFW, 1969a).
31 Mar.- 2 Apr.	0	(BSFW, 1969b).
26-31 May	0	(BSFW, 1969c).
10-19 Sept.	0	(BSFW, 1969d).

SOOTY STORM PETREL

Oceanodroma tristramiStatus

Common breeding species; present possibly late fall, winter, and spring. Nests at North, Seal, and Southeast Islands; known from Grass Island. Maximum POBSP and BSFW estimated population 7,500 in February 1969.

Observations

Willett (ms.) first recorded a nesting colony in March 1913 (see also Bailey, 1956: 60-61). Wetmore (ms.) observed young in April 1923. Richardson (1957: 19) also records it as breeding. POBSP and BSFW personnel found moderate numbers on the four vegetated islands each year since 1963.

Annual Cycle

The Sooty Storm Petrel has a winter-spring breeding season locally (Fig. 58). Adults possibly arrive in late fall, with egg laying probably starting in late December. Young most likely begin hatching in late January; eggs are known as late as mid-March and large young are known as early as early March. Adults probably leave by mid-May, with young fledging by late May.

Ecological Distribution

Sooty Storm Petrels nest at North, Seal, and Southeast Islands, and occur at Grass Island.

Grass Island: POBSP personnel found this species 5 March 1963; none has been observed since.

North Island: Willett (ms.) found a small colony, with young, on 15 March 1913 (see also Bailey, 1956: 60-61). POBSP personnel recorded 50 to 75 nestling and 100-200 adult Sooty Storm Petrels 17-18 March 1965. Two adults were handled and another seen 16 to 17 March 1967 by BSWF personnel.

Seal Island: Wetmore (ms.) observed a few young "Bulwer's Petrels" 27 April 1923. These, however, were probably Sooty Storm Petrel young, for Bulwer's Petrel young do not usually start hatching until mid-summer. A few young and 15 to 25 adults were found 18 to 19 March 1965.

Southeast Island: Young Sooty Storm Petrels were observed by Wetmore (ms.) in April 1923. POBSP and BSWF personnel recorded them nesting each spring since 1963 (Table 43). Although a high of 7,500 adults was estimated during the middle third of February 1969, the average March population (6 visits) is 441, and ranges from 200 to 1,000.

Nest burrows are most abundant in the Bermuda grass (Cynodon) area on the west half of the eastern portion; they are also found in nearby open rubble and Boerhavia, and in an Eragrostis area on the south side of the eastern portion. On the western portion burrows are located in an area of open coral rubble and Coronopus in the west interior.

Banding and Movement

In all, 788 Sooty Storm Petrels have been banded by POBSP and BSWF personnel on three islands (Table 44). Of these, 20 have been recaptured on the atoll (Table 16). No inter-atoll movement is known.

Specimens

POBSP: USNM 496219, 21, ♀♀, moderate light fat, respectively, collected at Southeast 14 March 1964 by B. Amerson; USNM 496220, ♂, light fat, collected at Southeast 14 March 1964 by B. Amerson.

Non-POBSP: USNM 240027, ♀, collected 15 May 1913 by Willett; USNM 289204, skull, collected 27 April 1923 by Wetmore; USNM 300811-12, ♂, ♀, collected 27 April 1923 by Wetmore; USNM 300813, unsexed, collected 26 April 1923 by Wetmore; USNM 300814, ♂, collected 16 May 1923 by Reno.

These are first specimen records.

Table 43. Observations of Sooty Storm Petrels at Southeast Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	?	Young only (Wetmore, ms.).

Table 43. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1930 23 July- Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	0	None seen, but 2 dead may have been this species (HDFG, 1961).
1963 26 Feb.- 8 Mar.	1,000	Eggs to chicks with well-developed primaries, secondaries, and back feathers (POBSP, 1964d).
18-23, 25 June	0	(POBSP, 1963).
1964 13-14 Mar.	200+	7 chicks (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	0	(POBSP, 1964a).
16 Sept.	0	(BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	600-700	400-500 adults, 200 chicks; 1 burrow with egg (POBSP, 1965b).
21-22 Mar.	700	Nocturnal adults; 5 young seen (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	?	2 chicks (BSFW, 1966a).
20-26 Sept.	0	(BSFW, 1966b).
25-27 Sept.	0	(POBSP, 1966).
1967 21-23 Mar.	200+	Nocturnal adults; <u>ca.</u> 10 chicks: all downy but with primaries just breaking out of sheaths (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	0	(POBSP, 1967b).
28-30 Aug.	0	(POBSP, 1967a).
1969 10-12 Feb.	7,500	Adults, nocturnal only; eggs to large young (BSFW, 1969a).
31 Mar.- 2 Apr.	250	(BSFW, 1969b).
26-31 May	?	2 adults, 1 near fledging young seen (BSFW, 1969c).
10-19 Sept.	0	(BSFW, 1969d).

Table 44. Sooty Storm Petrels banded at Pearl and Hermes Reef

146

Bander:		POBSP	BSFW	POBSP	BSFW	Period of Survey				
Island	Age- Class	Feb. -				1965	BSFW	BSFW	BSFW	Totals
		Mar. 1963	Mar. 1964	Mar. 1965	Mar. 1965	Total	Mar. 1967	Mar. 1968	Feb. 1969	
Southeast	Adult	438	3	19	121	140	0	19	92	692
	Young	0	31	26	4	30	0	0	1	62
	Total:	438	34	45	125	170	0	19	93	754
Seal	Adult	0	0	5	0	5	0	0	0	5
North	Adult	0		10		10	2		0	12
	Young	0		17		17	0		0	17
	Total:	0		27		27	2		0	29
Total	Adult	438	3	34	121	155	2	19	92	709
	Young	0	31	43	4	47	0	0	1	79
	Total:	438	34	77	125	202	2	19	93	788

RED-TAILED TROPICBIRD

Phaethon rubricaudaStatus

Common breeding species; present from late winter probably through late fall; possible straggler rest of year. Nests at Grass, North, Sand, and Southeast Islands. Maximum POBSP and BSFW population estimate 159 in June 1963.

Observations

Munro (1942: 12) recorded a few tropicbirds, probably Red-tailed Tropicbirds, off Pearl and Hermes Reef on 6 July 1891. Wetmore (ms.) noted nesting in April 1923. Clapp and Woodward (1968: 11) published the first record of nesting Red-tailed Tropicbirds using POBSP data for 1963 to 1967. Tables 45 to 48 present all observations, including POBSP and BSFW for 1963 to 1969.

Annual Cycle

Figure 58 presents the local annual breeding cycle. Adults arrive in early February, with eggs appearing as early as mid-March. Most eggs are probably laid by late April; some are known into August. Young are known as early as early May with peak fledging probably in July and August; some have been recorded in late September. The young generally leave the atoll as soon as they fledge. Adults probably are not present during late fall and early winter.

Ecological Distribution

Red-tailed Tropicbirds are known to breed at Grass, North, Seal, and Southeast Islands, and have been observed flying over Little North.

Grass Island: Nesting Red-tailed Tropicbirds were observed by Wetmore (ms.) in April 1923. Clapp and Woodward (1968: 11) recorded their presence in 1963, 1964, and 1967 from POBSP data. POBSP and BSFW personnel noted the species in 1966, but failed to find it in 1965 and 1968 (Table 45).

Red-tailed Tropicbirds nest under thick vegetation, especially high clumps of Eragrostis. The maximum number of nests in any year was two in 1963.

North Island: Clapp and Woodward (1968: 11) published 1963 to 1965 data on nesting Red-tailed Tropicbirds; their March 1967 data, however, should have referred to Southeast Island. All POBSP and BSFW data are shown in Table 46. The maximum number of nests was 19 in June 1963, which coincided with the peak population of 64. All nests were placed under clumps of Eragrostis or Solanum.

Seal Island: In April 1923 Wetmore (ms.) observed nesting. Clapp and Woodward (1968: 11) published part of the 1963 and 1964 POBSP data. All data are presented in Table 47.

Wetmore's (ms.) 1923 Seal population estimate of 30 Red-tailed Tropicbirds has not been equaled; 20 adults and 6 nests was the largest number present in recent years. Eragrostis clumps are favored vegetation under which this species nests.

Southeast Island: Wetmore (ms.) observed the species in April 1923 and POBSP and BSFW noted its presence from 1963 to 1966 (Clapp and Woodward, 1968: 11). These and other data are presented in Table 48.

March population estimates average 17 and range from 6 to 25. The two June visits have produced the highest populations, 70 and 59. Most nest under large Eragrostis clumps located west of the tidal pools, under low Scaevola, and in and under old oil drums scattered over the island.

Other Islands: Two adults flew over Little North Island on 27 August 1967; no nests or previously used nest sites were found. This species may occasionally fly over the remaining four sandy islands.

Banding and Movements

The POBSP banded 171 Red-tailed Tropicbirds on four islands (Table 49). Of these, 56 have been recaptured on the atoll (Table 16). An adult, sex unknown, banded at Southeast 28 August 1967 (USFW band no. 705-12788) was captured by POBSP personnel 18 May 1969 on Johnston Atoll where it was on an egg.

Specimens

Non-POBSP: USNM 301000-02, ♀♀, collected 27, 27, and 26 April 1923 by Wetmore. These are first specimen records.

Table 45. Observations of Red-tailed Tropicbirds at Grass Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1923 27 Apr.	4	Nesting among high grass clumps (Wetmore, ms.).
1963 5 Mar.	?	Present (POBSP, 1964d).
26-27 June	5	Adults, 2 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 14 Mar.	1	Flying over; no nests (BSFW, 1964a; POBSP, 1964b).
18 Aug.	9	8 adults, 1 nest with large young (Clapp and Woodward, 1968: 11; POBSP, 1964a).
1965 19 Mar.	0	(POBSP, 1965b).

Table 45. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1965 22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	2	Adults; no nests (BSFW, 1966b).
1967 22 Mar.	1	Adult on ground and flying; no nests (Clapp and Woodward, 1968: 11; BSFW, 1967a; POBSP, 1967d).
31 May	0	(POBSP, 1967b).
29 Aug.	2	Adults in courtship display over island; no nests found (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).

Table 46. Observations of Red-tailed Tropicbirds at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 6 Mar.	1	Flying over; no nests (POBSP, 1964d).
23-25 June	64	60 adults; 4 nestlings, 38 breeders; 19 nests: 15 (79%) with eggs, 4 (21%) with young (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 19-20 Aug.	55	40 adults, 32 breeders, 7 non-breeders, 15 young; 16 nests: 1 (6%) with an egg, 5 (31%) with small downy young, 10 (63%) with larger young (Clapp and Woodward, 1968: 11; POBSP, 1964a).
17 Sept.	11	10 adults, 2 breeders, 1 large dependent young (Clapp and Woodward, 1968: 11; BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	5-10	Adults, 4 breeders, 2 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1965b).
1966 22 Sept.	3	Adults flying overhead; no nests (BSFW, 1966b).
1967 16-17 Mar.	0	(BSFW, 1967d).
29-30 Aug.	45+	20 breeders, 15 non-breeders; from large downy young to dependent immatures; sample nest count of 10 nests: 1 (10%) with a large downy young, 9 (90%) with dependent immatures (POBSP, 1967a).

Table 46. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 12 Sept.	4	3 adults, 1 young (BSFW, 1969d).

Table 47. Observations of Red-tailed Tropicbirds at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 27 Apr.	30	15 pairs nesting among high grass clumps (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	20	12 breeders, 8 non-breeders; 6 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 14 Mar.	6	Flying over, courtship behavior; no nests (BSFW, 1964a; POBSP, 1964b).
18 Aug.	17-18	15 adults; 8 breeders; 4 nests: 1 leg, 1 small downy young, 1 medium-sized young, and 1 dependent immature (Clapp and Woodward, 1968: 11; POBSP, 1964a).
1965 18-19 Mar.	0	(POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	6	4 breeders (only 3 adults seen), 2 nearly full-grown young (BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	6	Breeders, 3 nests with eggs (POBSP, 1967b).
29 Aug.	2	Flying over; no nests (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).

Table 48. Observations of Red-tailed Tropicbirds at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 26-28 Apr.	20	[Presumably nesting.] (Wetmore, ms.).

Table 48. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1961 12 Mar.	-	Not mentioned in report (HDFG, 1961).
1963 26 Feb.- 8 Mar.	15	Adults; up to 11 in air at once, some on ground; no eggs (Clapp and Woodward, 1968: 11; POBSP, 1964d).
18-23, 25 June	70	65 adults, 58 breeders; 29 nests counted: 24 (83%) with eggs; 3 (10%) with small downy young; and 2 (7%) with larger young (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 13-14 Mar.	6	4 breeders; 2 nests with eggs, 1 of which was abandoned; 6 seen flying at once (Clapp and Woodward, 1968: 11; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	18	15 adults, 12 breeders; 6 nests counted: 3 (50%) with eggs, 1 (17%) with a small downy young, 1 (17%) with dependent immature; 1 (17%) with young of unrecorded size (Clapp and Woodward, 1968: 11; POBSP, 1964a).
16 Sept.	15	6 breeders; 3 large young (Clapp and Woodward, 1968: 11; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15-20	8 breeders; 4 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1965b).
21-22 Mar.	2	Breeders with an egg (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	12	As many as 12 flying at one time (BSFW, 1966a).
20-26 Sept.	2	Adults; no nests (BSFW, 1966b).
25-27 Sept.	several	Flying over; no nests (POBSP, 1966).
1967 21-23 Mar.	15	Adults; 4 breeders; 2 nests with eggs (BSFW, 1967a; POBSP, 1967d).*
28, 30 May- 1 June	59	56 breeders; 28 nests counted: 25 (89%) with eggs, 3 (10%) with small downy young; 1 nest also empty (POBSP, 1967b).
28-30 Aug.	39	20 breeders; 10 nests counted: 1 (10%) with egg; 3 (30%) with large downy young; 6 (60%) with dependent immatures (POBSP, 1967a).

Table 48. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1968 22-24 Mar.	20-25	Adults; 4 breeders: 2 nests with eggs; at least 11 birds on ground and 9 in air at one time (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	7	Adults; 1 on ground (BSFW, 1969a).
31 Mar.- 2 Apr.	22	11 nests counted (BSFW, 1969b).
26-31 May	40	36 breeding adults; 18 nests counted: 16 (89%) with eggs and 2 (11%) with half-grown young; 2 empty nests (BSFW, 1969c).
10-19 Sept.	6	4 breeders, 2 young (BSFW, 1969d).

*Erroneously listed by Clapp and Woodward (1968: 11) under North Island.

BLUE-FACED BOOBY

Sula dactylatra

Status

Common breeding species; present year-round with possible population decrease in late fall and early winter; occurs and nests on all islands except Sand and Planetree where it roosts only. Maximum POBSP and BSFW population estimate 585 in June 1963.

Observations

Blue-faced Boobies, with nests, were first recorded in March 1913 (Bailey, 1956: 32; Willett, ms.). Richardson (1957: 20) also notes that it breeds here, but gives no data. They have been recorded by all observers, including POBSP and BSFW personnel, since (Tables 50 to 56).

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Some remain on the atoll year-round; numbers increase in winter and decrease in late summer and fall. This fluctuation coincides with the breeding cycle. On the basis of recent data, eggs are laid as early as February; most eggs are laid by the end of March. Although hatching occurs as early as 1 April, most occurs in May and very few eggs remain into late June or July. Fledging takes place in late summer and fall. The total number of active nests in March has ranged from 66 to 109+.

Table 49. Red-tailed Tropicbirds banded at Pearl and Hermes Reef by the POBSP

Island	Age-Class	Period of Survey							Totals	
		Mar. 1963	June 1963	1963 Total	Aug. 1964	Mar. 1965	May 1967	Aug. 1967		1967 Total
Southeast	Adult	7	30	37	5	3	19	9	28	73
	<u>Nestling</u>	<u>0</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>0</u>	<u>0</u>	<u>9</u>	<u>9</u>	<u>13</u>
	Total:	7	32	39	7	3	19	18	37	86
Grass	Adult	0	2	2	1	0	0	0	0	3
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	Total:	0	2	2	2	0	0	0	0	4
Seal	Adult	0	8	8	4	0	0	0	0	12
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>
	Total:	0	8	8	6	0	0	0	0	14
North	Adult	0	27	27	10	2		7	7	46
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>11</u>	<u>0</u>		<u>10</u>	<u>10</u>	<u>21</u>
	Total:	0	27	27	21	2		17	17	67
Total	Adult	7	67	74	20	5	19	16	35	134
	<u>Nestling</u>	<u>0</u>	<u>2</u>	<u>2</u>	<u>16</u>	<u>0</u>	<u>0</u>	<u>19</u>	<u>19</u>	<u>37</u>
	Total:	7	69	76	36	5	19	35	54	171

Ecological Distribution

Blue-faced Boobies nest at Bird, Grass, Kittery, Little North, North, Seal, and Southeast Islands; in addition, they roost on Planetree and Sand.

Grass Island: Munter (ms.) first recorded Blue-faced Boobies in February 1916. Galtsoff's 1930 photographs (in litt.) show nesting Blue-faced Boobies at either Grass or Seal. In each year since 1963 (Table 50) except 1966 and 1969, POBSP and BSFW personnel found them nesting in small numbers. The most birds seen were in March 1965; the most nests were found in March 1963. This species nests on the upper sand beaches and eggs are laid in a slight depression in the bare sand.

Kittery Island: POBSP personnel recorded the first Blue-faced Boobies, with 24 nests, in March 1963. Since, they have been recorded each year until 1969 (Table 51). The March population has fluctuated from 22 to 80; March nests have varied from 11 to 32.

Nests are primarily near the perimeters and especially along the northwest edge. A few, however, nest as much as 150 yards inland from the waterline of this large sand island.

Little North Island: Rice (ms. a) first recorded Blue-faced Boobies on 14 October 1957 while flying over the atoll. POBSP and BSFW personnel have subsequently found them nesting each year since March 1963, except in 1968 when the island was not visited (Table 52). A high nest count of 29 was reached in June 1963. In August 1967 a large nocturnal roosting club of 150 formed at dusk.

Nests are placed on the raised, central portion.

North Island: Nesting Blue-faced Boobies first were recorded in March 1913 (Bailey, 1956: 32; Willett, ms.). Rice (ms. a) next noted them in October 1957. None was observed again until March 1963 when POBSP personnel found them nesting. POBSP and BSFW personnel have since found them nesting each year except 1966 (Table 53); no visits were made in 1968. The highest nest count was 29 in June 1963; the highest population estimate, 204, was also made at that time.

This species nests on the upper beach crest on all sides of the island. Nocturnal roosting birds are usually present in a club on the south tip.

Seal Island: Munter (ms.) observed several non-nesting Blue-faced Boobies in February 1916. Galtsoff's photographs (in litt.) show nests in summer 1930. POBSP personnel recorded it nesting each year since 1963 except 1969 (Table 54). March nest counts average 25 and range from 14 to 33. The highest March population estimate of 100-125 in 1965 equals that of May 1967 when 53 nests were counted.

Blue-faced Boobies nest on the upper beach crest of the vegetated portion, but prefer the rock ledge and open, coral rubble of the east portion.

Southeast Island: Blue-faced Boobies with eggs were first noted in February 1916 by Munter (ms.). They have been recorded on all visits since (Table 55). March nest counts made by POBSP and BSFW personnel average 26 and range from 6 to 40. March population estimates average 61 and range from 20 to 100; a peak population of 105 occurred in June 1963.

This species restricts nesting to the coral sand area just above the shoreline. The majority of the population nests on the west shore of the east section, on the seaward rock ledge of the western section, and on the south and southwest beaches of both sections.

Other Islands: A small population nests at Bird Island. Rice (ms. a) noted the species there in October 1957; POBSP and BSFW personnel found them nesting in 1964, 1965, and 1967. The maximum population estimate at Bird is 10 birds (Table 56).

POBSP and BSFW personnel also noted small numbers of roosting Blue-faced Boobies at Sand and Planetree Islands (Table 56).

Banding and Movements

POBSP personnel have banded 587 and BSFW personnel 6 Blue-faced Boobies on 8 islands (Table 57); of these, 249 have been recaptured on the atoll (Table 16). In addition, 3 Blue-faced Boobies--2 banded at Kure and 1 at French Frigate Shoals--were captured at Pearl and Hermes. Furthermore, 12 banded on the atoll moved to other atolls: 5 to Kure, 3 to Laysan, 2 to Lisianski, and 1 each to French Frigate Shoals and Johnston; these data are presented in Appendix Tables 7a and 7b.

Specimens

Non-POBSP: USNM 300951, ♀, collected April 1923 by Wetmore; USNM 300952-53, ♂, ♀, collected 28 and 26 April 1923 by Wetmore. These are first specimen records.

Table 50. Observations of Blue-faced Boobies at Grass Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	few	Nesting had not begun (Munter, ms.).
1923 27 Apr.	-	Not mentioned in notes (Wetmore, ms.).
1957 14 Oct.	1	Observed from aerial survey (Rice, ms. a).
1963 5 Mar.	12	Breeding adults; 6 nests (POBSP, 1964d).
26-27 June	15	10 breeders; 5 nests: 1 with a small downy young, 4 with medium-sized or larger young (POBSP, 1963).

Table 50. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1964 14 Mar.	4	2 breeders; 1 nest with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	2	Immatures (POBSP, 1964a).
1965 19 Mar.	15-20	Adults; 4 breeders: 2 nests with eggs (POBSP, 1965b).
22 Mar.	4	Adults on 2 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	-	None mentioned in notes (BSFW, 1966b).
1967 22 Mar.	1	Adult; no nests (BSFW, 1967a; POBSP, 1967d).
31 May	6	4 breeding adults; 2 nests: 1 with a small downy young, 1 with a medium-sized downy young (POBSP, 1967b).
29 Aug.	3	No adults observed but 1 dependent immature seen (POBSP, 1967a).
1968 24 Mar.	4	2 breeders: one nest with egg; 2 other adults flying over (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 51. Observations of Blue-faced Boobies at Kittery Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1963 5 Mar.	48 [±]	<u>Ca.</u> 24 nests with eggs (POBSP, 1964d).
26 June	84	60 adults; 50 breeders: 25 nests counted: 1 (4%) with eggs, 24 (96%) with young (POBSP, 1963).
1964 14 Mar.	70-80	Adults, 64 breeders: 32 nests with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	5	2 adults and 3 immatures seen from Seal I. (POBSP, 1964a).
1965 18 Mar.	25-35	22 breeders; 11 nests with eggs (POBSP, 1965b).

Table 51. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1965 22 Mar.	40	34 breeders; 17 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	11	9 adults and 2 flying immatures (BSFW, 1966b).
1967 22 Mar.	22	Adult breeders; 11 nests (BSFW, 1967a; POBSP, 1967d).
31 May	71	50 adult breeders; 25 nests: 4 (16%) with eggs, 4 (16%) with small downy young, 17 (68%) with medium-sized or large downy young (POBSP, 1967b).
29 Aug.	30	14 adults, 10 immatures counted, some of which were still being fed by their parents (POBSP, 1967a).
1968 24 Mar.	40	32 breeders; 16 nests with eggs counted (BSFW, 1968; POBSP, 1968).

Table 52. Observations of Blue-faced Boobies at Little North Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1957 14 Oct.	17	Observed from aerial survey (Rice, ms. a).
1963 6 Mar.	?	Nesting (POBSP, 1964d).
23, 25 June	73	58 breeders; 29 nests counted: 1 (4%) with eggs, 5 (17%) with small young, 23 (79%) with medium- or large-sized downy young (POBSP, 1963).
1964 19 Aug.	11	10 adults; 2 breeders, 1 downy young (POBSP, 1964a).
17 Sept.	75	51 adults counted; 2 immatures, 1 large dependent young (BSFW, 1964b; POBSP, 1964c).
1965 18 Mar.	20-30	18-20 breeders; 9-10 nests with eggs (POBSP, 1965b).
1966 22 Sept.	19	16 adults, 3 flying immatures (BSFW, 1966b).

Table 52. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 29 Aug.	200	20 breeders, 10 nests counted: 2 (20%) with eggs; 1 (10%) with a small downy young, 5 (50%) with medium-sized or large downy young, 2 (20%) with large dependent young; 150 in a nocturnal roosting club (POBSP, 1967a).
1969 31 Mar.	25	Breeders, most nests contained eggs (BSFW, 1969b).
12 Sept.	10	Adults (BSFW, 1969d).

Table 53. Observations of Blue-faced Boobies at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	100	Breeders; most nests with eggs, 2-3 with newly hatched young (Bailey, 1956: 32; Willett, ms.).
1957 14 Oct.	12	Observed from aerial survey (Rice, ms. a).
1963 6 Mar.	?	Nests with eggs (POBSP, 1964d).
23-25 June	204	175 adults; 58 breeders; 29 nests: 6 (21%) with small downy young, 23 (79%) with medium-sized or larger young (POBSP, 1963).
1964 19-20 Aug.	75+	Adults, some dependent immatures; nocturnal roosting clubs (POBSP, 1964a).
17 Sept.	30	20 adults and 1 flying immature counted (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	100-150	Adults; 32-34 breeders: 16 or 17 nests, all with eggs (POBSP, 1965b).
1966 22 Sept.	6	Adults; no young (BSFW, 1966b).
1967 16-17 Mar.	36+	34 breeders: 16 nests with eggs, 1 with a small young; 20 nocturnal roosting adults (BSFW, 1967d).
29-30 Aug.	60 ⁺	40 adults; 20 immatures, many of them still dependent (POBSP, 1967a).

1,000+ adults and 500 nest burrows with eggs, however, were recorded by POBSP personnel in June 1963. Nests were found only in the vegetated western part.

North Island: POBSP personnel first observed nesting Wedge-tailed Shearwaters in June 1963, and found them on most subsequent visits (Table 38). Summer estimates of nests with eggs or young ranged from 1,000 to 2,000.

Nest burrows were in the vegetated northern portion. Individual nest burrows were under dense Solanum, Sicyos, and Eragrostis.

Seal Island: Wetmore (ms.) noted Wedge-tailed Shearwaters in April 1923. POBSP and BSWF personnel observed them on most recent visits (Table 39). The only breeding population estimate is of 500 nests with eggs.

This species nests in burrows in the vegetated portion.

Southeast Island: In April 1923 Wetmore (ms.) found Wedge-tailed Shearwaters to be fairly common. Galtsoff (1933: 19) wrote of seeing large numbers in summer 1930. All recent visitors have recorded them during their spring-summer breeding season (Table 40). Fall estimates of adults and young range from 3,000 and 800 respectively to 14,000 and 5,000.

The population is distributed over the entire island, but is most numerous in the area of high grass in the northwest sector of the eastern portion. In areas of scant vegetation, the lack of extensive root systems causes loose sand; consequently, burrows frequently collapse. In June 1967 one percent of the population was estimated to be dark-phased individuals.

Banding and Movements

POBSP personnel banded 3,271 adults on North, Seal, and Southeast Islands (Table 41). Of these, 148 have been recaptured on the atoll (Table 16). In addition, one adult (USFW band no. 605-12758) banded on Kure 12 March 1964 was captured on Southeast one day later. An adult (615-16431) banded 17 August 1964 on Southeast was found injured at Kure 23 September 1964. Another adult (615-17584) banded on Southeast 18 August 1964 was captured on Manana Island, Oahu 2 June 1966.

Specimens

POBSP: USNM 492958, ♂, collected 7 March 1963 on Southeast by Amerson. This is a first specimen record.

Table 37. Observations of Wedge-tailed Shearwaters at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Island honeycombed with shearwater* and petrel holes (Munter, ms.).
1923 27 Apr.	100	(Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26-27 June	1,000+	An estimated 500 nest burrows with eggs (POBSP, 1963).
1964 14 Mar.	2	No evidence of nesting (BSFW, 1964a; POBSP, 1964b).
18 Aug.	?	Adults with eggs and nestlings in burrows (POBSP, 1964a).
1965 19 Mar.	100-200	A pair seen; no active burrows (POBSP, 1965b).
22 Mar.	20	Many burrows observed; only 1 pair seen during diurnal survey (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	?	Active burrows (BSFW, 1966b).
1967 22 Mar.	?	None seen during brief diurnal visit; no fresh burrow digging (BSFW, 1967a; POBSP, 1967d).
31 May	200	Diurnal survey (POBSP, 1967b).
29 Aug.	?	1 adult seen during diurnal survey; of 25 nests examined none was active (POBSP, 1967a).
1968 24 Mar.	?	1 adult seen on brief diurnal visit (BSFW, 1968; POBSP, 1968).

*Probably Bonin Petrel burrows.

Table 38. Observations of Wedge-tailed Shearwaters at North Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1963 6 Mar.	0	(POBSP, 1964d).
23-25 June	5,000	Adults; 2,000± burrows with eggs (POBSP, 1963).
1964 19-20 Aug.	7,500	Adults; 1,000 burrows with eggs, and 1,500 with very small nestlings (POBSP, 1964a).
17 Sept.	1,000-1,500	Burrows contained downy young (BSFW, 1964b; POBSP, 1964c).
1965 17 Mar.	100-200	No eggs or young (POBSP, 1965b).
1966 22 Sept.	0	(BSFW, 1966b).
1967 16-17 Mar.	0	(BSFW, 1967d).
29-30 Aug.	7,000-8,000	1,000-2,000 medium-sized downy young (POBSP, 1967a).
1969 12 Sept.	10	(BSFW, 1969d).

Table 39. Observations of Wedge-tailed Shearwaters at Seal Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	?	"Shearwater holes were found thickly scattered about the island" (Munter, ms.).*
1923 27 Apr.	600	300 pairs (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	1,200	Adults, 500 nest burrows with eggs (POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	?	Adults with nestlings and eggs in burrows (POBSP, 1964a).
1965 18-19 Mar.	10-15	Adults; no eggs or young (POBSP, 1965b).
22 Mar.	5	Only 1 pair (BSFW, 1965; POBSP, 1965a).

Table 39. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 22 Mar.	?	None seen on diurnal survey; burrows showed no signs of fresh digging (BSFW, 1967a; POBSP, 1967d).
31 May	200	Diurnal survey (POBSP, 1967b).
29 Aug.	?	None seen during diurnal visit; 5 or 6 burrows investigated were inactive (POBSP, 1967a).
1968 24 Mar.	0	Diurnal survey (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	Diurnal survey (BSFW, 1969d).

*Probably Bonin Petrel burrows.

Table 40. Observations of Wedge-tailed Shearwaters at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	?	Fresh egg found in a "Wedge-tailed Shearwater burrow" (Munter, ms.). [Observation probably erroneous; possibly refers to Bonin Petrel].
1923 26-28 Apr.	fairly common	Evidently no eggs laid (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 26 Feb.- 8 Mar.	5	First observed 6 March; no more than 3 nightly (POBSP, 1964d).
18-23, 25 June	5,000+	Almost all nesting, with fresh or nearly fresh eggs (POBSP, 1963).
1964 13-14 Mar.	200-300	Nocturnal, only 40± diurnal; some birds paired, some excavating burrows (BSFW, 1964a; POBSP, 1964b).

Table 40. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1964 16-19 Aug.	19,000	14,000 adults, 5,000 young; almost all active burrows contained young chicks; only 2 nests with eggs found (POBSP, 1964a).
16 Sept.	3,500	Downy young (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	100-300	No active burrows (POBSP, 1965b).
21-22 Mar.	700	No nests, most birds apparently paired (BSFW, 1965; POBSP, 1965a).
1966 20-26 Sept.	450-500	Young in late downy stages (BSFW, 1966b).
25-27 Sept.	3,800	3,000 adults, 800 mostly large downy young (POBSP, 1966).
1967 21-23 Mar.	40-50	Nocturnal; few paired, no active burrows (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	1,400- 2,600	Adults; some copulating and others digging burrows; neither eggs nor young found (POBSP, 1967b).
28-30 Aug.	9,000	8,000 adults, less than 1,000 young; all active burrows with medium-sized downy chicks (POBSP, 1967b).
1968 22-24 Mar.	50	Scattered individuals roosting quietly on surface of ground; no breeding activity (BSFW, 1968; POBSP, 1968).
1969 31 Mar.- 2 Apr.	1,000	(BSFW, 1969b).
26-31 May	?	Adults calling and digging burrows; no evidence of egg-laying (BSFW, 1969c).
10-19 Sept.	4	Adults (BSFW, 1969d).

CHRISTMAS SHEARWATER

Puffinus nativitatusStatus

Uncommon breeding species; present from late February until late September and early October. Nests at Southeast Island; occurs at North

Table 41. Adult Wedge-tailed Shearwaters banded at Pearl and Hermes Reef by the POBSP *

Island	1963			1964			Mar. 1965	Sept. 1966	Aug. 1967	Totals
	Mar. 1963	June 1963	Total	Aug. 1964	Sept. 1964	Total				
Southeast	2	500	502	1,500	286	1,786	43	247	56	2,634
Seal	0	0	0	0	0	0	1		0	1
North	0	200	200	400	0	400	36		0	636
Total	2	700	702	1,900	286	2,186	80	247	56	3,271

*No young were banded.

Island. POBSP and BSWF maximum population estimate 50 in March 1965 and 1968.

Observations

Wetmore (ms.) had a Christmas Shearwater reported to him in April 1923. Clapp and Woodward (1968: 8-9) published the first atoll record from early POBSP data. POBSP, BSWF, and HDFG have noted its presence in small numbers each year since 1963 except 1969 (Table 42).

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Adults begin arriving by late February; egg laying probably begins in mid- or late April. Young usually hatch early in June with some eggs probably remaining until early July. Young probably fledge in late August and September. None occurs in late fall and early winter. March populations ranged from 0 to 50.

Ecological Distribution

Christmas Shearwaters nest only at Southeast Island; adults are known from North Island.

North Island: Five adults were recorded by BSWF personnel 17 September 1964. This species may nest here.

Southeast Island: Although Wetmore (ms.) recorded the first Christmas Shearwater in 1923, Clapp and Woodward (1968: 8-9) first published its occurrence from 1963 to 1966 POBSP data. POBSP and BSWF personnel have since recorded it in 1967 and 1968 (Table 42). The population is small with a maximum estimate of 50.

Nests have been found under Scaevola and boards. Individuals have been sighted on open ground and in thick Solanum and Eragrostis. The species has been recorded from both the east and west portions of the island.

Banding and Movement

One adult was banded by POBSP personnel at Southeast in September 1966; no interisland movement exists for this species.

Specimen Records

POBSP: USNM 492965, ♂, collected on Southeast Island 7 March 1963, POBSP collector unknown; USNM 492966, ♂, collected on Southeast Island 26 February 1963, POBSP collector unknown.

Table 42. Observations of Christmas Shearwaters at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	1	Reported to, but not seen by, Wetmore (ms.).
1930 23 July-Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	?	Presence noted (HDFG, 1961).
1963 26 Feb.-8 Mar.	5	No nests (Clapp and Woodward, 1968: 8-9; POBSP, 1964d).
18-23, 25 June	5-10	Adults, 1 nest with egg (Clapp and Woodward, 1968: 8-9; POBSP, 1963).
1964 13-14 Mar.	12-15	2 diurnal, 15 nocturnal; no nests (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	10	Adults; only 2 found in a burrow which contained neither egg nor young (POBSP, 1964a).
16 Sept.	15-25	No evidence of nesting; 5 birds actually seen (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15-20	Adults sitting in pairs; no nests found (POBSP, 1965b).
21-22 Mar.	50	No active nests; 12 adults actually observed (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	-	Not mentioned in notes (BSFW, 1966b).
25-27 Sept.	20	3 large young (+21 days); only a few birds seen at sunset (Clapp and Woodward, 1968: 8-9; POBSP, 1966).
1967 21-23 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
28, 30 May-1 June	<50	4 breeders: 2 nests with eggs (POBSP, 1967b).
28-30 Aug.	20	Adults found in pairs near empty burrows (POBSP, 1967a).

Table 42. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1968 22-24 Mar.	50	Ca. 5 pairs actually seen; no evidence of nesting (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	0	(BSFW, 1969a).
31 Mar.- 2 Apr.	0	(BSFW, 1969b).
26-31 May	0	(BSFW, 1969c).
10-19 Sept.	0	(BSFW, 1969d).

SOOTY STORM PETREL

Oceanodroma tristramiStatus

Common breeding species; present possibly late fall, winter, and spring. Nests at North, Seal, and Southeast Islands; known from Grass Island. Maximum POBSP and BSFW estimated population 7,500 in February 1969.

Observations

Willet (ms.) first recorded a nesting colony in March 1913 (see also Bailey, 1956: 60-61). Wetmore (ms.) observed young in April 1923. Richardson (1957: 19) also records it as breeding. POBSP and BSFW personnel found moderate numbers on the four vegetated islands each year since 1963.

Annual Cycle

The Sooty Storm Petrel has a winter-spring breeding season locally (Fig. 58). Adults possibly arrive in late fall, with egg laying probably starting in late December. Young most likely begin hatching in late January; eggs are known as late as mid-March and large young are known as early as early March. Adults probably leave by mid-May, with young fledging by late May.

Ecological Distribution

Sooty Storm Petrels nest at North, Seal, and Southeast Islands, and occur at Grass Island.

Grass Island: POBSP personnel found this species 5 March 1963; none has been observed since.

North Island: Willett (ms.) found a small colony, with young, on 15 March 1913 (see also Bailey, 1956: 60-61). POBSP personnel recorded 50 to 75 nestling and 100-200 adult Sooty Storm Petrels 17-18 March 1965. Two adults were handled and another seen 16 to 17 March 1967 by BSWF personnel.

Seal Island: Wetmore (ms.) observed a few young "Bulwer's Petrels" 27 April 1923. These, however, were probably Sooty Storm Petrel young, for Bulwer's Petrel young do not usually start hatching until mid-summer. A few young and 15 to 25 adults were found 18 to 19 March 1965.

Southeast Island: Young Sooty Storm Petrels were observed by Wetmore (ms.) in April 1923. POBSP and BSWF personnel recorded them nesting each spring since 1963 (Table 43). Although a high of 7,500 adults was estimated during the middle third of February 1969, the average March population (6 visits) is 441, and ranges from 200 to 1,000.

Nest burrows are most abundant in the Bermuda grass (Cynodon) area on the west half of the eastern portion; they are also found in nearby open rubble and Boerhavia, and in an Eragrostis area on the south side of the eastern portion. On the western portion burrows are located in an area of open coral rubble and Coronopus in the west interior.

Banding and Movement

In all, 788 Sooty Storm Petrels have been banded by POBSP and BSWF personnel on three islands (Table 44). Of these, 20 have been recaptured on the atoll (Table 16). No inter-atoll movement is known.

Specimens

POBSP: USNM 496219, 21, ♀♀, moderate light fat, respectively, collected at Southeast 14 March 1964 by B. Amerson; USNM 496220, ♂, light fat, collected at Southeast 14 March 1964 by B. Amerson.

Non-POBSP: USNM 240027, ♀, collected 15 May 1913 by Willett; USNM 289204, skull, collected 27 April 1923 by Wetmore; USNM 300811-12, ♂, ♀, collected 27 April 1923 by Wetmore; USNM 300813, unsexed, collected 26 April 1923 by Wetmore; USNM 300814, ♂, collected 16 May 1923 by Reno.

These are first specimen records.

Table 43. Observations of Sooty Storm Petrels at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	?	Young only (Wetmore, ms.).

Table 43. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1930 23 July- Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	0	None seen, but 2 dead may have been this species (HDFG, 1961).
1963 26 Feb.- 8 Mar.	1,000	Eggs to chicks with well-developed primaries, secondaries, and back feathers (POBSP, 1964d).
18-23, 25 June	0	(POBSP, 1963).
1964 13-14 Mar.	200+	7 chicks (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	0	(POBSP, 1964a).
16 Sept.	0	(BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	600-700	400-500 adults, 200 chicks; 1 burrow with egg (POBSP, 1965b).
21-22 Mar.	700	Nocturnal adults; 5 young seen (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	?	2 chicks (BSFW, 1966a).
20-26 Sept.	0	(BSFW, 1966b).
25-27 Sept.	0	(POBSP, 1966).
1967 21-23 Mar.	200+	Nocturnal adults; <u>ca.</u> 10 chicks: all downy but with primaries just breaking out of sheaths (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	0	(POBSP, 1967b).
28-30 Aug.	0	(POBSP, 1967a).
1969 10-12 Feb.	7,500	Adults, nocturnal only; eggs to large young (BSFW, 1969a).
31 Mar.- 2 Apr.	250	(BSFW, 1969b).
26-31 May	?	2 adults, 1 near fledging young seen (BSFW, 1969c).
10-19 Sept.	0	(BSFW, 1969d).

Table 44. Sooty Storm Petrels banded at Pearl and Hermes Reef

Bander:		POBSP	BSFW	POBSP	BSFW	Period of Survey				
Island	Age-Class	Feb.-				1965				Totals
		Mar. 1963	Mar. 1964	Mar. 1965	Mar. 1965	Total	Mar. 1967	Mar. 1968	Feb. 1969	
Southeast	Adult	438	3	19	121	140	0	19	92	692
	Young	0	31	26	4	30	0	0	1	62
	Total:	438	34	45	125	170	0	19	93	754
Seal	Adult	0	0	5	0	5	0	0	0	5
North	Adult	0		10		10	2		0	12
	Young	0		17		17	0		0	17
	Total:	0		27		27	2		0	29
Total	Adult	438	3	34	121	155	2	19	92	709
	Young	0	31	43	4	47	0	0	1	79
	Total:	438	34	77	125	202	2	19	93	788

RED-TAILED TROPICBIRD

Phaethon rubricaudaStatus

Common breeding species; present from late winter probably through late fall; possible straggler rest of year. Nests at Grass, North, Sand, and Southeast Islands. Maximum POBSP and BSFW population estimate 159 in June 1963.

Observations

Munro (1942: 12) recorded a few tropicbirds, probably Red-tailed Tropicbirds, off Pearl and Hermes Reef on 6 July 1891. Wetmore (ms.) noted nesting in April 1923. Clapp and Woodward (1968: 11) published the first record of nesting Red-tailed Tropicbirds using POBSP data for 1963 to 1967. Tables 45 to 48 present all observations, including POBSP and BSFW for 1963 to 1969.

Annual Cycle

Figure 58 presents the local annual breeding cycle. Adults arrive in early February, with eggs appearing as early as mid-March. Most eggs are probably laid by late April; some are known into August. Young are known as early as early May with peak fledging probably in July and August; some have been recorded in late September. The young generally leave the atoll as soon as they fledge. Adults probably are not present during late fall and early winter.

Ecological Distribution

Red-tailed Tropicbirds are known to breed at Grass, North, Seal, and Southeast Islands, and have been observed flying over Little North.

Grass Island: Nesting Red-tailed Tropicbirds were observed by Wetmore (ms.) in April 1923. Clapp and Woodward (1968: 11) recorded their presence in 1963, 1964, and 1967 from POBSP data. POBSP and BSFW personnel noted the species in 1966, but failed to find it in 1965 and 1968 (Table 45).

Red-tailed Tropicbirds nest under thick vegetation, especially high clumps of Eragrostis. The maximum number of nests in any year was two in 1963.

North Island: Clapp and Woodward (1968: 11) published 1963 to 1965 data on nesting Red-tailed Tropicbirds; their March 1967 data, however, should have referred to Southeast Island. All POBSP and BSFW data are shown in Table 46. The maximum number of nests was 19 in June 1963, which coincided with the peak population of 64. All nests were placed under clumps of Eragrostis or Solanum.

Seal Island: In April 1923 Wetmore (ms.) observed nesting. Clapp and Woodward (1968: 11) published part of the 1963 and 1964 POBSP data. All data are presented in Table 47.

Wetmore's (ms.) 1923 Seal population estimate of 30 Red-tailed Tropic-birds has not been equaled; 20 adults and 6 nests was the largest number present in recent years. Eragrostis clumps are favored vegetation under which this species nests.

Southeast Island: Wetmore (ms.) observed the species in April 1923 and POBSP and BSWF noted its presence from 1963 to 1966 (Clapp and Woodward, 1968: 11). These and other data are presented in Table 48.

March population estimates average 17 and range from 6 to 25. The two June visits have produced the highest populations, 70 and 59. Most nest under large Eragrostis clumps located west of the tidal pools, under low Scaevola, and in and under old oil drums scattered over the island.

Other Islands: Two adults flew over Little North Island on 27 August 1967; no nests or previously used nest sites were found. This species may occasionally fly over the remaining four sandy islands.

Banding and Movements

The POBSP banded 171 Red-tailed Tropicbirds on four islands (Table 49). Of these, 56 have been recaptured on the atoll (Table 16). An adult, sex unknown, banded at Southeast 28 August 1967 (USFW band no. 705-12788) was captured by POBSP personnel 18 May 1969 on Johnston Atoll where it was on an egg.

Specimens

Non-POBSP: USNM 301000-02, ♀♀, collected 27, 27, and 26 April 1923 by Wetmore. These are first specimen records.

Table 45. Observations of Red-tailed Tropicbirds at Grass Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1923 27 Apr.	4	Nesting among high grass clumps (Wetmore, ms.).
1963 5 Mar.	?	Present (POBSP, 1964d).
26-27 June	5	Adults, 2 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 14 Mar.	1	Flying over; no nests (BSFW, 1964a; POBSP, 1964b).
18 Aug.	9	8 adults, 1 nest with large young (Clapp and Woodward, 1968: 11; POBSP, 1964a).
1965 19 Mar.	0	(POBSP, 1965b).

Table 45. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1965 22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	2	Adults; no nests (BSFW, 1966b).
1967 22 Mar.	1	Adult on ground and flying; no nests (Clapp and Woodward, 1968: 11; BSFW, 1967a; POBSP, 1967d).
31 May	0	(POBSP, 1967b).
29 Aug.	2	Adults in courtship display over island; no nests found (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).

Table 46. Observations of Red-tailed Tropicbirds at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 6 Mar.	1	Flying over; no nests (POBSP, 1964d).
23-25 June	64	60 adults; 4 nestlings, 38 breeders; 19 nests: 15 (79%) with eggs, 4 (21%) with young (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 19-20 Aug.	55	40 adults, 32 breeders, 7 non-breeders, 15 young; 16 nests: 1 (6%) with an egg, 5 (31%) with small downy young, 10 (63%) with larger young (Clapp and Woodward, 1968: 11; POBSP, 1964a).
17 Sept.	11	10 adults, 2 breeders, 1 large dependent young (Clapp and Woodward, 1968: 11; BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	5-10	Adults, 4 breeders, 2 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1965b).
1966 22 Sept.	3	Adults flying overhead; no nests (BSFW, 1966b).
1967 16-17 Mar.	0	(BSFW, 1967d).
29-30 Aug.	45+	20 breeders, 15 non-breeders; from large downy young to dependent immatures; sample nest count of 10 nests: 1 (10%) with a large downy young, 9 (90%) with dependent immatures (POBSP, 1967a).

Table 46. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 12 Sept.	4	3 adults, 1 young (BSFW, 1969d).

Table 47. Observations of Red-tailed Tropicbirds at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 27 Apr.	30	15 pairs nesting among high grass clumps (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	20	12 breeders, 8 non-breeders; 6 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 14 Mar.	6	Flying over, courtship behavior; no nests (BSFW, 1964a; POBSP, 1964b).
18 Aug.	17-18	15 adults; 8 breeders; 4 nests: 1 leg, 1 small downy young, 1 medium-sized young, and 1 dependent immature (Clapp and Woodward, 1968: 11; POBSP, 1964a).
1965 18-19 Mar.	0	(POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	6	4 breeders (only 3 adults seen), 2 nearly full-grown young (BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	6	Breeders, 3 nests with eggs (POBSP, 1967b).
29 Aug.	2	Flying over; no nests (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).

Table 48. Observations of Red-tailed Tropicbirds at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 26-28 Apr.	20	[Presumably nesting.] (Wetmore, ms.).

Table 48. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1961 12 Mar.	-	Not mentioned in report (HDFG, 1961).
1963 26 Feb.- 8 Mar.	15	Adults; up to 11 in air at once, some on ground; no eggs (Clapp and Woodward, 1968: 11; POBSP, 1964d).
18-23, 25 June	70	65 adults, 58 breeders; 29 nests counted: 24 (83%) with eggs; 3 (10%) with small downy young; and 2 (7%) with larger young (Clapp and Woodward, 1968: 11; POBSP, 1963).
1964 13-14 Mar.	6	4 breeders; 2 nests with eggs, 1 of which was abandoned; 6 seen flying at once (Clapp and Woodward, 1968: 11; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	18	15 adults, 12 breeders; 6 nests counted: 3 (50%) with eggs, 1 (17%) with a small downy young, 1 (17%) with dependent immature; 1 (17%) with young of unrecorded size (Clapp and Woodward, 1968: 11; POBSP, 1964a).
16 Sept.	15	6 breeders; 3 large young (Clapp and Woodward, 1968: 11; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15-20	8 breeders; 4 nests with eggs (Clapp and Woodward, 1968: 11; POBSP, 1965b).
21-22 Mar.	2	Breeders with an egg (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	12	As many as 12 flying at one time (BSFW, 1966a).
20-26 Sept.	2	Adults; no nests (BSFW, 1966b).
25-27 Sept.	several	Flying over; no nests (POBSP, 1966).
1967 21-23 Mar.	15	Adults; 4 breeders; 2 nests with eggs (BSFW, 1967a; POBSP, 1967d).*
28, 30 May- 1 June	59	56 breeders; 28 nests counted: 25 (89%) with eggs, 3 (10%) with small downy young; 1 nest also empty (POBSP, 1967b).
28-30 Aug.	39	20 breeders; 10 nests counted: 1 (10%) with egg; 3 (30%) with large downy young; 6 (60%) with dependent immatures (POBSP, 1967a).

Table 48. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1968 22-24 Mar.	20-25	Adults; 4 breeders: 2 nests with eggs; at least 11 birds on ground and 9 in air at one time (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	7	Adults; 1 on ground (BSFW, 1969a).
31 Mar.- 2 Apr.	22	11 nests counted (BSFW, 1969b).
26-31 May	40	36 breeding adults; 18 nests counted: 16 (89%) with eggs and 2 (11%) with half-grown young; 2 empty nests (BSFW, 1969c).
10-19 Sept.	6	4 breeders, 2 young (BSFW, 1969d).

*Erroneously listed by Clapp and Woodward (1968: 11) under North Island.

BLUE-FACED BOOBY

Sula dactylatra

Status

Common breeding species; present year-round with possible population decrease in late fall and early winter; occurs and nests on all islands except Sand and Planetree where it roosts only. Maximum POBSP and BSFW population estimate 585 in June 1963.

Observations

Blue-faced Boobies, with nests, were first recorded in March 1913 (Bailey, 1956: 32; Willett, ms.). Richardson (1957: 20) also notes that it breeds here, but gives no data. They have been recorded by all observers, including POBSP and BSFW personnel, since (Tables 50 to 56).

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Some remain on the atoll year-round; numbers increase in winter and decrease in late summer and fall. This fluctuation coincides with the breeding cycle. On the basis of recent data, eggs are laid as early as February; most eggs are laid by the end of March. Although hatching occurs as early as 1 April, most occurs in May and very few eggs remain into late June or July. Fledging takes place in late summer and fall. The total number of active nests in March has ranged from 66 to 109+.

Table 49. Red-tailed Tropicbirds banded at Pearl and Hermes Reef by the POBSP

Island	Age-Class	Period of Survey							Totals	
		Mar. 1963	June 1963	1963 Total	Aug. 1964	Mar. 1965	May 1967	Aug. 1967		1967 Total
Southeast	Adult	7	30	37	5	3	19	9	28	73
	<u>Nestling</u>	<u>0</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>0</u>	<u>0</u>	<u>9</u>	<u>9</u>	<u>13</u>
	Total:	7	32	39	7	3	19	18	37	86
Grass	Adult	0	2	2	1	0	0	0	0	3
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>
	Total:	0	2	2	2	0	0	0	0	4
Seal	Adult	0	8	8	4	0	0	0	0	12
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>
	Total:	0	8	8	6	0	0	0	0	14
North	Adult	0	27	27	10	2		7	7	46
	<u>Nestling</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>11</u>	<u>0</u>		<u>10</u>	<u>10</u>	<u>21</u>
	Total:	0	27	27	21	2		17	17	67
Total	Adult	7	67	74	20	5	19	16	35	134
	<u>Nestling</u>	<u>0</u>	<u>2</u>	<u>2</u>	<u>16</u>	<u>0</u>	<u>0</u>	<u>19</u>	<u>19</u>	<u>37</u>
	Total:	7	69	76	36	5	19	35	54	171

Ecological Distribution

Blue-faced Boobies nest at Bird, Grass, Kittery, Little North, North, Seal, and Southeast Islands; in addition, they roost on Planetree and Sand.

Grass Island: Munter (ms.) first recorded Blue-faced Boobies in February 1916. Galtsoff's 1930 photographs (in litt.) show nesting Blue-faced Boobies at either Grass or Seal. In each year since 1963 (Table 50) except 1966 and 1969, POBSP and BSFW personnel found them nesting in small numbers. The most birds seen were in March 1965; the most nests were found in March 1963. This species nests on the upper sand beaches and eggs are laid in a slight depression in the bare sand.

Kittery Island: POBSP personnel recorded the first Blue-faced Boobies, with 24 nests, in March 1963. Since, they have been recorded each year until 1969 (Table 51). The March population has fluctuated from 22 to 80; March nests have varied from 11 to 32.

Nests are primarily near the perimeters and especially along the northwest edge. A few, however, nest as much as 150 yards inland from the waterline of this large sand island.

Little North Island: Rice (ms. a) first recorded Blue-faced Boobies on 14 October 1957 while flying over the atoll. POBSP and BSFW personnel have subsequently found them nesting each year since March 1963, except in 1968 when the island was not visited (Table 52). A high nest count of 29 was reached in June 1963. In August 1967 a large nocturnal roosting club of 150 formed at dusk.

Nests are placed on the raised, central portion.

North Island: Nesting Blue-faced Boobies first were recorded in March 1913 (Bailey, 1956: 32; Willett, ms.). Rice (ms. a) next noted them in October 1957. None was observed again until March 1963 when POBSP personnel found them nesting. POBSP and BSFW personnel have since found them nesting each year except 1966 (Table 53); no visits were made in 1968. The highest nest count was 29 in June 1963; the highest population estimate, 204, was also made at that time.

This species nests on the upper beach crest on all sides of the island. Nocturnal roosting birds are usually present in a club on the south tip.

Seal Island: Munter (ms.) observed several non-nesting Blue-faced Boobies in February 1916. Galtsoff's photographs (in litt.) show nests in summer 1930. POBSP personnel recorded it nesting each year since 1963 except 1969 (Table 54). March nest counts average 25 and range from 14 to 33. The highest March population estimate of 100-125 in 1965 equals that of May 1967 when 53 nests were counted.

Blue-faced Boobies nest on the upper beach crest of the vegetated portion, but prefer the rock ledge and open, coral rubble of the east portion.

Southeast Island: Blue-faced Boobies with eggs were first noted in February 1916 by Munter (ms.). They have been recorded on all visits since (Table 55). March nest counts made by POBSP and BSFW personnel average 26 and range from 6 to 40. March population estimates average 61 and range from 20 to 100; a peak population of 105 occurred in June 1963.

This species restricts nesting to the coral sand area just above the shoreline. The majority of the population nests on the west shore of the east section, on the seaward rock ledge of the western section, and on the south and southwest beaches of both sections.

Other Islands: A small population nests at Bird Island. Rice (ms. a) noted the species there in October 1957; POBSP and BSFW personnel found them nesting in 1964, 1965, and 1967. The maximum population estimate at Bird is 10 birds (Table 56).

POBSP and BSFW personnel also noted small numbers of roosting Blue-faced Boobies at Sand and Planetree Islands (Table 56).

Banding and Movements

POBSP personnel have banded 587 and BSFW personnel 6 Blue-faced Boobies on 8 islands (Table 57); of these, 249 have been recaptured on the atoll (Table 16). In addition, 3 Blue-faced Boobies--2 banded at Kure and 1 at French Frigate Shoals--were captured at Pearl and Hermes. Furthermore, 12 banded on the atoll moved to other atolls: 5 to Kure, 3 to Laysan, 2 to Lisianski, and 1 each to French Frigate Shoals and Johnston; these data are presented in Appendix Tables 7a and 7b.

Specimens

Non-POBSP: USNM 300951, ♀, collected April 1923 by Wetmore; USNM 300952-53, ♂, ♀, collected 28 and 26 April 1923 by Wetmore. These are first specimen records.

Table 50. Observations of Blue-faced Boobies at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	few	Nesting had not begun (Munter, ms.).
1923 27 Apr.	-	Not mentioned in notes (Wetmore, ms.).
1957 14 Oct.	1	Observed from aerial survey (Rice, ms. a).
1963 5 Mar.	12	Breeding adults; 6 nests (POBSP, 1964d).
26-27 June	15	10 breeders; 5 nests: 1 with a small downy young, 4 with medium-sized or larger young (POBSP, 1963).

Table 50. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1964 14 Mar.	4	2 breeders; 1 nest with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	2	Immatures (POBSP, 1964a).
1965 19 Mar.	15-20	Adults; 4 breeders: 2 nests with eggs (POBSP, 1965b).
22 Mar.	4	Adults on 2 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	-	None mentioned in notes (BSFW, 1966b).
1967 22 Mar.	1	Adult; no nests (BSFW, 1967a; POBSP, 1967d).
31 May	6	4 breeding adults; 2 nests: 1 with a small downy young, 1 with a medium-sized downy young (POBSP, 1967b).
29 Aug.	3	No adults observed but 1 dependent immature seen (POBSP, 1967a).
1968 24 Mar.	4	2 breeders: one nest with egg; 2 other adults flying over (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 51. Observations of Blue-faced Boobies at Kittery Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1963 5 Mar.	48±	<u>Ca.</u> 24 nests with eggs (POBSP, 1964d).
26 June	84	60 adults; 50 breeders: 25 nests counted: 1 (4%) with eggs, 24 (96%) with young (POBSP, 1963).
1964 14 Mar.	70-80	Adults, 64 breeders: 32 nests with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	5	2 adults and 3 immatures seen from Seal I. (POBSP, 1964a).
1965 18 Mar.	25-35	22 breeders; 11 nests with eggs (POBSP, 1965b).

Table 51. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1965 22 Mar.	40	34 breeders; 17 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	11	9 adults and 2 flying immatures (BSFW, 1966b).
1967 22 Mar.	22	Adult breeders; 11 nests (BSFW, 1967a; POBSP, 1967d).
31 May	71	50 adult breeders; 25 nests: 4 (16%) with eggs, 4 (16%) with small downy young, 17 (68%) with medium-sized or large downy young (POBSP, 1967b).
29 Aug.	30	14 adults, 10 immatures counted, some of which were still being fed by their parents (POBSP, 1967a).
1968 24 Mar.	40	32 breeders; 16 nests with eggs counted (BSFW, 1968; POBSP, 1968).

Table 52. Observations of Blue-faced Boobies at Little North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1957 14 Oct.	17	Observed from aerial survey (Rice, ms. a).
1963 6 Mar.	?	Nesting (POBSP, 1964d).
23, 25 June	73	58 breeders; 29 nests counted: 1 (4%) with eggs, 5 (17%) with small young, 23 (79%) with medium- or large-sized downy young (POBSP, 1963).
1964 19 Aug.	11	10 adults; 2 breeders, 1 downy young (POBSP, 1964a).
17 Sept.	75	51 adults counted; 2 immatures, 1 large dependent young (BSFW, 1964b; POBSP, 1964c).
1965 18 Mar.	20-30	18-20 breeders; 9-10 nests with eggs (POBSP, 1965b).
1966 22 Sept.	19	16 adults, 3 flying immatures (BSFW, 1966b).

Table 52. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1967 29 Aug.	200	20 breeders, 10 nests counted: 2 (20%) with eggs; 1 (10%) with a small downy young, 5 (50%) with medium-sized or large downy young, 2 (20%) with large dependent young; 150 in a nocturnal roosting club (POBSP, 1967a).
1969 31 Mar.	25	Breeders, most nests contained eggs (BSFW, 1969b).
12 Sept.	10	Adults (BSFW, 1969d).

Table 53. Observations of Blue-faced Boobies at North Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1913 15 Mar.	100	Breeders; most nests with eggs, 2-3 with newly hatched young (Bailey, 1956: 32; Willett, ms.).
1957 14 Oct.	12	Observed from aerial survey (Rice, ms. a).
1963 6 Mar.	?	Nests with eggs (POBSP, 1964d).
23-25 June	204	175 adults; 58 breeders; 29 nests: 6 (21%) with small downy young, 23 (79%) with medium-sized or larger young (POBSP, 1963).
1964 19-20 Aug.	75+	Adults, some dependent immatures; nocturnal roosting clubs (POBSP, 1964a).
17 Sept.	30	20 adults and 1 flying immature counted (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	100-150	Adults; 32-34 breeders: 16 or 17 nests, all with eggs (POBSP, 1965b).
1966 22 Sept.	6	Adults; no young (BSFW, 1966b).
1967 16-17 Mar.	36+	34 breeders: 16 nests with eggs, 1 with a small young; 20 nocturnal roosting adults (BSFW, 1967d).
29-30 Aug.	60 ⁺	40 adults; 20 immatures, many of them still dependent (POBSP, 1967a).

Table 53. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 31 Mar.	14	6 nests: 4 with eggs and 2 with young (BSFW, 1969b).
12 Sept.	4	Adults (BSFW, 1969d).

Table 54. Observations of Blue-faced Boobies at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	several seen	No nests (Munter, ms.).
1923 27 Apr.	-	Not mentioned in notes (Wetmore, ms.).
1930 July-Aug.	few	Nesting (Galtsoff, photograph).
1963 5 Mar.	?	Nesting on the beach; some with eggs (POBSP, 1964d).
26 June	98	56 breeders; 12 non-breeders; 28 nests counted: 3 (11%) small young, 25 (89%) medium-sized or large downy young (POBSP, 1963).
1964 14 Mar.	70	Adults; 66 breeders: 33 nests, all with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	18	9 adults counted; 12 breeders: 6 dependent immatures counted (POBSP, 1964a).
1965 18-19 Mar.	100-125	Adults only; 28 breeders: 14 nests counted, all with eggs (POBSP, 1965b).
22 Mar.	28	Breeders; 13 adults observed; 14 nests counted, all with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	24	16 adults, 8 immatures capable of flight (BSFW, 1966b).
1967 22 Mar.	46	Breeders; 23 nests counted, all with eggs (BSFW, 1967a; POBSP, 1967d).
31 May	125	106 breeders; 53 nests counted: 34 (64%) with eggs; 4 (8%) with small downy young; 15 (28%) with medium-sized or large downy young (POBSP, 1967b).

Table 54. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 29 Aug.	62	50 flying birds; 24 breeders: 10 large downy young, 2 dependent immatures (POBSP, 1967a).
1969 24 Mar.	60	50 breeders: 25 nests counted, all with eggs (BSFW, 1968; POBSP, 1968).

Table 55. Observations of Blue-faced Boobies at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	70	Eggs (Munter, ms.).
1923 26-28 Apr.	100	50 nesting pairs; 1 nest with an egg (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19).
1957 14 Oct.	8	Observed from aerial survey (Rice, ms. a).
1961 12 Mar.	not abundant	With eggs or small young (HDFG, 1961).
1963 26 Feb.-8 Mar.	100	50 non-breeders; 50 breeders: 25 nests with 1 or 2 eggs (POBSP, 1964d).
18-23, 25 June	105	72 breeders, 33 young; 36 nests counted: 3 (8%) with eggs; 1 (3%) with a recently hatched young; 6 (17%) with small downy young; 26 (72%) with larger young (POBSP, 1963).
1964 13-14 Mar.	70-80	Adults; 35-40 nests contained eggs (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	50	40 adults, 2 dependent immatures, 8 other immatures (POBSP, 1964a).
16 Sept.	20-30	Adults, 1 flying immature; no nests (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	60-70	Adults; 34 breeders: 17 nests counted, all with eggs (POBSP, 1965b).
21-22 Mar.	35	Adults; 24 breeders: 12 nests counted, all with eggs (BSFW, 1965; POBSP, 1965a).

Table 55. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1966 1 Apr.	36	18 nests counted, all with eggs; 1 egg hatching (BSFW, 1966a).
20-26 Sept.	46	40 adults; 12 breeders with dependent young, each capable of flight (BSFW, 1966b).
25-27 Sept.	54	50 adults; 8 breeding adults with 4 dependent immatures (POBSP, 1966).
1967 21-23 Mar.	50	Adults; 32 breeders with 16 nests, all with eggs (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	95	78 breeders, 17 young; 39 nests counted; sample of 22 nests: 5 (23%) with eggs; 1 (5%) with small downy young, 15 (68%) with medium or large downy young, 1 (5%) dependent immature (POBSP, 1967b).
28-30 Aug.	19	15 flying birds; 8 breeders: 2 nests with large downy young, 2 dependent immatures (POBSP, 1967a).
1968 22-24 Mar.	50	44 breeders with 22 nests; 48% of nests with fresh or very slightly incubated eggs, the rest more heavily incubated; 2 pre-nesting pairs (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	30	Adults; 6 breeders: 3 nests with eggs (BSFW, 1969a).
31 Mar.- 2 Apr.	20	Adults; 12 breeders: 6 nests, all with eggs; 4 other pre-laying pairs (BSFW, 1969b).
26-31 May	52	38 breeding adults; 19 nests counted: 5 (26%) with eggs and 14 (74%) with small to large downy young; no nocturnal roosting clubs (BSFW, 1969c).
10-19 Sept.	26	22 adults, 4 young (BSFW, 1969d).

Table 56. Observations of Blue-faced Boobies on other islands at Pearl and Hermes Reef

Date of Survey	Island	Population Estimate	Breeding Status, Remarks, and References
1957 14 Oct.	Bird	4	Observed from aerial survey (Rice, ms. a).
1963 5 Mar.	Bird	6	Roosting (POBSP, 1964d).
1964 14 Mar.	Bird	6	Adults; 3 nests (BSFW, 1967a; POBSP, 1964b).
18 Aug.	Bird	3	2 adults, 1 dependent immature (POBSP, 1964a).
18 Aug.	Sand	9	Adults roosting (POBSP, 1964a).
1965 22 Mar.	Bird	6	Adults; 3 nests with eggs (POBSP, 1965a).
1966 21 Sept.	Planetree	1	Adult roosting (BSFW, 1966b).
1967 31 May	Bird	10	8 adults; 4 nests counted: 2 with eggs, 1 with a small downy young, 1 with a medium-sized downy young (POBSP, 1967b).
29 Aug.	Bird	9	4 adults, 4 subadults, 1 dependent immature roosting (POBSP, 1967a).
29 Aug.	Sand	3	Adults roosting (POBSP, 1967a).

RED-FOOTED BOOBY

Sula sulaStatus

Common breeding species; present year-round with possible population decrease in winter; occurs and nests on the four vegetated islands: Grass, North, Seal, and Southeast. Maximum recent population estimate 200 in February and March 1963.

Observations

Wetmore (ms.) noted Red-footed Boobies in April 1923. Galtsoff (1933: 19) recorded their presence in the summer of 1930. No data exist for the 1940's. Rice (ms. a) noted the species from aerial surveys in the fall of 1957. Woodside and Kramer (HDFG, 1961) found it nesting in spring 1961.

POBSP and BSFW personnel have recorded Red-footed Boobies each year on every visit since February 1963. These observations are presented in Tables 58 to 61.

Table 57. Blue-faced Boobies banded at Pearl and Hermes Reef

Bander:		POBSP	POBSP		POBSP	POBSP	POBSP	BSFW	POBSP		BSFW	
		Period of Survey										
Island	Age-Class	Feb.-		1963 Total	Aug. 1964	Mar. 1965	Sept. 1966	Mar. 1967	Aug. 1967	1967 Total	Mar. 1968	Totals
		Mar. 1963	June 1963									
Southeast	Adult	80	4	84	4	5	0	0	0	0	10	103
	Subad	0	0	0	0	0	0	0	2	2	0	2
	Imm	0	0	0	2	0	3	0	2	2	0	7
	Nestl	0	26	26	0	0	1	0	2	2	0	29
	Total:	80	30	110	6	5	4	0	6	6	10	141
Grass	Adult	6	4	10	0	0		0	0	0	0	10
	Nestl	0	4	4	0	0		0	0	0	0	4
	Total:	6	8	14	0	0		0	0	0	0	14
Seal	Adult	6	17	23	0	52		0	0	0	0	75
	Imm	0	0	0	6	0		0	0	0	0	6
	Nestl	0	27	27	0	0		0	0	0	0	27
	Total:	6	44	50	6	52		0	0	0	0	108
Kittery	Adult	34	9	43		0		0	0	0	0	43
	Nestl	0	23	23		0		0	0	0	0	23
	Total:	34	32	66		0		0	0	0	0	66
North	Adult	0	122	122	7	7		6	0	6		142
	Imm	0	0	0	15	0		0	12	12		27
	Nestl	0	23	23	1	0		0	0	0		24
	Total:	0	145	145	23	7		6	12	18		193
Little North	Adult	0	32	32	0	4			2	2		38
	Imm	0	0	0	0	0			1	1		1
	Nestl	0	23	23	0	0			7	7		30
	Total:	0	55	55	0	4			10	10		69
Sand	Adult	0		0	1							1
Bird	Imm	0		0	1							1
Total	Adult	126	188	314	12	68	0	6	2	8	10	412
	Subad	0	0	0	0	0	0	0	2	2	0	2
	Imm	0	0	0	24	0	3	0	15	15	0	42
	Nestl	0	126	126	1	0	1	0	9	9	0	137
	Total:	126	314	440	37	68	4	6	28	34	10	593

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Some remain on the atoll year-round; numbers decrease in winter and increase in spring, coincidental with breeding. Nests with eggs most likely have been present in January; they have been recorded in late February (1963). Egg laying is heavy from March to June. Hatching is known from late February and March to June and July. Fledglings remain into the fall months. The numbers of March nests have decreased in recent years from a high of 54 in 1963 to 7 in 1969; likewise, May and June nests have decreased from 45 in 1963 to 22 in 1969. Human disturbance may have been a factor in this decrease.

Ecological Distribution

Red-footed Boobies are known from the four permanently vegetated islands. Nesting occurs presently at Grass, North, and Southeast Islands.

Grass Island: POBSP personnel recorded the first Red-footed Boobies in March 1963. In 1964 and 1965 up to four nests were recorded but none has been noted since (Table 58).

Nests are built on the brushy plant, Solanum. In 1965 nests were placed in the middle of the Great Frigatebird colony.

North Island: Rice (ms. a) first recorded Red-footed Boobies from the air in 1957. Small numbers were observed nesting in March 1963 by POBSP personnel. Since then BSFW and POBSP personnel have observed the species on at least 7 of 8 visits (Table 59). The highest population was 30 in March 1965; the largest number of nests was 6 in June 1963. This species nests in the scant Solanum and Scaevola.

Seal Island: POBSP personnel found one Red-foot in June 1963. This species has been observed on only three of ten subsequent visits (Table 60).

Southeast Island: Red-footed Boobies were first recorded by Galtsoff in 1930. His photographs (in litt.) also show it nesting. Rice (ms. a) observed the species in October 1957, and Woodside and Kramer (HDFG, 1961) observed eggs or small young in March 1961. POBSP and BSFW personnel have recorded this species on all 17 survey trips since early 1963 (Table 61).

Both population numbers and nests have irregularly declined from a high in March 1963 to a low in March 1969. May and June populations and nests have also similarly decreased. Human disturbance of birds incubating eggs may have caused this decline. When an incubating Red-foot is flushed, Great Frigatebirds swoop down and break the unattended eggs.

Nests are placed on the low-growing, stunted Scaevola along the leeward beach, and on the matted Solanum, Tribulus, and Sicyos in the interior. Nests are composed of twigs and stems of Boerhavia, Tribulus, Solanum and Sicyos. The weight of the nest material and incubating adult on the low

plants causes many nests to sink to but a few inches off the ground. Nesting of this species at Southeast, as well as on the other three vegetated islands, is definitely restricted because of the lack of elevated nesting sites.

Banding and Movements

Two hundred Red-footed Boobies were banded by POBSP and BSFW personnel on three islands (Table 62). Of these, 118 have been recaptured on the atoll (Table 16). In addition, 10 banded on other atolls have been captured at Pearl and Hermes, 4 from Kure, 2 each from French Frigate Shoals and Johnston, and 1 each from Laysan and Midway. Furthermore, 20 originating from Pearl and Hermes have been captured on other atolls; 8 were from Johnston, 5 from Kure, 4 from Lisianski, 2 from French Frigate Shoals, and 1 from Midway. These data are presented in Appendix Tables 8a and 8b.

Table 58. Observations of Red-footed Boobies at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	-	Not mentioned in notes (Wetmore, ms.).
1963 5 Mar.	1	Adult; no nesting (POBSP, 1964d).
26-27 June	3	Roosting adults; no nests (POBSP, 1963).
1964 14 Mar.	6	Breeders; 3 nests with eggs (BSFW, 1964a; POBSP, 1964b).
18 Aug.	3	1 dependent immature (POBSP, 1964a).
1965 19 Mar.	10-15	Adults; 8 breeders: 4 nests with eggs (POBSP, 1965b).
22 Mar.	4	Breeders; 2 nests with an egg (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	0	(POBSP, 1967b).
29 Aug.	0	(POBSP, 1967a).
1968 24 Mar.	1	Adult flying over; no nests (BSFW, 1968; POBSP, 1968).

Table 59. Observations of Red-footed Boobies at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	-	Not mentioned by Bailey (1956) or Willett (ms.).
1957 14 Oct.	15	In sparse shrubbery, aerial survey data (Rice, ms. a).
1963 6 Mar.	few	With eggs (POBSP, 1964d).
23-25 June	16	12 breeders; 6 nests: 2 (33%) with eggs, 2 (33%) with small downy young, 2 (33%) with large downy young (POBSP, 1963).
1964 19-20 Aug.	9	6 breeders; 3 nests, all with large downy young (POBSP, 1964a).
17 Sept.	20	4 adults and 3 large dependent young (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	30	Adults; 2 nests with eggs (POBSP, 1965b).
1966 22 Sept.	0	(BSFW, 1966b).
1967 16-17 Mar.	4	3 diurnal, 4 nocturnal; 1 empty, active nest and 1 nest with egg (BSFW, 1967d).
29-30 Aug.	6	No diurnal adults; 2 diurnal immatures; 1 nocturnal subadult; 1 nest with large downy young (POBSP, 1967a).
1969 12 Sept.	10	(BSFW, 1969d).

Table 60. Observations of Red-footed Boobies at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	-	None mentioned in notes (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	1	Immature; no nests (POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	0	(POBSP, 1964a).

Table 60. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1965 18-19 Mar.	0	(POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	1	Adult seen; no nests (BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	0	(POBSP, 1967b).
29 Aug.	1	Roosting immature, capable of flight (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).
1969 11 Sept.	19	(BSFW, 1969d).

Table 61. Observations of Red-footed Boobies at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned (Munter, ms.).
1923 26-28 Apr.	?	Presence noted (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19); 10 breeders, 2 almost-fledged immatures, 3 large downy young; nest in <u>Scaevola</u> (Galtsoff photograph).
1957 14 Oct.	6	In sparse shrubbery, aerial survey data (Rice, ms. a).
1961 12 Mar.	not abundant	Eggs or small young (HDFG, 1961).
1963 26 Feb.-8 Mar.	200	96 breeders; 48 nests: 4 (8%) empty but active, 43 (90%) with eggs, 1 (2%) with a recently hatched young; 9 nests (19%) deserted during stay of survey party (POBSP, 1964d).
18-23, 25 June	106+	78 breeders; many non-breeders; 39 nests: 11 (28%) with eggs, 4 (10%) with recently hatched young, 13 (33%) with small downy young, 11 (28%) with larger young (POBSP, 1963).

Table 61. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1964 13-14 Mar.	30-40	Adults; 26-30 breeders; 13-15 nests: some with eggs (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	27	20 adults (12 breeders), 1 subadult; 6 nests: 3 with large downy young, 3 with dependent immatures (POBSP, 1964a).
16 Sept.	30	6 breeders with 3 dependent immatures, 5 flying immatures (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15-20	2 nests; the single chick subsequently died (POBSP, 1965b).
21-22 Mar.	10	4 breeders, 2 nests with eggs, no young (BSFW, 1965; POBSP, 1965a).
1966 20-26 Sept.	110-120	70 diurnal, to 120 nocturnal; about 10 flying immatures; no nests (BSFW, 1966b).
25-27 Sept.	67	4 breeders, 1 large downy young and 1 dependent immature (POBSP, 1966).
1967 21-23 Mar.	85	54 breeders; 27 nests: 8 (30%) empty but active, 9 (33%) with eggs, 4 (15%) with recently hatched young, 5 (19%) with small downy young; about 10 flying immatures (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	60-70	46 breeders; 23 nests: 14 (61%) with eggs, 2 (9%) with small downy young, 2 (9%) with medium-sized young, 4 (17%) with large downy young, 1 (4%) dependent immature (POBSP, 1967b).
28-30 Aug.	85	20 breeders; 10 nests: 1 (10%) with a large downy young, 9 (90%) with large dependent young; many nocturnal roosting adults and subadults (POBSP, 1967a).
1968 22-24 Mar.	50	38 breeders; sample count of 17 nests: 6 (35%) empty but active, 10 (59%) with eggs, and 1 (6%) with a medium-sized downy young; eggs: 5 fresh or slightly incubated, 2 moderately incubated, and 3 heavily incubated (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	20	2 nests (BSFW, 1969a).

Table 61. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 31 Mar.- 2 Apr.	70	14 breeders; 7 nests: 5 (71%) empty but active, 2 (29%) with eggs; 55 birds roosting at night (BSFW, 1969b).
26-31 May	73	60 nocturnal adults; 44 breeding; 22 nests: 1 (5%) empty but active, 8 (36%) with eggs, and 13 (59%) with small downy young (BSFW, 1969c).
10-19 Sept.	63	6 adults and 21 young counted (BSFW, 1969d).

BROWN BOOBY

Sula leucogasterStatus

Common breeding species; present year-round; occurs on most islands but nests only at Southeast. Maximum BSFW and POBSP population estimate 200 in June 1963.

Observations

Brown Boobies were first reported in March 1913 (Bailey, 1956: 32). Wetmore (ms.) found them nesting in April 1923. Rice (ms. a) observed this species on 14 October 1957. POBSP and BSFW personnel have recorded the species on at least 17 of 18 visits to the atoll. All observations are presented in Tables 63 and 64.

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Eggs may be laid as early as January; most are laid in February and March; eggs may be present into August and September. Young begin hatching in late February and March and continue into August and September. Fledging begins in late June and July and continues into winter.

The population fluctuates from year to year. March population estimates average 79 and range from 30+ to 100±. In 1964 and 1967 the population increased later in the year; nest data in these years show a later breeding season.

Ecological Distribution

Brown Boobies are recorded from Grass, Kittery, North, Seal, and Southeast Islands; nesting is known only at Southeast.

Table 62. Red-footed Boobies banded at Pearl and Hermes Reef

Island	Age-Class	POBSP	POBSP	POBSP		POBSP	BSFW	POBSP	POBSP		Totals	
		Mar. 1963	June 1963	1963 Total	Aug. 1964	Mar. 1965	Sept. 1966	Mar. 1967	Aug. 1967	1967 Total		Mar. 1968
Period of Survey												
Feb.-												
Southeast	Adult	120	11	131	4	1	2	0	5	5	2	145
	Subad	2	0	2	1	0	2	0	6	6	0	11
	Imm	0	0	0	3	0	1	0	2	2	0	6
	Nestl	0	6	6	3	0	1	0	7	7	0	17
	Total:	122	17	139	11	1	6	0	20	20	2	179
North	Adult	0	4	4	1	5		1	0	1		11
	Subad	0	0	0	0	0		0	1	1		1
	Imm	0	0	0	0	0		0	2	2		2
	Nestl	0	2	2	3	0		0	1	1		6
	Total:	0	6	6	4	5		1	4	5		20
Grass	Imm	0	0	0	1	0		0	0	0	0	1
Total	Adult	120	15	135	5	6	2	1	5	6	2	156
	Subad	2	0	2	1	0	2	0	7	7	0	12
	Imm	0	0	0	4	0	1	0	4	4	0	9
	Nestl	0	8	8	6	0	1	0	8	8	0	23
	Total:	122	23	145	16	6	6	1	24	25	2	200

Southeast Island: Wetmore (ms.) recorded breeding Brown Boobies in April 1923. Galtsoff¹ (in litt.) photographed them in summer 1930; HFDG personnel noted them in March 1961. POBSP and BSFW personnel have recorded this species breeding each year since 1963 (Table 63). March nest counts from 1963 through 1969 (no count in 1966) average 25 and range from 10 to 36.

Most nests are placed inland on grassy, Sesuvium, or Chenopodium areas; a few are placed on bare areas of coral rubble. Most twig-lined nests are on the eastern section, with a few on the western. The primary area for nocturnal roosting was on the exposed rocks seaward from the western section. Other roosts are on the oil drums, and, on one occasion, the tower.

Other Islands: Brown Boobies have been recorded roosting on the three other vegetated islands, and on sand-covered Kittery (Table 64). North and Seal Islands are the most popular roosting islands; the species has been seen on Grass and Kittery only twice each.

Banding and Movements

POBSP and BSFW personnel banded 313 Brown Boobies (Table 65). Of these, 145 have been recaptured on the atoll (Table 16). In addition, 2 birds originating from Kure and one each from Wake and Laysan have been captured at Pearl and Hermes. Seven banded at Pearl and Hermes have been captured elsewhere: Kure (4), and Laysan, Wake, and the Ellice Islands (1 each). Details on these movements are found in Appendix Tables 9a and 9b.

Specimens

POBSP: USNM 494128, ♀, collected 15 March 1965 on Southeast by Amerman.

Non-POBSP: USNM 300879, ♀, collected 26 April 1923 by Wetmore.

These are first specimen records.

Table 63. Observations of Brown Boobies at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 26-28 Apr.	21	20 breeding adults; 9 nests with eggs, 1 with small young (Wetmore, ms.).
1930 23 July-Aug.	few	Adults with downy young (Galtsoff, photograph).

¹Galtsoff's 1930 photographs show about a dozen nesting Brown Boobies with chicks on the rocky western section of Southeast Island. Another picture, showing an adult with 2 chicks on rocky terrain, is labeled Seal or Grass Island but probably was Southeast (see Fig. 67).

Table 63. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1961 12 Mar.	not abundant	Eggs or small young (HDFG, 1961).
1963 26 Feb.- 8 Mar.	100	60 breeders; some subadults; 30 nests counted in February, 26 of these deserted by March; sample count of 28 nests: 23 (82%) with eggs, 5 (18%) with young (POBSP, 1964d).
18-23, 25 June	195+	144 breeding adults; 72 nests: 19 (26%) with eggs, 11 (15%) with recently hatched young, 12 (17%) with small downy young, 28 (39%) with larger young; 2 (3%) nests with no contents but with attendant adults; many subadults (POBSP, 1963).
1964 13-14 Mar.	30	27 adults, 2 subadults; 10 nests counted: 9 (90%) with eggs, 1 (10%) with young (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	125	74 adult breeders, 37 nests: 8 (22%) with eggs, 29 (78%) with varying sizes of young; about 20 flying immatures (POBSP, 1964a).
16 Sept.	100-125	50 breeders; 6 of 25 nests (24%) with eggs, 19 (76%) with young; 10 flying immatures (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	40-50	24 breeders; 12 nests with eggs (POBSP, 1965b).
21-22 Mar.	44	26 breeders; 13 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	40+	20 nests with eggs to flying young counted (BSFW, 1966b).
25-27 Sept.	120	40 ⁺ breeders; count of 19 nests: 3 (16%) with eggs, 5 (26%) with small young, 11 (58%) with larger young (POBSP, 1966).
1967 21-23 Mar.	50+	42 breeding adults; count of 21 nests: 2 (10%) empty but active, 18 (86%) with eggs, and 1 (5%) with a recently hatched young; several fledged immatures (BSFW, 1967a; POBSP, 1967d).

Table 63. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 28, 30 May- 1 June	139	114 breeders; 57 nests: 32 (56%) with eggs, 16 (29%) with downy young, 9 (15%) with medium-sized or large downy young (POBSP, 1967b).
28-30 Aug.	117	68 breeders; 34 nests: 7 (21%) with eggs; 2 (6%) with recently hatched young; 3 (9%) with small downy young, 10 (29%) with large downy young, 12 (35%) dependent immatures (POBSP, 1967a).
1968 22-24 Mar.	100±	90 breeders; 41 nests: 1 (2%) empty but active, 36 (88%) with eggs, 3 (7%) with recently hatched young, and 1 (2%) with a large downy young (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	40	18 breeders; 9 nests with eggs (BSFW, 1969a).
31 Mar.- 2 Apr.	84	72 breeders; 36 nests: 24 (66%) with eggs, 4 (11%) with an egg and young, and 8 (22%) with 1 young (BSFW, 1969b).
26-31 May	107	82 breeders; 28 nests: 3 (10%) contained eggs, and 25 (90%) contained recently hatched to near-fledging young (BSFW, 1969c).
10-19 Sept.	99	90 adults, 9 young (BSFW, 1969d).

Table 64. Observations of Brown Boobies on other islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	North	2-3	(Bailey, 1956: 32).
1957 14 Oct.	Seal	1	(Rice, ms. a).
14 Oct.	Northeast Reef	2	In flight (Rice, ms. a).
1963 5 Mar.	Seal	?	Roosting on rock ledges; no nests (POBSP, 1964d).
5 Mar.	Grass	1	Roosting on beach; no nesting (POBSP, 1964d).

Table 64. (continued)

Date of Survey	Island	Population Estimate	Breeding Status, Remarks, and References
1963 6 Mar.	North	few	None nesting (POBSP, 1964d).
23-25 June	North	few	Flying by island each day (POBSP, 1963).
26 June	Kittery	1	(POBSP, 1963).
26-27 June	Grass	1	Roosting adult; banded (POBSP, 1963).
1964 14 Mar.	Seal	1	Flying over (BSFW, 1964a; POBSP, 1964b).
18 Aug.	Kittery	1	Seen from Seal Island (POBSP, 1964a).
19-20 Aug.	North	1	Adult; none nesting (POBSP, 1964a).
1965 17-18 Mar.	North	24	Flock of 22 adults and 2 subadults; none nesting (POBSP, 1965b).
18-19 Mar.	Seal	30-35	Birds roosting; none nesting (POBSP, 1965b).
22 Mar.	Seal	1	Roosting immature (BSFW, 1965; POBSP, 1965a).
1967 16-17 Mar.	North	1	In flight (BSFW, 1967d).
22 Mar.	Seal	3	Flying from island; no nests (BSFW, 1967a; POBSP, 1967d).
29-30 Aug.	North	1	Adult roosting on rocks at dusk (POBSP, 1967a).
1968 24 Mar.	Seal	14	13 adults and 1 immature or subadult flying from island; paint on 2 birds indicated they had been on Southeast Island 1-2 days previously (BSFW, 1968; POBSP, 1968).

GREAT FRIGATEBIRD

Fregata minorStatus

Common breeding species; present year-round; nests at Grass, North, and Southeast Islands; in the past bred at Seal Island; occurs at Kittery. Maximum POBSP and BSFW population estimate 890 in March 1965.

Table 65. Brown Boobies banded at Pearl and Hermes Reef

Island	Age-Class	Bander: <u>POBSP</u> <u>POBSP</u> <u>POBSP</u> <u>POBSP</u> <u>BSFW</u> <u>POBSP</u> <u>POBSP</u> <u>POBSP</u>										Totals
		Period of Survey										
		Feb.-										
		Mar. 1963	June 1963	1963 Total	Aug. 1964	Mar. 1965	Mar. 1965	1965 Total	Sept. 1966	Aug. 1967	Mar. 1968	
Southeast	Adult	56	48	104	21	0	1	1	9	11	25	171
	Subad	10	0	10	2	0	0	0	0	0	1	13
	Imm	0	0	0	15	1	0	1	8	11	3	38
	<u>Nestl</u>	<u>0</u>	<u>29</u>	<u>29</u>	<u>22</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>14</u>	<u>22</u>	<u>1</u>	<u>88</u>
	Total:	66	77	143	60	1	1	2	31	44	30	310
Grass	Adult	0	1	1	0	0	0	0		0	0	1
North	Adult	0	0	0	1	1	0	1		0		2
Total	Adult	56	49	105	22	1	1	2	9	11	25	174
	Subad	10	0	10	2	0	0	0	0	0	1	13
	Imm	0	0	0	15	1	0	1	8	11	3	38
	<u>Nestl</u>	<u>0</u>	<u>29</u>	<u>29</u>	<u>22</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>14</u>	<u>22</u>	<u>1</u>	<u>88</u>
	Total:	66	78	144	61	2	1	3	31	44	30	313

Observations

Munro (1942: 12) and Palmer observed a few frigates offshore on 7 July 1891; no landing was made on the atoll. Elschner (1915: 60) in 1912 found some 20 live and 100 dead frigatebirds. A small nesting colony was noted in March 1913 (Bailey, 1956: 32; Willett, ms.). Wetmore (ms.) found Great Frigatebirds, some nesting, on most islands in April 1923. The species was present in large numbers in late summer 1930 (Galtsoff, 1933: 19). Rice (ms. a) counted 770 on an aerial survey in October 1957. Nesting pairs were found by Woodside and Kramer (HDFG, 1961) in March 1961.

POBSP and BSFW personnel recorded Great Frigatebirds on every visit since 1963. Tables 66 to 69 present all observations.

Annual Cycle

The local annual breeding cycle is presented in Figure 58. Great Frigatebirds remain on the atoll throughout the year; numbers are probably highest from late winter until late fall. This coincides with the breeding period. Eggs are laid as early as late February, but most are laid during March. Eggs may be present as late as late June. Hatching probably commences in early May, with most young hatched by late June. Fledging probably starts in October, but most young birds, even though able to fly, probably sit on or near their nest sites into late fall or early December; some may remain into the following breeding season. In March 1965 the three breeding islands yielded 120 to 175 active nests; the number of active March nests probably varies from year to year. The number of young during August and September averaged 118, and ranged from 65 to 187.

Ecological Distribution

Great Frigatebirds are known to nest on Grass, North, Seal, and Southeast Islands, and to roost on Kittery Island.

Grass Island: Wetmore (ms.) noted non-breeding Great Frigatebirds in April 1923. Rice (ms. a) estimated 200 on an aerial survey in October 1957. POBSP and BSFW personnel found them nesting each year (Table 66). Active March nest counts averaged 71, and ranged from 37 to 123. August-September young counts averaged 34, and ranged from 20 to 48. Nests are placed on the dense vegetation, especially Solanum.

North Island: Elschner (1915: 60) noted non-breeding frigatebirds in 1912; frigatebirds were observed nesting in March 1913 (Bailey, 1956: 32; Willett, ms.). Rice (ms. a) found them in October 1957 and POBSP and BSFW personnel have recorded them breeding each year since 1963 when visits were made (Table 67). Only a few nests were found on March visits. August-September young counts averaged 41 and ranged from 14 to 80. All nests were in Solanum in the central and northwestern parts of the island; all nests were within a foot of the ground.

Seal Island: Munter (ms.) noted a few female Great Frigatebirds in February 1916. In April 1923, Wetmore (ms.) recorded this species breeding. POBSP and BSFW personnel found roosting frigatebirds on most visits (Table 68). No evidence of recent nesting was found.

Southeast Island: A few Great Frigatebirds were observed by Munter (ms.) in February 1916. Wetmore (ms.) found them nesting in April 1923. They have been recorded by all subsequent visitors, and have been seen nesting by POBSP and BSFW personnel each year (Table 69).

March nest counts averaged 52, and ranged from 13 to 83. August-September young counts averaged 43, and ranged from 20 to 67. Nests were all built in low, shrubby vegetation, especially Solanum, on the south side of the eastern portion. All nests were within two feet of the ground and consisted of simple platforms of Boerhavia, Solanum, and Tribulus. Roosting birds utilized the low vegetation, the tower, and oil drums scattered about the island.

Other Islands: POBSP personnel recorded one Great Frigatebird at Kittery Island on 18 August 1964. A single female roosted on the Kittery Fish and Wildlife sign 29 August 1967. This species may also fly over or roost on the other four sandy islands. Rice (ms. a) noted 210 Great Frigatebirds in flight over various parts of the atoll on 14 October 1957.

Banding and Movements

POBSP and BSFW personnel banded 539 Great Frigatebirds (Table 70). Of these, 53 were recaptured on the atoll (Table 16). Fifty others were recaptured elsewhere, on Kure (42 birds), Johnston and the Philippines (3 each), and French Frigate Shoals and Lisianski (1 each); data are presented in Appendix Table 10. In addition, two originating elsewhere were captured at Pearl and Hermes. A subadult (USFW band no. 767-45468), sex unknown, banded on Kure 6 May 1966 was captured on Southeast as an adult female 31 May 1967 on a nest containing a naked chick. The other, an adult female (737-37124)* captured 4 October 1966 at Sand Island, Johnston Atoll, was recaptured at Southeast 30 May 1967 on a nest with an egg, and recaptured again at Southeast 3 July 1967 on a nest with a week-old chick.

Specimens

POBSP: USNM 494129, ♂, collected 15 March 1965 on Southeast by Amerman.

Non-POBSP: USNM 300968, ♂, collected 26 April 1923 by Wetmore.

These are first specimen records.

*Great Frigatebird number 737-37124 was originally banded on Southeast 21 June 1963 by POBSP personnel.

Table 66. Observations of Great Frigatebirds at Grass Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	?	Present but not breeding (Wetmore, ms.).
1957 14 Oct.	200	Aerial survey (Rice, ms. a).
1963 5 Mar.	100+	Most breeding birds on nests with eggs (POBSP, 1964d).
26-27 June	350	250 adults, 226 breeders; 113 nests: 17 (15%) with eggs, 43 (38%) with recently hatched and small downy young, 53 (47%) with larger young (POBSP, 1963).
1964 14 Mar.	300	246 breeders; 123 nests, most with eggs, no young (BSFW, 1964a; POBSP, 1964b).
18 Aug.	298	250 adults; 96 breeders, 48 nests with young (POBSP, 1964a).
1965 19 Mar.	250-350	100-150 breeders: 50-75 nests, most with eggs; immatures from the previous breeding season still present (POBSP, 1965b).
22 Mar.	245+	2124 breeders, 62 nests counted with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	87	58 breeders; 29 nests with young (BSFW, 1966b).
1967 22 Mar.	-	Not mentioned in notes (BSFW, 1967a; POBSP, 1967d).
31 May	130+	104 breeders; 52 nests: 27 (52%) with eggs, 14 (27%) with recently hatched young, 10 (19%) with small downy young, and 1 (2%) with medium-sized downy young (POBSP, 1967b).
29 Aug.	60	No adults present; 40 breeders, 20 nests with large downy young (POBSP, 1967a).
1968 24 Mar.	150	86 breeders; 37 nests: 24 (65%) empty but active, 13 (35%) with eggs; 6 partially built nests also seen; many courting males present (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	120	80 breeders; 40 nests with young; no adults seen (BSFW, 1969d).

Table 67. Observations of Great Frigatebirds at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1912 ?	20±	Non-breeding; 100± dead along the beach (Elschner, 1915: 60).
1913 15 Mar.	few	Nesting (Bailey, 1956: 32); small colony (Willett, ms.).
1957 14 Oct.	60	Aerial survey (Rice, ms. a).
1963 6 Mar.	?	Probably more nesting on North than on Southeast (POBSP, 1964d).
23-25 June	280	225 adults; 124 breeders, 62 nests: 7 (11%) with eggs, 34 (55%) with recently hatched and small downy young, 21 (34%) with larger young (POBSP, 1963).
1964 19-20 Aug.	200-350	96 breeders; 48 nests with young; none of the young appeared to be as old as the oldest on Southeast (POBSP, 1964a).
17 Sept.	200	80 counted in air; 72 breeders; 36 large dependent young and 7 flying immatures counted (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	100-200	60-80 breeders: 30-40 nests, many with eggs; some immatures from the previous breeding season still present (POBSP, 1965b).
1966 22 Sept.	63	1 adult seen; 42 breeders: 21 nests counted, each containing 1/4- to 1/2-grown young (BSFW, 1966b).
1967 16-17 Mar.	80	Adults and immatures; 30 breeders: 15 nests with eggs (BSFW, 1967d).
29-30 Aug.	100	28 breeders; 14 nests with large downy young (POBSP, 1967a).
1969 12 Sept.	240	160 breeders, 80 young; only 60 adults seen (BSFW, 1969d).

Table 68. Observations of Great Frigatebirds at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	few	Females (Munter, ms.).
1923 27 Apr.	160	Breeding (Wetmore, ms.).
1963 5 Mar.	?	Roosting (POBSP, 1964d).
26 June	50-75	Roosting; none nesting (POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	75	Roosting; none nesting (POBSP, 1964a).
1965 18-19 Mar.	30-40	Roosting adults; none nesting (POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	6	Adults seen flying over; no nests (BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	1	Adult male roosting on beach (POBSP, 1967b).
29 Aug.	10	Mostly roosting subadults; none nesting (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).

Table 69. Observations of Great Frigatebirds at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	few	(Munter, ms.).
1923 26-28 Apr.	300	Breeders; nests either empty or containing eggs (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19).
1957 14 Oct.	300	Aerial survey (Rice, ms. a).
1961 12 Mar.	not abundant	Nesting on low vegetation (HDFG, 1961).

Table 69. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1963 26 Feb.- 8 Mar.	100	Nesting; sample count of 13 nests: 2 (15%) empty but active, 11 (85%) with eggs; 10 deserted by end of survey period (POBSP, 1964d).
18-23, 25 June	81	58 breeders; 29 nests: 6 (21%) with eggs, 8 (28%) with recently hatched young, 6 (21%) with small downy young, and 9 (31%) with large downy young (POBSP, 1963).
1964 13-14 Mar.	125-150	112 breeders; 56 nests counted; sample count of 27 nests: 7 (26%) empty but active, 20 (74%) with eggs (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	150	130 adults; 40 breeders; 20 nests with half-grown to nearly fledged young (POBSP, 1964a).
16 Sept.	100	15 adults and 20 large young unable to fly counted; 40 breeders (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	200-300	80-120 breeders; 40-60 nests, most containing eggs (POBSP, 1965b).
21-22 Mar.	149	82 breeders; 41 nests, most containing eggs; 8 flying immatures (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	?	Incubating eggs (BSFW, 1966a).
20-26 Sept.	159+	106 breeders; 53 nests with young from 2/3 to almost full grown; an undetermined number of adults roosting at night (BSFW, 1966b).
25-27 Sept.	250	98 breeders; 49 nests with large downy young to well-feathered birds (POBSP, 1966).
1967 21-23 Mar.	96	Breeders; 48 nests: 22 (46%) empty but active; 26 (54%) with eggs (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	270	242 breeders; 121 nests counted; sample count of 40 nests: 30 (75%) with eggs; 3 (8%) with recently hatched young; and 7 (17%) with small downy young (POBSP, 1967b).
28-30 Aug.	100	Flying; 62 breeders; 31 nests counted, all containing large downy young (POBSP, 1967a).

Table 69. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1968 22-24 Mar.	125	102 breeders; 51 nests; sample count of 38 nests: 17 (45%) empty but active, 21 (55%) with eggs; about 85% of eggs fresh or very slightly incubated, 15% slightly incubated (POBSP, 1968).
1969 10-11 Feb.	25	Mostly subadults; 1 displaying adult male (BSFW, 1969a).
31 Mar.- 2 Apr.	176	Breeders; 83 nests counted: 19 (23%) empty but active, 64 (77%) with eggs (BSFW, 1969b).
26-31 May	146	Breeders; 73 nests counted: 55 (75%) with eggs and 18 (25%) with small downy young (BSFW, 1969c).
10-19 Sept.	201	134 breeders; 67 young, only 33 adults seen (BSFW, 1969d).

PINTAILAnas acutaStatus

Very uncommon migrant; one sight record.

Observations

An immature male Pintail was observed at Southeast Island 13 September 1969 by BSFW personnel. Sex and age were verified when the bird was captured on the 14th in an emaciated condition.

This sighting is a new species record for Pearl and Hermes Reef. Pintails are common migrants to the Main Hawaiian Islands, and are known to have occurred at most of the Northwestern Hawaiian Islands as well (Amerson, 1971: 228).

LAYSAN TEALAnas laysanensisStatus

Recent unsuccessful introduction.

Table 70. Great Frigatebirds banded at Pearl and Hermes Reef

		Bander: POBSP POBSP		POBSP POBSP BSW				POBSP BSW POBSP POBSP						
		Period of Survey												
		Feb.-												
Island	Age-Class	Mar. 1963	June 1963	1963 Total	Aug. 1964	Mar. 1965	Mar. 1965	1965 Total	Sept. 1966	Mar. 1967	May 1967	Aug. 1967	1967 Total	Totals
Southeast	Adult	35	18	53	3	4	1	5	7	0	43	5	48	116
	Subad	18	5	23	0	0	1	1	0	0	0	3	3	27
	Imm	0	0	0	1	1	0	1	4	0	0	0	0	6
	Nestl	0	13	13	19	0	0	0	48	0	0	0	0	80
	Total:	53	36	89	23	5	2	7	59	0	43	8	51	229
Grass	Adult	14	39	53	0	0	0	0	0	0	0	0	0	53
	Subad	8	0	8	0	0	0	0	0	0	0	0	0	8
	Nestl	0	53	53	48	0	0	0	0	0	0	0	0	101
	Total:	22	92	114	48	0	0	0	0	0	0	0	0	162
North	Adult	0	39	39	8	9		9		8		6	14	70
	Subad	0	5	5	0	1		1		0		2	2	8
	Imm	0	0	0	0	0		0		0		1	1	1
	Nestl	0	21	21	47	0		0		0		0	0	68
	Unknown	0	0	0	0	0		0		0		1	1	1
	Total:	0	65	65	55	10		10		8		10	18	148
Total	Adult	49	96	145	11	13	1	14	7	8	43	11	62	239
	Subad	26	10	36	0	1	1	2	0	0	0	5	5	43
	Imm	0	0	0	1	1	0	1	4	0	0	1	1	7
	Nestl	0	87	87	114	0	0	0	48	0	0	0	0	249
	Unknown	0	0	0	0	0	0	0	0	0	0	1	1	1
	Total:	75	193	268	126	15	2	17	59	8	43	18	69	539

Observations

Fourteen Laysan Teal--9 female and 5 male--were captured on Laysan 18 March 1967 by BSFW personnel and banded and released on Southeast Island, Pearl and Hermes Reef, 21 March. The first two ducks released, a female and a male, soon took flight, left the atoll, and headed out to sea. The remaining birds were wing-clipped before release.

On 22 March a wing-clipped drake was seen on a sandspit near Seal Island about five miles from the release point. Four others were observed roosting on Southeast Island that night. The following morning a dead drake was found on the north shore of Southeast, reducing the surviving population to 5 drakes and 4 hens.

When the island was visited by POBSP personnel in late May and early June 1967 only one live bird--a drake seen near the lagoon at Southeast--was observed. A dead teal was found on Southeast, reducing the possible number of surviving birds to eight. No teal were seen on any of the other islets visited. BSFW personnel visited Southeast 3 to 9 July 1967 but no biological report was written on this trip. POBSP personnel observed a pair of teal at their campsite on the east point of Southeast Island 28 to 30 August 1967.

On their 27 to 29 September 1967 visit to Southeast, BSFW (1967c) personnel "searched for [a Teal]...nest...[and] found evidence it did not hatch." This refers to a teal nest with an egg, presumably seen at Southeast in July, that did not hatch. They did, however, observe the pair of teal, both of which were banded. No trace of these adults could be found when Southeast was visited in 1968 and 1969 by POBSP and BSFW personnel.

Banding and Movements

The 14 Laysan Teal introduced in 1967 were banded by BSFW personnel. Two were recaptured later in 1967.

LAYSAN RAIL

Porzana palmeriStatus

Unsuccessful introduced species; now extinct.

Observations

In June 1929 Captain William G. Anderson released seven pairs of Laysan Rail* from Sand Island, Midway Atoll, on an island, most likely Southeast, at

*Laysan Rails were native to Laysan Island. In 1891 rails were first transported to Midway, where they multiplied. They probably became extinct on Laysan soon after 1923. The last record of the Laysan Rail occurred at Midway in June 1944, or possibly June 1945 (Baldwin, 1945: 343-348, and 1947: 14-21; Bailey, 1956: 84-90; Ely and Clapp, in press).

Pearl and Hermes Reef (Munro, 1945: 13-14). George Kaufmann, who lived at Midway from 1929 to 1931, visited Pearl and Hermes in 1930 and found no rails; in addition, he saw no live vegetation, and found that storms had left only tall clumps of dead bunchgrass. He saw only 3 or 4 large seabirds during his visit. Since the rail depended upon insects, birds' eggs, and meat scraps for food, Fisher and Baldwin (1945: 11-12) believed it impossible for the transplanted colony to have survived, even if Kaufmann had overlooked living specimens in 1930. Fisher and Baldwin (1946: 8) furthermore, pointed out that Galtsoff (1933: 19) did not observe the Laysan Rail during his late summer 1930 visit to Pearl and Hermes.

GOLDEN PLOVER

Pluvialis dominica

Status

Common migrant; usually found in small to large flocks on beaches and rock outcrops. Most abundant during early spring, late summer, and fall; a few individuals present throughout the year. POBSP and BSFW maximum population estimate 230 in March 1968.

Observations

Willetts (ms.) first recorded the Golden Plover in March 1913. Munter (ms.) next observed a few hundred in February 1916, and Wetmore (ms.) recorded it in April 1923.

POBSP and BSFW personnel have recorded Golden Plovers on most of the islands since 1963. All observations are presented in Tables 71 to 74.

Annual Cycle

Golden Plovers may be present throughout the year. Although observations are lacking for five months, available data indicate a peak population in early spring, late summer, and fall. This fits with the known migration pattern on other Northwestern Hawaiian Islands. The arrival and departure of new birds during migration periods may cause the daily population to vary.

Ecological Distribution

Golden Plovers have been recorded from all four major islands and the two larger sand islands; it has not been recorded at Bird, Planetree, and Sand Islands.

Grass Island: Wetmore (ms.) observed Golden Plovers in 1923. POBSP and BSFW personnel recorded it infrequently and in low numbers (Table 71). This species prefers the beach areas of the island.

North Island: Following Willett's (ms.) 1913 observations, none was recorded until POBSP personnel noted 70 in March 1963. BSFW and POBSP personnel have found it only six times since and in much smaller numbers (Table 72).

Seal Island: Wetmore (ms.) observed a few in 1923. None was recorded again until 1965. Since then POBSP and BSWF personnel have only seen this species on five visits. Usually the population has been low (2-10) but in March 1969 the population was 200 (Table 73). At that time birds were most numerous around the central inlet and around the tidal pools.

Southeast Island: Munter (ms.) first recorded Golden Plovers in 1916. POBSP, BSWF, and HDFG personnel recorded them each year during the 1960's when visits were made (Table 74). March populations average 14, with a range of from 0 to 25; September populations average 81, and range from 18 to 175.

Golden Plovers are usually very abundant around the cove that separates the two sections of the island, and on the seaward rocky ledge of the western section.

Other Islands: POBSP personnel recorded 2 Golden Plovers from Kittery Island 31 May 1967 and 1 from Little North 29 August 1967.

Banding and Movements

Five Golden Plovers have been banded on Southeast Island by POBSP and BSWF personnel: 2 by the POBSP in February 1963; 1 each in March 1964, March 1965, and February 1969 by the BSWF.

POBSP and BSWF personnel have captured one Golden Plover, originally banded on Lisianski, at Pearl and Hermes. The unsexed adult (USFW band no. 662-06097) was banded 11 March 1964 by BSWF personnel, captured at Kure on 1 September 1964, and found dead on Southeast Island 15 March 1965.

Table 71. Observations of Golden Plovers at Grass Island

Date of Survey	Population Estimate	Remarks and References
1923 27 Apr.	few	(Wetmore, ms.).
1963 5 Mar.	few	(POBSP, 1964d).
26-27 June	0	(POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	0	(POBSP, 1964a).
1965 19 Mar.	few	(Clapp and Woodward, 1968: 17; POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966b).

Table 71. (continued)

Date of Survey	Population Estimate	Remarks and References
1967 22 Mar.	2	(Clapp and Woodward, 1968: 17; BSFW, 1967a; POBSP, 1967d).
31 May	1	(POBSP, 1967b).
29 Aug.	0	(POBSP, 1967a).
1968 24 Mar.	5	2 seen in a small flock of turnstones; 3 others seen flying along beach (POBSP, 1968).

Table 72. Observations of Golden Plovers at North Island

Date of Survey	Population Estimate	Remarks and References
1913 15 Mar.	plentiful	(Willett, ms.).
1963 6 Mar.	70	(POBSP, 1964d).
23-25 June	2-3	Daily (Clapp and Woodward, 1968: 17; POBSP, 1963).
1964 19-20 Aug.	0	(POBSP, 1964a).
17 Sept.	1	(Clapp and Woodward, 1968: 17; BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	few	(POBSP, 1965b).
1966 22 Sept.	1	(BSFW, 1966b).
1967 16-17 Mar.	5	(BSFW, 1967d).
29-30 Aug.	10	(POBSP, 1967a).

Table 73. Observations of Golden Plovers at Seal Island

Date of Survey	Population Estimate	Remarks and References
1923 27 Apr.	few	(Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	0	(POBSP, 1963).

Table 73. (continued)

Date of Survey	Population Estimate	Remarks and References
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	0	(POBSP, 1964a).
1965 18-19 Mar.	few	(Clapp and Woodward, 1968: 17; POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	10	(BSFW, 1966b).
1967 22 Mar.	2	(Clapp and Woodward, 1968: 17; BSFW, 1967a; POBSP, 1967d).
31 May	2	(POBSP, 1967b).
29 Aug.	10	Flock of 7 and a single bird flying with turnstones (POBSP, 1967a).
1968 24 Mar.	200	Most numerous around tidal pools (BSFW, 1968; POBSP, 1968).

Table 74. Observations of Golden Plovers at Southeast Island

Date of Survey	Population Estimate	Remarks and References
1916 4 Feb.	few hundred	(Munter, ms.).
1923 26-28 Apr.	few	(Wetmore, ms.).
1930 23 July-Aug.	0	Not mentioned (Galtsoff, 1933).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 25 Feb.-8 Mar.	40	Widespread (Clapp and Woodward, 1968: 16; POBSP, 1964d).
18-23, 25 June	5	Less than 5 daily (Clapp and Woodward, 1968: 16; POBSP, 1963).
1964 13-14 Mar.	3	(Clapp and Woodward, 1968: 16; BSFW, 1964a; POBSP, 1964b).

Table 74. (continued)

Date of Survey	Population Estimate	Remarks and References
1964 16-19 Aug.	1	(Clapp and Woodward, 1968: 16; POBSP, 1964a).
16 Sept.	150	(Clapp and Woodward, 1968: 16; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	few	(Clapp and Woodward, 1968: 16; POBSP, 1965b).
21-22 Mar.	9	(Clapp and Woodward, 1968: 16; BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	0	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	125	(BSFW, 1966b).
25-27 Sept.	175	Most common in area between interior lagoon and south rock ledge (Clapp and Woodward, 1968: 16; POBSP, 1966).
1967 21-23 Mar.	15-20	Along reef and around lagoon (Clapp and Woodward, 1968: 16; BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	27	Actual count; about half molting into or in breeding plumage; all seen in 1 flock near lagoon (POBSP, 1967b).
28-30 Aug.	100	Most foraging in central <u>Sesuvium</u> depressions and in areas of low density grass and <u>Tribulus</u> (POBSP, 1967a).
1968 22-24 Mar.	25	Most in 1 flock on rock ledge west of entrance to interior lagoon (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	10	(BSFW, 1969a).
31 Mar.- 2 Apr.	0	(BSFW, 1969b).
26-31 May	6	Maximum count during survey period (BSFW, 1969c).
10-19 Sept.	18	(BSFW, 1969d).

BRISTLE-THIGHED CURLEW

Numenius tahitiensisStatus

Common migrant; usually recorded in small to medium-sized flocks in rocky areas. Most abundant during late summer and fall; some may be present throughout the year. POBSP and BSWF maximum population estimate 30 in August 1967 and September 1966.

Observations

Bristle-thighed Curlews were first noted in March 1913 (Willetts, ms.). Munter (ms.) observed large numbers in February 1916; Wetmore (ms.) collected one in April 1923.

POBSP, BSWF, and HDFG personnel found this species present each year during the 1960's when visits were made. All observations are presented in Tables 75 and 76.

Annual Cycle

Bristle-thighed Curlews are known from all seasons. Recent March population counts average 19, and range from 3 to 28; September counts average 27, and range from 20 to 30.

Ecological Distribution

The Bristle-thighed Curlew is known only from Grass, North, Seal, and Southeast Islands. These four islands are the only ones in the atoll that are vegetated and have rocky portions.

Southeast Island: Bristle-thighed Curlews are more frequently found at Southeast than on all the other islands combined (Tables 75 and 76). Southeast is much larger than the other islands. Its size and its expansive seaward rock ledges and Sesuvium-lined, brackish tidal pools apparently attract this species, which normally forages in such areas.

Other Islands: Curlews utilize the rocky eastern portions of Seal and Grass. At North they have been seen in the vegetated portion eating caterpillars. On most visits to these islands curlews were not noted.

Banding and Movements

Four Bristle-thighed Curlews were banded on Southeast Island by POBSP and BSWF personnel: 1 in March 1963 (POBSP), 2 in March 1965 (BSWF), and 1 in May 1967 (POBSP).

One adult Bristle-thighed Curlew, originally banded (USFW no. 645-12620) at Southeast 31 May 1967, was captured on Laysan 27 September 1967 by BSWF personnel.

Specimens

Non-POBSP: USNM 301042, ♀, collected at Southeast 19 May 1923 by Wetmore. This is a first specimen record.

Table 75. Observations of Bristle-thighed Curlews at Southeast Island

Date of Survey	Population Estimate	Remarks and References
1916 4 Feb.	50	(Munter, ms.).
1923 26-28 Apr.	?	1 collected 26 April; 1 or more seen 28 April (Wetmore, ms.).
1930 23 July-Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	1	(HDFG, 1961).
1963 26 Feb.-8 Mar.	5	(POBSP, 1964d).
18-23, 25 June	4	(POBSP, 1963).
1964 13-14 Mar.	6	(BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	15	Counted about the inlet (POBSP, 1964a).
16 Sept.	29	Count (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	15	Flock seen 16 March (POBSP, 1965b).
21-22 Mar.	13	(BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	28-30	Maximum of 28 seen at one time; found particularly in <u>Sesuvium</u> areas, especially around interior lagoon (BSFW, 1966b).
25-27 Sept.	27	Most often on tank ledge (POBSP, 1966).
1967 21-23 Mar.	20-25	Flock of 14 on 23 March (BSFW, 1967a; POBSP, 1967d).
28, 30 May-1 June	2-3	(POBSP, 1967b).

Table 75. (continued)

Date of Survey	Population Estimate	Remarks and References
1967 28-30 Aug.	30	Most in 1 flock of 22 birds; appeared to have a distinct preference for the open flat in vicinity of large bank on southeast corner of lagoon and rocky ledge opposite it; isolated individuals frequented the interior; 4-5 in largest interior tidal pool (POBSP, 1967a).
1968 22-24 Mar.	15	Foraged on beaches and interior, but most common on tank ledge where 10 were seen in 1 flock on 23 March (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	20	Feeding along tidal pools (BSFW, 1969a).
31 Mar.- 2 Apr.	3	Count (BSFW, 1969b).
26-31 May	7	Count (BSFW, 1969c).
10-19 Sept.	20	(BSFW, 1969d).

Table 76. Observations of Bristle-thighed Curlews on other islands at Pearl and Hermes Reef

Date of Survey	Island	Population Estimate	Remarks and References
1913 15 Mar.	North	several	(Willett, ms.).
1923 27 Apr.	Seal	?	Presence noted (Wetmore, ms.).
27 Apr.	Grass	?	Presence noted (Wetmore, ms.).
1963 5 Mar.	Seal	9	(POBSP, 1964d).
5 Mar.	Grass	2	(POBSP, 1964d).
23-25 June	North	4	1 eating large caterpillar (POBSP, 1963).
26 June	Seal	2	(POBSP, 1963).
26-27 June	Grass	3	On the reef (POBSP, 1963).
1964 14 Mar.	Seal	16	(BSFW, 1964a; POBSP, 1964b).

Table 76. (continued)

Date of Survey	Island	Population Estimate	Remarks and References
1964 19-20 Aug.	North	2	Count (POBSP, 1964a).
17 Sept.	North	1	Count (BSFW, 1964b; POBSP, 1964c).
1965 18-19 Mar.	Seal	13	1 flock (POBSP, 1965b).
1967 31 May	Grass	1	(POBSP, 1967b).
31 May	Seal	1	(POBSP, 1967b).
29 Aug.	Seal	8	On rocky eastern half (POBSP, 1967a).
1968 24 Mar.	Grass	2	On unvegetated areas (BSFW, 1968; POBSP, 1968).

WANDERING TATTLER

Heteroscelus incanumStatus

Common migrant; usually recorded as singles or in small flocks on beaches. Most abundant during late summer and fall; a few birds probably present throughout the year. POBSP and BSFW maximum population count 29 in May and June 1967.

Observations

Wandering Tattlers were first recorded in April 1923 by Wetmore (ms.). HDFG personnel noted them next in small numbers in March 1961.

POBSP and BSFW personnel on 15 of 18 visits observed the species on all the islands except Planetree and Sand (Tables 77 and 78).

Annual Cycle

Wandering Tattlers can probably be found throughout the year. Observations are lacking for five months, but available data indicate a peak population in summer.

Ecological Distribution

The Wandering Tattler has been sighted on Bird (1 time), Grass (4), Kittery (1), Little North (1), North (5), Seal (9), and Southeast (14) (Tables 77 and 78). This species is commonly seen as singles or in small flocks on the beaches. At Southeast it prefers the western rocky outcroppings, especially along the water's edge. It also frequents the rocky ledges of Grass and Seal Islands.

Specimens

Non-POBSP: USNM 301024-25, ♀, ♂, collected 26 April 1923 by Wetmore. These are first specimen records.

Table 77. Observations of Wandering Tattlers at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Remarks and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	12-15	In a flock on bare rock at the eastern end (Wetmore, ms.).
1930 23 July- Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 26 Feb.- 8 Mar.	3	Not seen some days (Clapp and Woodward, 1968: 19; POBSP, 1964d).
18-23, 25 June	1	(Clapp and Woodward, 1968: 19; POBSP, 1963).
1964 13-14 Mar.	1	(Clapp and Woodward, 1968: 19; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	1-2	(Clapp and Woodward, 1968: 19; POBSP, 1964a).
16 Sept.	5	(Clapp and Woodward, 1968: 19; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	0	(POBSP, 1965b).
21-22 Mar.	1	(Clapp and Woodward, 1968: 19; BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	0	(BSFW, 1966b).
25-27 Sept.	4	Together on northwest beach 25 September (Clapp and Woodward, 1968: 19; POBSP, 1966).
1967 21-23 Mar.	2	(Clapp and Woodward, 1968: 19; BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	25	15 counted; most singly (POBSP, 1967b).

Table 77. (continued)

Date of Survey	Population Estimate	Remarks and References
1967 28-30 Aug.	10-15	Maximum number seen at once: 4; none inland, most foraging on rocky outcroppings (POBSP, 1967a).
1968 22-24 Mar.	0	(BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	2	(BSFW, 1969a).
31 Mar.- 2 Apr.	0	(BSFW, 1969b).
26-31 May	0	(BSFW, 1969c).
10-19 Sept.	1	(BSFW, 1969d).

Table 78. Observations of Wandering Tattlers on other islands at Pearl and Hermes Reef

Date of Survey	Island	Population Estimate	Remarks and References
1923 27 Apr.	Grass	few	(Wetmore, ms.).
27 Apr.	Seal	few	(Wetmore, ms.).
1963 23-25 June	North	1	Daily (Clapp and Woodward, 1968: 19; POBSP, 1963).
26-27 June	Grass	1	(Clapp and Woodward, 1968: 19; POBSP, 1963).
1964 14 Mar.	Seal	1	(Clapp and Woodward, 1968: 19; BSFW, 1964a; POBSP, 1964b).
18 Aug.	Bird	1	(POBSP, 1964a).
19-20 Aug.	North	1-2	(Clapp and Woodward, 1968: 19; POBSP, 1964a).
17 Sept.	Little North	1	(BSFW, 1964b; POBSP, 1964c).
1965 18 Mar.	Little North	1	(Clapp and Woodward, 1968: 19; POBSP, 1965b).
18-19 Mar.	Seal	1	(Clapp and Woodward, 1968: 19; POBSP, 1965b).

Table 78. (continued)

Date of Survey	Island	Population Estimate	Remarks and References
1965 22 Mar.	Seal	1	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	Seal	2	(BSFW, 1966b).
22 Sept.	North	1	(BSFW, 1966b).
1967 16-17 Mar.	North	1	(BSFW, 1967d).
22 Mar.	Kittery	1	(Clapp and Woodward, 1968: 19; BSFW, 1967a; POBSP, 1967d).
22 Mar.	Seal	1	(Clapp and Woodward, 1968: 19; BSFW, 1967a; POBSP, 1967d).
31 May	Seal	3	(POBSP, 1967b).
31 May	Grass	1	(POBSP, 1967b).
29 Aug.	Seal	6	(POBSP, 1967a).
29-30 Aug.	North	3	(POBSP, 1967a).
1968 24 Mar.	Grass	1	On the rocky ledge at southwest corner (BSFW, 1968; POBSP, 1968).
24 Mar.	Seal	5	Foraging on rocky south perimeter (BSFW, 1968; POBSP, 1968).

RUDDY TURNSTONE

Arenaria interpresStatus

Common migrant; usually recorded in flocks on beaches or inland tidal pools. Most abundant during late summer and fall; some birds present throughout the year. POBSP and BSFW maximum population estimate 670 in August 1967.

Observations

Ruddy Turnstones were first observed in March 1913 (Willett, ms.). On 14 October 1957 Rice (ms. a) observed about 30 during an aerial survey but gave no specific locations.

The first published record appeared after POBSP personnel began visiting the atoll in 1963 (Clapp and Woodward, 1968: 20). It has been observed each year since (Tables 79 to 83).

Annual Cycle

Ruddy Turnstones, the predominant shorebird on the atoll, can be found throughout the year. Available data indicate the highest population is in late summer and fall. During the migratory period, the population fluctuates from day to day as birds arrive and depart.

Ecological Distribution

The Ruddy Turnstone is known from all islands. Southeast, the largest island, is by far the most popular; it is commonly seen there in small to large flocks on the beaches, rock flats, and around the central tidal pools.

Banding and Movements

POBSP and BSFW personnel banded 46 Ruddy Turnstones on Pearl and Hermes Reef. The POBSP banded 2 on Seal Island in March 1965, 26 on Southeast Island in February 1963, and 1 on Southeast in August 1964. All banded by the BSFW were on Southeast: 3 in March 1965, 9 in March 1968, and 5 in February 1969.

Three Ruddy Turnstones originally banded on Pearl and Hermes have been recaptured on the atoll (Table 16). In addition, three originally banded by POBSP personnel on the Pribilof Islands have been captured on the atoll; these data are presented in Appendix Table 11.

Specimens

POBSP: USNM 494155, ♀, collected 17 August 1964 on Southeast by Woodward; USNM 497545, ♀, (USFW band # 722-14020), collected 28 May 1967 on Southeast by DeLong.

Non-POBSP: USNM 301061, ♂, collected 26 April 1923 by Wetmore.

Table 79. Observations of Ruddy Turnstones at Grass Island

Date of Survey	Population Estimate	Remarks and References
1923 27 Apr.	?	Present (Wetmore, ms.).
1963 5 Mar.	several	(POBSP, 1964d).
26-27 June	1	On reef (Clapp and Woodward, 1968: 20; POBSP, 1963).
1964 14 Mar.	20	(Clapp and Woodward, 1968: 20; BSFW, 1964a; POBSP, 1964b).
18 Aug.	3	(POBSP, 1964a).
1965 19 Mar.	50-60	Flock of 39, as well as scattered individuals (POBSP, 1965b).

Table 79. (continued)

Date of Survey	Population Estimate	Remarks and References
1965 22 Mar.	80	(Clapp and Woodward, 1968: 20; BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	30	(BSFW, 1966b).
1967 22 Mar.	80	1 flock (BSFW, 1967a; POBSP, 1967d).
31 May	2	(POBSP, 1967b).
29 Aug.	35	Flocks of 13 and 18 (POBSP, 1967a).
1968 24 Mar.	100	Seen along beach perimeter and in sand and rubble at east end; flocks of 30, 32, 40, and 18; some probably seen in more than 1 flock (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 80. Observations of Ruddy Turnstones at North Island

Date of Survey	Population Estimate	Remarks and References
1913 15 Mar.	common	(Willett, ms.).
1963 23-25 June	12-15	Daily (Clapp and Woodward, 1968: 20; POBSP, 1963).
1964 19-20 Aug.	0	(POBSP, 1964a).
17 Sept.	75	Count (Clapp and Woodward, 1968: 20; BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	75-100	(Clapp and Woodward, 1968: 20; POBSP, 1965b).
1966 22 Sept.	40	(BSFW, 1966b).
1967 16-17 Mar.	75	(BSFW, 1967d).
29-30 Aug.	60	51 counted (POBSP, 1967a).
1969 12 Sept.	35	(BSFW, 1969d).

Table 81. Observations of Ruddy Turnstones at Seal Island

Date of Survey	Population Estimate	Remarks and References
1923 27 Apr.	?	Presence noted (Wetmore, ms.).
1963 5 Mar.	?	Presence noted (POBSP, 1964d).
26 June	0	(POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	9	Count (POBSP, 1964a).
1965 18-19 Mar.	?	Presence noted (POBSP, 1965b).
22 Mar.	50	In 1 flock (Clapp and Woodward, 1928: 20; BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	30	(BSFW, 1966b).
1967 22 Mar.	45	In 1 flock (BSFW, 1967a; POBSP, 1967d).
31 May	5	(POBSP, 1967b).
29 Aug.	65	Flock of 50 around tidal pools (POBSP, 1967a).
1968 24 Mar.	35-40	Most numerous around tidal pools (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 82. Observations of Ruddy Turnstones at Southeast Island

Date of Survey	Population Estimate	Remarks and References
1916 4 Feb.	large numbers	(Munter, ms.).
1923 26-28 Apr.	common	(Wetmore, ms.).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 26 Feb.- 8 Mar.	150-200	Throughout the island; roosting on rocky reefs nocturnally (Clapp and Woodward, 1968: 20; POBSP, 1964d).

Table 82. (continued)

Date of Survey	Population Estimate	Remarks and References
1963 18-23, 25 June	15-20	Daily (Clapp and Woodward, 1968: 20; POBSP, 1963).
1964 13-14 Mar.	200	Count of 178 (Clapp and Woodward, 1968: 20; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	75	In several flocks along south shore and around interior lagoon (Clapp and Woodward, 1968: 20; POBSP, 1964a).
16 Sept.	500	(Clapp and Woodward, 1968: 20; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	few	(POBSP, 1965b).
21-22 Mar.	86	Count (Clapp and Woodward, 1968: 20; BSFW, 1965; POBSP, 1965a).
1966 20-26 Sept.	200	(BSFW, 1966b).
25-27 Sept.	350	75-100 new birds arrived on night of 26 Sept. (Clapp and Woodward, 1968: 20; POBSP, 1966).
1967 21-23 Mar.	100+	Scattered around (Clapp and Woodward, 1968: 20; BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	116	Count (POBSP, 1967b).
28-30 Aug.	500	Flocks of 50-70 frequently flushed from rock ledges on south side; <u>ca.</u> 30 birds feeding at once in central tidal pools; flocks of 10-30 frequented beaches (POBSP, 1967a).
1968 22-24 Mar.	100	Feeding in small numbers in interior tidal pools but most numerous on rocky ledges along south side (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	50	Common along beaches (BSFW, 1969a).
31 Mar.- 2 Apr.	26	Count (BSFW, 1969b).
26-31 May	16	Maximum number during survey (BSFW, 1969c).
10-19 Sept.	225	(BSFW, 1969d).

Table 83. Observations of Ruddy Turnstones on other islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Remarks and References</u>
1964 18 Aug.	Bird	3	(POBSP, 1964a).
18 Aug.	Sand	2	(POBSP, 1964a).
18 Aug.	Kittery	1	Seen from Seal Island (POBSP, 1964a).
17 Sept.	Little North	15	Count (Clapp and Woodward, 1968: 20; BSFW, 1964b; POBSP, 1964c).
1965 18 Mar.	Little North	1	(Clapp and Woodward, 1968: 20).
18 Mar.	Kittery	30	Flock flying over island (Clapp and Woodward, 1968: 20; POBSP, 1965b).
22 Mar.	Planetree	1	(Clapp and Woodward, 1968: 20; BSFW, 1965; POBSP, 1965a).
22 Mar.	Sand	4	(Clapp and Woodward, 1968: 20; BSFW, 1965; POBSP, 1965a).
22 Mar.	Bird	0	1 long-dead banded turnstone found (BSFW, 1965; POBSP, 1965a).
22 Mar.	Kittery	1	(Clapp and Woodward, 1968: 20; BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	Kittery	3	(BSFW, 1966b).
1967 22 Mar.	Kittery	15	(Clapp and Woodward, 1968: 20; BSFW, 1967d).
29 Aug.	Little North	10	Count; 1 flock (POBSP, 1967a).
1968 24 Mar.	Kittery	17	1 flock (BSFW, 1968; POBSP, 1968).

SNIPE species

Capella sp.Status

Accidental; one sight record.

Observations

An unusual shorebird, identified by Kridler (BSFW, 1964a) as a Common (Wilson's) Snipe, was seen on Southeast Island 13 March 1964. Both Common Snipe, Capella gallinago delicata, and Pintail Snipe, Capella stenura, have been collected on Kure Atoll (Clapp and Woodward, 1968: 21). This is a first sight record for Pearl and Hermes.

KNOT

Calidris canutusStatus

Accidental; one specimen record.

Observations

A very fat female Knot, collected 15 March 1965, constitutes the only record; it was the first specimen taken in the entire Hawaiian area. Knots have been seen at Midway and Oahu (Clapp and Woodward, 1968: 21-22); one was recently collected on Oahu (Clapp and Pyle, 1968: 38).

It was first seen in the afternoon as it fed along the Sesuvium-bordered edge of a small brackish pond in the center of Southeast Island. The bird was very wary, flushing when approached; it was later observed on rocky rubble with a flock of Golden Plovers. After flushing once more, the Knot returned to the margin of the central pond where it was collected (POBSP, 1965b).

Specimens

POBSP: USNM 494130, ♀, collected on Southeast Island 15 March 1965 by Clapp.

SANDERLING

Crocethia albaStatus

Common migrant; usually recorded in singles or in small flocks on beaches. A few birds present throughout the year. POBSP and BSFW maximum population count 7 in March 1963 and August 1967.

Observations

HDFG personnel first recorded Sanderlings in March 1961. POBSP and BSFW personnel recorded them in 1963, and have found them each year except 1966. Clapp and Woodward (1968: 22) reported some of these observations; all Sanderling observations are presented in Tables 84 to 86.

Annual Cycle

Sanderlings can be found on the atoll in small numbers throughout the year. March population counts average 5 and range from 3 to 7.

Ecological Distribution

Sanderlings have been recorded on Grass (7 times), Kittery (2), Little North (1), North (1), Seal (3), and Southeast (9). This species is commonly seen as singles, or in small flocks on beaches, where it frequently associates with Ruddy Turnstone.

Table 84. Observations of Sanderlings at Grass Island

Date of Survey	Population Estimate	Remarks and References
1963 5 Mar.	1-2	(Clapp and Woodward, 1968: 22; POBSP, 1964d).
26-27 June	0	(POBSP, 1963).
1964 14 Mar.	3	(Clapp and Woodward, 1968: 22; BSFW, 1964a; POBSP, 1964b).
18 Aug.	2	(Clapp and Woodward, 1968: 22; POBSP, 1964a).
1965 19 Mar.	3	In flock of turnstones at southwest corner (Clapp and Woodward, 1968: 22; POBSP, 1965b).
22 Mar.	3	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	0	(POBSP, 1967b).
29 Aug.	2	(POBSP, 1967a).
1968 24 Mar.	3	Feeding with turnstones along sandy strip connecting 2 halves of island (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 85. Observations of Sanderlings at Southeast Island

Date of Survey	Population Estimate	Remarks and References
1923 26-28 Apr.	0	(Wetmore, ms.).
1961 12 Mar.	small numbers	(HDFG, 1961).
1963 26 Feb.- 8 Mar.	3	(Clapp and Woodward, 1968: 22; POBSP, 1964d).
18-23, 25 June	0	(POBSP, 1963).
1964 13-14 Mar.	2	(Clapp and Woodward, 1968: 22; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	0	(POBSP, 1964a).
16 Sept.	0	(BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	1	On several occasions (Clapp and Woodward, 1968: 22; POBSP, 1965b).
21-22 Mar.	1	(Clapp and Woodward, 1968: 22; BSFW, 1965; POBSP, 1965a).
1966 25-27 Sept.	0	(POBSP, 1966).
1967 21-23 Mar.	2	(BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	0	(POBSP, 1967b).
28-30 Aug.	2-3	Most frequently along sandy north beach, also foraging along east shore of lagoon; 1 feeding inland in a tidal pool (POBSP, 1967a).
1968 22-24 Mar.	1-2	Most frequently on sandy north beach and spit connecting two halves of island; 1 on southwest beach (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	0	(BSFW, 1969a).
31 Mar.- 2 Apr.	0	(BSFW, 1969b).
26-31 May	0	(BSFW, 1969c).
10-19 Sept.	2	(BSFW, 1969d).

Table 86. Observations of Sanderlings on other islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Remarks and References</u>
1963 5 Mar.	Seal	few	(Clapp and Woodward, 1968: 22; POBSP, 1964d).
1964 19-20 Aug.	North	1	(Clapp and Woodward, 1968: 22; POBSP, 1964a).
17 Sept.	Little North	1	(BSFW, 1964b; POBSP, 1964c).
1965 22 Mar.	Kittery	1	(BSFW, 1965; POBSP, 1965a).
1967 22 Mar.	Seal	1	In flock of Ruddy Turnstones (Clapp and Woodward, 1968: 22; BSFW, 1967a; POBSP, 1967d).
29 Aug.	Seal	2	Foraging around tidal pools (POBSP, 1967a).
1968 24 Mar.	Kittery	1	In flock of turnstones (BSFW, 1968; POBSP, 1968).

SHARP-TAILED SANDPIPER

Erolia acuminataStatus

Accidental; two specimen records.

Observations

On 27 September 1966 POBSP personnel collected two female Sharp-tailed Sandpipers at the pond on the east side of Southeast Island. Both had extremely heavy fat deposits and were not molting. These birds, and one seen the preceding day, comprise the only records. The species is also known from Laysan, Midway, and Kure (Clapp and Woodward, 1968: 23-24; POBSP, 1966).

Specimens

POBSP: USNM 497216-17, ♀♀, collected on Southeast Island 27 September 1966 by Lewis.

DUNLIN

Erolia alpina sakhalinaStatus

Accidental; one specimen record.

Observations

A very fat male Dunlin, with medium to heavy body molt, was collected by POBSP personnel on 15 March 1965 as it fed in a small Sesuvium-bordered brackish pond on Southeast Island. This specimen, the only record for Pearl and Hermes Reef, was subsequently identified as Erolia alpina sakhalina by Mrs. Roxie C. Laybourne of the U.S. Fish and Wildlife Service. Dunlins have also been recorded from Kure, Laysan, and Midway (Clapp and Woodward, 1968: 24; POBSP, 1965b).

Specimens

POBSP: USNM 494127, ♂, collected on Southeast Island 15 March 1965 by Clapp.

RUFF

Philomachus pugnaxStatus

Accidental; one specimen record.

Observations

A Ruff was seen on the morning of 28 August 1967 as it fed with several Ruddy Turnstones in the largest tidal pool in the Sesuvium-filled depression on Southeast Island. It was subsequently collected and found to be an immature bird, not molting, with light fat deposits (POBSP, 1967a).

This is the third record from the Central Pacific. Ruffs have been reported from Kure Atoll (Clapp and Woodward, 1968: 24-25) and from Johnston Atoll (Shelton, in prep.).

Specimens

POBSP: USNM 543042, immature ♀, collected 28 August 1967 on Southeast by Clapp. This is a first specimen record.

RED PHALAROPE

Phalaropus fulicariusStatus

Accidental; one specimen record.

Observations

On 22 March 1967 POBSP personnel found the dried carcass of a Red Phalarope in a stand of wild mustard in the interior of Southeast Island (POBSP, 1967d). This is the only record from Pearl and Hermes Reef; this species has also been taken from Kure and the main Hawaiian area (Clapp and Woodward, 1968: 25).

Specimens

POBSP: USNM 497293, collected 22 March 1967 on Southeast Island by Hackman.

RING-BILLED GULL

Larus delawarensis

Status

Straggler; one specimen and one sight record.

Observations

A Ring-billed Gull in second winter plumage was collected 5 March 1963 on Little North Island by POBSP (1964d) personnel. This specimen constituted the first record from Pearl and Hermes Reef; this species is also known from Kure Atoll (Clapp and Woodward, 1968: 25; Sibley and McFarlane, 1968: 315).

On the afternoon of 23 March 1967 BSFW personnel reported a Ring-billed Gull flying off Southeast Island. This bird was not seen by the POBSP observer present on the survey and no corroboratory details of the sighting are available (BSFW, 1967a; POBSP, 1967d).

Specimens

POBSP: USNM 493342, unsexed, collected 5 March 1963 on Little North Island by Sibley.

HERRING GULL

Larus argentatus vegae

Status

Rare visitor; two specimen records.

Observations

The only specimens of Herring Gulls were collected by POBSP personnel in 1963: a young male in first winter plumage was shot on Southeast on 27 February; a young female in first nuptial plumage was shot on Kittery on 5 March (POBSP, 1964d).

Both specimens were subsequently referred to Dr. Lester L. Short, Jr., of the American Museum of Natural History, and Mrs. Roxie C. Laybourne, of the U.S. Fish and Wildlife Service, for subspecific determination. Both were identified as Larus argentatus vegae, a race that breeds in Siberia.

Herring Gulls have also been recorded from Kure, Laysan, Lisianski, and Midway (Clapp and Woodward, 1968: 26; Sibley and McFarlane, 1968: 315).

Specimens

POBSP: USNM 493346, ♂, collected on Southeast Island 27 February 1963 by Sibley; USNM 493347, ♀, collected on Kittery Island 5 March 1963 by Sibley.

GLAUCOUS-WINGED GULL

Larus glaucescensStatus

Irregular visitor; four specimens and three sight records from February, March, and April.

Observations

The first record was the carcass of an adult bird collected on Seal Island 27 April 1923 by Alexander Wetmore (Clapp and Woodward, 1968: 27).

Another Glaucous-winged Gull, one of four gulls present on the atoll, was shot on Southeast Island by POBSP personnel on 26 February 1963 (Sibley and McFarlane, 1968: 315; POBSP, 1964d). This bird was a male in first nuptial plumage.

POBSP personnel saw two more Glaucous-winged Gulls on the southern tip of North Island on 17 March 1965. An unsuccessful attempt was made to collect these gulls which flushed and flew to nearby Little North Island where they were collected the following morning (Sibley and McFarlane, 1968: 315; POBSP, 1965b). Both specimens were young birds in first nuptial plumage. Their stomachs contained fish remains; one contained a gastropod and several foraminifera as well.

Specimens

POBSP: USNM 493345, ♂, collected 26 February 1963 on Southeast by Sibley. USNM 494131-32, ♀♀, collected 18 March 1965 on Little North by Hoeman.

Non-POBSP: USNM 489330, collected 27 April 1923 on Seal by Wetmore.

BLACK-LEGGED KITTIWAKE

Rissa tridactylaStatus

Rare visitor; three specimen records.

Observations

On 15 March 1965 POBSP personnel found the remains of two Black-legged Kittiwakes on Southeast Island: one nearly whole carcass of an adult in winter plumage, and a wing from an immature bird on the beach near the western

end of the island. Partial remains of another immature bird were found 19 March 1965 on the north beach of Grass Island near the vegetation line (POBSP, 1965b). Markings on the wings of the two immature birds indicate that both were less than two years old.

Black-legged Kittiwakes have been reported from Kure and Laysan (Clapp and Woodward, 1968: 28-29).

Specimens

POBSP: USNM 496205 and 497375, adult and immature respectively, collected 15 March 1965 on Southeast Island by Stadel; USNM 496206, immature, collected 19 March 1965 on Grass Island by Wirtz.

GRAY-BACKED TERN

Sterna lunata

Status

Common breeding species; present spring, summer, and early fall; absent rest of year. Nests during spring and summer on Grass, Seal, and Southeast Islands; occasionally seen on other islands. POBSP and BSFW maximum population estimate 1,860[±] in May and June 1967.

Observations

Wetmore (ms.) recorded nesting Gray-backed Terns in April 1923. Anderson (1954: 82) saw a colony during his late 1920's visits. On 14 October 1957, while surveying the atoll from the air, Rice (ms. a) noted several uniformly gray terns in bright sunlight flying near White Terns over the large protruding rocks at the northeastern end of the reef. He tentatively identified these as Blue-gray Noddies (Procelsterna cerulea), but they were more likely to have been Gray-backed Terns. Woodside and Kramer (HDFG, 1961) found Gray-backed Terns in March 1961. POBSP and BSFW personnel recorded nesting gray-backs each year since 1963. All Gray-backed Tern observations are presented in Tables 87 to 89.

Annual Cycle

The local annual breeding cycle is shown in Figure 58. Adults return as early as early February after being absent during late fall and winter. Eggs are known as early as mid-March; peak egg laying must be during April, and eggs are known as late as mid-August. Hatching began as early as late April in 1923, and flying immatures were seen in late May 1969. Most young fledge by late August and September.

Ecological Distribution

Gray-backed Terns nest on Grass, Seal, and Southeast Islands, and have been seen at Bird, Kittery, and North Islands.

Grass Island: POBSP personnel first recorded a few adults but no nests in May 1967. Several unfledged young were found on the north beach and in low vegetation in August 1967; no nests were seen then. BSFW and POBSP personnel again noted a few adults in March 1968 (Table 89).

Seal Island: Wetmore (ms.) found nesting Gray-backed Terns in April 1923. Clapp and Woodward (1968: 29) recorded their presence in 1963 to 1965 and 1967 from POBSP data. Table 87 presents all observations.

March maximum population estimates average 32, and range from 0 to 300. The peak population estimate was 350 \pm , which coincided with the peak nest count of 175 \pm . This species nests on the rocky east portion of the island; a few birds may nest on the ground in the vegetated west portion.

Southeast Island: Although Wetmore (ms.) noted breeding Gray-backed Terns in April 1923 and Woodside and Kramer (HDFG, 1961) found some in March 1961, Clapp and Woodward (1968: 29) first published records of their occurrence using 1963 to 1967 POBSP data. All observations are presented in Table 88.

March maximum population estimates average 209, and range from 30 to 600. The peak population of 1,500 occurred in May and June 1967; coinciding with this was a peak nest estimate of 450. Nests are found on both east and west portions. On the east portion small groups of nests are scattered about the vegetated portions, around the central tidal pools, and along the perimeter of the northeast, south, and southeast beaches. Some nests are found around the perimeter of vegetation on the west portion. Usually, the nests are on the edge of the Sooty Tern sub-colonies.

Other Islands: POBSP personnel have recorded Gray-backed Terns roosting on Bird and Kittery Islands and flying over North Island (Clapp and Woodward, 1968: 29). These data are presented in Table 89.

Banding and Movements

POBSP and BSFW personnel banded 338 Gray-backed Terns (Table 90). Eleven have been recaptured on the atoll. There have been no interisland movements involving Pearl and Hermes Reef.

Specimens

Non-POBSP: USNM 300633-34, σ , f , collected 27 April 1923 by Wetmore; USNM 300635-36, σ , σ , collected 26 April 1923 by Wetmore. These are first specimen records.

Table 87. Observations of Gray-backed Terns at Seal Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	300	Breeders with eggs and newly hatched young (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26 June	120-140	100 adults, 20-40 young (Clapp and Woodward, 1968: 29; POBSP, 1963).
1964 14 Mar.	4-5	No nests (Clapp and Woodward, 1968: 29; BSFW, 1964a; POBSP, 1964b).
18 Aug.	15	All adults; no evidence of breeding (Clapp and Woodward, 1968: 29; POBSP, 1964a).
1965 18-19 Mar.	200-300	Roosting at night; 40-100 breeders; 20-50 nests with eggs; just beginning to lay (Clapp and Woodward, 1968: 29; POBSP, 1965b).
22 Mar.	150	Mostly adults present nocturnally; 4 nests with eggs (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	7+	5 flying immatures and 2 large dependent young (BSFW, 1966b).
1967 22 Mar.	25	Roosting on rocky area at north end; no nests found (Clapp and Woodward, 1968: 29; BSFW, 1967a; POBSP, 1967d).
31 May	350+	Breeders; 175 ⁺ nests: most with eggs, a few with chicks up to 10 days old (POBSP, 1967b).
29 Aug.	10	1 adult; 9 fledged immatures (POBSP, 1967a).
1968 24 Mar.	100	Adults; 30-40 breeders; 15-20 nests with eggs (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	12	(BSFW, 1969d).

Table 88. Observations of Gray-backed Terns at Southeast Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.		Not mentioned in report (Munter, ms.).

Table 88. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1923 26-28 Apr.	600	Breeders, with eggs or newly hatched young (Wetmore, ms.).
1961 12 Mar.	?	Apparently just arriving; on the ground but no eggs yet laid (HDFG, 1961).
1963 26 Feb.- 8 Mar.	200	Adults; 1st arrived 3 March; gradually increased in numbers throughout survey; no eggs laid (Clapp and Woodward, 1968: 29; POBSP, 1964d).
18-23, 25 June	1,040	1,000 adults, most breeding birds on eggs, but 40 pairs with small chicks (Clapp and Woodward, 1968: 29; POBSP, 1963).
1964 13-14 Mar.	20-30	Adults on the ground; no nests (Clapp and Woodward, 1968: 29; BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	850-950	600-700 adults; 500 breeders with 250± near-fledged young, a few 1/4-grown chicks, 1 egg (Clapp and Woodward, 1968: 29; POBSP, 1964a).
16 Sept.	50±	40 adults, <u>ca.</u> 10 flying immatures (Clapp and Woodward, 1968: 29; BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	500-600	Adults on ground but no eggs (Clapp and Woodward, 1968: 29; POBSP, 1965b).
21-22 Mar.	300	Adults, no nests (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	10	8 adults, 2 flying immatures (BSFW, 1966b).
25-27 Sept.	47	40 adults, 14± breeders, <u>ca.</u> 7 flying immatures still being fed (Clapp and Woodward, 1968: 29; POBSP, 1966).
1967 21-23 Mar.	75	Adults on ground by day, but no nests with eggs (Clapp and Woodward, 1968: 29; BSFW, 1967a; POBSP, 1967d).
28-30 May- 1 June	1,500	900-1,000 breeders; 450 nests: mostly with fresh eggs, 10-day-old chicks (POBSP, 1967b).

Table 88. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 28-30 Aug.	75	50 breeders, <u>ca.</u> 25 dependent young, some flying (POBSP, 1967a).
1968 22-24 Mar.	100-150	Adults on ground by day, but no eggs (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	50	Adults, nocturnal only (BSFW, 1969a).
31 Mar.- 2 Apr.	190	Breeding adults, 95 nests (BSFW, 1969b).
26-31 May	150	100 on east portion, 50 on west; eggs to flying young (BSFW, 1969c).
10-19 Sept.	4	(BSFW, 1969d).

Table 89. Observations of Gray-backed Terns on other islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 23-25 June	North	1-2	Flying over daily (Clapp and Woodward, 1968: 29; POBSP, 1963).
1964 18 Aug.	Bird	1	(Clapp and Woodward, 1968: 29; POBSP, 1964a).
18 Aug.	Kittery	1	Seen from Seal Island (Clapp and Woodward, 1968: 29; POBSP, 1964a).
19-20 Aug.	North	6	Adults flying over (Clapp and Woodward, 1968: 29; POBSP, 1964a).
1967 31 May	Grass	6-8	Adults flying over; their behavior indicated nests but none was found (POBSP, 1967b).
29 Aug.	Grass	7-10	1 unfledged young; remainder were recently fledged young (POBSP, 1967a).
1968 24 Mar.	Grass	4-6	On the ground but no eggs (BSFW, 1968; POBSP, 1968).

Table 90. Gray-backed Terns banded at Pearl and Hermes Reef

Island	Age- Class	Bander: POBSP		POBSP			POBSP		BSFW	Totals	
		Period of Survey									
		Feb.- Mar. 1963	June 1963	1963 Total	Aug. 1964	Sept. 1964	1964 Total	Mar. 1965	Mar. 1965		1965 Total
Southeast	Adult	13	200	213	27	0	27	0	47	47	287
	Young	0	1	1	44	1	45	0	0	0	46
	Total:	13	201	214	71	1	72	0	47	47	333
Seal	Adult	0	0	0	0		0	5	0	5	5
Total		13	201	214	71	1	72	5	47	52	338

SOOTY TERN

Sterna fuscataStatus

Abundant breeding species; present usually from mid-February through early October; absent during rest of year. Nests on the ground at Seal and Southeast Islands; known from Grass and North Islands. Maximum POBSP and BSFW population estimate 80,000+ in May and June 1967.

Observations

Munro (1942: 12), on 6 July 1891, was the first to see a few Sooty Terns off Pearl and Hermes Reef; he did not go ashore. One was seen by Willett in mid-March 1913 (Bailey, 1956: 32). Wetmore (ms.) observed Sooty Terns with eggs in April 1923, and Galtsoff (1933: 19) noted them in large numbers in late summer 1930. Richardson (1967: 24) noted that they bred here, but gave no data. POBSP, HDFG, and BSFW personnel observed this species in 1961, and 1963 to 1969. All observations are summarized in Tables 91 to 93.

Annual Cycle

The local breeding cycle is illustrated in Figure 58. Adults begin to arrive in mid-February; after swirling overhead diurnally and alighting on the ground nocturnally during late February and March, they usually settle on the ground both day and night by late March. Egg laying probably commences in mid-April and reaches a high from late April to mid-May. Hatching may be as early as mid-May, but reaches a high in late May and early June. Fledging occurs by mid-August; some young remain into late September, with a few stragglers remaining into October. The majority of adults and immatures usually departs by mid-September.

The Sooty Tern is the most abundant species at Pearl and Hermes Reef. The peak population occurs in late May and June: 80,000 in 1967 and 40,000 in 1963 and 1969. The peak nest counts also occur during May-June: 38,700+ in 1967, ca. 20,000 in 1963 and 1969.

Ecological Distribution

The Sooty Tern nests at Seal and Southeast Islands, and is known from Grass and North Islands.

Seal Island: Wetmore (ms.) first observed nesting Sooty Terns in April 1923. POBSP and BSFW personnel observed nesting in most years since 1963 (Table 91).

The highest population was 1,000 to 1,500 roosting birds in August 1964. Nine nests were found in late May 1967, and 50 in late June 1963. Nest sites in 1967 were in an area of Tribulus, Boerhavia, Lepidium, and Eragrostis.

Southeast Island: Southeast is the major breeding island at Pearl and Hermes Reef. Wetmore (ms.) first recorded nesting in April 1923. Galtsoff

(1933: 19) published the first record of their occurrence from observations taken in late summer 1930. Since 1963 BSWF and POBSP personnel observed nesting Sooty Terns each year (Table 92). A peak population of 30,000 occurred in May and June 1967.

Nests are usually scattered over the entire island. The May and June 1967 population contained definite subpopulations, groups of birds that had begun to nest at different times; some of these subpopulations were isolated, but others were contiguous. Density of nesting birds and age of eggs (using flotation method) were determined for all the subpopulations. From this, the entire island's Sooty Tern population size was calculated (Table 94).

Other Islands: Willett observed a Sooty Tern at North Island in March 1913 (Bailey, 1956: 32). In recent years, POBSP and BSWF personnel noted sooties flying over in very small numbers. From 2 to 20 individuals were also recorded over Grass Island by POBSP and BSWF personnel (Table 93). Sooty Terns probably fly over all the other islands in the atoll during the spring and summer.

Banding and Movements

POBSP personnel banded 4,327 Sooty Terns (Table 95). Of these, 343 have been recaptured on the atoll (see Table 16); another 8 have been captured (2 each) at Lisianski, Midway, Kure, and Johnston. Furthermore, 14 Sooty Terns, 7 from Johnston, 5 from Kure and 1 each from Lisianski and Midway, have been captured on Pearl and Hermes. Data are presented in Appendix Tables 12a and 12b.

Specimens

POBSP: USNM 494934, ♀, collected on Southeast Island 17 August 1964 by Marshall (USFW 753-24662).

Non-POBSP: USNM 300543-44, ♂, ♂, collected 26 April 1923 by Wetmore.

These are first specimen records.

Table 91. Observations of Sooty Terns at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1923 27 Apr.	300	Adults, few with eggs (Wetmore, ms.).
1963 5 Mar.	?	Flying over (POBSP, 1964d).
26 June	100	Adult breeders, 50 nests with eggs (POBSP, 1963).
1964 14 Mar.	0	(BSWF, 1964a; POBSP, 1964b).

Table 91. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1964 18 Aug.	1,000-1,500	Adults roosting on ground (POBSP, 1964a).
1965 18-19 Mar.	200-300	Swirling overhead at night; none on ground (POBSP, 1965b).
22 Mar.	100	Flying over by day (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	18	Adult breeders; 9 on eggs among nesting Gray-backed Terns (POBSP, 1967b).
29 Aug.	0	(POBSP, 1967a).
1968 24 Mar.	2	Adults flying offshore (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	20	(BSFW, 1969d).

Table 92. Observations of Sooty Terns at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	200	Adults, few with eggs (Wetmore, ms.).
1930 23 July-Aug.	large numbers	(Galtsoff, 1933: 19).
1961 12 Mar.	?	Apparently just arriving; none on ground (HDFG, 1961).
1963 26 Feb.-8 Mar.	5,000-7,000	Adults, on ground by day and night; no eggs (POBSP, 1964d).
18-23, 25 June	40,000	Most with eggs but a few recently hatched young present; very few with large chicks (POBSP, 1963).

Table 92. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1964 13-14 Mar.	2,000	Adults: about 300 in air at noon, 700 at dark; about 1,000 on ground at night with more overhead; no eggs (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	25,000	Most with fledged young but some unfledged birds; 6,000 [±] young (POBSP, 1964a).
16 Sept.	5,000- 6,000	Adults and immatures, some still incapable of flight (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	1,500- 2,000	Adults flocking overhead, some on ground by day; no eggs (POBSP, 1965b).
21-22 Mar.	3,000- 4,000	Adults, some on ground by day, many more at night; no eggs (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	thousands	Circling; few on ground (BSFW, 1966a).
20-26 Sept.	?	Few heard overhead at night; 1 emaciated immature incapable of flight (BSFW, 1966b).
25-27 Sept.	5	Few flying over (POBSP, 1966).
1967 21-23 Mar.	2,000- 5,000	About 2,000 in swirling flocks by day, 5,000 at night; 1,200 on ground at night; no eggs (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	80,000	38,707 nests; fresh eggs to recently hatched young; most with moderately or heavily incubated eggs; estimate based on density-area calculations (POBSP, 1967b).
28-30 Aug.	650	Adults and flying young; some 200 young; most fledged but some still being fed by parents (POBSP, 1967a).
1968 22-24 Mar.	1,000	Swirling by day, numbers increasing towards dusk; about 150 on the ground by day; no eggs (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	5	Heard calling at night, none on ground (BSFW, 1969a).
31 Mar.- 2 Apr.	3,000	Adults; numbers increased towards evening; no nests (BSFW, 1969b).

Table 92. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1969 26-31 May	40,000	A number of sub-colonies: the great majority (20,000) with eggs or recently hatched young; 1 small colony of about 400 contained near-fledged chicks; sample nest counts in 2 other colonies suggest 87% eggs and 13% young (BSFW, 1969c).
10-19 Sept.	1,570	(BSFW, 1969d).

Table 93. Observations of Sooty Terns on other islands at Pearl and Hermes Reef

Date of Survey	Island	Population Estimate	Breeding Status, Remarks, and References
1891 6 July	Offshore	few	(Munro, 1942: 12).
1913 15 Mar.	North	1	(Bailey, 1956: 32).
1963 23-25 June	North	few	Flying over (POBSP, 1963).
26-27 June	Grass	several	Flying over (POBSP, 1963).
1964 18 Aug.	Grass	20	Flying around (POBSP, 1964a).
19-20 Aug.	North	few	Flying over (POBSP, 1964a).
1967 16-17 Mar.	North	2	Flew over by day (BSFW, 1967d).
29-30 Aug.	North	several	Flew over late afternoon and evening (POBSP, 1967a).
1968 24 Mar.	Grass	2	Adults flying offshore (BSFW, 1968; POBSP, 1968).

Table 94. Density and status of subpopulations of Sooty Terns on Southeast Island, 28, 30 May-1 June 1967

Subpopulation	Area*	Density**	Nest Sites	Status
1	4,815	400	15,600	18-day eggs and hatchlings
2	1,780	441	5,231	1-day eggs to hatchlings

Table 94. (continued)

Subpopulation	Area*	Density**	Nest Sites	Status
3	2,676	576	6,621	8-14-day eggs
4	500	900	978	fresh eggs
5	675	575	1,124	14-day eggs to hatchlings
6	6,075	576	1,514	14-day eggs to hatchlings
7	2,774	575	5,835	14-day eggs to hatchlings
8	800	576	1,800	7-day eggs to hatchlings
Total	20,095	577***	38,703	1-day eggs to hatchlings

*Subpopulation area in square yards.

**Mean individual territory sizes in square inches.

***Average.

Table 95. Sooty Terns banded at Pearl and Hermes Reef by the POBSP

Island	Age-Class	Period of Survey				Totals
		June 1963	Aug. 1964	Mar. 1965	Aug. 1967	
Southeast	Adult	1,300	2,000	0	25	3,325
	Young	0	1,000	0	0	1,000
	Total:	1,300	3,000	0	25	4,325
Seal	Adult	0	0	2	0	2
Total		1,300	3,000	2	25	4,327

BROWN NODDY

Anous stolidus

Status

Common breeding species; present year-round, lower numbers in late fall and winter; breeding season may extent throughout the year. Nests at

Grass, North, Seal, and Southeast Islands; roosts on most other islands. Maximum POBSP and BSWF population estimate 8,395 in August 1964.

Observations

Brown Noddies, with eggs and young, were first recorded in March 1913 (Bailey, 1956: 32). Munter (ms.) found non-nesting flocks of various sizes in February 1916, and Wetmore (ms.) noted nesting birds in April 1923. In recent years, Rice (ms. a) saw low numbers in October 1957 and POBSP and BSWF personnel observed nesting Brown Noddies each year since 1963. All observations are presented in Tables 96 to 99.

Annual Cycle

The local annual breeding cycle is shown in Figure 58. Observations and interpolations of data reveal that eggs and young are known or are possible throughout the year. Eggs and young are, however, probably found infrequently during the late fall and winter. In most years the first eggs are laid in March; eggs have occurred as late as September. Although a few young occur in March, most usually hatch in April and continue into August. Fledging is known from spring months, but is more common in August and September.

The peak population in recent years has been in August: 8,395 in 1964, and 4,010 in 1967. The peak nest count was in May and August 1967, 663 \pm and 990, respectively.

Ecological Distribution

Brown Noddies nest at Grass, North, Seal, and Southeast Islands, and are known to roost at Kittery, Little North, and Sand Islands.

Grass Island: Munter (ms.) first recorded small numbers in February 1916. Wetmore (ms.) found them nesting in April 1923. POBSP and BSWF personnel observed this species each year (Table 96).

March population estimates average 10, and range from 0 to 30, whereas August and September estimates average 872, and range from 0 to 3,000. A peak nest count of 263 was recorded in May 1967. Nests are located in the vegetated west part of the island. They are found on the ground in association with Tribulus, Boerhavia, and Solanum. Roosting birds utilize the northwest beach and the rocky east portion of the island.

North Island: Eggs and young were first recorded in March 1913 (Bailey, 1956: 32). POBSP and BSWF personnel observed them on each visit made since 1963 (Table 97).

March population estimates are few, but range from 0 to 200. Peak populations of adults and flying immatures as well as a peak nest count occurred in August 1964; September estimates ranged from 45 to 1,300. Nesting occurs over the entire vegetated part of the island; nests are

concentrated, however, around the periphery, particularly along the north-east and northwest beaches. Nests are located on the ground, primarily in association with Tribulus, Boerhavia, and Lepturus; smaller numbers are in areas of Eragrostis, Sicyos, and Solanum.

Seal Island: Brown Noddies were first observed by Munter (ms.) in February 1916. Wetmore (ms.) found the species nesting in April 1923. POBSP and BSFW personnel recorded Brown Noddies each year except 1969 (Table 98).

March maximum population estimates averaged 58, and ranged from 0 to 150; August and September estimates ranged from 0 to 1,500. A peak nest count of 200 was made in May 1967. Nests are mostly in the areas of low Tribulus and Lepturus bordering higher growth on the west half of the island. Roosting birds primarily utilize the beaches and the east rocky area.

Southeast Island: Munter (ms.) found large flocks in February 1916. Some 30 nesting pairs, with almost fledged young, were recorded by Wetmore (ms.) in April 1923. POBSP and BSFW personnel observed nesting Brown Noddies each year (Table 99).

March maximum population estimates averaged 37, and ranged from 10 to 100; June maximum estimates averaged 500; August and September maximum estimates averaged 2,040, and ranged from 50 to 2,600.

Nests are located on both halves of the island. On the east portion, nests are around the Scaevola on the perimeter of the island, in Sesuvium around the central tidal pools, in the Tribulus and Lepturus areas south and east of those pools, and a few are in association with Solanum. On the west portion, this species nests in association with Tribulus, Lepturus, Brasica, and a few with Solanum and Boerhavia. In May and June 1967 30 nests were examined; all contained Tribulus, 96 percent contained grass, 70 percent feathers, 67 percent bones, and 27 percent seaweed (Table 100).

Other Islands: POBSP personnel observed 20 roosting at Sand Island 18 August 1964. Three were noted flying over Little North Island 22 September 1966 by BSFW personnel. At Kittery Island 29 August 1967, 10, including 4 to 5, mostly immatures, roosting on the beach and 2 flying offshore, were estimated by POBSP personnel. Brown Noddies probably also roost on the two other sandy islands.

Banding and Movements

The POBSP and BSFW banded 695 Brown Noddies (Table 101). Of these, 17 have been recaptured on the atoll (Table 16); 2 others travelled to other atolls. One (USFW 723-65116) unsexed adult banded on Southeast 20 June 1963 was found dead at Sand Island, Johnston Atoll 24 February 1964. The other (723-63485), also an unsexed adult, was banded on North Island 24 June 1963 and was captured at Sand Island, Johnston 11 February 1966. Still another Sooty Tern (753-24902) banded as an adult on Sand Island, Johnston Atoll 20 December 1963 was collected at North Island 19 August 1964.

Specimens

POBSP: USNM 494154, ♀, collected 19 August 1964 on North Island by Woodward (USFW 753-24902).

Non-POBSP: USNM 300502-03, ♂, ♂, collected 26 April 1923 by Wetmore.

These are first specimen records.

Table 96. Observations of Brown Noddies at Grass Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	small number	No eggs or young (Munter, ms.).
1923 27 Apr.	40	Breeders, young well grown (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26-27 June	500 [±]	200 [±] nests with eggs; few young (POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	3,000	Adults, not breeding (POBSP, 1964a).
1965 19 Mar.	15-20	12 breeders; 6 nests with eggs (POBSP, 1965b).
22 Mar.	10	1 nest with egg and 1 with a very small chick (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	90	Adults and flying immatures; no nests (BSFW, 1966b).
1967 22 Mar.	2	Breeding adults; 1 nest with egg (BSFW, 1967a; POBSP, 1967d).
31 May	650	526 breeders; 263 nests counted: 95% with eggs, 5% with small downy young; ca. 100 birds roosting on beach (POBSP, 1967b).
29 Aug.	400	44 breeders; 22 nests; sample count of 20 nests: 10 (50%) with eggs, 4 (20%) with small downy young, and 6 (30%) with near-fledging young (POBSP, 1967a).
1968 24 Mar.	30	Mostly roosting birds; 1 medium-sized downy young (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 97. Observations of Brown Noddies at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	small colonies	Eggs and young (Bailey, 1956: 32).
1963 6 Mar.	0	(POBSP, 1964d).
23-25 June	1,000-2,500	All nests with eggs except 1 with small downy young (POBSP, 1963).
1964 19-20 Aug.	3,150	2,500 adults; 600 breeders; 300 nests: 50% with eggs, 50% with dependent young; also 500 flying immatures, many non-breeding adults (POBSP, 1964a).
17 Sept.	400	A few eggs and large dependent young, but most young already fledged (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	100-200	28-38 breeders; <u>ca.</u> 10-15 nests with eggs, 1 with small downy young, and 3 with near-fledging young (POBSP, 1965b).
1966 22 Sept.	45	33 adults, 12 flying immatures (BSFW, 1966b).
1967 16-17 Mar.	38-50	34 breeders; 17 nests: 13 with eggs, 3 recently hatched young, and 1 nearly fledged young (BSFW, 1967d).
29-30 Aug.	750	700 flying birds; 300 breeders; 100 nests with eggs and 50 with unfledged young; sample count of 53 nests: 36 (68%) with eggs, 16 (30%) with small downy young, and 1 (2%) with a near-fledging young (POBSP, 1967a).
1969 12 Sept.	1,300	(BSFW, 1969d).

Table 98. Observations of Brown Noddies at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	100	Not nesting (Munter, ms.).
1923 27 Apr.	60	Breeders; young well grown (Wetmore, ms.).
1957 14 Oct.	24	Aerial survey (Rice, ms. a).
1963 5 Mar.	0	(POBSP, 1964d).

Table 98. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 26 June	150-200	150+ breeders, <u>ca.</u> 75 nests with eggs and few young (POBSP, 1963).
1964 14 Mar.	30	Roosting; no nests (BSFW, 1964a; POBSP, 1964b).
18 Aug.	500-1,500	Roosting; no nests (POBSP, 1964a).
1965 18-19 Mar.	50-100	Roosting; no nests (POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	300	Flying about; no nests (BSFW, 1966b).
1967 22 Mar.	9	Roosting on beach; no nests (BSFW, 1967a; POBSP, 1967d).
31 May	400 [±]	Breeders; <u>ca.</u> 200 nests, most with eggs but few with young (POBSP, 1967b).
29 Aug.	250	36 breeders; 18 nests, 6 with eggs and 12 with small downy young; most of population roosting on beaches or reef rocks (POBSP, 1967a).
1968 24 Mar.	150	<u>Ca.</u> 15 on the ground in beach rubble and <u>Lepturus</u> , but no nests; most birds roosting on reef rocks (BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 99. Observations of Brown Noddies at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	large flocks	None nesting (Munter, ms.).
1923 26-28 Apr.	60	Breeders; some near-fledging young (Wetmore, ms.).
1930 23 July-Aug.	-	Not mentioned in report (Galfsoff, 1933).
1961 12 Mar.	-	Not mentioned in report (HDFG, 1961).

Table 99. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 26 Feb.- 8 Mar.	20	Mostly diurnal; no nests (POBSP, 1964d).
18-23, 25 June	500 [±]	300 breeders; an estimated 150 nests with eggs, only 1 young (POBSP, 1963).
1964 13-14 Mar.	20-30	Diurnal; no nests (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	725	600 adults, 100 immatures; 250 breeders; 100 nests with eggs and 25 with small chicks (POBSP, 1964a).
16 Sept.	600-800	100+ breeders; 50 nests with eggs, also flying young (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	20-50	4-8 breeders; 2-3 nests with eggs (POBSP, 1965b).
21-22 Mar.	15	8 breeders; 3 nests with eggs, 1 with chick (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	-	Not mentioned in field notes (BSFW, 1966b).
25-27 Sept.	50	6 breeders; 1 small chick, 2 fully-feathered dependent immatures; no eggs (POBSP, 1966).
1967 21-23 Mar.	9	Roosting nocturnally; not nesting (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	400-500	Breeders; most birds on eggs, many of which were pipped; a small proportion (10%) with 1-5-day-old chicks (POBSP, 1967b).
28-30 Aug.	2,600	1,600 breeders; 600 dependent young; 200 nests with eggs (POBSP, 1967a).
1968 22-24 Mar.	50-100	Very few breeding: 2 nests, 1 contained an egg (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	10	No evidence of nesting (BSFW, 1969a).
31 May- 2 Apr.	10	(BSFW, 1969b).

Table 99. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1969 26-31 May	10	1 adult found brooding a small chick; rest of birds apparently non-breeding (BSFW, 1969c).
10-19 Sept.	630	(BSFW, 1969d).

Table 100. Nest material used by Brown Noddies at Southeast Island, 28, 30 May - 1 June 1967

<u>Tribulus</u>	Grass	Feathers	Bones	Seaweed	No. Nests
x	x	x	x	x	2
x	x	x	x		12
x	x	x		x	4
x		x		x	1
x	x		x		6
x	x	x			2
x	x			x	1
x	x				2
<hr/>					
No. Nests: 30	29	21	20	8	30

BLACK NODDY

Anous tenuirostrisStatus

Common breeding species; present throughout the year, but population probably low during late fall and winter. Nests at North and Southeast Islands; previously nested at Grass and Seal Islands; roosts at Sand Island. Maximum POBSP and BSFW population estimate 4,300 in August 1967.

Observations

Black Noddies, with eggs and young, were first recorded in March 1913 (Bailey, 1956: 32). Wetmore (ms.) found them nesting in April 1923, and Rice (ms. a) observed a few in October 1957. POBSP and BSFW personnel recorded Black Noddies nesting in most years. Tables 102 to 105 present all observations.

Annual Cycle

The local annual breeding cycle is illustrated in Figure 58. Observations indicate nesting may occur year-round although most nesting occurs during the summer and fall. Eggs are known as early as mid-March and as

Table 101. Brown Noddies banded at Pearl and Hermes Reef

228

Island	Age- Class	Period of Survey								Totals
		Bander: POBSP		1963 Total	BSFW		1964 Total	POBSP		
		Feb.- Mar. 1963	June 1963		Mar. 1964	Aug. 1964		Mar. 1965	Aug. 1967	
Southeast	Adult	2	100	102	6	0	6	0	26	134
	Young	0	0	0	0	0	0	0	3	3
	Total:	2	100	102	6	0	6	0	29	137
Grass	Adult	0	100	100	0	0	0	0	0	100
Seal	Adult	0	0	0	0	0	0	5	0	5
North	Adult	0	246	246		0	0	2	88	336
	Young	0	0	0		100	100	5	12	117
	Total:	0	246	246		100	100	7	100	453
Total	Adult	2	446	448	6	0	6	7	114	575
	Young	0	0	0	0	100	100	5	15	120
	Total:	2	446	448	6	100	106	12	129	695

late as late August. Young may hatch as early as mid-April, but most hatch in late May and June, and probably into July. Fledging normally occurs in summer and fall, but may take place in spring.

March maximum population estimates for the atoll averaged 430, and ranged from 25 to 900+; May-June population counts averaged 2,023, and ranged from 1,400 to 3,070; August and September maximum counts averaged 1,761, and ranged from 1,036 to 4,300. The peak nest count of 55 to 75 occurred in June.

Ecological Distribution

Black Noddies nest at North and Southeast Islands; roosting birds are known from Sand Island.

Grass Island: Wetmore (ms.) found nesting Black Noddies with young in April 1923. No evidence of nesting was found by POBSP and BSWF personnel since 1963 (Table 102). Recent population estimates ranged from 0 on several visits to 400 in September 1969.

North Island: Small colonies of Black Noddies with eggs and young were first recorded in March 1913 (Bailey, 1956: 32). POBSP and BSWF personnel observed evidence of breeding in 1963, 1964, and probably 1967. Most counts were low. All observations are given in Table 103.

A peak population of 1,100 roosting Black Noddies was present in August 1967. Nests are placed in Eragrostis clumps. Most roosting birds utilize the beaches.

Seal Island: Wetmore (ms.) first recorded breeding Black Noddies with young in April 1923. POBSP and BSWF observers noted this species roosting but not nesting on six visits since 1963. The roosting population has varied from 1 in March to 700 in August; roosting occurs on the beaches.

Southeast Island: Breeding Black Noddies were first noted by Wetmore (ms.) in April 1923. POBSP and BSWF personnel observed this species breeding each year. All observations are presented in Table 105.

March maximum population estimates averaged 174, and ranged from 40 to 400; May and June estimates ranged from 1,000 to 3,000; August and September estimates averaged 1,354, and ranged from 550 to 3,000. A high nest count of 50 occurred in June 1963.

Most nests have been located in Eragrostis clumps; a few have been in Solanum. Most are on the east half. Nests are constructed with Tribulus, grasses, and leaves and may be within 6 inches of the ground. Roosting birds utilize the tall Eragrostis, Brassica, and Scaevola.

Other Islands: Rice (ms. a) observed 25 Black Noddies on the "south sandspits"--Bird, Planetree and Sand Islands--on 14 October 1957; five additional birds were sighted flying along the northeast reef. POBSP

personnel recorded 100 roosting at Sand Island on 18 August 1964; another 100 roosting birds were noted on 31 May 1967. Black Noddies probably also occasionally visit Kittery and Little North Islands.

Banding and Movements

POBSP and BSFW personnel banded 377 Black Noddies (Table 106); of these, 20 have been recaptured on the atoll (Table 16); 9 others moved elsewhere, 3 each to Kure and French Frigate Shoals, 2 to Lisianski, and 1 to Midway. In addition, 1 each from French Frigate Shoals, Laysan, and Midway travelled to Pearl and Hermes Reef. All movements are presented in Appendix Tables 13a and 13b.

Specimens

POBSP: USNM 497922-25, ♀, ♂, ♂, ♀, collected 18 June 1963 on Southeast by Sibley and Amerson.

Non-POBSP: USNM 300464-65, ♂, ♂, collected 27 April 1923 by Wetmore.

These are first specimen records.

Table 102. Observations of Black Noddies at Grass Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	40	20 pairs with well-grown young (Wetmore, ms.).
1963 5 Mar.	0	(POBSP, 1964d).
26-27 June	0	(POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	3	Not nesting (POBSP, 1964a).
1965 19 Mar.	1	Roosting (POBSP, 1965b).
22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	0	(BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	200	Diurnal roosting; no evidence of nesting (POBSP, 1967b).
29 Aug.	50	1 flock roosting on the vegetated portion; few roosting with Brown Noddies; none nesting (POBSP, 1967a).

Table 102. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).
1969 11 Sept.	400	(BSFW, 1969d).

Table 103. Observations of Black Noddies at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	small colonies	Eggs and young (Bailey, 1956: 32).
1963 6 Mar.	0	(POBSP, 1964d).
23-25 June	70	20-60 breeders; 10-30 nests (POBSP, 1963).
1964 19-20 Aug.	303+	300 adults; 6 breeders: 3 young counted (POBSP, 1964a).
17 Sept.	100	No nests (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	200-300	Mostly roosting at night; no nests (POBSP, 1965b).
1966 22 Sept.	-	Not mentioned in notes (BSFW, 1966b).
1967 16-17 Mar.	900+	Maximum of 60 on ground by day, an additional 850 arriving at dusk from the east and settling in one large flock (BSFW, 1967d).
29-30 Aug.	1,100	Adults, mostly nocturnal, but flocks of 20-350 along beaches during the day; no active nests, but 1 found that may have been used earlier in the year (POBSP, 1967a).
1969 12 Sept.	0	(BSFW, 1969d).

Table 104. Observations of Black Noddies at Seal Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 27 Apr.	40	Breeders; young well-grown (Wetmore, ms.).

Table 104. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 5 Mar.	0	(POBSP, 1964d).
26 June	0	(POBSP, 1963).
1964 14 Mar.	0	(BSFW, 1964a; POBSP, 1964b).
18 Aug.	700	Roosting adults; no nests (POBSP, 1964a).
1965 18-19 Mar.	50-100	Roosting adults at night; no nests found (POBSP, 1965b).
22 Mar.	1	Diurnal; no nests (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	36	Flying about; no nests (BSFW, 1966b).
1967 22 Mar.	0	(BSFW, 1967a; POBSP, 1967d).
31 May	200	Roosting; no nests (POBSP, 1967b).
29 Aug.	150	Roosting on the open beach towards the end of the reef; no evidence of nesting (POBSP, 1967a).
1968 24 Mar.	0	(BSFW, 1968; POBSP, 1968).
1969 11 Sept.	0	(BSFW, 1969d).

Table 105. Observations of Black Noddies at Southeast Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1916 4 Feb.	-	Not mentioned in report (Munter, ms.).
1923 26-28 Apr.	100	Breeders: 1 fresh egg collected, but most nests apparently contained young, some near fledging (Wetmore, ms.).
1930 23 July-Aug.	-	Not mentioned in report (Galtsoff, 1933).
1961 12 Mar.	-	Not mentioned in report (HDFG, 1961).
1963 26 Feb.-8 Mar.	40	Mostly present at night; no nests (POBSP, 1964d).

Table 105. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1963 18-23, 25 June	2,000- 3,000	100 breeders: 45 nests with eggs, 5 with young; remainder roosting non-breeding population (POBSP, 1963).
1964 13-14 Mar.	300-400	Mostly nocturnal; no nests (BSFW, 1964a; POBSP, 1964b).
16-19 Aug.	550	Adults; 16 breeders: 6 nests with eggs and 2 with medium-sized young (POBSP, 1964a).
16 Sept.	800-900	Roosting population that became larger at night; no nests (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	300-400	Mostly roosting birds; 12-14 breeders: 6-7 nests with eggs (POBSP, 1965b).
21-22 Mar.	0	(BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	-	Not mentioned in notes (BSFW, 1966a).
20-26 Sept.	1,000	Ca. 400 by day increasing to 1,000 at night; no eggs or young (BSFW, 1966b).
25-27 Sept.	1,000	All non-breeding, except 2 breeders with 1 large chick (POBSP, 1966).
1967 21-23 Mar.	5	Roosting at night; occasional during day; no nests (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	1,000+	Nocturnally; only 200 diurnally; 22 breeders: 11 nests, 4 with eggs and 7 with small downy young (POBSP, 1967b).
28-30 Aug.	3,000	Mostly roosting non-breeders; 8-20 breeders: 2 nests with eggs and 2 with small downy young (POBSP, 1967a).
1968 22-24 Mar.	25	16-20 breeders: 8-10 nests, 1 with fresh egg, rest recently built but empty (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	50	Nocturnal, no evidence of nesting (BSFW, 1969a).
31 Mar.- 2 Apr.	-	Not listed in report (BSFW, 1969b).

Table 105. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1969 26-31 May	1,600	Nocturnally; 50 breeders; 25 nests counted; of 22 nests sampled: 7 (32%) contained eggs and 15 (68%) contained small downy chicks (BSFW, 1969c).
10-19 Sept.	1,320	(BSFW, 1969d).

WHITE TERN

Gygis albaStatus

Irregular breeding species; present irregularly year-round; likely to occur on most islands, known to nest only at Southeast. Maximum POBSP and BSFW population estimate 10 in September 1969.

Observations

A single White Tern at North Island in March 1913 was the first record at Pearl and Hermes Reef (Bailey, 1956: 32). Rice (ms. a) observed 25 on, and flying near, the northeast reef on an aerial survey 14 October 1957. He suggested they probably nest there but no other observers have suggested this nor have such numbers been seen subsequently.

POBSP and BSFW personnel recorded small numbers each year from 1963 to 1969 (Table 107); nesting was first recorded at Southeast in 1969.

Annual Cycle

White Terns were observed during all survey periods except February (see Fig. 58). Few birds were seen in March; most birds were seen in late spring and summer.

BSFW personnel found a White Tern incubating an egg at Southeast on 26 May 1969; although this is the first breeding record on the atoll, perhaps it has bred in other years and has been overlooked because of its extremely small population.

Ecological Distribution

White Terns have been recorded as flying over or roosting on Grass, Little North, North, Seal, and Southeast Islands.

Wetmore (ms.) was the first to observe White Terns on Southeast; all other observations were by POBSP and BSFW personnel. Recorded populations have ranged from 1 to 7 birds. A pair nested in May 1969; its egg, precariously placed on a small piece of raised coral near the southwest shore, was subsequently destroyed by a wave.

Table 106. Black Noddies banded at Pearl and Hermes Reef

Island	Age- Class	Bander: <u>POBSP</u> <u>POBSP</u> <u>BSFW</u> <u>POBSP</u> <u>POBSP</u>							Totals
		Period of Survey							
		Feb.- Mar. 1963	June 1963	1963 Total	Mar. 1964	Aug. 1964	1964 Total	Mar. 1965	
Southeast	Adult	27	216	243	8	100	108	4	355
	Young	0	0	0	0	2	2	0	2
	Total:	27	216	243	8	102	110	4	357
North	Adult	0	5	5		3	3	9	17
	Young	0	0	0		3	3	0	3
	Total:	0	5	5		6	6	9	20
Total	Adult	27	221	248	8	103	111	13	372
	Young	0	0	0	0	5	5	0	5
	Total:	27	221	248	8	108	116	13	377

Banding and Movements

POBSP personnel banded two adult White Terns on Southeast Island in August 1964.

Table 107. Observations of White Terns on islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Remarks and References</u>
1913 15 Mar.	North	1	(Bailey, 1956: 32).
1923 26-28 Apr.	Southeast	1	(Wetmore, ms.).
1957 14 Oct.	northeast reef	25	On and flying near (Rice, ms. a).
1963 18-23, 25 June	Southeast	3	Flying over (POBSP, 1963).
23, 25 June	Little North	3	Alighted (POBSP, 1963).
23-25 June	North	6-8	Flying over each day; a few roosted on beach (POBSP, 1963).
26 June	Seal	3	(POBSP, 1963).
26-27 June	Grass	2	1 roosting on reef (POBSP, 1963).
1964 16-19 Aug.	Southeast	6	Most common in early morning (POBSP, 1964a).
18 Aug.	Seal	2	(POBSP, 1964a).
18 Aug.	Grass	5	(POBSP, 1964a).
19-20 Aug.	North	7	Flying over (POBSP, 1964a).
16 Sept.	Southeast	3	Flying over (BSFW, 1964b; POBSP, 1964c).
17 Sept.	North	2	Flying over (BSFW, 1964b; POBSP, 1964c).
1965 17-18 Mar.	North	4	(POBSP, 1965b).
1966 20-26 Sept.	Southeast	2	Flying over (BSFW, 1966b).
22 Sept.	North	1	(BSFW, 1966b).
1967 16-17 Mar.	North	3	After dark (BSFW, 1967d).

Table 107. (continued)

Date of Survey	Island	Population Estimate	Remarks and References
1967 21-23 Mar.	Southeast	2	Flying over (BSFW, 1967a; POBSP, 1967d).
22 Mar.	Grass	2	Roosting on reef (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	Southeast	3	2 roosting on exposed coral on south side (POBSP, 1967b).
29 Aug.	Grass	3	Flying over (POBSP, 1967a).
29 Aug.	Little North	2	Roosting on small central rock (POBSP, 1967a).
29-30 Aug.	North	2	Flying over; same birds as observed on Little North (POBSP, 1967a).
1968 24 Mar.	Seal	1	Roosting on coral block (BSFW, 1968; POBSP, 1968).
1969 26-31 May	Southeast	7	Adults; 1 incubating an egg 26 May on a small piece of raised coral near the southwest shore; egg destroyed 27 May by storm-generated waves (BSFW, 1969c).
10-19 Sept.	Southeast	4	(BSFW, 1969d).
12 Sept.	North	10	(BSFW, 1969d).

HORNED PUFFIN

Fratercula corniculataStatus

Accidental; two unpreserved specimen records.

Observations

Two badly decayed carcasses found by POBSP personnel in March 1963 constitute the only records for Pearl and Hermes Reef (Clapp and Woodward, 1968: 30-31). One was found on Grass Island on 5 March and the other on North Island the following day. Neither carcass was preserved (POBSP, 1964d). The identification is not in doubt since the same POBSP personnel had previously found a number of these birds on Laysan, Kure, and Midway, and had obtained two specimens.

Status

Recent introduced breeder; present year-round with population increasing; occurs on Southeast, once recorded on Grass, may eventually inhabit all vegetated islands in the atoll. Maximum population estimate 274 (?) in March 1968.

Observations

One hundred ten Laysan Finches were captured by BSWF personnel on Laysan 18 March 1967, transported to Pearl and Hermes Reef by ship, and banded (excepting one) and released 21 March on Southeast Island. They were color banded, 59 males with red leg bands and 51 females with blue leg bands.

All but one or two of the released birds appeared alert and healthy. Immediately after their release they began foraging on the fruits and seeds of Tribulus and Chenopodium, and the blades of Lepturus. The only observed evidence of incipient mortality following the release was a sick male with an injured wing found on the morning of 23 March.

Laysan Finches have been found breeding on all subsequent visits to Southeast (Table 108). Two birds were later seen on Grass.

Annual Cycle

Since their introduction, Laysan Finches have remained year-round and numbers have increased. Nests with eggs and young have been found in February, March, April, and May.

Ecological Distribution

The Laysan Finch nests only at Southeast Island. As this population increases, the finch will probably spread to, and breed on, the other vegetated islands in the atoll. Two individuals have been observed at Grass.

Grass Island: Two, a banded male and female, were observed on 24 March 1968 by POBSP personnel. No nest was found, but proper habitat exists for this species to nest.

Southeast Island: The Laysan Finch presently breeds only on Southeast Island. Since the original introduction, the number has increased.¹ In March 1968, 274 were estimated; only 165 were estimated in March 1969 (Table 108). The 1968 estimate may be high, and the 1969 estimate may be low. Banding totals indicate that 110 young were produced in a little over two years. Only 25 have been recaptured.

The finches frequent the tall Eragrostis west of the central depression, as well as the low-growing Solanum and the Brassica. Most nests are in

¹Berger (1970: 38) thought the population numbered between 75 and 100 birds.

Eragrostis clumps and a few are in the moderately dense Solanum. Food consists of seeds of Setaria, Tribulus, Eragrostis, Boerhavia, and Sonchus.

Banding and Movements

BSFW personnel banded 220 Laysan Finches at Southeast Island: 109 adults in March 1967 (original introduction), 17 young in March 1968, 34 adults in February 1969, 19 adults and 6 young in March and April 1969, and 12 adults and 23 young in May 1969. Of these, 25 have been recaptured on the atoll (Table 16). These data are being analyzed by BSFW personnel.

Table 108. Observations of Laysan Finches at Southeast Island

Date of Survey	Population Estimate	Remarks and References
1967 21-23 Mar.	110	59 males and 51 females, all but one banded, introduced from Laysan (BSFW, 1967a; POBSP, 1967d).
28, 30 May- 1 June	30-50	Successfully adapted to local conditions; 16 nests counted in <u>Eragrostis</u> clumps: 3 old, 9 recently completed, 1 with 4 eggs, 1 with 3 eggs, and 2 with 2 eggs (POBSP, 1967b).
1968 22-24 Mar.	274*	9 nests: 4 with 2-3 eggs, 3 recently completed, and 2 old (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	100	5 nests: 1 with 2 downy young and an egg, 1 with 2 eggs, 1 new but empty, and 2 old (BSFW, 1969a).
31 Mar.- 2 Apr.	165	13 nests: 2 with 1 egg, 1 with 2 eggs, 1 with 3 eggs, 3 with 4 eggs, 2 with 1 young, 2 with 2 young, and 2 with 3 young (BSFW, 1969b).
26-31 May	?	No estimate taken; 17 active nests: 1 with 1 egg, 1 with 2 eggs, 1 with 1 egg and 1 young, 3 with 1 young, 6 with 2 young, 4 with 3 young, and 1 empty; 7 old nests (BSFW, 1969c).

*This estimate is possibly high.

MAMMALS

Besides man, four mammalian species have been recorded from Pearl and Hermes Reef. The Hawaiian Monk Seal is a resident breeding species found on most islands. The Hawaiian Spinner Dolphin, a new record for the atoll, and the Bottle-nosed Dolphin are visitors to the lagoon waters. The European Rabbit, introduced between 1913 and 1916, was exterminated in 1928. No mice, cats, or dogs are known to have occurred.

For descriptions of these species, the reader is referred to Tomich (1969).

HAWAIIAN SPINNER DOLPHIN

Stenella roseiventrisStatus

Visitor; one definite record.

Observations

POBSP and BSWF personnel sighted 8 dolphins offshore Southeast Island on 24 March 1968. Photographs by Kosaka were later examined by Brownell who identified them as Stenella roseiventris. This dolphin is common in Hawaiian waters (Tomich, 1969: 44), but has not been previously recorded from Pearl and Hermes Reef.

BOTTLE-NOSED DOLPHIN

Tursiops truncatusStatus

Visitor; two definite records.

Observations

On 14 March 1958 Rice (1960b: 407) observed from the air about 30 Bottle-nosed Dolphins in shallow water just outside the southwest reef. His data led Tomich (1969: 46) to suggest that this species is regularly associated with shallow waters from French Frigate Shoals to Kure Atoll. Hershkovitz (1966: 48-53) thought the dolphins Rice sighted belonged to the race Tursiops truncatus aduncus.

Bailey (1918: 398) first recorded porpoises on 15 March 1913; he wrote that "a school of porpoises played off our bow and came in so close as almost to splash in the boat as they cut water."

On 22 March 1956 POFI personnel sighted "3 large bottle nose porpoise in front of [the] bow" of the USFW John R. Manning on the western side of the reef (POFI, 1956a).

POBSP and BSWF personnel noted 15 to 20 unidentified porpoises inside the lagoon between Southeast and Grass Islands 14 March 1964. Lewis sighted

40 small unidentified porpoises inside the lagoon near Southeast as he approached the island in a helicopter on 25 September 1966.

HAWAIIAN MONK SEAL

Monachus schauinslandi

Status

Common resident breeder; present year-round; occurs and breeds on most islands. Maximum recent POBSP and BSWF population estimate 195 in February and March 1963.

Observations

Hawaiian Monk Seals were first recorded by Morrell (1832: 217-218) 8-11 July 1825, who wrote "the sea-elephant and sea-leopard resort to the islands in the summer season, in large rookeries, and the former are perfectly tame." Osburn, who visited in August 1850, wrote of killing 10 or 12 seal for their livers and hearts; he also noted their tameness and estimated their weight at 500 pounds (Kemble, 1966: 155). Seals were next recorded in 1857 by Paty (1857: 2-3) who noted that the "islets...seemed to abound with...seals." Brooks, who visited Pearl and Hermes and other Northwestern Hawaiian Islands in July 1859, may have found seals here; he returned to Honolulu with a cargo of 240 barrels of seal oil and 1,500 seal skins (Anon., 1859a, 1859b). Brooks (1960: 502) failed, however, to mention seals in his subsequent description of the atoll, though he noted birds and turtles (see also Kenyon and Rice, 1959: 215).

Frear's notation of 35 seals and a newborn pup in December 1912 prompted Atkinson and Bryan (1913: 1050-1051) to write that "Pearl and Hermes Reef seem [sic] to have been the place where they were most abundant." In March 1913 Willett and Bailey found seals with pups on North Island and a nearby sandbar (Bailey, 1918: 399; 1956: 30), and Elschner (1915: 60) reported many there in September 1914. Munter (ms.) found 30 or 35, including several pups, in February 1916. Wetmore (ms.) estimated 125 on Grass, Seal and Southeast Islands in April 1923, while Galtsoff (1933: 19) counted 68 in the lagoon in summer 1930. Bailey (1952: 16) estimated over 100 seals when he flew over the atoll in May 1949.

A POFI survey in June 1950 found 100 seals during the day and noted that females had pups that were a few days or weeks old (POFI, 1950); Brock estimated 180 seals (Bailey, 1952: 25). Dumont and Neff (Svihla, 1959: 227) reported 96 in November 1954. Kenyon and Rice (1959: 221), on aerial surveys, counted 257 adults and subadults on 17 December 1956, and counted 33 pups on 15 April and 14 May 1957. Using the same type surveys, Rice (1960a: 377) counted 286 adults and subadults and 52 pups in spring 1958.

Hawaiian Monk Seals have been counted, sexed, and tagged on most BSWF, POBSP, and HDFG survey trips during the 1960's. Tables 109 to 115 present all seal observation data for Pearl and Hermes.

Annual Cycle

Hawaiian Monk Seals are found at Pearl and Hermes year-round. Kenyon and Rice (1959: 236) found that pups are born throughout the entire Hawaiian chain from late December until the end of June, with most born from mid-March through May. Bailey (1952: 5) recorded a newborn pup at Pearl and Hermes in late December 1912. Only one pup was found in two recent February surveys. The maximum March count¹ was 5 pups, while the highest June count¹ was 28. The highest August count¹ was 17, and the highest September count was 13.

Recent population counts¹ produce a high of 195 in late February and early March, while five March counts¹ average 140. Two August counts¹ numbered 116 and 115; and two September counts¹ gave 105 and 119. The average population count¹ from 11 recent surveys was 128.

Kenyon (in prep.) recently pointed out, using data from Midway Atoll, Kure Atoll, French Frigate Shoals, and Pearl and Hermes Reef (1968 data only), that Hawaiian Monk Seal populations will not tolerate repeated disturbance by man. He found that the Midway population has almost disappeared and the Kure population has decreased. The Pearl and Hermes Reef data obtained over the last seven years seem to indicate a declining population, both in total size and in number of young produced. The 1963 February population contained 195 and produced at least 28 pups by June; the 1969 February population contained 152 adults and produced at least 17 pups by late May.

Ecological Distribution

Hawaiian Monk Seals have been recorded from all islands and sandbars. Breeding occurs on all islands except Planetree and Sand. Movement from islet to islet within the atoll is common (see Tagging and Movement section). Females with newborn pups, however, do not usually move from islet to islet.

Seals are found predominately on the beaches, but may be found in the vegetated areas.

Grass Island: Hawaiian Monk Seals have been recorded on at least 16 POBSP and BSFW surveys (Table 109). The average population was 18 seals, and ranged from 9 to 39. Six pups are known to have been born since 1963.

Kittery Island: BSFW and POBSP personnel recorded seals on 14 surveys (Table 110). The population count averaged 24, and ranged from 2 to 43. Eleven pups are known to have been born since 1963.

Little North Island: Seals were noted by POBSP and BSFW personnel on 10 surveys (Table 111). The population count averaged 19 and ranged from 4 to 29. In all, 25 pups are known to have been born since 1963.

¹Using only surveys where counts were taken on six or more islands.

North Island: POBSP and BSFW personnel observed seals on 13 surveys (Table 112). The average population count of 28 was higher than on any of the other islands in the atoll; the population has ranged from 15 to 53. The number of pups produced since 1963 is 24, which is also a high for the atoll. Pup counts for both Little North and North Islands are high since they are isolated and not greatly affected by human disturbance.

Seal Island: Seals were recorded on 15 surveys by POBSP and BSFW personnel (Table 113). The average population count was 14, and ranged from 9 to 25. Seventeen pups are known to have been born since 1963.

Southeast Island: Seals were recorded on 19 POBSP and BSFW surveys (Table 114). Southeast, the atoll's largest island, had the highest island population, 58+. However, because of human disturbance (most campsites were here), the average population was only 26. Average winter and spring counts are higher (29 seals) than summer and fall counts (21 seals). Only 10 pups were observed from 1963 through 1969.

Seals are most common along the lagoon beach (Fig. 79). Some occur on the seaward beach and a few have been found in the vegetated areas (Fig. 80) and the tidal pools.

Other Islands: Small numbers (average 5) were noted on Bird, Planetree, and Sand Islands during visits by POBSP and BSFW personnel (Table 115). A single pup is known from Bird.

Tagging and Movement

Since 1963 POBSP and BSFW tagged at least 197 seals, including 94 in 1963, 33 in 1966, 33 in 1967, 8 in 1968, and 29 in 1969. Tagging showed that movement within the atoll was common. Seven seals tagged on Pearl and Hermes have been recaptured on Laysan, 4 on Lisianski, 2 on French Frigate Shoals, and 1 on Kure. These data are being analyzed by BSFW personnel.

Specimens

POBSP: USNM 334576, dead newborn pup, alcoholic, collected on Grass Island 5 March 1963 by Wirtz; USNM 334577, adult skull and skeleton, collected on beach at Southeast Island 6 March 1963 by Wirtz.

Non-POBSP: USNM 181251, ♀ pup, collected on North Island 15 March 1913 by Willett for the U.S. Bureau of Biological Survey; USNM 243843-4, skin and skull, collected 28 April 1923 by Wetmore; USNM 243845, skull, collected 28 April 1923 by Wetmore.

Table 109. Observations of Hawaiian Monk Seals at Grass Island

Date of Survey	Population		Breeding Status, Remarks, and References
	Estimate		
1950 27 June	present		(POFI, 1950).

Table 109. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1951 14 May	present	Adults with pups (POFI, 1951; Svihla, 1959: 227).
1956 22 Mar.	18	Adults (POFI, 1956a).
26 May	7	Adults (POFI, 1956b).
1963 5 Mar.	39	16 tagged--13 adults: 5 ♂, 8 ♀; 3 subadults: 2 ♂, 1 ♀; 8 repeats; 13 adults and 1 subadult untagged; 1 dead pup (POBSP, 1964d).
26-27 June	8-10	Daily (POBSP, 1963).
1964 14 Mar.	27	15 adults: 3 ♂, 3 ♀, 9 unk*; 12 subadults: 9 ♂, 3 ♀ (BSFW, 1964a; POBSP, 1964b).
18 Aug.	20+	Adults (POBSP, 1964a).
1965 19 Mar.	29	Adults (POBSP, 1965b).
22 Mar.	27	19 adults: 7 ♂, 8 ♀, 4 unk; 8 subadults: 2 ♂, 2 ♀, 2 unk (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	12	7 adults, 4 subadults, 1 pup (BSFW, 1966b).
1967 17 Mar.	19	Includes counts for Bird, Planetree, and Seal Islands (BSFW, 1967d).
22 Mar.	9	Adults (BSFW, 1967a; POBSP, 1967d).
31 May	13	12 adults: 4 ♂, 4 ♀, 4 unk; 1 unk yearling (POBSP, 1967c).
29 Aug.	19	16 adults: 8 ♂, 7 ♀, 1 unk; 3 pups (POBSP, 1967a).
28 Sept.	10	9 adults, 1 yearling (BSFW, 1967c).
1968 24 Mar.	15	12 adults: 6 ♂, 6 ♀; subadults: 1 ♂, 1 ♀; 1 ♂ yearling (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	18	17 unk adults, 1 unk subadult (BSFW, 1969a).
26 May	8	7 adults: 2 ♀, 5 unk; 1 ♀ pup (BSFW, 1969c).
11 Sept.	12	11 adults: 3 ♂, 2 ♀, 6 unk; 1 ♀ subadult (BSFW, 1969d).

*unk = unknown.

Table 110. Observations of Hawaiian Monk Seals at Kittery Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1956 22 Mar.	30	Adults (POFI, 1956a).
26 May	15	Adults, no pups (POFI, 1956b).
1963 5 Mar.	32	10 tagged--7 adults: 5 ♂, 2 ♀; 3 subadults: 1 ♂, 2 ♀ (POBSP, 1964d).
1964 14 Mar.	38	25 adults: 11 ♂, 9 ♀, 5 unk; 13 subadults: 4 ♂, 5 ♀, 4 unk (BSFW, 1964a; POBSP, 1964b).
18 Aug.	2	Adults (POBSP, 1964a).
1965 18 Mar.	22	Adults (POBSP, 1965b).
22 Mar.	35	26 adults: 15 ♂, 10 ♀, 1 unk; 9 subadults: 2 ♂, 5 ♀, 2 unk (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	21	16 adults, 5 subadults (BSFW, 1966b).
1967 22 Mar.	43	41 adults, 1 subadult, 1 yearling (BSFW, 1967a; POBSP, 1967d).
31 May	20	17 adults: 14 ♂, 1 ♀, 2 unk; 3 yearlings: 2 ♂, 1 ♀ (POBSP, 1967c).
29 Aug.	26	16 adults, 10 pups (POBSP, 1967a).
28 Sept.	18	16 adults, 1 subadult, 1 yearling (BSFW, 1967c).
1968 24 Mar.	28	21 adults: 16 ♂, 4 ♀, 1 unk; 7 subadults: 5 ♂, 2 ♀ (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	10	9 adults: 4 ♂, 3 ♀, 2 unk; 1 ♂ pup (BSFW, 1969a).
26 May	23	22 adults: 1 ♀, 21 unk; 1 ♀ pup (BSFW, 1969c).
11 Sept.	13	12 adults: 3 ♂, 1 ♀, 8 unk; 1 ♂ subadult (BSFW, 1969d).

Table 111. Observations of Hawaiian Monk Seals at Little North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1963 23, 25 June	13	Pups (POBSP, 1963).

Table 111. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1964 19 Aug.	25-28	Adults (POBSP, 1964a).
17 Sept.	19	9 adults, 7 yearlings, 3 unk (BSFW, 1964b; POBSP, 1964c).
1965 18 Mar.	25	23 adults, 2 pups (POBSP, 1965b).
1966 22 Sept.	11	(BSFW, 1966b).
1967 17 Mar.	4	Aerial count (BSFW, 1967d).
29 Aug.	20	12 adults, 4 yearlings, 4 pups (POBSP, 1967a).
1969 10-12 Feb.	29	Unclassified (BSFW, 1969a).
26 May	19	13 adults: 12 ♀, 1 unk; 6 pups: 5 ♂, 1 ♀ (BSFW, 1969c).
12 Sept.	21	17 adults: 4 ♂, 2 ♀, 11 unk; 4 pups: 1 ♀, 3 unk (BSFW, 1969d).

Table 112. Observations of Hawaiian Monk Seals at North Island

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1913 15 Mar.	50-60	About 15-20 ♀ with young, few ♂, several half-grown (Bailey, 1956: 30).
1914 Sept.	many	"Sea lions" (Elschner, 1915: 60).
1950 27 June	present	(POFI, 1950).
1956 25 May	31	18 adults, 13 pups; several born previous night (POFI, 1956b).
1963 6 Mar.	27	4 tagged--2 adults: 1 ♂, 1 ♀; 2 ♀ sub-adults; 1 dead pup (POBSP, 1964d).
23-25 June	13-15	Pups (POBSP, 1963).
1964 19-20 Aug.	22	20 adults, 2 pups (POBSP, 1964a).
17 Sept.	36	14 adults: 1 ♂, 3 ♀, 10 unk; 19 yearlings: 6 ♂, 4 ♀, 9 unk; 3 unclassified (BSFW, 1964b; POBSP, 1964c).

Table 112. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1965 17-18 Mar.	53	52 adults, 1 dead pup (POBSP, 1965b).
1966 22 Sept.	26	(BSFW, 1966b).
1967 16-17 Mar.	30	11 adults, 19 subadults; 2 recaptured (BSFW, 1967d).
29-30 Aug.	21	15 adults, 6 subadults (POBSP, 1967a).
27 Sept.	29	21 adults, 2 subadults, 6 yearlings (BSFW, 1967c).
1969 10-12 Feb.	44	33 unclassified on North; 11 unclassified on nearby sandbars (BSFW, 1969a).
31 Mar.	27	17 adults: 3 ♂, 7 ♀, 6 unk, 1 dead ♀; 5 subadults: 1 ♂, 1 ♀, 3 unk; 1 yearling; 4 pups (BSFW, 1969b).
26 May	17	9 adults: 7 ♂, 2 unk; 2 unk subadults; 6 pups: 2 ♂, 3 ♀, 1 unk (BSFW, 1969c).
12 Sept.	21	13 adults: 6 ♂, 4 ♀, 3 unk; 2 subadults: 1 ♂, 1 ♀; 3 ♂ pups; 3 adults: 1 ♂, 2 unk on nearby sandbars (BSFW, 1969d).

Table 113. Observations of Hawaiian Monk Seals at Seal Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1956 22-24 Mar.	16	12 adults, 3 pups, 1 dead pup (POFI, 1956a).
26 May	ca. 35	Ca. 20 adults, 15 pups (POFI, 1956b).
1963 5 Mar.	19	2 subadult ♀ tagged; 5 repeats (POBSP, 1964d).
26 June	25 ⁺	(POBSP, 1963).
1964 14 Mar.	17	8 adults: 4 ♂, 1 ♀, 3 unk; 9 subadults: 4 ♂, 5 ♀ (BSFW, 1964a; POBSP, 1964b).
18 Aug.	15-20	Adults (POBSP, 1964a).
1965 18-19 Mar.	20	18 adults, 2 dead pups (POBSP, 1965b).

Table 113. (continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1965 22 Mar.	10	2 adults, 5 subadults, 2 pups, 1 unk (BSFW, 1965; POBSP, 1965a).
1966 21 Sept.	8	3 adults, 1 subadult, 4 pups (BSFW, 1966b).
1967 22 Mar.	4	3 adults, 1 pup (BSFW, 1967a; POBSP, 1967d).
31 May	18	11 adults: 2 ♂, 7 ♀, 2 unk; 1 ♀ subadult; 6 pups: 3 ♀, 3 unk; 5 pups tagged on the 28th (POBSP, 1967c).
29 Aug.	7	4 adults: 3 ♂, 1 ♀, 3 pups (POBSP, 1967a).
28 Sept.	15	9 adults, 6 subadults (BSFW, 1967c).
1968 24 Mar.	16	9 adults: 6 ♂, 3 ♀; 3 subadults: 1 ♂, 2 ♀; 2 yearlings: 1 ♂, 1 ♀; 2 ♀ pups (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	9	8 adults: 1 ♂, 3 ♀, 4 unk; 1 ♀ subadult (BSFW, 1969a).
26 May	10	8 adults: 7 ♀, 1 unk; 2 pups: 1 ♂, 1 ♀ (BSFW, 1969c).
11 Sept.	12	9 adults: 1 ♂, 4 ♀, 4 unk; 3 pups: 1 ♂, 2 ♀ (BSFW, 1969d).

Table 114. Observations of Hawaiian Monk Seals at Southeast Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1950 27 June	present	(POFI, 1950).
1956 22 Mar.	0	No adults seen (POFI, 1956a).
26 May	20	Adults, no pups (POFI, 1956b).
1963 26 Feb.- 8 Mar.	58+	58 tagged--32 adults: 12 ♂, 18 ♀, 2 unk; 26 yearlings: 14 ♂, 12 ♀ (POBSP, 1964d).
18-23, 25 June	12	Counted on 18th; 6-8 other days (POBSP, 1963).
1964 13-14 Mar.	22	11 adults: 5 ♂, 5 ♀; 11 subadults: 6 ♂, 2 ♀ (BSFW, 1964a; POBSP, 1964b).

Table 114. (continued)

<u>Date of Survey</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1964 16-19 Aug.	15	Adults (POBSP, 1964a).
16 Sept.	33	16 adults, 16 subadults (BSFW, 1964b; POBSP, 1964c).
1965 15-19 Mar.	31	Adults (POBSP, 1965b).
21-22 Mar.	45	24 adults: 10 ♂, 14 ♀; 18 subadults: 5 ♂, 13 ♀; 1 unk pup; 2 unclassified (BSFW, 1965; POBSP, 1965a).
1966 1 Apr.	18	4 adults, 14 subadults (BSFW, 1966a).
20-26 Sept.	27	8 adults, 14 subadults, 5 pups counted on 20th; 33 tagged (Kenyon, in prep.; BSFW, 1966b).
1967 17 Mar.	14	8 adults, 6 subadults, 1 dead (BSFW, 1967d).
21-23 Mar.	24	15 adults, 1 subadult, 8 yearlings (BSFW, 1967a; POBSP, 1967d).
28-30 May- 1 June	21	13 adults: 3 ♂, 7 ♀, 3 unk; 7 yearlings: 1 ♂, 2 ♀, 4 unk; 1 ♀ pup; counted on 28 May (POBSP, 1967c).
28-30 Aug.	15	12 adults, 3 yearlings (POBSP, 1967a).
27-29 Sept.	11	10 adults, 1 yearling (BSFW, 1967c).
1968 22-24 Mar.	37	19 adults: 11 ♂, 7 ♀, 1 unk; 11 subadults: 6 ♂, 5 ♀; 7 yearlings: 4 ♂, 3 ♀ (BSFW, 1968; POBSP, 1968).
1969 10-12 Feb.	23	15 adults: 5 ♂, 8 ♀, 2 unk; 3 unk subadults; 5 unclassified (BSFW, 1969a).
31 Mar.- 2 Apr.	37	17 adults: 6 ♂, 4 ♀, 5 unk, 2 dead; 20 subadults: 3 ♂, 9 ♀, 8 unk (BSFW, 1969b).
26-31 May	16	13 adults: 3 ♂, 5 ♀, 5 unk; 2 unk subadults; 1 ♀ pup (BSFW, 1969c).
10-19 Sept.	31	18 adults: 4 ♂, 5 ♀, 9 unk; 10 subadults: 2 ♀, 8 unk; 3 unk pups (BSFW, 1969d).



79. Yearling Hawaiian Monk Seal on lagoon beach at Southeast Island, March 1963. POBSP photograph by W.O. Wirtz, II.

80. Adult Hawaiian Monk Seals basking in the sun on the vegetated portion at Southeast Island, 28 August 1967. POBSP photograph by D.I. Hoff.



Table 115. Observations of Hawaiian Monk Seals on other islands at Pearl and Hermes Reef

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>	
1825	8-11 July	?	?	Large rookeries (Morrell, 1832: 217-218).
1850	11 Aug.	?	few	Killed 10 or 12 for food (Kemble, 1966: 155).
1857	19-20 May	?	?	Islets abound with seal (Paty, 1857: 2-3).
1950	27 June	Bird	present	(POFI, 1950).
	27 June	Sand	present	(POFI, 1950).
1956	22 Mar.	Bird	11	Adults (POFI, 1956a).
	22 Mar.	Sand	6	Adults (POFI, 1956a).
	26 May	Bird	5	Adults (POFI, 1956b).
1963	5 Mar.	Bird	13	3 tagged: 2 ♂ adults, 1 ♂ subadult (POBSP, 1964d).
	5 Mar.	Sand	7	1 unk adult tagged (POBSP, 1964d).
1964	14 Mar.	Bird	3	Subadults: 1 ♀, 2 unk (BSFW, 1964a; POBSP, 1964b).
	14 Mar.	Planetree	7	6 adults: 4 ♂, 1 ♀, 1 unk; 1 ♂ subadult (BSFW, 1964a; POBSP, 1964b).
	14 Mar.	Sand	7	2 adults: 1 ♂, 1 ♀; 5 subadults: 3 ♂, 2 unk (BSFW, 1964a; POBSP, 1964b).
	18 Aug.	Bird	5	Adults (POBSP, 1964a).
	18 Aug.	Planetree	3	Adults (POBSP, 1964a).
	18 Aug.	Sand	1	Adult (POBSP, 1964a).
1965	22 Mar.	Bird	8	5 adults, 3 subadults (BSFW, 1965; POBSP, 1965a).
	22 Mar.	Planetree	7	6 adults: 3 ♂, 1 ♀, 2 unk; 1 subadult (BSFW, 1965; POBSP, 1965a).
	22 Mar.	Sand	6	4 adults: 3 ♂, 1 ♀; 2 ♀ subadults (BSFW, 1965; POBSP, 1965a).

Table 115. (continued)

<u>Date of Survey</u>	<u>Island</u>	<u>Population Estimate</u>	<u>Breeding Status, Remarks, and References</u>
1967 31 May	Bird	7	5 adults: 2 ♂, 3 unk; 2 subadults: 1 ♂, 1 ♀ (POBSP, 1967c).
29 Aug.	Bird	6	5 adults: 4 ♀, 1 unk; 1 pup (POBSP, 1967a).
29 Aug.	Planetree	1	Adult (POBSP, 1967a).
1969 10-12 Feb.	Bird, Planetree and Sand	20	Unclassified (BSFW, 1969a).
26 May	Bird, Planetree and Sand	7	Adults (BSFW, 1969c).
11 Sept.	Bird	4	3 adults: 2 ♂, 1 unk; 1 ♀ subadult (BSFW, 1969d).

EUROPEAN RABBIT

Oryctolagus cuniculusStatus

Introduced prior to 1916; exterminated in 1928.

Observations

Munter (ms.) 1st lieutenant aboard the USCGC Thetis, first recorded¹ rabbits on Southeast Island on 4 February 1916. Since they were of the domestic variety, Munter believed they had "been brought to the island from Laysan or Lisiansky [sic]...by fishermen."² This was suggested when the remains of a crude shelter which Munter believed to be less than a year and a half old and which probably was built by Japanese³ fishermen, were found. Munter caught four of the rabbits.

¹During Jacobs' 21 January 1910 visit to Pearl and Hermes, no rabbits were noted. Salisbury also found none there 15 March 1913 (U.S. Nat. Archives, R.G. 26, letter from Jacobs to Secretary of Treasury dated 2 February 1910; R.G. 22, letter from Salisbury to Palmer dated 20 March 1913).

²Rabbits were introduced to Laysan about 1903 by Max Schlemmer to start a rabbit canning business (Dill and Bryan, 1912: 9-10).

³Three Japanese were rescued from Pearl and Hermes in January 1909 by the schooner Florence Ward. They had been left there 7 July 1908 with a

Tanager Expedition personnel next recorded "a number of rabbits and the remains of a camp" on Southeast in April 1923 (Bryan *et al.*, 1926: 6). On 26 April, Wetmore (ms.) wrote: "When we camped we were astonished to find rabbit dung scattered about and later found the animals fairly common in the bunch grass. Apparently they had been introduced three or four years ago by the crew that had camped there. Indications were that the animals had come from Laysan as they were of the same size and mixed colors. I shot a considerable number and Dr. Wilson more so that we killed 25 before I was out of shells." On 27 April he noted "no sign of rabbits on either Grass or Seal Islands." Rabbits were hunted on Southeast on the 28th; afterward Wetmore wrote "the number killed today and on the 26th made a total of 90 rabbits." He estimated "that perhaps 30 remain," and observed they "were wilder than on Laysan and usually ran as soon as they saw us."

The Tanager personnel left Southeast on the 28th (Wetmore, ms.), leaving some 30 live rabbits. Additional Tanager personnel returned on 17 May; prior to leaving on the 19th they had "killed all but one of the rabbits seen" (Gregory, 1924: 21). Two of three rabbits on Southeast were shot by G.P. Wilder on 2 May 1924. Rabbits (20?) were subsequently collected in May 1927 and returned in several crates to Honolulu by Captain Peterson of the Lanikai. During April 1928 the Lanikai crew shot three rabbits on Southeast. In June or July 1928 a diligent search was made by Captain Anderson of the Lanikai, but none was found. None has been found since (U.S. Nat. Archives, R.G. 22, letters from Wilder to Nelson dated 19 April 1926, and Wilder to Goldman dated 20 July 1928; Anon., 1927).

SUMMARY

Pearl and Hermes Reef is an uninhabited atoll containing nine islands in the Northwestern Hawaiian Islands. Wildlife is protected as the atoll is part of the Hawaiian Islands National Wildlife Refuge.

Personnel of the Pacific Ocean Biological Survey Program (POBSP), Smithsonian Institution, Washington, D.C., made 12 biological survey trips to the atoll from February 1963 to March 1968. Data from these visits, as well as from visits through 1969 by Bureau of Sport Fisheries and Wildlife (BSFW) personnel, Hawaiian Division of Fish and Game personnel, Pacific Ocean Fisheries Investigation personnel, and from all previously published literature are summarized and discussed. Emphasis is placed on the vascular flora and the vertebrate terrestrial fauna.

month's supply of food by a Japanese schooner; the vessel was supposed to have been lost in a storm (Thrum, 1909: 176). Japanese feather poachers were on Laysan and Lisianski at this same time (Ely and Clapp, in press); the three on Pearl and Hermes were probably part of that group. It is most likely that rabbits were introduced during this period.

Twenty-five species of vascular plants, representing 17 families, have been observed or collected from five islands. Only one breeding reptile species is known. Since 1964 BSWF personnel have tagged at least 137 Black Sea Turtles; 46 of these were recaptured on the atoll, and one was captured elsewhere in the Hawaiian Islands. In addition, two tagged elsewhere were captured on the atoll. Of the 37 species of birds recorded, 17 are resident seabirds, 5 are regular migrant shorebirds, and 15 are vagrant, accidental, or introduced. In all, 68 specimens of 26 species have been collected. Before the POBSP, 37 specimens of 16 species were collected. POBSP personnel collected 31 specimens of 18 species, 14 of which represent new specimen records. An additional three species represent new sight records, and four represent new breeding records. Of the 31,661 birds of 22 species banded on the atoll, 1,790 of 18 species were recaptured on the atoll, and 211 of 13 species were captured at other Pacific localities. In addition, 70 birds of 12 species banded at other Pacific localities were captured on the atoll. Beside man, four mammalian species have been recorded. Since 1963, POBSP and BSWF personnel have tagged at least 197 Hawaiian Monk Seals; many recaptures are known, and 14 inter-atoll movements exist between other Hawaiian Islands.

ACKNOWLEDGMENTS

Acknowledgment is first and foremost made to Eugene Kridler, Refuge Manager, Hawaiian Islands National Wildlife Refuge, Kailua, Oahu, and Michio Takata, Director, Hawaiian Division of Fish and Game, for granting permission for POBSP personnel to visit Pearl and Hermes Reef and for providing unpublished field notes and preliminary reports of U.S. Fish and Wildlife Service and State of Hawaii survey trips to the atoll. We would also like to thank the U.S. Navy and U.S. Coast Guard for full cooperation and assistance in providing transportation and in gathering scientific and historical data.

We are very grateful for the full cooperation and assistance in obtaining POBSP band recapture information from the Bird Banding Center, Yamashina Institute for Ornithology, Tokyo, Japan, and The Centre of Ringing and Marking of Birds and Terrestrial Mammals, USSR Academy of Sciences, Zoological Institute, Moscow, USSR, as well as the Bird Banding Laboratory, Migratory Bird Populations Station, Bureau of Sport Fisheries and Wildlife, Laurel, Maryland.

It is difficult to give adequate acknowledgment to all individuals who helped gather historical and scientific data. Those who deserve special acknowledgment include: Ronald R. Amerson, U.S. Navy, Honolulu, Hawaii; Edwin H. Bryan, Jr., Pacific Scientific Information Center, Bernice P. Bishop Museum, Honolulu, Hawaii; Archie F. Carr, University of Florida, Gainesville, Florida; Jean Dabagh, Hawaii State Archives, Honolulu, Hawaii; Paul S. Galtsoff, Woods Hole, Massachusetts; E.C. Jones, Bureau of Commercial Fisheries, Honolulu, Hawaii; Chandler S. Robbins, Bureau of Sport Fisheries and Wildlife, Patuxent, Maryland; Harry Schwartz, Modern Military History Division, U.S. National Archives, Washington, D.C.; Alexander Wetmore, Smithsonian Institution, Washington, D.C.; and Virginia Frear Wild, Honolulu, Hawaii. We are

especially grateful to Kay B. Forck, Redwood City, California, for assistance in assemblage of the history section.

We are deeply indebted to the following POBSP personnel who have contributed to this manuscript: Kenneth E. Amerman, Alan H. Anderson, Winston E. Banko, F. Allen Blagden, David L. Burckhalter, Robert L. DeLong, Charles A. Ely, Robert R. Fleet, C. Douglas Hackman, the late J. Vincent Hoeman, T. James Lewis, Charles R. Long, Peter Marshall, Robert W. McFarlane, Richard W. Merrill, Fred C. Sibley, Dennis L. Stadel, F. Christian Thompson, Robert Tuxson, J. Douglas Whitman, George S. Wislocki, and Paul W. Woodward who spent long hours collecting field data; Anne Keenan Poulson who carefully drafted the maps and charts; Mae H. Esterline who gave editorial advice on early drafts of the manuscript; Jane P. Church who edited the final draft and attended to all details of producing the final copy; and Philip S. Humphrey who encouraged and supervised the entire POBSP field and writing effort.

We also wish to thank Robert L. Brownell, POBSP; F. Raymond Fosberg, Smithsonian Institution; Eugene Kridler, BSFW; Robert M. Mengel, University of Kansas; Philip C. Shelton, POBSP; and George E. Watson, Smithsonian Institution, for critically reading various sections of the manuscript. The camera copy was typed by Barbara B. Anderson with funding through a contract with the Bureau of Sport Fisheries and Wildlife, Department of Interior (contract number 14-16-008-596, February 3, 1971).

LITERATURE CITED

- Air Weather Service [MATS] Climatic Center, USAF. Pearl and Hermes Reef, Hawaii. USN. Summaries 1953-1963. Asheville, North Carolina.
- Aldrich, J.W., C.S. Robbins, and D.W. Rice. (ms.). Investigations of bird hazards to aircraft of Midway Island - 1956. 4 February 1957 Progress Report. Smithsonian Institution, Washington. 11 pp.
- Alexander, W.B. et al. 1965. The families and genera of the petrels and their names. *Ibis* 107: 401-405.
- Allen, G.M. 1942. Extinct and vanishing mammals of the Western Hemisphere. *Amer. Comm. Int. Wildlife Prot., Spec. Publ.* 11: 1-620.
- American Ornithologists' Union. 1957. Checklist of North American birds. 5th ed. Lord Baltimore Press, Baltimore.
- Amerson, A.B., Jr. 1968. Tick distribution in the Central Pacific as influenced by sea bird movement. *J. Med. Ent.* 5: 332-339.
- 1971. The natural history of French Frigate Shoals, Northwestern Hawaiian Islands. *Atoll Res. Bull.* 150: 1-383.
- Amerson, A.B., Jr., and K.C. Emerson. 1971. Records of Mallophaga from Pacific birds. *Atoll Res. Bull.* 146: 1-30.
- Anderson, W.G. 1954. Notes on food habits of sea birds of the Pacific. *Elepaio* 14: 80-84.
- Anonymous. 1859a. *The Friend*, 13 August 1859.
- 1859b. *Polynesian*, August 1859.
- 1868. North Pacific Ocean. Report of Captain Wm. Reynolds, U.S. Ship "Lackawanna," on Midway or Brooks Islands, Ocean Islands, and Pearl and Hermes Reefs--30th September 1867. *Naut. Mag.* 37: 269-275.
- 1927. Fishing and shell hunting expedition returns from Pearl and Hermes Reef. *Honolulu Advertiser*, 13 May 1927, 1: 1-6, 2: 3-4.
- 1939. Manure. *Sales Builder*, January 1939, 12(1): 2-22.
- Atkinson, A.L.C., and W.A. Bryan. 1913. A rare seal. *N.Y. Zool. Soc. Bull.* 16: 1050-1051.
- Attems, C.G. 1938. Myriopods of Hawaii [English translation]. *Zool. Soc. London, Proc., B*, 108: 365-387.
- Bailey, A.M. 1918. The monk seal of the Southern Pacific. *Nat. Hist.* 18: 396-399.

- 1952. The Hawaiian monk seal. Denver Mus. Nat. Hist., Mus. Pict. 7: 1-30.
- 1956. Birds of Midway and Laysan Islands. Denver Mus. Nat. Hist., Mus. Pict. 12: 1-130.
- Baldwin, P.H. 1945. Fate of the Laysan rail. Audubon Mag. 47: 343-348.
- 1947. The life history of the Laysan rail. Condor 49: 14-21.
- Bartsch, P. 1931. A new pearl oyster from the Hawaiian Islands. U.S. Nat. Mus., Proc. 79(12): 1-2.
- Beardsley, J.W. 1966. Insects and other terrestrial arthropods from the Leeward Hawaiian Islands. Pac. Sci. 19: 157-185.
- Berger, A.J. 1970. The present status of the birds of Hawaii. Pac. Sci. 24: 29-42.
- Bitter, G. 1900. Die phanerogamische Pflanzenwelt der Insel Laysan. Abh. Nat. Ver. Brem. 16: 430-439.
- Bock, W.J. 1958. A generic review of the plovers (Charadriinae, Aves). Mus. Comp. Zool. Bull. 118: 27-97.
- Brennan, J.M. 1965. A small collection of chiggers (Acarina: Trombiculidae) from the North Central Pacific. J. Parasitol. 51: 888-892.
- Brennan, J.M., and A.B. Amerson, Jr. 1971. Six new species and additional records of chiggers from the Central Pacific (Acarina: Trombiculidae). J. Parasitol. 57: 1311-1317.
- Brooks, N.C. 1860. Islands and reefs west-northwest of the Sandwich Islands, Pacific. Naut. Mag. 29: 499-504.
- Bryan, E.H., Jr. 1937. Pearl and Hermes Reef. Parad. Pac. 49(10): 19, 30.
- 1942. American Polynesia and the Hawaiian chain. Tongg Publ. Co., Honolulu. 253 pp.
- 1954. The Hawaiian chain. B.P. Bishop Mus. Press, Honolulu. 71 pp.
- 1958. Check list and summary of Hawaiian birds. Books about Hawaii. Honolulu, Hawaii. 28 pp.
- Bryan, E.H., Jr. et al. 1926. Insects of Hawaii, Johnston Island and Wake Island. B.P. Bishop Mus. Bull. 31: 1-94.
- BSFW--Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Dept. of Interior, Kailua, Hawaii [unpublished reports]:
- 1964a. Kridler, E. Hawaiian Islands National Wildlife Refuge, March 1964.

- 1964b. ---- Hawaiian Islands National Wildlife Refuge, September 16 through 27, 1964. 30 pp.
1965. ---- Hawaiian Islands National Wildlife Refuge, March 11-23, 1965. 20 pp.
- 1966a. ---- Hawaiian Islands National Wildlife Refuge trip report, March 17 - April 16, 1966. 24 pp.
- 1966b. ---- Hawaiian Islands National Wildlife Refuge trip--September 8-28, 1966. 34 pp.
- 1967a. ---- Refuge log book for 6 March - 1 April 1967. 39 pp.
- 1967b. ---- Pers. comm., July 1967.
- 1967c. ---- Refuge log book for 19-29 September 1967. 12 pp.
- 1967d. Robbins, C.S. Pers. corresp., March 1967.
1968. Kridler, E. Pers. comm., March 1968.
- 1969a. ---- Field trip report, Pearl and Hermes Reef, Hawaiian Islands National Wildlife Refuge, 9-13 February 1969. 7 pp.
- 1969b. ---- Hawaiian Islands National Wildlife Refuge spring trip, March 19 - April 6, 1969. 32 pp.
- 1969c. ---- Hawaiian Islands National Wildlife Refuge, Kailua, Hawaii, field trip report, May 25 - June 1, 1969. 8 pp.
- 1969d. ---- Hawaiian Islands National Wildlife Refuge, field trip report. August 19 - September 23, 1969. 32 pp.
- 1969e. Olsen, D.L. Hawaiian Islands National Wildlife Refuge field trip May 28- June 11, 1969. 18 pp.
- Carr, A.F., Jr. 1964. Transoceanic migrations of the green turtle. *Bioscience* 14(8): 49-52.
- 1972. Great reptiles, great enigmas. *Audubon Mag.* 74(2): 24-35.
- Christophersen, E., and E.L. Caum. 1931. Vascular plants of the Leeward Islands, Hawaii. *B.P. Bishop Mus. Bull.* 81: 1-41.
- Clapp, R.B. 1968. Three unusual shorebirds from Midway Atoll, Pacific Ocean. *Elepaio* 28: 76-77.
- Clapp, R.B., and R.L. Pyle. 1968. Noteworthy records of waterbirds from Oahu. *Elepaio* 29: 37-39.
- Clapp, R.B., and P.W. Woodward. 1968. New records of birds from the Hawaiian Leeward Islands. *U.S. Nat. Mus., Proc.* 124(3640): 1-39.

- Clark, A.H. 1949. Ophiuroidea of the Hawaiian Islands. B.P. Bishop Mus. Bull. 195: 1-133.
- Clark, H.L. 1925. Echinoderms other than sea stars. In Edmondson et al., 1925. B.P. Bishop Mus. Bull. 27: 89-111.
- Cushman, J.L. 1925. Foraminifera. In Edmondson et al., 1925. B.P. Bishop Mus. Bull. 27: 121-144.
- 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: 1-233.
- Delacour, J. 1954. The waterfowl of the world. Vol. 1. Country Life Ltd., London.
- 1959. The waterfowl of the world. Vol. 3. Country Life Ltd., London.
- Dill, H.R., and W.A. Bryan. 1912. Report of an expedition to Laysan Island in 1911 under the joint auspices of the United States Department of Agriculture and the University of Iowa. U.S. Dept. Agr., Biol. Surv. Bull. 42: 1-30.
- Edmondson, C.H. 1925. Crustacea. In Edmondson et al., 1925. B.P. Bishop Mus. Bull. 27: 3-62.
- 1930. New Hawaiian Crustacea. B.P. Bishop Mus., Occ. Pap. 9(10): 1-18.
- 1935. New and rare Polynesian Crustacea. B.P. Bishop Mus., Occ. Pap. 10(24): 3-40.
- Elschner, C. 1915. The Leeward Islands of the Hawaiian Group. Honolulu Advertiser, Honolulu. 68 pp.
- Ely, C.A., and R.B. Clapp. In press. The natural history of Laysan Island, Northwestern Hawaiian Islands. Atoll Res. Bull.
- Farrell, A. [ed.]. 1928. John Cameron's odyssey. The Macmillan Co., New York. 461 pp.
- Fisher, H.I., and P.H. Baldwin. 1945. A recent trip to Midway Islands, Pacific Ocean. Elepaio 6: 11-13.
- 1946. War and the birds of Midway Atoll. Condor 48: 3-15.
- Fisher, W.K. 1925. Sea stars. In Edmondson et al., 1925. B.P. Bishop Mus. Bull. 27: 63-88.
- Fowler, H.W. 1927. Fishes of the tropical Central Pacific. B.P. Bishop Mus. Bull. 38: 1-32.
- 1928. The fishes of Oceania. B.P. Bishop Mus., Mem. 10: 1-540.

- 1931. The fishes of Oceania. Supplement 1. B.P. Bishop Mus., Mem. 11: 313-381.
- 1934. The fishes of Oceania. Supplement 2. B.P. Bishop Mus., Mem. 11: 385-466.
- 1949. The fishes of Oceania. Supplement 3. B.P. Bishop Mus., Mem. 12: 37-186.
- Fowler, H.W., and S.C. Ball. 1925. Fishes of Hawaii, Johnston Island, and Wake Island. B.P. Bishop Mus. Bull. 26: 1-31.
- Galtsoff, P.S. 1933. Pearl and Hermes Reef, Hawaii, hydrographical and biological observations. B.P. Bishop Mus. Bull. 107: 1-49.
- Garrett, L.E., and F.H. Haramoto. 1967. A catalog of Hawaiian Acarina. Haw. Ent. Soc., Proc. 19: 381-414.
- Goff, M.L. 1971. New records of chiggers (Acarina, Trombiculidae) from the Northwestern Hawaiian Islands. J. Med. Ent. 8: 456.
- Gosline, W.A., and V.E. Brock. 1965. Handbook of Hawaiian fishes. Univ. of Hawaii Press, Honolulu. 372 pp.
- Gregory, H.E. 1924. Report of the director for 1923. B.P. Bishop Mus. Bull. 10: 1-38.
- Gross, M.G., J.D. Milliman, J.I. Tracy, Jr., and H.S. Ladd. 1969. Marine geology of Kure and Midway Atolls, Hawaii; a preliminary report. Pac. Sci. 23: 17-25.
- Hartman, O. 1966. Polychaetous annelids of the Hawaiian Islands. B.P. Bishop Mus., Occ. Pap. 23: 163-252.
- Hawaiian Mission Children's Society Library, Honolulu [unpublished letters]:
Missionary Letters. 1: 20-21: Letter from Bingham, Thurston, and Loomis dated 12 October 1822; letter from E. Loomis to his brother dated October 1822.
- HDFG--Hawaiian Division of Fish and Game, State of Hawaii, Honolulu [unpublished reports]:
1961. Woodside, D.H., and R.J. Kramer. A report on a survey trip to the Hawaiian Islands National Wildlife Refuge, March 1961. 32 pp.
1964. Walker, R.L. Notes on a survey of the Hawaiian Leeward Islands, March 1964. 35 pp.
- Hershkovitz, P. 1966. Catalog of the living whales. U.S. Nat. Mus. Bull. 246: 1-259.
- Holly, M. 1932. Echinodermata from Pearl and Hermes Reef. B.P. Bishop Mus., Occ. Pap. 10(1): 1-9.

- 1935. Polychaeta from Hawaii. B.P. Bishop Mus. Bull. 129: 1-33.
- Hornell, J. 1934. Log of the schooner Ada on a fishing cruise in the North Pacific, 1882. Mariner's Mirror 20: 426-437.
- Howe, M.A. 1934. Hawaiian algae collected by Dr. Paul C. Galtsoff. J. Wash. Acad. Sci. 24: 32-42.
- Hutchinson, G.E. 1950. Survey of existing knowledge of biogeochemistry. 3. The biogeochemistry of vertebrate excretion. Amer. Mus. Nat. Hist. Bull. 96: 1-554.
- Ikehara, I.I. 1953. Live-bait fishing for tuna in the Central Pacific. U.S. Fish and Wildl. Serv., Spec. Sci. Rep.: Fisheries 107: 1-20.
- June, F.C., and J.W. Reintjes. 1953. Common tuna-bait fishes of the Central Pacific. U.S. Fish and Wildl. Serv., Res. Rep. 34: 1-54.
- Kemble, J.H. [ed.]. 1966. To California and the south seas: the diary of Albert G. Osbun, 1849-1851. The Huntington Library, San Marino, Calif. 233 pp.
- Kenyon, K.W. In prep. Man versus the monk seal.
- Kenyon, K.W., and E. Kridler. 1969. Laysan Albatrosses swallow indigestible matter. Auk 86: 339-343.
- Kenyon, K.W., and D.W. Rice. 1959. Life history of the Hawaiian monk seal. Pac. Sci. 13: 215-252.
- King, J.E. 1956. The monk seals (genus Monachus). Brit. Mus. (Nat. Hist.) Zool. Bull. 3: 201-256.
- King, W.B. 1967. Preliminary Smithsonian identification manual. Seabirds of the tropical Pacific Ocean. Smithsonian Institution, Washington. 126 pp.
- Kohls, G.M. 1966. A new sea bird tick, Ixodes amersoni, from Phoenix Island. J. Med. Ent. 3: 38-40.
- Kohls, G.M., and C.M. Clifford. 1967. The male and larva of Ixodes laysanensis Wilson with notes on rearing (Acarina, Ixodidae). J. Med. Ent. 4: 83-86.
- Kohls, G.M., D.E. Sonenshine, and C.M. Clifford. 1965. The systematics of the subfamily Ornithodorinae (Acarina: Argasidae). II. Identification of the larvae of the Western Hemisphere and description of three new species. Ent. Soc. Amer., Ann. 58: 331-364.
- Kroenke, L.W., and G.P. Woollard. 1965. Gravity investigations on the Leeward Islands of the Hawaiian Ridge and Johnston Island. Pac. Sci. 19: 361-366.

- Ladd, H.S., J.I. Tracey, Jr., and M.G. Gross. 1957. Drilling on Midway Atoll, Hawaii. *Science* 156: 1088-1094.
- Lamoureux, C.H. 1964. The Leeward Hawaiian Islands. *Haw. Bot. Soc., Newsl.* 3(2): 7-11.
- Laycock, G. 1970a. The Hawaiian islands of birds. *Audubon Mag.* 72(1): 44-61.
- 1970b. Haunted sands of Laysan. *Audubon Mag.* 72(2): 42-49.
- Lopes, H. de Souza. 1938. On the genus Goniophyto Townsend, 1927, with description of a new species from Hawaii. *B.P. Bishop Mus., Occ. Pap.* 14: 193-197.
- Maa, T.C. 1968. Records of Hippoboscidae (Diptera) from the Central Pacific. *J. Med. Ent.* 5: 325-328.
- Morison, S.E. 1949. History of United States Naval Operations in World War II. Vol. IV. Coral Sea, Midway, and submarine actions, May 1942 - August 1942. Little, Brown and Co., Boston. 307 pp.
- Morrell, B., Jr. 1832. A narrative of four voyages, to the South Sea, North and South Pacific Ocean, Chinese Sea, Ethiopic and Southern Atlantic Ocean, Indian and Antarctic Ocean. Harper and Brothers, New York. 492 pp.
- Morris, P.C. 1934. How the Territory of Hawaii grew and what domain it covers. *Haw. Hist. Soc. 42nd Ann. Rep. for 1933*: 13-39.
- Munro, G.C. 1942. Birds of Hawaii and adventures in bird study; an ocean cruise, no. 10. *Elepaio* 3: 12-13.
- 1945. The small birds of Midway. *Elepaio* 6: 13-14.
- 1947. Effect of a tidal wave on some sea bird nesting islands. *Elepaio* 7: 43-44, 51-52.
- Munter, W.H. (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. U.S. Nat. Archives. Rec. Group 26. 19 pp.
- Office of Geography. U.S. Dept. of the Interior. 1956. NIS [National Intelligence Survey] Gazetteer, Hawaiian Islands. Central Intelligence Agency, Washington. 89 pp.
- Parsons, J.J. 1962. The green turtle and man. Univ. of Florida Press, Gainesville. 126 pp.
- Paty, J. 1857. Account of the Manuokawai--interesting account of her explorations. *The Polynesian.* 6 June 1857, 40: 2-3.
- Pearcy, G.E. 1959. Hawaii's territorial sea. *Prof. Geog.* 11(6): 2-6.

- Peters, J.L. 1931. Check-list of birds of the world. Vol. I. Harv. Univ. Press, Cambridge, Mass. 345 pp.
- 1934. Check-list of birds of the world. Vol. II. Harv. Univ. Press, Cambridge, Mass. 401 pp.
- 1937. Check-list of birds of the world. Vol. III. Harv. Univ. Press, Cambridge, Mass. 311 pp.
- Pettingill, O.A., Jr. 1964. Midway Islands: man and birds in conflict. Audubon Mag. 66: 154-159.
- Pietschmann, V. 1930. Remarks on Pacific fishes. B.P. Bishop Mus. Bull. 73: 1-24.
- 1938. Hawaiian shore fishes. B.P. Bishop Mus. Bull. 156: 1-55.
- Pilsbry, H.A. 1917. Marine molluscs of Hawaii, IV-VII. Acad. Nat. Sci. Phila., Proc. 69: 309-333.
- 1920. Marine molluscs of Hawaii, VII-XIII. Acad. Nat. Sci. Phila., Proc. 72: 296-328.
- 1927. Littoral barnacles of the Hawaiian Islands and Japan. Acad. Nat. Sci. Phila., Proc. 79: 305-317.
- POBSP--Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington [unpublished reports]:
1963. Sibley, F.C. Pacific Project field trip--June 1963. [Leeward Survey No. 2]. 9 pp.
- 1964a. Amerman, K.E. Leeward Islands survey: Pearl and Hermes Reef, Lisianski Island, August 1964. [Leeward Survey No. 4]. 11 pp.
- 1964b. Amerson, A.B., Jr. Northwest Hawaiian Islands trip report, March 1964. [Leeward Survey No. 3]. 20 pp.
- 1964c. Fleet, R.R. Leeward Islands survey no. 5, September 1964. 15 pp.
- 1964d. Sibley, F.C. Preliminary report on ATF trip no. 1, February-March 1963. [Leeward Survey No. 1]. 13 pp.
- 1965a. Banko, W.E. Trip report, Hawaiian Leeward Islands survey, March 11-23, 1965. [Leeward Survey No. 8]. 11 pp.
- 1965b. Wirtz, W.O., II. Leeward Islands survey: Pearl and Hermes Reef, Laysan Island, Lisianski Island, March 1965. [Leeward Survey No. 7]. 26 pp.
1966. Lewis, T.J. Trip report, Pearl and Hermes Reef, September 25-27, 1966. [Leeward Survey No. 16]. 10 pp.

- 1967a. Clapp, R.B., and C.A. Ely. Leeward survey no. 20, preliminary report, Pearl and Hermes Reef, 28-30 August 1967. 16 pp.
- 1967b. DeLong, R.L. Preliminary report: Pearl and Hermes Reef survey, May 28 - June 1, 1967. [Leeward Survey No. 19]. 12 pp.
- 1967c. ---- Census and observations of Hawaiian monk seal on Pearl and Hermes Reef, Lisianski, and Laysan Islands, May 31 to June 11, 1967. [Leeward Survey No. 19]. 8 pp.
- 1967d. Hackman, C.D. Preliminary report of Leeward Island survey no. 18, March 6 to March 27, 1967. 12 pp.
1968. Clapp, R.B. Leeward survey no. 22, preliminary report, Pearl and Hermes Reef, 22-24 March 1968. 20 pp.
- POFI--Pacific Ocean Fisheries Investigations, Bureau of Commercial Fisheries, Honolulu [unpublished notes and reports]:
1950. Narrative report; Hugh M. Smith - cruise V; 16 June - 6 August.
1951. Narrative report; Hugh M. Smith, cruise IX; 5 May - 2 July.
1955. Cruise report; FSW M/V John R. Manning, cruise 23, Part II; 5 January - 6 February.
- 1956a. Cruise report; FWS M/V John R. Manning, cruise 30; 15 March - 20 April.
- 1956b. Cruise report; FWS M/V John R. Manning, cruise 31; 19 May - 22 June.
- Rice, D.W. 1960a. Population dynamics of the Hawaiian monk seal. *J. Mammal.* 41: 376-385.
- 1960b. Distribution of the bottle-nosed dolphin in the Leeward Hawaiian Islands. *J. Mammal.* 41: 407-408.
- 1964. The Hawaiian monk seal. *Nat. Hist.* 72: 48-55.
- (ms. a). Sea bird populations on Pearl and Hermes Reef - 1957. 15 October 1957 memorandum to John W. Aldrich. Smithsonian Institution, Washington. 5 pp.
- (ms. b). Findings of the 1957-58 investigations of the bird problem at Midway Island. Undated summary report. Smithsonian Institution, Washington. 3 pp.
- Rice, D.W., and K.W. Kenyon. 1962. Breeding distribution, history and populations of North Pacific albatrosses. *Auk* 79: 365-386.
- Richardson, F. 1957. The breeding cycles of Hawaiian seabirds. *B.P. Bishop Mus. Bull.* 218: 1-41.

- St. John, H. 1970. The genus Sicyos (Cucurbitaceae) on the Hawaiian Leeward Islands, Hawaiian plant studies 35. Pac. Sci. 24: 439-456.
- Schilder, F.A. 1933. Cypraeaacea from Hawaii. B.P. Bishop Mus., Occ. Pap. 10(3): 1-22.
- Shelton, P.C. In prep. The natural history of Johnston Atoll, Central Pacific Ocean. Atoll Res. Bull.
- Sibley, F.C., and R.W. McFarlane. 1968. Gulls in the Central Pacific. Pac. Sci. 22: 314-321.
- Standen, R.S. 1967. An explanatory description of the sand islands of Kure, Midway, and Pearl and Hermes Atolls: Hawaiian Islands. MA thesis, Calif. State Coll., Los Angeles. 93 pp.
- Stearns, H.T. 1966. Geology of the state of Hawaii. Pacific Books, Palo Alto, Calif. 266 pp.
- Svihla, A. 1959. Notes on the Hawaiian monk seal. J. Mammal. 40: 226-229.
- Taylor, W.R. 1964. The genus Turbinaria in eastern seas. J. Linn. Soc. (Bot.) 58: 471-487.
- Thompson, G.B. 1948. Mallophaga collected by the Tanager expedition. B.P. Bishop Mus., Occ. Pap. 19: 195-200.
- Thorp, E.M. 1936. The sediments of the Pearl and Hermes Reef. J. Sed. Petrol. 6: 109-118.
- Thrum, T.G. [comp.]. 1909. Hawaiian almanac and annual for 1910. T.G. Thrum, Honolulu. 216 pp.
- Tomich, P.Q. 1969. Mammals of Hawaii. A synopsis and notational bibliography. B.P. Bishop Mus., Spec. Publ. 57: 1-238.
- Treadwell, A.L. 1925. Polychaetous annelids. In Edmondson et al., 1925. B.P. Bishop Mus. Bull. 27: 113-119.
- Tsuda, R.T. 1966. Marine benthic algae from the leeward Hawaiian group. Atoll Res. Bull. 115: 1-13.
- Udvardy, M.D.F. 1961. Additions to the check list of Hawaiian birds. Elepaio 21: 83-90.
- USCGS--U.S. Coast and Geodetic Survey, Washington.
Chart 4175.
- U.S. Department of State. 1965. United States and outlying areas. Geog. Bull. 5: 1-15.

U.S. National Archives, Washington [unpublished letters, documents, and reports]:

Record Group 22. U.S. Fish and Wildlife Service.

Record Group 24. U.S. Navy personnel records and ships' logs.

Record Group 26. U.S. Coast Guard.

Record Group 37. U.S. Hydrographic Office.

Record Group 48. U.S. Department of Interior.

Record Group 126. Records of the Office of Territories.

USNHO--U.S. Naval Hydrographic Office, Washington.

Chart 4.

Chart 5647.

U.S. Navy, Classified Operational Archives. Navy Yard, Washington [unpublished]:

War Diary, USS Preble, 1942.

Usinger, R.L. 1942. The genus Nysius and its allies in the Hawaiian Islands. B.P. Bishop Mus. Bull. 173: 1-167.

Watson, G.E., III. 1966. Smithsonian identification manual: seabirds of the tropical Atlantic Ocean. Smithsonian Institution, Washington.

----Wetmore, A. 1925. Bird life among lava rock and coral sand. Nat. Geogr. Mag. 48: 77-108.

----(ms.). Field notes, 1923. Smithsonian Institution, Washington.

Wheeler, W.M. 1934. Revised list of Hawaiian ants. B.P. Bishop Mus., Occ. Pap. 10(21): 3-21.

Wiens, H.J. 1959. Atoll development and morphology. Assoc. Amer. Geogr., Ann. 49: 31-54.

----1962. Atoll environment and ecology. Yale Univ. Press, New Haven. 532 pp.

Wilder, G.P. 1905. A short trip to Midway Islands with Capt. A.P. Nidblack in the U.S.S. "Iroquois." Haw. For. Agr. 2: 390-396.

Willett, G. 1919. Notes on the nesting of two little-known species of petrel. Condor 21: 60-61.

----(ms.). Report on the Bureau of the Biological Survey Expedition to the Northwestern Hawaiian Islands in 1912-1913. Bureau of Sport Fisheries and Wildlife, Kailua, Hawaii.

Yocom, C.F. 1965. Longevity record of a Black-footed Albatross. Condor 67: 187-188.

Zimmerman, E.C. 1940. Studies of Hawaiian Neuroptera. Haw. Ent. Soc., Proc. 10: 487-510.

----1948a. Insects of Hawaii. Vol. 1. Introduction. Univ. of Hawaii Press, Honolulu. 191 pp.

----1948b. Insects of Hawaii. Vol. 2. Apterygota to Thysanoptera. Univ. of Hawaii Press, Honolulu. viii and 475 pp.

----1948c. Insects of Hawaii. Vol. 3. Heteroptera. Univ. of Hawaii Press, Honolulu. v and 255 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, Neuroptera, Tridoptera, and supplements to Vols. 1 to 5. Univ. of Hawaii Press, Honolulu. ix and 209 pp.

----1958. Insects of Hawaii. Vol. 7. Macrolepidoptera. Univ. of Hawaii Press, Honolulu. ix and 542 pp.

Appendix Table 1. Scientific visits to Pearl and Hermes Reef, 1857-1969 **

<u>Date of Visit</u>	<u>Vessel</u>	<u>Personnel</u>
1857 19-20 May	<u>Manoukawai</u>	John Paty
1859 5 July	<u>Gambia</u>	N.C. Brooks
1891 6-7 July	<u>Kaalakai</u>	Rothschild Expedition: George C. Munro, Henry C. Palmer
1912 24 Dec.	USRC <u>Thetis</u>	USN: Cmdr. G.R. Salisbury
1913 15 Mar.	USRC <u>Thetis</u>	BBS: Alfred M. Bailey, George Willett, David T. Fullaway
1914 ? Sept.	USRC <u>Thetis</u>	Carl Elschner
1916 4 Feb.	USRC <u>Thetis</u>	W.H. Munter
1923 26-28 Apr.	USS <u>Tanager</u>	<u>Tanager</u> Expedition: Edwin L. Caum, Chapman Grant, David T. Fullaway, Eric L. Schlemmer, Ditlev Thaanum, Alexander Wetmore*
17-19 May	USS <u>Tanager</u>	Theodore T. Dranga, Austin Jones, Frank R. Lawrence, E.C. Reno,* Lorrin A. Thurston, Gerrit P. Wilder
1927-1931	<u>Hermes</u> (renamed <u>Lanikai</u>)	William G. Anderson, George Kaufman
1928 ?	<u>Lanikai</u>	Victor Pietschmann
1930 22 July-23 Aug.	USS <u>Whippoorwill</u>	Paul S. Galtsoff,* N.S. Castle, John F. Reppun, Leon Amboy, Anatolio Polo

**Symbols and abbreviations: BBS - Bureau of Biological Survey; BPBM - Bernice P. Bishop Museum; BSFW - Bureau of Sport Fisheries and Wildlife; CC - Claremont College; HDFG - Hawaiian Division of Fish and Game; HSB - Honolulu Star Bulletin; NAS - National Audubon Society; POBSP - Pacific Ocean Biological Survey Program; POFI - Pacific Ocean Fisheries Investigation; UF - University of Florida; UH - University of Hawaii; USCG - U.S. Coast Guard; USFW - U.S. Fish and Wildlife Service; USN - U.S. Navy; VU - Vienna University.

*Biologist-in-charge.

Appendix Table 1. (continued)

Date of Visit	Vessel	Personnel
1949 May	Navy PBV	Alfred M. Bailey
1950 25-27 June	USFW <u>Hugh M. Smith</u>	HDFG: Vernon E. Brock; UH: William A. Gosline; POFI personnel
1951 14 May	USFW <u>Hugh M. Smith</u>	POFI personnel
1954 1 Nov.	Aerial survey	BSFW: Philip Dumont, Johnson A. Neff
5 Dec.	" "	" " " " "
1955 25-26 Jan.	USFW <u>John R. Manning</u>	POFI: Tamio Otsu, Walter Matsumoto
1956 22-24 Mar.	USFW <u>John R. Manning</u>	POFI: Daniel T. Yamashita, Herbert S. Shippen
24-26 May	USFW <u>John R. Manning</u>	POFI: E.C. Jones, T.S. Hida
9 Dec.	Aerial survey	BSFW: John W. Aldrich, Karl W. Kenyon, Dale W. Rice, Chandler S. Robbins
10 Dec.	" "	BSFW: Karl W. Kenyon, Dale W. Rice
17 Dec.	" "	" " " " "
1957 7 Jan.	" "	" " " " "
24 Jan.	" "	" " " " "
15 Apr.	" "	" " " " "
14 May	" "	" " " " "
14 Oct.	" "	BSFW: Dale W. Rice
18 Dec.	" "	" " "
1958 24 Jan.	" "	" " "
14 Apr.	" "	" " "
2 May	" "	" " "
16 June	" "	" " "

Appendix Table 1. (continued)

Date of Visit	Vessel	Personnel
1961 12 Mar.	USCGC <u>Planetree</u>	HDFG: David H. Woodside, Raymond J. Kramer
1962 Jan.	Aerial survey	UF: Archie F. Carr
1963 26 Feb.- 8 Mar.	USS <u>Moctobi</u> (ATF-105)	POBSP: A. Binion Amerson, Jr., F. Allen Blagden, Robert W. McFarlane, Fred C. Sibley, William O. Wirtz II*
18-23, 27 June	USS <u>Tawakoni</u> (ATF-114)	POBSP: A. Binion Amerson, Jr., Fred C. Sibley*
1964 13-14 Mar.	USCGC <u>Planetree</u> (WAGL-307)	POBSP: A. Binion Amerson, Jr.,* George S. Wislocki; BSFW: Eugene Kridler, Edward O'Neal; HDFG: Ronald L. Walker; UH: Loren W. Kroenke
16-20 Aug.	USNS <u>Shearwater</u> (T-AG-177)	POBSP: Kenneth E. Amerman,* Allen Anderson, Peter Marshall, Richard W. Merrill, J. Douglas Whitman, Paul W. Woodward; UH: Allen L. Young
16-17 Sept.	USCGC <u>Basswood</u>	POBSP: Robert R. Fleet, Charles R. Long; BSFW: Eugene Kridler;* HDFG: Ronald L. Walker; UH: John Beardsley
1965 15-19 Mar.	USNS <u>Shearwater</u> (T-AG-177)	POBSP; Kenneth E. Amerman, Roger B. Clapp, J. Vincent Hoeman, Dennis L. Stadel, William O. Wirtz II*
21-22 Mar.	USCGC <u>Blackhaw</u> (WAGL-390)	POBSP: Winston E. Banko; BSFW: Eugene Kridler,* Chandler Robbins; HDFG: Ronald L. Walker
1966 1 Apr.	USCGC <u>Buttonwood</u> (WAGL-306)	BSFW: Eugene Kridler;* HDFG: Nelson Rice, Ronald L. Walker; UH: Andrew J. Berger
20-26 Sept.	USCGC <u>Ironwood</u> (WAGL-297)	BSFW: Karl W. Kenyon, Eugene Kridler;* HDFG: Ronald L. Walker; CC: Sherwin Carlquist; HSB: Warren Roll
25-27 Sept.	Navy helicopter	POBSP: T. James Lewis;* USN: George Young
1967 16-17 Mar.	" "	BSFW: Van T. Harris, Chandler Robbins*

Appendix Table 1. (continued)

<u>Date of Visit</u>	<u>Vessel</u>	<u>Personnel</u>
1967 21-23 Mar.	USCGC <u>Basswood</u>	POBSP: C. Douglas Hackman; BSFW: Eugene Kridler;* HDFG: Ernest F. Kosaka; UH: John Maciolek, Richard Wass
28, 30 May- 1 June	LT 2081, LT 2086, LT 2087	POBSP: David L. Burckhalter, Robert L. DeLong,* Dennis L. Stadel, F. Christian Thompson, Robert Tuxson; USN: Ronald Amerson
3-9 July	?	BSFW: Eugene Kridler, ?
28-30 Aug.	LT 2081, LT 2086, LT 2087	POBSP: Roger B. Clapp, Charles A. Ely,* David I. Hoff; USN: Wrangel
27-29 Sept.	USCGC <u>Buttonwood</u>	BSFW: Robert Ballou, Eugene Kridler,* John L. Sincock; UDFG: Ronald L. Walker
1968 22-24 Mar.	USCGC <u>Ironwood</u> (WAGL-297)	POBSP: Roger B. Clapp; BSFW: Karl W. Kenyon, Eugene Kridler,* John L. Sincock; HDFG: Ernest F. Kosaka; USCG: Douglas Keran
8 Aug.	?	BSFW: Eugene Kridler, ?
1969 10-12 Feb.	Navy helicopter	BSFW: Eugene Kridler, David L. Olsen; USN: Ronald Amerson
31 Mar.- 2 Apr.	USCGC <u>Buttonwood</u>	BSFW: Karl W. Kenyon, Eugene Kridler, David L. Olsen, John L. Sincock; NAS: George Laycock
26-31 May	Navy helicopter	BSFW: Eugene Kridler; BPBM: Donald Allred; USN: Ronald Amerson
5 June	<u>Mahi</u>	BSFW: David L. Olsen,* John L. Sincock; HDFG: Ernest F. Kosaka; UH: Karl Bathen, Thomas Clark, James McVay, William Patzert; BPBM: Douglas Yen; Ronald Kent
28 July	?	BSFW: ?
10-19 Sept.	USCGC <u>Buttonwood</u>	BSFW: Eugene Kridler,* David L. Olsen, John L. Sincock; UH: John Maciolek

Appendix Table 2. Publications and manuscripts on collections and studies made on Pearl and Hermes Reef *

PROTOZOA	
Cushman, 1925	Records 25 species of Foraminifera from <u>Tanager</u> Expedition
PORIFERA	
Galtsoff, 1933	Records 1 sponge species from 1930
COELENTERATA	
Galtsoff, 1933	Records 1 jellyfish species and 12 coral species from 1930
MOLLUSCA	
Pilsbry, 1917	Records 1 mollusk species collected by Munter
Pilsbry, 1920	Lists 3 mollusk species collected by Munter
Pilsbry, 1927	Lists 1 barnacle from <u>Tanager</u> collection
Bartsch, 1931	Describes a new pearl oyster from Galtsoff's collection
Galtsoff, 1933	Lists 10 mollusk species from 1930
Schilder, 1933	Reports 14 species of Cypraea collected by Pietschmann in February 1928
Dall, Bartsch, and Rehder, 1938	Records 8 species of mollusks
ECHINODERMATA	
Clark, 1925	Reports 10 species of echinoderms from <u>Tanager</u> collection
Fisher, 1925	Lists 3 species of starfish collected by <u>Tanager</u> Expedition
Holly, 1932	Reports 13 echinoderms from collections made in 1927-28

*Authors are in chronological order.

Appendix Table 2. (continued)

ECHINODERMATA (continued)

- Galtsoff, 1933 Lists 4 species of sea urchins, 3 starfish, 1 brittle star, and 9 holothurian species from 1930
- Clark, 1949 Lists 33-34 brittle stars (Ophiuroidea) collected by Albatross and Tanager Expeditions

ANNELIDA

- Treadwell, 1925 Reports 1 annelid from Tanager collection
- Holly, 1935 Lists 15 Polychaeta from Pietschmann's 1928 collection
- Hartman, 1966 Summarizes earlier polychaetous annelids; lists 11 species

ARTHROPODA

1. Crustacea

- Edmondson, 1925 Reports 33 species of decapods from Tanager collection
- Edmondson, 1930 Describes 1 new species of crab taken in 1927 by T.T. Dranga
- Galtsoff, 1933 Mentions collection of over 50 species taken in 1930; lists only 5 species
- Edmondson, 1935 Describes 1 new crustacea species

2. Chilopoda

- Attems, 1938 Records 1 myriapod species collected by Tanager Expedition

3. Arachnida

- Brennan, 1965 Records 1 chigger from POBSP material
- Kohls, Sonnenshine and Clifford, 1965 Records 1 tick species from POBSP material
- Kohls, 1966 Records 1 ixodid species from POBSP material
- Garrett and Haramoto, 1967 Summarizes 2 earlier records of acarina

Appendix Table 2. (continued)

ARTHROPODA (continued)

3. Arachnida (continued)

Kohls and Clifford, 1967	Mentions occurrence of ixodid species from POBSP data
Amerson, 1968	Records 2 tick species from POBSP collections
Brennan and Amerson, 1971	Records 1 chigger collected by J.L. Gressitt in December 1970.
Goff, 1971	Records 3 chiggers collected by J.L. Gressitt in December 1970

INSECTA

Bryan, <u>et al.</u> , 1926	Lists <u>ca.</u> 24 insects from <u>Tanager</u> collection
Wheeler, 1934	Lists 1 ant species
Lopes, 1938	Describes new sarcophagid from <u>Tanager</u> material
Zimmerman, 1940	Reports a neuropteran
Munro, 1942	Mentions 2 insects on ship while offshore in 1891
Usinger, 1942	Records 1 new <u>Nysius</u> species from <u>Tanager</u> collection
Thompson, 1948	Records 2 Mallophaga species from <u>Tanager</u> collection
Zimmerman, 1948a	Lists 1 Orthoptera and 2 Dermaptera
Zimmerman, 1948b	Lists 1 Orthoptera species
Zimmerman, 1948c	Lists 3 Hemiptera species
Zimmerman, 1948d	Lists 1 Homoptera species
Zimmerman, 1957	Lists 1 Neuroptera species
Zimmerman, 1958	Lists 1 Lepidoptera species
Beardsley, 1966	Lists 52 insect species

Appendix Table 2. (continued)

INSECTA (continued)

Maa, 1968	Records 2 hippoboscid flies from POBSP collection
Amerson and Emerson, 1971	Records 2 Mallophaga species from POBSP material

CHORDATA

1. Pisces

Brooks, 1860	First record of fish in 1859
Fowler and Ball, 1925	Reports 16 fish species taken by <u>Tanager Expedition</u>
Fowler, 1927	Lists 1 fish species from <u>Tanager Expedition</u>
Pietschmann, 1930	Lists 9 fish species collected by Dranga in 1927
Fowler, 1931	Adds 3 fish species, collected by Dranga, April 1927
Schilder, 1932	Discusses hemirhampids collected in 1928
Galtsoff, 1933	Lists 31 fish species collected in 1930
Pietschmann, 1938	Reports fishes collected in 1927-28
POFI (1950-56) mss.	Consists of 5 trip reports listing fish collections and observations
Ikehara, 1953	Records 5 species of bait fish from 1950 and 1951 POFI surveys
Jones and Reintjes, 1953	Records 4 fish species
Gosline and Brock, 1965	Includes fish from earlier trips

2. Reptilia

Morrell, 1832	First record of sea turtles
Paty, 1857	Notes presence of turtles
Brooks, 1860	Records presence of turtles
Bailey, 1918	Reports sleeping turtles

Appendix Table 2. (continued)

CHORDATA (continued)

2. Reptilia (continued)

Galtsoff, 1933	Records sea turtles in 1930
POFI (1950-56) mss.	Consists of 5 trip reports listing turtle observations
Bailey, 1956	Records many large sea turtles at North Island seen by Willett in 1913
HDFG (1961-64) mss.	Includes 2 trip reports of Refuge surveys
POBSP (1963-68) mss.	Includes 12 trip reports from island surveys
BSFW (1964-69) mss.	Includes 15 trip reports of Refuge surveys
Carr, 1964	Notes presence of sea turtle
Kemble, 1966	Reports turtle observations by Osburn in 1850

3. Mammalia

Paty, 1857	Mentions presence of seals in May 1857
Atkinson and Bryan, 1913	Notes estimate by Frear in 1912
Bailey, 1918	Reports less than 60 seals and a school of porpoise observed in 1913
Wetmore, ms.	1923 personal journal notes presence of seals and rabbits
Gregory, 1924	Mentions <u>Tanager</u> personnel killed all but one of the rabbits seen in May 1923
Wetmore, 1925	Notes presence of seals in 1923
Bryan <u>et al.</u> , 1926	Notes presence of number of rabbits on Southeast in 1923
Galtsoff, 1933	Counts 68 seals
Allen, 1942	Reports seal colony found by <u>Tanager Expedition</u>

Appendix Table 2. (continued)

CHORDATA (continued)

3. Mammalia (continued)

POFI (1950-56) mss.	Consists of 5 trip reports listing mammal observations
Bailey, 1956	Records <u>ca.</u> 50 seals seen by Willett in 1913
King, 1956	Summarizes previous information on Hawaiian Monk Seals
Kenyon and Rice, 1959	Reports observations of Hawaiian Monk Seals from 1956 and 1957 aerial surveys
Svihla, 1959	Summarizes previous seal data
Rice, 1960a	Gives results of 1956 and 1957 aerial Surveys of Hawaiian Monk Seals
Rice, 1960b	Reports observations of dolphin in March 1958
HDFG (1961-64) mss.	Includes 2 trip reports of Refuge surveys
POBSP (1963-68) mss.	Includes 12 trip reports from island surveys
BSFW (1964-69) mss.	Includes 15 trip reports of Refuge surveys
Rice, 1964	Mentions presence of seals
Kemble, 1966	Reports seal observations by Osburn in 1850
Tomich, 1969	Records Hawaiian Monk Seal and bottlenose dolphin; excellent bibliography
Laycock, 1970a	Notes presence of seals in March 1969 at Southeast
Laycock, 1970b	Notes rabbit data in April 1923 as reported by Wetmore
Kenyon, ms.	Discusses man's influence on seals

Appendix Table 2. (continued)

CHORDATA (continued)

4. Aves

Elschner, 1915	Records 5 bird species in September 1914
Willett, ms.	1912-13 bird observations
Willett, 1919	Records 1 storm petrel species in 1912-13
Wetmore, ms.	Records 21 bird species during 1923 <u>Tanager Expedition</u>
Galtsoff, 1933	Records 6 bird species, summer 1930
Munro, 1942	Records 4 bird species seen offshore 6-7 July 1891
Fisher and Baldwin, 1945	Records introduction and fate of Laysan Rail
Munro, 1945	Records severe storm of 1930 or 1931 which killed many seabirds
Fisher, 1946	Discusses unsuccessful introduction of Laysan Rail
Baldwin, 1947	Discusses Laysan Rail introduction
Munro, 1947	Speculates on destruction of bird life on low islands by tidal waves
POFI (1950-56) mss.	5 trip reports listing bird observations
Bailey, 1956	Records 11 species seen by Willett on North Island, March 1913
Aldrich, Robbins, and Rice, ms.	Records about 40,000 of both albatrosses on 9 December 1956
Rice, ms. a	Memo to Dr. J.W. Aldrich records 12 species of birds from aerial survey of 14 October 1957
Richardson, 1957	Records 8 breeding seabird species
Rice, ms. b	Records 43% nest destruction of Black-footed Albatross and 6% of Laysan Albatross by January 1958 tidal wave

Appendix Table 2. (continued)

CHORDATA (continued)

4. Aves (continued)

HDFG (1961-64) mss.	Includes 2 trip reports of Refuge surveys
Rice and Kenyon, 1962	Aerial surveys of populations of albatrosses during 1956-57 and 1957-58 seasons
POBSP (1963-68) mss.	Includes 12 trip reports from island surveys
BSFW (1964-69) mss.	Includes 15 trip reports of Refuge surveys
Pettingill, 1964	Mentions 17,800 breeding pairs of Laysan Albatross observed by Rice and Kenyon
Clapp and Woodward, 1968	Lists 17 new bird species records for the atoll from POBSP data
Sibley and McFarlane, 1968	Records 4 gull species from POBSP data
Laycock, 1970a	Notes presence of 5 bird species on Southeast in March 1969

FLORA

1. Vascular Plants

Kemble, 1966	First record of plants
Brooks, 1860	Second record of plants
Bitter, 1900	Reports 2 plant species from photographs by F.G.E. Walker in 1899(?)
Bailey, 1918	Notes presence of grass in 1913
Gregory, 1924	Lists plants introduced by <u>Tanager</u> Expedition in 1923
Christophersen and Caum, 1931	Reports 11 species of vascular plants from <u>Tanager</u> Expedition
Galtsoff, 1933	Lists 2 plant species from 1930

Appendix Table 2. (continued)

FLORA (continued)

1. Vascular Plants (continued)

HDFG (1961-64) mss.	Notes 4 plant species
POBSP (1963-68) mss.	Includes botanical notes in 12 trip reports
Lamoureux, 1964	Mentions 11 plant species taken by <u>Tanager Expedition</u>
Laycock, 1970a	Mustard sprayed with herbicide
St. John, 1970	Describes 1 new species collected in 1923

2. Algae

Galtsoff, 1933	Records 2 algae species from 1930
Howe, 1934	Reports 12 algae collected by Galtsoff in 1930
POFI (1950-56) mss.	Reports 4 algae species in 1956
Taylor, 1964	Lists 1 algae species collected by Galtsoff in 1930
Tsuda, 1966	Reports 39 species of marine benthic algae taken by POBSP in June 1956, August and September 1964, and earlier records

GEOPHYSICAL

Elschner, 1915	Describes reef, lagoon, and North Island
Galtsoff, 1933	Records hydrographic data from 1930
Thorp, 1936	Records of sediments from Galtsoff's 1930 collection
Bryan, 1937	General description of atoll
Bryan, 1942	General description of atoll
Bryan, 1954	General description of atoll
Kroenke and Wollard, 1965	Gives gravity observations made in March 1964

Appendix Table 2. (continued)

GEOPHYSICAL (continued)

- Standen, 1967 Describes formation of sand islands (POBSP)
- Gross et al., 1969 Analysis of Gemini VII photographs

Appendix Table 3. Annotated list of vascular plants from Pearl and Hermes Reef. Specimens are found in the herbaria of the National Museum of Natural History (USNM), the Bernice P. Bishop Museum (BPBM), and the University of Hawaii (UH)

Gramineae

*Cynodon dactylon (L.) Pers. Specimens only from Southeast Island. Lamoureux s.n. (UH); Sibley 10 (USNM); Young 115 (UH).

Eragrostis variabilis (Gaud.) Steud. Specimens from Grass, North and Southeast Islands; known also from Seal Island. Caum 38, 45 (BPBM); Lamoureux s.n. (UH); Long 2272, 2285, 2313 (UH); Sibley 5 (USNM); Young 105, 122 (UH).

Lepturus repens (Forst.) R. Br. Specimens from Grass, Little North, North, and Southeast Islands; known from Seal Island. Caum 39, 46 (BPBM) as L. repens var. subulatus Fosb.; Lamoureux s.n. (UH); Long 2270 (appears to be var. subulatus Fosb.), 2273, 2274, 2277, 2279, 2292, 2293, 2302, 2311, 2312 (UH); Young 110, 128 (UH).

*Setaria verticellata (L.) Beauv. Specimens only from Southeast Island; known also from Grass Island. Lamoureux s.n. (BPBM); Long 2269 (UH); Sibley 12 (USNM); Young 109 (UH).

Liliaceae

*Allium sp. Found growing on Southeast Island refuse heap, eradicated March 1963. No specimens collected.

Palmae

*Cocos sp. Planted in 1928-29 on Southeast Island, all dead or dying in 1930 (Galtsoff, 1933: 14). No specimen record.

*Pritchardia pacifica Wendl. Planted in 1923 on Southeast Island by Tanager Expedition personnel (Gregory, 1924: 21). No specimen record.

*Presumably exotic.

Appendix Table 3. (continued)

Casuarinaceae

*Casuarina equisetifolia L. Specimen only from Southeast Island; planted in 1963 by U.S. Navy. Young 120 (UH).

Amaranthaceae

Achyranthes splendens var. reflexa Hbd. Specimens from Grass and North Islands; known from Seal Island. Caum 50 (BPBM); Lamoureux s.n. (UH); Long 2298 (UH); Wilder 3 (BPBM).

Nyctaginaceae

Boerhavia repens L. Specimens from Grass, Little North, North and Southeast Islands; known from Seal Island. Caum 40, 41, 47, 48 (BPBM); Galtsoff s.n. (USNM); Lamoureux s.n. (UH); Long 2271, 2291, 2295, 2306, 2307, 2310 (UH); Sibley 3 (USNM); Young 98, 130 (UH).

Aizoaceae

Sesuvium portulacastrum L. Specimens from Seal and Southeast Islands. Caum 43, 55 (BPBM); Galtsoff s.n. (USNM); Lamoureux s.n. (UH); Long 2276 (UH); Sibley 7 (USNM); Young 100, 103 (UH).

Portulacaceae

Portulaca lutea Sol. Specimens from North and Southeast Islands. Sibley 9 (USNM); Long 2283 (UH); Young 104, 108, 123 (UH).

Capparidaceae

Capparis sandwichiana Dc. Specimens only from Seal Island. Wilder 2 (BPBM); Caum 54 (BPBM); Lamoureux s.n. (UH).

Cruciferae

*Brassica campestris L. Specimens from only Southeast Island; known also at North Island. Sibley 2 (USNM); Young 106, 107, 111, 116 (UH).

*Coronopus didymus (L.) J.E. Smith. Specimen only from Southeast Island. Sibley 8 (USNM).

Lepidium bidentatum var. o-waihense (C. and S.) Fosb. Specimens from Grass, North, and Southeast Islands; known from Seal Island. Caum 51 (BPBM); Lamoureux s.n. (UH); Long 2286, 2289, 2299 (UH); Sibley 14 (USNM); Young 99, 124 (UH).

Zygophyllaceae

Tribulus cistoides L. Specimens from Grass, Little North, North, Seal and Southeast Islands. Caum 44 (BPBM); Lamoureux s.n. (UH); Long 2268, 2282, 2296, 2305 (UH); Sibley 1 (USNM); Wilder 1 (BPBM); Young 102, 126 (UH).

Malvaceae

*Malvastrum coromandelianum (L.) Garcke. Specimen only from Southeast Island. Young 114 (UH).

*Hibiscus tiliaceus L. Planted in 1923 on Southeast Island by Tanager Expedition personnel (Gregory, 1924: 21). No specimen record.

Boraginaceae

Tournefortia argentea L. f. Specimens from Grass, Little North, and North Islands. Long 2297, 2300 (UH); Young 118, 129 (UH).

Solanaceae

Solanum nelsoni Dunal. Specimens from Grass, North, and Southeast Islands; known also from Seal Island. Caum 49 (BPBM); Lamoureux s.n. (UH); Long 2275, 2301 (UH); Sibley 4 (USNM); Wilder 5 (BPBM); Young 101, 125 (UH).

Solanum nigrum L. Specimens only from Southeast Island; known also from Grass Island. Sibley 11 (USNM); Young 112 (UH).

Cucurbitaceae

Sicyos caunii St. John. Specimens from Seal (type locality), North and Southeast Islands. Caum 42, 53 (BPBM); Galtsoff (USNM); Lamoureux s.n. (UH); Long 2280, 2303 (UH); Sibley 6 (USNM) as Cucumis sativus L.; Wilder 4 (BPBM); Young 117, 119, 121 (UH).

Goodeniaceae

Scaevola taccada (Gaertn.) Roxb. Specimens from Grass, North, and Southeast Islands; known from Seal Island. Caum 52 (BPBM); Galtsoff s.n. (USNM); Lamoureux s.n. (UH); Long 2265, 2281, 2287, 2304 (UH); Young 97, 127 (UH).

Compositae

*Sonchus oleraceus L. Specimens only from Southeast Island. Long 2290 (UH); Young 113 (UH).

Appendix Table 4a. Movements of Black-footed Albatross from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex*</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex*</u>
<u>Grass Island</u>					
737-25724	06-26-63	N - U	Ocean shores beach, east of Olympia, Washington	09-??-65	U - U (found dead)
767-42371	03-19-65	N - U	At Sea, 33°23'N, 122°18'W	01-21-67	U - U (dead)
767-42398	03-19-65	N - U	At Sea, <u>ca.</u> 37°30'N	07-22-67	U - U
767-42423	03-19-65	N - U	Near Chirikof I., Alaska (<u>ca.</u> 56'N, 156°W)	08-??-67	U - U
<u>Kittery Island</u>					
737-25459	06-26-63	L - U	At Sea 15 mi. S.W. of Point Sur, California	04-25-64	U - U
737-25483	06-26-63	L - U	At Sea, 59°18'N, 143°20'W in the Gulf of Alaska	08-20-65	U - U (dead)
737-25496	06-26-63	L - U	Off Nemuro Hok, Japan (<u>ca.</u> 43°10'N, 145°40'E)	08-07-67	U - U (found dead)
737-25945	06-26-63	L - U	15 mi. W. of Crescent City, California	07-25-65	U - U
737-25951	06-26-63	L - U	Pacific Coast of Hokkaido, Japan (42°16'N, 142°27'E)	08-06-66	U - U (dead)
<u>North Island</u>					
737-25080	06-23-63	L - U	At Sea, 15 mi. W. of Crescent City, California	07-09-65	U - U

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

Appendix Table 4a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>North Island</u>					
737-25110	06-24-63	N - U	Kure Atoll	01-15-69	A - U (with egg)
737-25406	06-24-63	L - U	Trig I., French Frigate Shoals	03-22-66*	A - U
767-41723	03-12-65	N - U	Kure Atoll	03-03-69	A - U
<u>Seal Island</u>					
737-25514	06-26-63	L - U	At Sea, 32°25'N, 137°30'W	03-09-64	U - U (dead)
<u>Southeast Island</u>					
737-31030	02-26-63	A - U	Sand I., Midway Atoll	02-25-67*	A - U
737-31216	02-27-63	A - U	At Sea, 31°20'N, 173°00'W	05-12-66	A - U
737-31250	02-27-63	A - U	At Sea, ca. 46°00'N, 147°10'W	07-05-69	A - U
737-31392	02-27-63	A - U	Near Waldport, Oregon (ca. 44°20'N, 124°00'W)	06-28-69	A - U (found dead)
737-31463	02-27-63	A - U	Kure Atoll	12-13-65	A - U (with egg)
737-31464	02-27-63	A - U	Kure Atoll	12-13-65	A - U
737-31614	02-27-63	A - U	Kure Atoll	01-24-65	A - U
737-31634	02-27-63	A - U	Kure Atoll	12-14-65	A - U (with egg)
737-31666	02-27-63	A - U	Kure Atoll	01-14-69	A - U

*Recaptured by BSWF.

Appendix Table 4a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-31540	02-28-63	A - U	At Sea, <u>ca.</u> 55°50'N, 154°20'W	07-21-67	A - U
737-31557	02-28-63	A - U	Near Kaines I., British Columbia (<u>ca.</u> 50°20'N, 128°00'W)	10-12-68	A - U
737-31589	02-28-63	A - U	Near Shumagin I., Alaska	08-??-67	A - U (dead)
737-31598	02-28-63	A - U	Tillamook, Oregon (<u>ca.</u> 45°20'N, 123°50'W)	04-??-69	A - U (found dead)
737-31818	02-28-63	A - U	At Sea, <u>ca.</u> 55°50'N, 154°20'W	07-20-67*	A - U
737-32046	02-28-63	A - U	On beach 12 mi. S. of Gray's Harbour, Washington	07-04-66	A - U (dead)
737-32068	02-28-63	A - U	At Sea, 54°30'N, 133°50' SSW of For- rester Is., Alaska	10-03-63	A - U
737-32151	02-28-63	A - U	At Sea, 48°15'N, 126°30'W	04-29-65	A - U (dead)
737-32257	02-28-63	A - U	At Sea, 48°15'N, 126°30'W	04-29-65	A - U
737-32247	03-01-63	A - U	Kure Atoll	02-06-65	A - U
			Kure Atoll	01-17-66	A - U
			Kure Atoll	11-29-68	A - U
737-32248	03-01-63	A - U	At Sea, 59°38'N	07-05-65	A - U
737-32287	03-01-63	A - U	At Sea, 46°31'N, 131°57'W	05-01-63	A - U (dead)

*Recaptured by BSWF.

Appendix Table 4a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-34035	03-01-63	A - U	Kure Atoll	11-08-68	A - U
737-34307	03-02-63	A - U	At Sea, 23°20'N, 176°40'W, 280 Mi. SE of Midway Atoll	04-22-66	A - U
737-34316	03-02-63	A - U	S. of Port Oxford, Oregon (ca. 42°30'N, 124°20'W)	06-03-69	A - U (found dead)
737-32461	03-03-63	A - U	Kure Atoll	01-24-65	A - U
737-32463	03-03-63	A - U	Kure Atoll	12-10-65	A - U (with egg)
			Kure Atoll	01-14-69	A - U
737-32499	03-03-63	I - U	At Sea, ca. 25°N, 175°	05-16-66	A - U
737-34235	03-03-63	A - U	At Sea, 40°40'N, 23 mi. NE of Hachihote, Japan	07-20-66	A - U
737-34738	03-03-63	A - U	59°00'N, 140°50'E, near Amka, U.S.S.R.	06-??-63	A - U (dead)
737-32523	03-04-63	A - U	Kure Atoll	01-25-65	A - U
737-32540	03-04-63	A - U	At Sea, ca. 27°10'N, 170°10'W	05-05-68	A - U
737-33087	03-04-63	L - U	Kure Atoll	02-07-66	A - U
737-33260	03-04-63	L - U	20 mi. S. of Ti- juana, Mexico	06-26-64	U - U
737-33300	03-04-63	L - U	At Sea, 31°27'N, 166°08'E	04-24-65	U - U
737-34992	03-04-63	A - U	Cape Lookout, Ore- gon (ca. 45°20'N, 124°00'W)	08-01-69	A - U

Appendix Table 4a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-32522	03-04-63	I - U	At Sea, <u>ca.</u> 30°N, 140°W	02-06-66	U - U
737-32667	03-06-63	A - U	Kure Atoll	12-07-65	A - U
			Kure Atoll	01-14-69	A - U
737-32686	03-06-63	A - U	At Sea, 24°30'N, 151°25'W	11-25-64	A - U
737-35199	03-06-63	A - U	At Sea, 57°54'N, 180°54', near the Pribilof I.	09-15-63	A - U (dead)
737-32711	03-07-63	A - U	15 mi. SE of Cres- cent City, Cali- fornia	07-15-67	A - U
737-35298	03-07-63	A - U	Kure Atoll	12-06-65	A - U
			Kure Atoll	12-01-68	A - U (with egg)
737-35445	03-07-63	A - U	Beach at Ilwaco, Washington <u>ca.</u> 46°10'N, 124°00'W	07-14-63	U - U (found dead)
737-32806	03-08-63	L - U	East I., French Frigate Shoals	06-10-69	A - U
737-32860	03-08-63	L - U	At Sea, 43°50'N, 174°30'W	05-16-67	U - U (dead)
737-32867	03-08-63	L - U	At Sea, <u>ca.</u> 35°N, 140°W	06-25-64	U - U
737-32966	03-08-63	N - U	On beach, Santa Mon- ica, California	07-07-65	U - U (found dead)
737-33753	03-08-63	L - U	At Sea, 22°24'N, 125°05'	03-24-64	U - U (dead)

Appendix Table 4a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-33796	03-08-63	L - U	Sultan Lake, Oregon (ca. 44°00'N, 124°00'W)	04-30-69	U - U (found dead)
737-33990	03-08-63	L - U	Terra de Mar, Pacific City, Oregon	05-29-65	U - U
737-33991	03-08-63	L - U	At Sea, 43°00'N, 142°20'W	08-01-67	U - U (dead)
737-37637	06-20-63	L - U	Kure Atoll	03-16-66	A - U (dead)
737-39019	06-20-63	L - U	Ford Ord, California ca. 36°30'N, 121°40'W	07-19-64	U - U (found dead)
737-39178	06-23-63	N - U	Kure Atoll	12-10-68	A - U (with egg)

Appendix Table 4b. Movements of Black-footed Albatross to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>At Sea, ca. 43°N, 136°W</u>					
44-711603	09-05-45*		Southeast I.	02-27-63	A - U
<u>At Sea, ca. 50°, 145°W</u>					
509-03279	05-14-54		Southeast I.	02-28-63	A - U
527-65504	07-04-54		Southeast I.	03-13-64	A - U

*Banded by Yocom (see Yocom, 1965: 187-188). Band replaced on 02-27-63 with 737-31376.

Appendix Table 4b. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>French Frigate Shoals, East I.</u>					
737-37004	06-08-63	L - U	Southeast I.	03-21-67*	A - U
<u>Kure Atoll</u>					
737-45767	11-16-63	A - U	Southeast I.	03-13-64	A - U
737-93980	01-17-64	A - U	Southeast I.	03-13-64	A - U
737-93706	01-21-64	A - U	Eastern I., Midway Atoll	02-17-64	A - U
			Southeast I.	03-13-64	A - U
737-93740	02-12-64	A - U	North I.	03-17-65	A - U
737-92652	01-31-65	A - U	Southeast I.	03-21-65	A - U
737-92654	01-31-65	A - U	Southeast I.	03-21-65	A - U
<u>Midway Atoll, Eastern I.</u>					
587-58199	06-03-57+	N - U	Southeast I.	02-27-63	A - U
597-69479	07-01-59	N - U	Southeast I.	03-03-63	A - U
587-72834	04-06-60+	N - U	Southeast I.	03-07-63	A - U
597-27231	04-06-60+	N - U	Southeast I.	03-04-63	A - U
597-27234	04-06-60+	N - U	Southeast I.	02-26-63	A - U
597-27286	04-06-60+	N - U	Southeast I.	03-13-64	A - U
597-52847	04-06-60+	N - U	Southeast I.	03-06-63	A - U
597-52912	04-06-60+	N - U	Southeast I.	03-01-63	A - U
697-73944	02-22-63+	N - U	Southeast I.	03-16-65	A - U
697-72553	02-25-63+	N - U	Southeast I.	03-16-65	A - U

*Recaptured by BSFW.

+Banded by BSFW.

Appendix Table 4b. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Midway Atoll, Sand I.</u>					
587-27255	04-06-60+	N - U	Southeast I.	03-01-63	A - U
597-27129	04-07-60+	N - U	Southeast I.	02-28-63	A - U
587-27157	04-10-60+	N - U	Southeast I.	03-06-63	A - U
597-27170	04-10-60+	N - U	Southeast I.	02-27-63	A - U

Appendix Table 5. Movements of Laysan Albatross from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Grass Island</u>					
737-24473	06-26-63	N - U	Kure Atoll	05-14-69	A - U
737-29019	06-26-63	N - U	Kure Atoll	05-20-69	A - U
737-26942	06-27-63	N - U	Kure Atoll	04-17-66	U - U (dead)
<u>Kittery Island</u>					
737-24258	06-26-63	N - U	Kure Atoll	03-25-69	A - U
<u>Little North Island</u>					
737-38558	06-24-63	N - U	Kure Atoll	03-25-69	A - U
<u>North Island</u>					
737-24797	06-23-63	N - U	Kure Atoll	05-06-69	A - U
737-24827	06-23-63	N - U	Kure Atoll	02-25-69	A - U
737-24833	06-23-63	L - U	At Sea, 29°45'N, 150°50'E	02-19-64	U - U

+Banded by BSFW.

Appendix Table 5. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>North Island</u>					
737-24841	06-23-63	N - U	At Sea, 37°20'N, 151°10'E	12-20-65*	U - U
737-24905	06-23-63	L - U	Eastern I., Midway Atoll	04-01-68	U - U (found dead)
737-24153	06-24-63	L - U	At Sea, 42°52'N, 153°24'E	05-13-64	U - U
757-17198	03-17-65	N - U	Kure Atoll	03-10-69	A - U
<u>Seal Island</u>					
737-24310	06-26-63	N - U	Kure Atoll	02-24-69	A - U
737-24365	06-26-63	L - U	At Sea, <u>ca.</u> 36°N, 142°E	05-13-64	U - U
<u>Southeast Island</u>					
737-36039	03-06-63	N - U	At Sea, <u>ca.</u> 37°N, 151°E	12-27-64	U - U
737-36223	03-06-63	N - U	Kure Atoll	04-17-66	U - U (dead)
737-36227	03-06-63	N - U	Kure Atoll	04-01-69	A - U
737-36277	03-06-63	N - U	Kure Atoll	02-25-69	A - U
737-36527	03-07-63	N - U	At Sea, 30°00'N, 150°43'E	01-04-64	U - U
737-37637	06-20-63	N - U	Kure Atoll	03-16-66	U - U
737-37986	06-21-63	N - U	Kure Atoll	04-11-69	A - U
757-18422	03-15-65	N - U	Kure Atoll	04-01-69	A - U
757-19488	03-15-65	N - U	Kure Atoll	02-24-69	A - U
			Kure Atoll	05-06-69	A - U

*Recaptured by BSWF.

Appendix Table 5. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
757-19562	03-15-65	N - U	Kure Atoll	02-24-69	A - U
757-20484	03-16-65	N - U	Kure Atoll	05-05-69	N - U
757-20828	03-15-65	N - U	Laysan I.	03-27-66 to 03-30-66*	U - U
737-21168	03-16-65	N - U	Kure Atoll	04-14-69	A - U
757-21409	03-16-65	N - U	Laysan I.	03-27-66 to 03-30-66*	U - U
757-22320	03-16-65	N - U	Kure Atoll	02-25-69	A - U

Appendix Table 6a. Movements of Bonin Petrels from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
723-60810	03-01-63	A - U	Laysan I.	09-19-64	A - U
713-99525	03-16-65	A - U	Kure Atoll	09-10-66	A - U

Appendix Table 6b. Movements of Bonin Petrels to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Kure Atoll</u>					
793-20559	11-23-64	A - U	Seal I.	03-19-65	A - U
793-21293	03-10-65	A - U	Seal I.	03-18-65	A - U
			Kure Atoll	11-23-65	A - U
793-20381	10-21-64	A - U	Southeast I.	03-16-65	A - U

*Recaptured by BSFW.

Appendix Table 7a. Movements of Blue-faced Boobies from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Kittery Island</u>					
737-26522	06-26-63	N - U	Kure Atoll	06-29-67	A - U
737-26549	06-26-63	N - U	Laysan I.	09-16-64	A - F
			Johnston Atoll	05-20-65	A - U
<u>Little North Island</u>					
558-83563	06-23-63	N - U	Laysan I.	03-09-65	A - F
587-91109	08-29-67	N - U	Kure Atoll	07-25-68	S - U
<u>North Island</u>					
558-83080	06-23-63	A - U	Whale-Skate I., French Frigate Shoals	08-16-65	A - F
			Whale-Skate I., French Frigate Shoals	06-26-66	A - F
			Whale-Skate I., French Frigate Shoals	06-03-67	A - F
558-83100	06-23-63	A - U	Lisianski I.	03-13-65	A - F
558-83580	06-24-63	N - U	Lisianski I.	09-02-67	A - F (in roost- ing club)
558-83595	06-23-63	A - U	Kure Atoll	11-10-63	U - U
<u>Seal Island</u>					
737-26562	06-26-63	N - U	Laysan I.	09-16-64	A - F

Appendix Table 7b. Movements of Blue-faced Boobies to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>French Frigate Shoals</u>					
757-26182	06-11-66	A - U	Southeast I.	05-28-67	A - U (found dead)
<u>Kure Atoll</u>					
697-70633	08-06-62+	I - U	Kure Atoll	10-09-63	S - U
			Southeast I.	03-13-64	S - U
			Kure Atoll	10-26-64	A - U
			Kure Atoll	11-24-65	A - F
			Kure Atoll	07-01-66	A - F (with nestling)
			Kure Atoll	05-31-67	A - F (with 2 eggs)
			Kure Atoll	03-28-68	A - F (with egg)
			Kure Atoll	03-01-69	A - F (with 2 eggs)
737-99590	09-24-66	N - U	Southeast I.	05-30-67	S - U
			Kure Atoll	11-30-68	A - U
			Kure Atoll	04-03-69	A - F

+Banded by BSFW.

Appendix Table 8a. Movements of Red-footed Boobies from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Grass Island</u>					
587-80011	08-18-64	A - U	Johnston Atoll	04-26-65	A - U (found dead)
<u>North Island</u>					
587-80060	08-20-64	N - U	East I., French Frigate Shoals	06-17-66	S - U
587-91131	08-29-67	S - U	Kure Atoll	07-20-68	S - U
<u>Southeast Island</u>					
737-30079	02-26-63	A - U	Johnston Atoll	03-09-65	A - U
			Southeast I.	09-25-66	
737-30093	02-26-63	S - U	Kure Atoll	11-11-64	A - U
			Kure Atoll	06-30-68	A - U
737-30100	02-26-63	A - U	Kure Atoll	01-29-65	A - U
			Kure Atoll	06-09-67	A - U
			East I., French Frigate Shoals	06-07-68	A - U
			Kure Atoll	07-24-68	A - U
737-30151	02-27-63	A - U	Johnston Atoll	02-27-66	A - F
737-30156	02-27-63	I - U	Johnston Atoll	03-26-65	A - U
737-30281	02-28-63	A - U	Kure Atoll	06-07-66	A - U
737-38050	06-19-63	N - U	Lisianski I.	06-17-66	U - U
737-38051	06-19-63	N - U	Johnston Atoll	03-26-65	I - U
			Lisianski I.	09-01-67	A - U
737-38053	06-21-63	A - U	Kure Atoll	07-15-66	A - U

Appendix Table 8a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
757-89355	08-17-64	(A) - U	Johnston Atoll	05-04-65	(I) - U
757-89390	08-17-64	A - U	Lisianski I.	03-12-65	A - U
757-43066	09-25-66	S - U	Lisianski I.	09-04-67	S - U
587-85172	08-28-67	I - U	Johnston Atoll	03-19-69	S - U
767-40621	08-08-68	(A) - U	Johnston Atoll	06-23-69	S - U

Appendix Table 8b. Movements of Red-footed Boobies to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>French Frigate Shoals, East I.</u>					
757-26100	06-10-66	A - U	Southeast I.	03-22-67	A - U (on egg)
<u>French Frigate Shoals, Trig I.</u>					
757-27618	08-13-66	S - U	Southeast I.	02-10-69*	A - U
<u>Johnston Atoll</u>					
737-43576	02-22-66	A - F	Southeast I.	05-31-67	A - U (with chick)
737-44695	02-23-66	I - U	Southeast I.	05-31-67	A - U
			Eastern I., Midway	12-??-67	U - U
<u>Kure Atoll</u>					
737-45360	10-14-63	I - U	North I.	08-20-64	S - U
737-45332	10-14-63	A - U	Kure Atoll	01-29-65	A - U
			Kure Atoll	10-03-66	A - U

*Recaptured by BSWF.

Appendix Table 8b. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Kure Atoll</u>					
737-45332	10-14-63	A - U	Southeast I.	08-28-67	A - U
737-95942	12-12-64	A - U	Southeast I.	02-10-69*	A - U
767-45935	07-09-66	A - U	Southeast I.	03-23-68	A - U
<u>Laysan I.</u>					
757-28129	10-21-66	A - U	Southeast I.	08-28-67	A - U
<u>Midway Atoll, Eastern I.</u>					
767-49147	06-22-66	A - U	Southeast I.	03-21-67*	A - U

Appendix Table 9a. Movements of Brown Boobies from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-30106	02-26-63	A - U	Southeast I.	06-19-63	A - U (with newly hatched young)
			Laysan I.	03-07-65	A - U
			Seal I., Pearl and Hermes Reef	03-18-65	A - M
737-37516	06-19-63	N - U	Kure Atoll	05-20-66	A - M
737-37552	06-19-63+	N - U	Funafuti I., Ellice Is.	02-06-67	U - U (found dead)
737-37557	06-21-63	A - U	Kure Atoll	04-20-66	A - M

*Recaptured by BSFW.

+Also banded with #737-37564 on 06-21-63.

Appendix Table 9a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
737-37557	06-21-63	A - U	Southeast I.	09-20-66	A - M (with nest- ling)
757-89307	08-17-64	S - U	Wake I.	12-31-66	U - U
757-89344	08-17-64	N - U	Kure Atoll	06-04-67	A - M
587-85182	08-28-67	A - M (with nest- ling)	Kure Atoll	06-03-69	A - M (with 2 eggs)

Appendix Table 9b. Movements of Brown Boobies to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Kure Atoll</u>					
737-98173	11-08-64	A - F	Seal I.	03-18-65	A - F
			Southeast I.	03-21-67*	A - M
<u>Wake Island</u>					
757-89729	04-27-65	A - U	Southeast I.	09-26-66	A - M

Appendix Table 10. Movements of Great Frigatebirds from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Grass Island</u>					
737-30334	03-05-63	S - U	Kure Atoll	05-20-66	S - U
737-30348	03-05-63	A - M	Kure Atoll	05-22-66	A - M
737-30351	03-05-63	S - U	Kure Atoll	05-22-66	S - U

*Recaptured by BSFW.

Appendix Table 10. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Grass Island</u>					
737-30359	03-05-63	S - U	Kure Atoll	06-20-66	S - U
737-26702	06-26-63	A - M	Kure Atoll	07-31-68	A - M
737-26707	06-26-63	A - M	Kure Atoll	06-10-66	A - M
737-26708	06-26-63	A - M	Kure Atoll	06-11-69	A - M
737-26717	06-26-63	N - U	Kure Atoll	05-07-66	S - U
737-26723	06-26-63	N - U	Kure Atoll	05-15-66	S - U
737-26739	06-26-63	N - U	Kure Atoll	06-04-67	S - U (dead)
737-26741	06-26-63	N - U	Johnston Atoll	01-29-69	S - U (dead)
737-26751	06-26-63	A - F	Kure Atoll	06-17-69	A - F
737-26752	06-26-63	A - M	Kure Atoll	05-25-66	A - M
737-26759	06-26-63	N - U	Kure Atoll	06-05-67	A - F
			Kure Atoll	06-17-69	A - F
737-37396	06-26-63	N - U	Kure Atoll	06-15-66	S - U
587-80008	08-18-64	N - U	Kure Atoll	07-20-68	S - F
587-80013	08-18-64	N - U	Kure Atoll	07-02-67	S - U
587-80031	08-18-64	N - U	Kure Atoll	04-20-66	S - U
587-80040	08-18-64	L - U	Manicomi I., off- shore Samar I., Philippine Is. (10°59'N, 125°37'E)	12-16-65	U - U
587-80044	08-18-64	N - U	Kure Atoll	04-20-66	S - U
			Kure Atoll	06-25-67	S - F

Appendix Table 10. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>North Island</u>					
737-37138	06-23-63	A - M	Kure Atoll	05-06-66	A - M
737-37145	06-23-63	A - F	Tubabao I., off-shore Samar I., Philippine Is. (1°03'N, 125°42'E)	12-11-65	A - F
737-37163	06-23-63	N - U	Kure Atoll	05-12-66	S - U
737-37164	06-23-63	N - U	Kure Atoll	05-20-66	S - U
737-37171	06-23-63	A - M	Kure Atoll	12-15-65	A - M
737-37178	06-23-63	N - U	Whale-Skate I., French Frigate Shoals	09-29-65	I - U
737-37196	06-24-63	A - F	Kure Atoll	05-26-68	A - F (dead)
587-80059	08-20-64	A - F	Kure Atoll	07-10-66	A - F
587-80094	08-20-64	N - U	Kure Atoll	05-20-66	S - U
587-80100	08-18-64	N - U	Johnston Atoll	03-11-67	I - U
587-80104	08-20-64	N - U	Kure Atoll	06-04-67	S - U (dead)
587-80106	08-20-64	N - U	Kure Atoll	04-23-66	S - U
587-80108	08-20-64	N - U	Kure Atoll	06-05-67	S - U
587-80114	08-20-64	N - U	Kure Atoll	06-05-66	S - U
587-80116	08-20-64	N - U	Kure Atoll	05-23-66	S - U
767-42210	03-17-65	A - M	Kure Atoll	05-14-69	A - M
587-91136	08-29-67	S - U	Talibon, Bohol I., Philippine Is.	01-??-68	U - U
<u>Southeast Island</u>					
737-30034	02-26-63	A - M (with egg)	Kure Atoll	05-31-68	A - M

Appendix Table 10. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
737-30253	02-28-63	S - U	Kure Atoll	06-08-67	S - M
			Kure Atoll	05-31-68	U - U (dead)
737-30321	03-02-63	A - M	Kure Atoll	06-10-66	A - M
737-37493	06-19-63	N - U	Kure Atoll	06-20-66	S - U
737-37123	06-21-63	A - M	Kure Atoll	08-09-64	A - M
			Kure Atoll	05-23-66	A - M
737-37124	06-21-63	A - U	Johnston Atoll	10-04-66	A - F
			Southeast I.	05-30-67	A - F (with egg)
			Southeast I.	07-03-67	A - F (with week old chick)
737-30119	06-26-63	A - F	Kure Atoll	04-21-64	A - F (dead)
757-89301	08-17-64	N - U	Kure Atoll	05-06-66	S - U
757-89354	08-17-64	N - U	Kure Atoll	05-10-66	S - U
757-43048	09-25-66	N - U	Kure Atoll	07-28-68	S - F
757-43056	09-25-66	N - U	Lisianski I.	09-02-67	S - U
757-43070	09-25-66	A - F	Kure Atoll	06-27-68	A - F
587-83832	05-30-67	A - M (with egg)	Kure Atoll	06-09-67	A - M

Appendix Table 11. Movements of Ruddy Turnstones to Pearl and Hermes Reef.

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Alaska, Pribilof Is., St. George</u>					
722-10282	08-04-66	A - U	St. George, Pribilof I., Alaska	08-01-67	A - U
			Southeast I.	08-28-67	A - U (found dead)
722-14020	08-18-66	I - F	Southeast I.	05-28-67	U - U (recovered)
1103-02294	08-18-67	A - U	Southeast I.	08-28-67	A - U (found dead)

Appendix Table 12a. Movements of Sooty Terns from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
723-64552	06-20-63	A - U	Kure Atoll	06-14-67	A - U (dead)
723-64928	06-21-63	A - U	Eastern I., Midway Atoll	10-20-65	A - U
723-64994	06-21-63	A - U	Eastern I., Midway Atoll	08-15-64	A - U
753-43213	08-17-64	I - U	Johnston Atoll	08-21-68	A - U
753-43868	08-17-64	A - U	Lisianski I.	06-18-66	A - U
753-44069	08-18-64	A - U	Johnston Atoll	04-23-66	A - U
754-44797	08-18-64	A - U	Lisianski I.	05-30-67	A - U (nesting)
753-44982	08-18-64	A - U	Kure Atoll	05-20-66	

Appendix Table 12b. Movements of Sooty Terns to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Johnston Atoll</u>					
753-16049	08-06-63	A - U	Southeast I.	06-01-67	A - U (with egg)
753-24199	09-15-63	A - U	Southeast I.	08-28-67	A - U
753-24357	09-16-63	A - U	Southeast I.	06-01-67	A - U (with egg)
753-24662	09-19-63	A - U	Southeast I.	08-17-64	A - F (collected)
753-73704	03-09-64	A - U	Southeast I.	06-01-67	A - U (with egg)
843-99581	08-21-65	A - U	Southeast I.	06-01-67	A - U (with egg)
933-41833	08-21-66	A - U	Southeast I.	06-01-67	A - U (with chick)
<u>Kure Atoll</u>					
813-91771	08-28-64	A - U	Kure Atoll	06-03-66	A - U (with egg)
			Southeast I.	06-01-67	A - U
813-91969	08-30-64	A - U	Southeast I.	06-01-67	A - U (with egg)
793-20138	09-07-64	A - U	Southeast I.	05-30-67	A - U (with egg)
903-08519	06-22-66	A - U (breeding)	Southeast I.	05-30-67	A - U

Appendix Table 12b. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Kure Atoll</u>					
903-14367	08-20-66	A - U	Southeast I.	05-28-67	A - U (with egg)
<u>Lisianski Island</u>					
943-04396	06-17-66	A - U	Southeast I.	05-29-69*	A - U
<u>Midway Atoll, Eastern Island</u>					
863-07439	07-22-65	A - U	Southeast I.	03-22-67	A - U

Appendix Table 13a. Movements of Black Noddies from Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
632-20082	06-18-63	A - U	Whale-Skate I., French Frigate Shoals	08-30-65	A - U
632-20751	06-21-63	A - U	Whale-Skate I., French Frigate Shoals	06-26-66	A - U
652-42283	08-20-64	N - U	Whale-Skate I., French Frigate Shoals	08-13-65	A - U
632-20573	06-18-63	A - U	Lisianski I.	09-03-67	A - U
632-20761	06-21-63	A - U	Lisianski I.	09-04-67	A - U
632-20731	06-21-63	A - U	Kure Atoll	01-25-65	A - U (dead)
652-42330	08-18-64	A - U	Sand I., Midway Atoll	03-05-66	U - U
652-42340	08-17-64	A - U	Kure Atoll	05-11-66	A - U

*Recaptured by BSW.

Appendix Table 13a. (continued)

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>Southeast Island</u>					
632-20558	06-18-63	A - U	Kure Atoll	07-07-67	A - U
			Kure Atoll	07-30-68	A - U (dead)

Appendix Table 13b. Movements of Black Noddies to Pearl and Hermes Reef

<u>Original Banding Data</u>			<u>Recapture Data</u>		
<u>Band Number</u>	<u>Date</u>	<u>Age-Sex</u>	<u>Where Recaptured</u>	<u>Date</u>	<u>Age-Sex</u>
<u>French Frigate Shoals, Whale-Skate Island</u>					
712-58386	06-26-66	A - U	Southeast I.	05-30-67	A - U
<u>Laysan Island</u>					
723-60435	02-12-63	A - U	Southeast I.	05-30-67	A - U
<u>Midway Atoll, Sand Island</u>					
662-05446	02-20-64*	U - U	Southeast I.	08-18-64	A - U (dead)

*Banded by BSFW.