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THE NATURAL HISTORY OF NIHOA ISLAND, NORTHWESTERN HAWAIIAN ISLANDS

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1953	21-22 Dec.	0	Only part of island surveyed (Richardson, pers. comm.).
1954	18 Mar.	40-60	? (Richardson, pers. comm.).
1961	2 Mar.	?	Not noted offshore (Woodside and Kramer, ms.).
	9-16 Dec.	0	(Kramer, ms.).
1962	10 June	"common"	On eggs (Kramer and Beardsley, ms.).
1963	5-6 June	?	Thousands seen offshore (POBSP).
1964	6-7 Mar.	?	Courting behavior observed (BSFW, POBSP).
	25 July	very common	Several nests with eggs found (BSFW).
	23-24 Sept.	?	*Ca.* 2,000 downy nestlings present (BSFW, POBSP).
1965	13-14 Mar.	18,000	No eggs or young seen (BSFW, POBSP).
1966	28 July-1 Aug.	20,000-31,000	*Ca.* 10,000 nests present, almost all with incubated eggs. One *ca.* 3 week old nestling observed (BSFW, POBSP).
1967	8-9 Mar.	5 (seen)	Apparently vanguard of breeding population (BSFW, POBSP).
	13-14 Sept.	many thousands	Small and large downy chicks (BSFW).
1968	7-9 Mar.	less than 50	No evidence of breeding. Only 2 individuals actually noted (BSFW, POBSP).
	24-27 Aug.	many thousands	So many calling in early dawn hours that combined sound made a low steady roar (BSFW).
1969	21 Mar.	875	Nesting had evidently begun (BSFW).
1970	15 Aug.	20,000-25,000	(BSFW).
1971	18-19 Aug.	?	At least 2,000 birds were present (BSFW).

Color-Phases

Dark, light, and intermediate plumaged morphs have all been seen on the island. No quantitative data exist on the occurrence of the different color phases but one POBSP observer estimated that 95 percent of the birds were light-phase morphs. Wetmore (ms.) saw gray-breasted birds occasionally, but the great majority was white-breasted.

Banding

The BSFW and POBSP banded 288 adults on recent visits: 3 in March 1964 and 85 in March 1965 by the BSFW, and 200 by the POBSP in July and August 1966. None has been recaptured.

Specimens

We have found records of 8 study skins from Nihoa (Table 9). The USNM houses in addition an embryo alcoholic (USNM 289301) collected by Wetmore on 14 June 1923.

Table 8. Observations of Wedge-tailed Shearwaters on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	A number flew aboard. Stomachs contained the "hard parts of small cephalopods (squid, octopus, and the like)" (Fisher, 1903: 792).
5-9 Aug.	?	Presence noted (Fisher, 1903: 779).
1915 18 Mar.	"very common"* (50,000)	None found nesting (Munter, 1915: 131). Alternate estimate by Brown (ms.).
1923 24-26 May	?	Thousands seen circling ship (Wetmore, ms.).
11-16 June	30,000*	Birds laying. Many fresh eggs (Wetmore, ms.).
1936 3 Mar.	?	25 birds, found under clumps of grass and rock, had red celluloid bands placed on their legs (Trempe, ms.).
1940 7-15 Aug.	?*	"Breeding was in its early stages, both eggs and small young being observed" (Vanderbilt and de Schauensee, 1941: 9).

absent during remainder of year. Most nesting occurs from June through November. Nests in burrows, on the surface of the ground under thick vegetation, and in cavities and crevices in rock falls and ledges. Well distributed over entire island.

Populations

The few numerical estimates (Table 8) suggest that maximal populations are on the order of tens of thousands rather than hundreds of thousands. In August and September many thousands are present; at dawn the steady chorus of calling results in a dull roar that, at lower elevations, is muffled only by the surf.

Annual Cycle

March observations suggest that these shearwaters return to Nihoa in great numbers within a very short period. In 1964, 1967, and 1968 only a few birds were present in early March, while in 1915 and 1965 thousands were present by the middle of the month. Richardson's lower mid-March estimate does not fit this pattern. However, he did not spend the night on the island and as a result possibly did not see many birds that may have come to the island to roost at night.

The nesting cycle appears to be similar to that found on Laysan and other northwestern Hawaiian Islands. Most egg laying evidently occurs in June although a few eggs may be laid in May. A few young hatch in July but by far the greater proportion hatch in August. It seems likely that most fledge within 5 to 5 1/2 months[26/] after the peak of laying. Thus, a few possible fledge as early as late October and as late as early December with the peak being in November. No surveys were made on the island during the presumed fledging period. Kramer observed none in mid-December 1961 (Table 8).

Breeding Habitat

Nests have been found in a wide variety of situations on the slopes of the island. A small proportion of the population digs burrows in the ground but few such burrows are possible because of the shallow soil cover and rocky nature of the island. Wetmore (ms.) noted a number of burrows as much as 3 or 4 feet long but most were only deep enough to provide shelter. A much larger proportion nest in natural cavities in the rocks and on rock ledges protected by overhanging rock. Many others nest on the surface, particularly in areas covered by dense vegetation such as *Chenopodium* or *Sida*.

26/ Based on the range of fledging periods (99-111 days) obtained in a small sample (n = 10) on Kure Atoll (Woodward, 1972: 125) and on an estimated 52 to 54 day incubation period (Woodward, pers. comm.).

Table 6. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1971 18-19 Aug.	4,000	Half-grown young seen (BSFW).
15 Sept.	?	Nearly fully-grown young were common (BSFW).
1972 16 Sept.	?	At least 300 adults seen during day (BSFW).
1973 31 July	?	At least 400 adults seen during day (BSFW).

* In their report Kramer and Beardsley noted that "Bonin Petrels" were common and on eggs. Since no other observer has found that species on Nihoa, and, since Kramer and Beardsley did not mention the presence of Bulwer's Petrel, we assume that "Bonin Petrel" was a *lapsus calimis* for Bulwer's Petrel. Marshall (1964: 160), in a popular account of the visit, also indicates, we think erroneously, that Bonin Petrels were present.

** Most abundant species on island.

Table 7. Bulwer's Petrel Specimens from Nihoa Island.

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and yg.	Museum Nos.	Date Collected	Collector
SUI			1	18597			3 June 1902	Nutting
USNM	2	300799, 530875	1	530876			11-15 June 1923	Wetmore
PAS	3	146160, 146168-69	1	146161			Aug. 1940	Vanderbilt
USNM			1	493022*	1	493023*	6 June 1963	POBSP

* Collected offshore.

WEDGE-TAILED SHEARWATER *Puffinus pacificus*

Status

Abundant breeder; maximum recent estimate: 20,000 to 31,000. Present from March through at least mid-November; most birds probably

Table 6. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1954	18 Mar.	0	Only part of island surveyed (Richardson, pers. comm.).
1961	2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	0	(Kramer, ms.).
1962	10 June	common*	On eggs (Kramer and Beardsley, ms.).
1963	5-6 June	?	Thousands seen offshore (POBSP).
1964	6-7 Mar.	10	One photographed by Kridler (BSFW, POBSP).
	25 July	very abundant	Many nests found. Only eggs and newly hatched young seen (BSFW).
	23-24 Sept.	1,500	Nearly full grown young and *ca.* 25 dead fledglings seen (BSFW, POBSP).
1966	28 July-1 Aug.	250,000** (225,000)	Mostly on heavily incubated eggs or with *ca.* 1 week old nestlings (BSFW, POBSP). Alternate estimate by Berger (1972: 33).
1967	8-9 Mar.	?	Heard calling in burrows (BSFW, POBSP); see text.
	13-14 Sept.	?	A number of adults and half-feathered young seen but most young evidently departed from island (BSFW).
1968	7-9 Mar.	0?	None seen on island but a few small petrels seen offshore may have been this species (BSFW, POBSP).
	24-27 Aug.	thousands	Hundreds of adults seen during day with numbers increasing to thousands at night. Several downy chicks found (BSFW).
1969	21 Mar.	0	(BSFW).
1970	15 Aug.	75,000-100,000	Burrows examined contained pairs and small downy chicks. Much calling by adults (BSFW).

Although detailed data on the nesting cycle are scanty, those available suggest that these petrels have much the same cycle on Nihoa as on Laysan and other northwestern Hawaiian Islands. Most birds probably do not arrive at Nihoa until April and eggs probably are not laid until a month or so later. Only eggs were found on two June visits, and only eggs and newly hatched young were found on the two visits in late July and early August. Only young were found from mid-August through mid-September but it seems likely that a few late fledging birds may be present as late as October.

We tentatively assume that the hatching peak occurs in July and early August and that most young fledge about late September.

Breeding Habitat

Several observers noted that this species was found throughout the island but few described the nest sites. Nests were found under rocks, in small holes in the rocks, and particularly in crevices in rock ledges. A few nests were also found in shallow depressions under dense vegetation.

Banding

The POBSP and BSFW banded 808 adults on recent visits: 8 by the BSFW in September 1964 and 800 by the POBSP in July and August 1966. None has been recaptured.

Specimens

Ten Bulwer's Petrel specimens have been collected on Nihoa (Table 7).

Table 6. Observations of Bulwer's Petrels on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1902 1-3 June	?	Abundant offshore. "Birds had been feeding on fish eggs? and ctenophores or comb-jelly" (Fisher, 1903: 795).
5-9 Aug.	?	Presence noted from offshore (Fisher, 1903: 779).
1923 11-16 June	abundant	Incubating eggs. No nests with young found (Wetmore, ms.).
1940 7-15 Aug.	extremely common	"No eggs were found, all nests examined containing downy, black young" (Vanderbilt and de Schauensee, 1941: 9).
1953 21-22 Dec.	0	Only part of island surveyed (Richardson, pers. comm.).

Table 5. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1970 15 Aug.	0	(BSFW).
1971 18-19 Aug.	0	(BSFW).
15 Sept.	0	(BSFW).
1972 16 Sept.	0	(BSFW).
1973 31 July	40**	20 nearly fledging young counted (BSFW).

* Probable number of breeding birds utilizing island.

** Figure represents a minimum estimate of numbers of birds that bred on the island.

\+ Aerial observations only.

BULWER'S PETREL *Bulweria bulwerii*

Status

Abundant breeder; maximum recent estimate: 250,000. Present from March through September or October; probably absent the rest of the year. Breeds from at least June through September. Nests under rocks, in holes or crevices in rock ledges or occasionally in shallow depressions under dense vegetation.

Populations

None of the numerical estimates (Table 6) is very accurate because of the difficulty of censusing populations of this very numerous petrel. Clearly, however, many thousands are present during July and August.

Annual Cycle

March 1964 and 1965 observations suggest that Bulwer's Petrels begin to return to Nihoa in March but none was observed on a number of other March visits. It seems likely that their reported "absence" in a number of cases may have been the result of simply overlooking small numbers that were present. Descriptions of a bird call heard in March 1967 suggest that Sooty Storm Petrels rather than Bulwer's Petrels were heard on that visit.

Table 5. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1936 3 Mar.	?	Evidently nesting (Trempe, ms.).
1940 7-15 Aug.	0	(Vanderbilt and de Schauensee, 1941: 8).
1953 21-22 Dec.	6-8	Breeding in small numbers (Richardson, 1957: 16; pers. comm.).
1954 18 Mar.	0	Only part of island surveyed (Richardson, pers. comm.).
1957 28 Dec.	*ca.* 1,000+	"Nesting" (Rice and Kenyon, 1962: 377).
1961 9-16 Dec.	*ca.* 30	"No eggs. Much bachelor dancing" (Kramer, ms.).
1963 5-6 June	?	None noted offshore (POBSP).
1964 6-7 Mar.	38	Only adults seen. 1 seen on empty nest (BSFW, POBSP).
25 July	0	(BSFW).
23-24 Sept.	0	(BSFW, POBSP).
1965 8-9 Mar.	?	One seen from offshore; Miller Plateau not censused (BSFW, POBSP).
1966 28 July-1 Aug.	0	(BSFW, POBSP).
1967 8-9 Mar.	1	No young seen; Miller Plateau not censused (BSFW, POBSP).
13-14 Sept.	0	(BSFW).
1968 7-9 Mar.	10*	4 young banded on Miller Plateau. 6 adults seen on Tanager Peak; no young found there (BSFW, POBSP).
24-27 Aug.	0	(BSFW).
1969 21 Mar.	7	Counted. Miller Plateau area not visited (BSFW).

Breeding Habitat

Only Munter (1915: 132) and Kridler have given any indication of where nests were found. Munter found a half-grown young about 500 feet up one of the slopes, and in March 1968 Kridler banded four chicks within the Black-footed Albatross colony on Miller Plateau.

Other Areas of Occurrence

Other observers reported pre-breeding or non-breeding birds from several areas. In December 1961, Kramer noted that all Laysan Albatross were on Miller Plateau. In March 1964, BSFW personnel saw most Laysan Albatross on Miller Plateau, but a few were as much as a hundred feet down the south slope of Miller's Peak. In March 1965 Kridler noted that most were on the high ridge between Miller's and Tanager Peaks; in March 1968 these albatross were seen only on Miller Plateau and Tanager Peak.

Banding

Ten Laysan Albatross were banded by the BSFW on recent visits: 6 adults in March 1964 and 4 young in March 1968. No returns have been obtained for these birds.

Table 5. Observations of Laysan Albatross on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Only 1 or 2 seen some miles west of island (Fisher, 1903: 778).
5-9 Aug.	?	None seen from offshore (Fisher, 1903: 779).
1915 18 Mar.	*ca.* 50 (100)	At least 1 half-grown young seen (Munter, 1915: 132). Alternate estimate by Brown (ms.).
1916 12 Feb.	?	Nesting on Miller Plateau. About as abundant as Black-footed Albatross; 2 pairs seen "near the top of the middle peak" (Munter, ms.).
1923 5 Apr.	?	Many seen in ship's wake offshore (Wetmore, ms.).
14 June	1	1 adult seen with Black-footed Albatross (Wetmore, ms.).

Table 4. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1972 16 Sept.	0	(BSFW).
1973 31 July	0	(BSFW).

* Number of breeding birds utilizing island.

+ Aerial observations only.

LAYSAN ALBATROSS *Diomedea immutabilis*

Status

Rare breeder; maximum recent breeding population estimate: 40. Present from at least December (see footnote 25 in the Black-footed Albatross species account) through May or June, but may not breed in all years. Nests on the ground, primarily in the Miller Plateau area.

Populations

Laysan Albatross apparently were never common on Nihoa (see Table 5). The only large estimate--1,000 birds in December 1957 (Kenyon and Rice, 1962: 377)--is certainly erroneous in view of the numbers recorded on other surveys. Evidently Kenyon and Rice confused this species with either Red-footed or Blue-faced Boobies when they made their aerial count, a possibility they themselves suggested.

Direct evidence of breeding has been noted only in March 1915, December 1953, March 1968, and July 1973. The lack of nests on the three other March visits indicates that during some years Laysan Albatross nest unsuccessfully, if at all. No more than 40 birds are known to have nested in any one year but it is possible that a few more may have initiated nests. Rice and Kenyon's estimate of numbers breeding in 1956-1957 is much larger but is erroneous (see Table 5).

Annual Cycle

The data are insufficient to document adequately the periods of arrival, laying, hatching, and fledging. Existing data do not indicate that Laysan Albatross on Nihoa have a cycle any different from that on other northwestern Hawaiian Islands.

Table 4. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1961	2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	50	Many incubating eggs (Kramer, ms.).
1962	10 June	?	Only 5 young seen, downy on head but capable of flight (Kramer and Beardsley, ms.).
1963	5-6 June	?	One seen offshore (POBSP).
1964	6-7 Mar.	120-130*	50 young banded, about 10-15 more present (BSFW, POBSP).
	25 July	0	(BSFW).
	23-24 Sept.	0	(BSFW, POBSP).
1965	13-14 Mar.	80-90*	35 young banded. Possibly 5 or 10 more present (BSFW, POBSP).
1966	28 July-1 Aug.	0	(BSFW, POBSP).
1967	8-9 Mar.	?	5 birds seen about ship; breeding area on Miller Plateau not censused (BSFW, POBSP).
	13-14 Sept.	0	(BSFW).
1968	7-9 Mar.	120-124*	60 young banded on Miller Plateau. 1 or 2 more may have been present (BSFW, POBSP).
	24-27 Aug.	0	(BSFW).
1969	21 Mar.	?	None observed, but primary nesting area on Miller Peak not visited (BSFW).
1970	15 Aug.	0	(BSFW).
1971	18-19 Aug.	0	(BSFW).
	15 Sept.	0	(BSFW).

Banding

The BSFW banded 186 Black-footed Albatross on recent visits to Nihoa: 50 young in March 1964, 35 young and 41 adults in March 1965, and 60 young in March 1968. None has been recaptured.

Specimens

Only one Black-footed Albatross, a male (USNM 300832), has been collected on Nihoa. It was collected by Wetmore on 12 June 1923.

Table 4. Observations of Black-footed Albatross on Nihoa Island

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1891	26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902	1-3 June	?	A number seen some miles west of island (Fisher, 1903: 778).
	5-9 Aug.	?	None seen from offshore (Fisher, 1903: 779).
1915	18 Mar.	500 (2,000)	Young were still in "pin feathers" [probably means birds were still downy] (Munter, 1915: 132). Alternate estimate by Brown (ms.).
1916	12 Feb.	?	Nesting on Miller Plateau. About as abundant as Laysan Albatross (Munter, ms.).
1923	5 Apr.	?	Seen offshore (Wetmore, ms.).
	11-16 June	120*	Only 3 adults seen but 60 well grown young found, some with wings fully feathered (Wetmore, ms.).
1936	3 Mar.	?	Evidently nesting (Trempe, ms.).
1940	7-15 Aug.	0	(Vanderbilt and de Schauensee, 1941: 8).
1953	21-22 Dec.	0(?)	Only part of island surveyed (Richardson, pers. comm.).
1954	18 Mar.	0(?)	Only part of island surveyed (Richardson, pers. comm.).
1957	28 Dec.	100*,+	An estimated 50 nests present (Rice and Kenyon, 1962: 377).

BLACK-FOOTED ALBATROSS *Diomedea nigripes*

Status

Uncommon breeder; maximum recent breeding population estimate: 120 to 130. Present and breeding from at least December[25/] through June; probably absent from July through at least the middle of October. Nests on the ground in the Miller Plateau area.

Populations

Estimates from the 1915 survey (Table 4) are so large in comparison to all others that we believe they are probably erroneous. Wetmore's 1923 estimate, and all but one of the more recent estimates that have incorporated careful observations of the Miller Plateau area, have consistently indicated a breeding population of about 100 to 130 birds.

Reports from a number of March visits indicate that the number of young present may vary considerably. This may indicate either that the number of breeding birds varies from year to year or that mortality may be considerably greater in some years. No evidence of mortality was found in July 1964, July-August 1966 and August 1968 so it seems more likely that the former hypothesis is correct.

Annual Cycle

The scant data indicate that birds lay at least by early December and that all young hatch by early March. Young apparently fledge by mid-July since none has been seen at the end of that month or later.

Breeding Habitat

All observers who noted the location of Black-footed Albatross nests stated or indicated that this species was confined to areas of little vegetation on Miller Plateau, north and northwest of Miller's Peak.

Munter (1915: 132) described an area which was likely Miller Plateau. He noted that the colony was located on "a plateau several acres in extent...near the highest part of the island." Similarly, Wetmore (ms.) noted that the colony was "on a small flat below the pinnacle point of Miller's Peak at a point about 850 feet above the sea." The Miller Plateau area was the only one where these birds were found nesting in December 1961 and March 1964, 1965, and 1968.

25/ These albatross almost certainly return earlier than December, judging from observations on other northwestern Hawaiian Islands, but direct observational evidence is unavailable for the late fall and early winter on Nihoa.

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Table 3. Periods of peak egg-laying on three northwestern Hawaiian Islands

Species	Nihoa Island	Laysan Island*	Kure Atoll**
Wedge-tailed Shearwater	Probably June	June	Late June to early July
Christmas Shearwater	May or June	Late April to mid-May	Early or mid-May
Red-tailed Tropicbird	Mid- or late April	Late April to early June	May to mid-June
Blue-faced Booby	March and April	Late March to mid-April	Variable--February to April
Brown Booby	February	May (?)	May to June
Red-footed Booby	February and March	April or May	Variable--mid-March to early June
Great Frigatebird	Late February to March	March	April
Gray-backed Tern	Variable--from February to June	Mid- to late April	Mid-April to mid-May
Sooty Tern	Late February and early March	Mid-May to mid-June	May
Brown Noddy	Variable--usually June or July	Mid-May to early June	May to June
White Tern	Insufficient data	Late April to late May	Late April to early May

* Data from Ely and Clapp, 1973.

** Data from Woodward, 1972.

Table 2. (Continued)

Taxa	Current Status	Maximum Estimate since 1960 and when recorded
Sterna fuscata Sooty Tern	Abundant breeder	100,000; March 1965
Procelsterna cerulea Blue-gray Noddy	Common breeder	2,500; July-August 1966
Anous stolidus Brown Noddy	Abundant breeder	20,000; July-August 1966
Anous tenuirostris Black Noddy	Common breeder	several or low thousands; March 1967, September 1971
Gygis alba White Tern	Common breeder	3,000; August 1971
ORDER PASSERIFORMES FAMILY SYLVIIDAE		
Acrocephalus familiaris kingi Nihoa Millerbird	Common endemic breeder	625; September 1967
FAMILY DREPANIDIDAE		
Psittatrostra cantans ultima Nihoa Finch	Abundant endemic breeder	6,686; August 1968
FAMILY MIMIDAE		
Mimus polyglottos Mockingbird	Vagrant	1; August 1971

* Recorded once in 1923.

Table 2. (Continued)

Taxa	Current Status	Maximum Estimate since 1960 and when recorded
FAMILY SULIDAE		
Sula dactylatra Blue-faced Booby	Common breeder	350; March 1968
Sula leucogaster Brown Booby	Common breeder	225; March 1968
Sula sula Red-footed Booby	Common breeder	3,500; March 1965
FAMILY FREGATIDAE		
Fregata minor Great Frigatebird	Abundant breeder	10,000; March 1964
ORDER ANSERIFORMES		
FAMILY ANATIDAE		
Anas acuta Pintail	Vagrant	2; September 1971
ORDER CHARADRIIFORMES		
FAMILY CHARADRIIDAE		
Pluvialis dominica Golden Plover	Uncommon migrant	50; March 1965
FAMILY SCOLOPACIDAE		
Numenius tahitiensis Bristle-thighed Curlew	Uncommon migrant	5; September 1972
Heteroscelus incanus Wandering Tattler	Uncommon migrant	2; September 1972
Arenaria interpres Ruddy Turnstone	Common migrant	200; March 1968
FAMILY LARIDAE		
Larus argentatus Herring Gull	Vagrant	1; March 1965
Sterna lunata Gray-backed Tern	Abundant breeder	10,000; March 1967

Comparison (Table 3) of peak egg laying periods on Nihoa with those on Laysan, a more westerly island in the leeward chain, and with those on Kure Atoll, westernmost of the northwestern Hawaiian Islands, reveals that some species show distinct geographical variation in their reproductive cycles. In general, peak laying periods on Laysan and Kure are in rough accord but it appears that on Nihoa at least five species breed earlier than on the outlying islands. At present we have no adequate explanation for these differences in breeding regimes.

Table 2. The avifauna of Nihoa Island.

Taxa	Current Status	Maximum Estimate since 1960 and when recorded
ORDER PROCELLARIIFORMES		
FAMILY DIOMEDEIDAE		
Diomedea nigripes Black-footed Albatross	Uncommon breeder	120-130; March 1964
Diomedea immutabilis Laysan Albatross	Rare breeder	40; July 1973
FAMILY PROCELLARIIDAE		
Bulweria bulwerii Bulwer's Petrel	Abundant breeder	250,000; July-August 1966
Puffinus pacificus Wedge-tailed Shearwater	Abundant breeder	20,000-31,000; July-August 1966
Puffinus nativitatis Christmas Shearwater	Common breeder	800; March 1965
FAMILY HYDROBATIDAE		
Oceanodroma tristrami Sooty Storm Petrel	Uncertain; almost certainly breeds in at least small numbers	150; March 1965
ORDER PELECANIFORMES		
FAMILY PHAETHONTIDAE		
Phaethon aethereus mesonauta Red-tailed Tropicbird	Vagrant	*
Phaethon rubricauda Red-tailed Tropicbird	Common breeder	375-625; July-August 1966

represent the maximum number of flying birds present during any one survey. Such estimates include breeding and non-breeding adults, sub-adults, and flying immatures but do not include dependent non-flying young.

The section entitled Populations discusses numerical estimates in part attempting to discover whether there have been any historical changes in population levels and in part to analyze seasonal population changes. Most population numbers were based on visual estimates supplemented by nest counts and banding data. For the two endemic subspecies of birds, the Nihoa Millerbird and Nihoa Finch, recent estimates were usually based on randomly chosen transect censuses. In these transects, usually 16.5 feet wide and 200 to 250 feet long, all birds of either species seen were counted. Usually about 50 transects were covered and a total area of about 4 to 5 acres was sampled. Standard deviation was calculated from the results of the transect counts to obtain 95 percent confidence levels.

The section entitled Annual Cycle contains an attempt, based on all available data, to determine the reproductive cycles and, where possible, to pinpoint peaks of breeding activity. The section headed Breeding Habitat specifies areas or habitats which seem particularly favored by the species under discussion.

The section headed Banding summarizes all known bandings by the POBSP and BSFW and the section headed Specimens lists the locations of all specimens from Nihoa of which we are aware. The specimens cited are deposited in the American Museum of Natural History (AMNH), Bernice P. Bishop Museum (BPBM), Los Angeles County Museum (LACM), Museum of Comparative Zoology (MCZ), Philadelphia Academy of Natural Sciences (PAS), State University of Iowa (SUI), and United States National Museum of Natural History (USNM). These two latter sections are omitted if we have no records indicating that the species has ever been banded or collected on Nihoa.

Birds

In all, 27 species of birds have been recorded from Nihoa Island (Table 2). Eighteen of these are seabirds, all but one of which (the vagrant Red-billed Tropicbird) breed on Nihoa. The remaining avifauna consists of four migrant shorebirds, three vagrants (the Herring Gull, Pintail, and Mockingbird) and two endemic passerines, the Nihoa Finch and the Nihoa Millerbird.

Most species exhibit a distinct annual breeding cycle but in some species at least a few individuals can be found breeding in every month of the year. It seems likely that the birds of Nihoa, like those on other northwestern Hawaiian Islands more intensively studied, vary initiation of nesting by up to several weeks from year to year. This certainly appears to be the case for the Gray-backed Terns and Sooty Terns on Nihoa and may well apply to other species as well.

Among the remaining taxa, eight are restricted to the Hawaiian Islands:

Eragrostis variabilis
Panicum torridum
Rumex giganteus
Chenopodium oahuense
Sesbania tomentosa
Euphorbia celastroides
Solanum nelsoni
Portulaca villosa

Seven taxa are native to Hawaii, but are distributed widely throughout the Pacific:

Boerhavia repens
Portulaca lutea
Tribulus cistoides
Sida fallax
Ipomoea indica
Ipomoea pes-caprae
Heliotropium curassavicum

The remaining taxa are not native to Nihoa, to Hawaii or the Pacific:

Cenchrus echinatus var. *hillebrandianus*[24/]
Paspalum sp.
Tetragonia tetragonioiodes
Portulaca oleracea
Setaria verticillata

To summarize: of the 25 taxa of vascular plants known from Nihoa, 20 are native to the Hawaiian archipelago; of the 13 taxa endemic to the Hawaiian archipelago, 5 are restricted to Nihoa.

TERRESTRIAL VERTEBRATES

Species Accounts

Common names of seabirds follow King (1967) in the following species accounts. Taxonomic order follows that of Peter's (1931, 1934) Checklist of Birds of the World, volumes I and II, with the exception of the Procellariiformes which follow Alexander *et al.* (1965), the Charadriidae and Scolopacidae which follow Jehl (1968), and the Sulidae which follow the A.O.U. Checklist (1957). The scientific name of the Wandering Tattler has been modified to follow the latest supplement to the A.O.U. Checklist (A.O.U., 1973).

The species accounts which follow are set forth in a standard format which is used throughout except in those instances (e.g., accounts of vagrants) where its use would be inappropriate. The section headed Status gives the maximum recent population estimate, delimits periods of occurrence and breeding, and briefly indicates areas of the island used for nesting. The maximum recent estimate is the maximum estimate obtained since 1960. These estimates, as well as those others listed in the tables of observations are meant to

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[24/] Variety native to Hawaii.

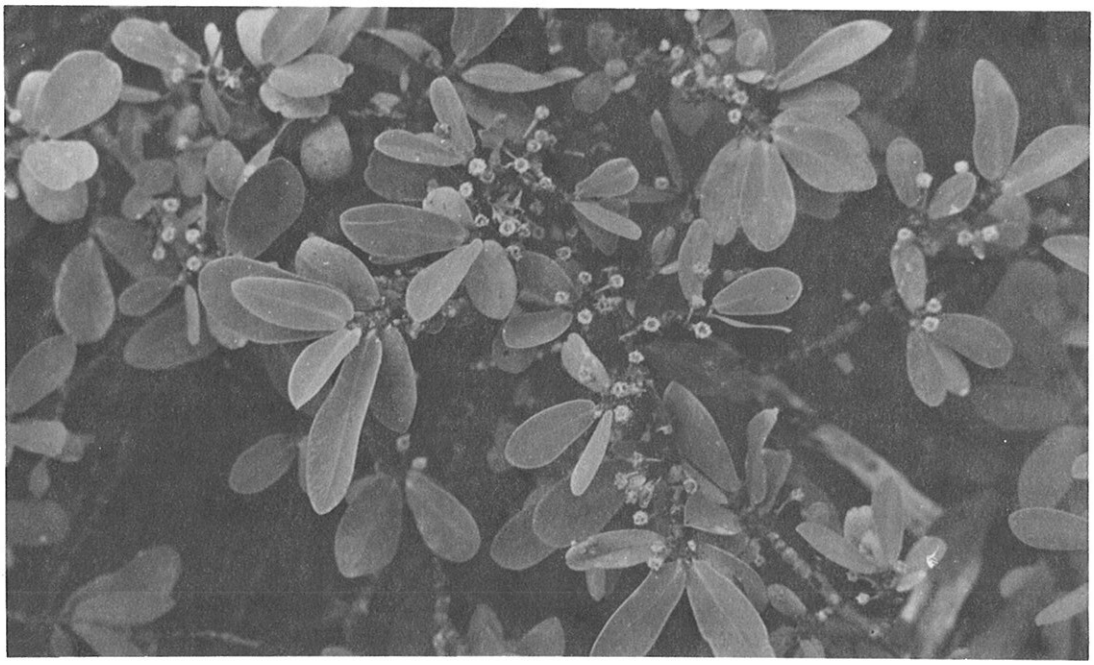

Figure 22. *Euphorbia celastroides*, August 1968. A variety with the same habit growing in a somewhat similar environment at Kaena Point, Oahu, was in flower at this time but was leafless. Photograph by Derral Herbst.

Figure 23. The *Solanum nelsoni* flowers on Nihoa in August 1968 had a white corolla and purple anthers; those of Moomi Beach, Molokai, have light blue petels.

meters. A littoral species cosmopolitan in the tropics and subtropics. Its large, buoyant seeds were doubtless carried to the island by ocean currents and deposited at the mouth of West Palm Valley--an area to which several strand species have been restricted.

Boraginaceae

Heliotropium curassavicum L.

Bryan 4 (BPBM), Caum 77 (BPBM), Christophersen 6 (BPBM), Long 2436 (UH), Yen 1008 (BPBM). Collected from the sand beach at the base of West Palm Valley and the immediately adjacent area in 1923, 1924, and 1964. In September 1964, 27 plants were counted mainly on the slopes above the beach.

Solanaceae

Solanum nelsoni Dunal
S. nelsoni var. *caumii* F.Br.
S. nelsoni var. *acuminatum* F.Br.

Bryan 3 (BPBM), Caum 68, 84 (BPBM), Judd 6, 7, 8 (BPBM), Kramer and Swedberg 5, 12 (BPBM), Long 2424, 2434, 2339 (UH), Herbst 1210 (UH), Yen 1018 (BPBM). Found commonly over the island (Fig. 23).

Solanum nigrum L. var. *nihoense* F. Br.

Caum 62 (BPBM). Two plants were seen in 1923 "one on the edge of the southern cliff, about the middle of the island, and the other in the pocket of a stream bed just above the sand beach" (Christophersen and Caum, 1931: 6-7). Not reported subsequently.

Cucurbitaceae

Sicyos nihoaensis St. John

Christophersen and Dranga 9 (BPBM), Kramer and Swedberg 4 (BPBM), Beardsley s.n. (BPBM), Yen 1006 (BPBM). This species, previously identified as *Sicyos pachycarpus* H. and A., has recently been described as a new species by St. John (1970). It was found only below Tanager Peak in 1924. Several patches found just below and south of the highest Pritchardias in West Palm Valley in 1961. In 1962 found in the HIRAN camp area on Miller Plateau.

Plant Affinities

Of the 25 taxa known from Nihoa, four species and one variety are endemic to the island:

Pritchardia remota
Amaranthus brownii
Schiedea verticillata
Solanum nigrum var. *nihoense*
Sicyos nihoanensis

Leguminosae

Sesbania tomentosa H. and A.

Bryan 5 (BPBM), Caum 63 (BPBM), Judd 3 (BPBM), Christophersen 4 (BPBM), Kramer and Swedberg 2 (BPBM), Long 2409, 2428 (UH), Yen 1016 (BPBM). As in 1923-1924, *Sesbania* is now distributed widely over the island. Found flowering in December 1961 and June 1962.

Zygophyllaceae

Tribulus cistoides L.

Bryan 2a (BPBM), Caum 78 (BPBM), Long 2420 (UH). In 1923 "observed only at the foot of the ridge leading up to Miller's Peak, just above the cliff" (Christophersen and Caum, 1931: 6). In 1962 found in flower at the bottom of West Palm Valley (Kramer and Beardsley, ms.). Last collected in September 1964 when it was found on the south side of the cliffs on the upper slopes.

Euphorbiaceae

Euphorbia celastroides Boiss.

Bryan 6 (BPBM), Caum 64 (BPBM), Judd 5 (BPBM), Kramer and Swedberg 10 (BPBM), Long 2405, 2430 (UH), Yen 1014 (BPBM). Common on the edge of the cliffs in 1923-1924 and on recent visits (Fig. 22)

Malvaceae

Sida fallax Walp.

Caum 69 (BPBM), Bryan 1a (BPBM), Judd 4 (BPBM), Kramer and Swedberg 8, 11 (BPBM), Long 2421, 2429, 2437 (UH), Yen 1004 (BPBM). Common over entire island.

Convolvulaceae

Ipomoea indica (Burm.) Merr.
I. insularis (Choisy) Steud.
I. congesta R. Br.

Caum 83 (BPBM), Christophersen 1 (BPBM), Kramer and Swedberg 9 (BPBM), Long 2427 (UH), Yen 1017 (BPBM). In 1923-1924 "observed in the gorge just below Millers Peak, at the base of the pinnacle on the west cliff, and above the sand beach" (Christophersen and Caum, 1931: 6). Seen in the former area in 1961.

Ipomoea pes-caprae (L.) Sw.

Yen 1007 (BPBM). Collected from stony south face adjacent to the east slope of the mouth of West Palm Valley; elevation about 35

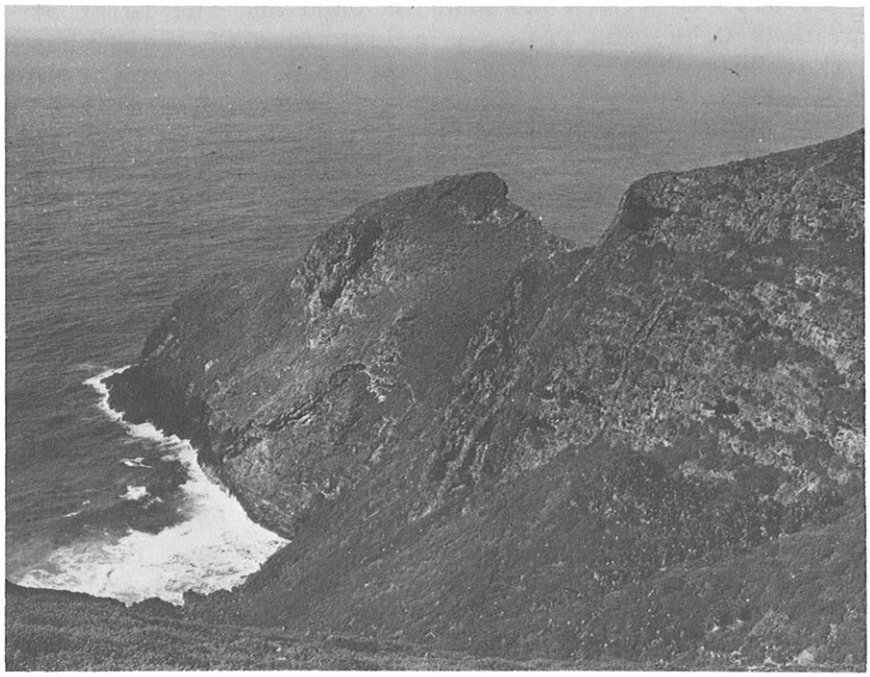

Figure 20. Grove of *Pritchardia* (right foreground) in West Palm Valley, 10 June 1962. BSFW photograph by David B. Marshall.

Figure 21. *Portulaca villosa* plant growing from crack in face of stone ledge, August 1968. Photograph by Derral Herbst.

minutely rugous seeds." Egler (1938: 265)--after studying living plants of *P. villosa* from Koko Head on Oahu and the islet of Kauhikaipu near Oahu, and from the collections of the Bishop Museum --states that "with the possible exception of a statement of petal color," all characters listed from the Nihoa species existed in the portulacas of Oahu. The Nihoa specimen collected by Caum had white petals, while those of *P. villosa* generally have the outer third to outer half pink. However, Egler did find plants with entirely white petals in the colony on Kaohikaupu. Stone (1963) concurs with Egler's conclusions.

After observing plants from Nihoa and Kaohikaipu, grown in the botany greenhouse of the University of Hawaii, Herbst concurs with Egler's conclusions and notes that a number of plants on Nihoa had deep pink or pink-tipped petals in August 1968. These plants were found at an elevation of 165 meters in West Palm and Miller Valleys.

On Nihoa, *P. lutea* grows in shallow, rocky soil and in cracks along the lower south side; a large colony was found in August 1968 near the remains of a heiau (temple) at the northeast end of Miller Plateau. *Portulaca villosa* was found in pockets of soil and in cracks throughout the island (Fig. 21). An introduced species, *P. oleracea*, occurs in two places, the largest colony being on Miller Plateau. A smaller colony, probably established within a year of the August 1968 visit, is located at the base of Miller Valley on a small rise usually used as a campsite by recent survey parties.

Seeds of *P. oleracea* probably were introduced accidentally during the HIRAN operation in 1961 when the Miller Plateau area was used as a helicopter landing pad and campsite.

Caryophyllaceae

Schiedea verticillata F. Br.

Bryan 2 (BPBM), Caum 70 (BPBM), Christophersen 3 (BPBM), Kridler and Sincock, s.n. (UH), Herbst 1210a (UH), Herbst 1401 (BPBM, UH), Yen 1005 (BPBM). In 1923-1924 "seen only on the cliff west of the sand beach, and north of Millers Peak, just below the summit" (Christophersen and Caum, 1931: 6). Two fleshy roots just beginning to send out new leaves were collected by Kridler and Sincock in August 1968, about half-way down Devil's Slide; specimens from one of the roots, grown in the botany greenhouse, Manoa Campus, University of Hawaii, were listed under Herbst's no. 1401. Seeds from Herbst no. 1401 were later distributed to the Foster Botanic Garden and the Lyon Arboretum. Herbst 1210a, consisting of a dried fragment of a plant, was found at about 165 meters elevation in West Palm Valley. Yen 1005 was collected on the south face of the cliffs of Dog's Head (west end), adjacent to Emory's site No. 2 (Emory, 1928: 18).

it was "most common on the ridge leading to Miller Peak, but [was] abundant also on the ridges to the east" (Christophersen and Caum, 1931: 6). This endemic species was not seen again until May 1969, when Yen found four plants growing near the summit of Miller's Peak. The region around Miller's Peak was traversed by most, if not all, of the parties recently visiting Nihoa. It does not seem likely that other botanists would have missed the plant. However, *Amaranthus brownii* is an annual and the ridges are the driest part of the island. If it has the delayed germination period and the rapid life cycle that are common in many annuals, it could easily have been missed by the botanists who collected during August, September and December.

Nyctaginaceae

Boerhavia repens L.
B. diffusa L.

Bryan 3a (BPBM), Caum 79 (BPBM). In 1923 it was found only on the sandy beach in Adams Bay and may have washed away. Not collected or seen since 1923.

Aizoaceae

Tetragonia tetragonioides (Pallas) O. Kuntze
Tetragonia expansa Murray

Caum 80 (BPBM), Christophersen 2 (BPBM). Christophersen and Caum (op. cit.) listed it as "rare, found only just above the sand beach and on steep rock faces west of it." Possibly the corky buoyant fruits floated to Nihoa from one of the main islands and although at least one generation grew there, the species apparently failed to become established. Not collected since 1924.

Portulacaceae

Portulaca lutea Sol

Caum 65 (BPBM), Kramer and Swedberg 1 (BPBM), Yen 1002 (BPBM).

Portulaca oleracea L.

Long 2431 (UH), Herbst 1204, 1205 (UH), Yen 1001 (BPBM).

Portulaca villosa Cham.
P. caumii F.Br.

Caum 66 (BPBM), Kramer and Swedberg 3 (BPBM), Long 2414, 2433 (UH), Herbst 1207 (UH), Yen 1003 (BPBM). *Portulaca caumii* was described as a new species by F. Brown in 1931 (in Christophersen and Caum, 1931: 29) with Caum 66 designated as the type. Brown states that *P. caumii* is "allied to *P. villosa* Chamisso, from which it differs in the color of the flower, the commonly flat leaves and the smaller,

his count of September 1964 into six localities: West Palm Valley contained 107 seedlings, 148 non-flowering or non-fruiting trees, and 127 with flowers or fruit; East Palm Valley had 32 seedlings, 69 non-flowering or non-fruiting, and 46 with flowers or fruits. Long's total is 390 mature trees and 139 seedlings. Herbst attempted to follow Long's system when he counted the trees in August 1968. His census follows: in the west valley, 142 seedlings, 106 non-flowering or non-fruiting and 139 with flowers or fruits; in the east valley, 238 seedlings, 11 non-flowering or non-fruiting plants and 43 with flowers or fruits. The total of 516 palms does not include the very young seedlings with less than five leaves.

Kramer attributed the decline in the palm population to the excessive crowding of the trees in the terraces and to a natural thinning of a long-range cycle of the population. Herbst's observations of this species and of the growth rate of closely allied species on Oahu left little doubt in his mind that the discrepancies between the counts lay primarily in the lack of a uniform definition of the word "seedling." In addition, the difficulty of counting the palms is aggravated by the density of the population and by the numerous, vociferous seabirds that nest in the trees. The population probably has remained fairly static over the last 45 years.

In August 1968 mature fruits were collected from both valleys and were distributed to the Lyon Arboretum of the University of Hawaii, Honolulu, and the Foster Botanic Garden, also located in Honolulu.

Polygonaceae

Rumex giganteus Ait.

Caum 71 (BPBM), Christophersen 8 (BPBM), Long 2411 (UH), Yen 1015 (BPBM). Has been found only in the Devil's Slide-Miller Peak area. Sterile in September 1964 and August 1968.

Chenopodiaceae

Chenopodium oahuense (Mey.) Aellen
C. sandwicheum Moq. f. *microspermum* Aellen

Caum 58, 67 (BPBM), Judd 1 (BPBM), Christophersen 7 (BPBM), Kramer and Swedberg 6 (BPBM), Long 2410, 2413, 2418, 2444 (UH), Yen 1019 (BPBM). Widespread; one of the most common, if not the most common, plant on the island (Fig. 6).

Amaranthaceae

Amaranthus brownii Christophersen and Caum

Caum 73 (BPBM), Judd 2 (BPBM), Yen 1013 (BPBM). Caum and Judd made the first collections of this plant in June 1923, observing that

Figure 18. Low scrambling *Euphorbia* shrubs around rock outcroppings along northern cliffs, August 1968. In the foreground are *Chenopodium* and *Solanum* shrubs. Photograph by Derral Herbst.

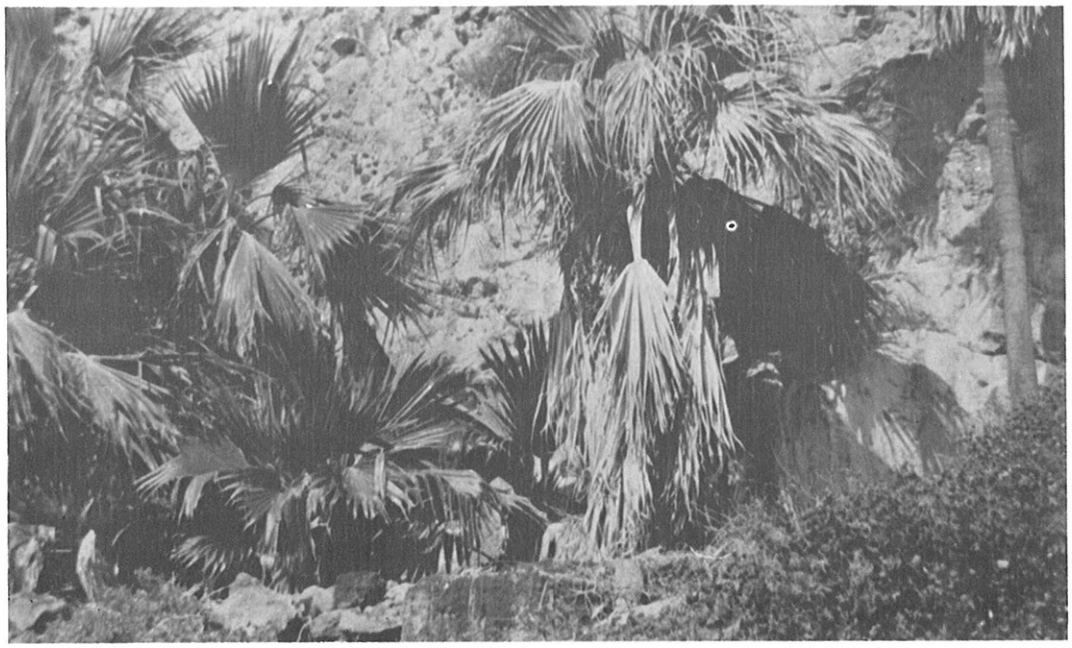

Figure 19. Small grove of *Pritchardia remota* at base of cliff in upper East Palm Valley, August 1968. Photograph by Derral Herbst.

Eragrostis variabilis (Gaud.) Steud.

Caum 61 (BPBM), Long 2417 (UH), Herbst 1208 (UH), Yen 1009 (BPBM). Found widespread over the island as in 1923-1924 but observers in both December 1961 and September 1964 believed this species was less abundant than indicated by Christophersen and Caum.

Panicum torridum Gaud.

Caum 60 (BPBM), Christophersen 5 (BPBM), Kramer and Swedberg 7 (BPBM), Long 2408 2432 (UH), Herbst 1209 (UH), Yen 1011 (BPBM). Widely distributed in 1923. Observers in December 1961 and September 1964 believed this species to be more abundant than indicated by Christophersen and Caum. Only a few plants were seen in August 1968, however.

Paspalum sp.

Found growing in the vicinity of the HIRAN area of operations in June 1962 (Kramer and Beardsley, ms.). Not seen subsequently.

Setaria verticillata (L.) Beauv.

Yen 1012 (BPBM). Near south coast, May, 1969.

Palmae

Pritchardia remota Becc.

Dr. Rooke in 1858 (mentioned in Hillebrand, 1888: 451; not seen), Brown s.n. (BPBM), two sheets, one with Rock's no. 10347, Caum 72 (BPBM), Cooke 299 (BPBM), Christophersen 9a (BPBM), Long 2412, 2440, 2443 (UH). This endemic species of palm, found only in East and West Palm Valleys (Figs. 19-20), is the most conspicuous component of the flora. A few trees--most of which are mature--grow at the bases of basaltic cliffs on the steep outer slopes of each valley. Most of the population, however, is crowded into small, dense groves on the terraces lower in the valleys. Kramer (ms.) suggests that their distribution may be determined by soil depth and availability of water. The faces of the cliffs may act as natural catchment areas which would add to the moisture at their bases, while part of the run-off during rains would be held by the deep accumulations of debris in the ancient, man-made terraces.

The palms have been counted four times in the last 45 years. In June 1923 C.S. Judd counted 347 trees in West Palm Valley and 168 in East Palm Valley. The count did not include small seedlings (Christophersen and Caum, 1931: 6). In December 1961 Kramer and Swedberg counted 229 trees in West Palm Valley and 54 in the east valley. Seedlings under one meter were omitted, and immature fruits were noted on some of the plants (Kramer, ms.). C.R. Long divided

The first recorded botanical collection was made by a Dr. Rooke in 1858 when he brought specimens of the Nihoa loulu, *Pritchardia remota*, to Honolulu (Hillebrand, 1888: 451). Later collections were made by the following: Capt. J.H. Brown of the U.S. Revenue Cutter THETIS, September 1914; E.L. Caum, E.H. Bryan, Jr., C.M. Cooke, Jr., and C.S. Judd, June 1923; E. Christophersen and T.T. Dranga, July 1924; R.J. Kramer and G. Swedberg, December 1961; J.W. Beardsley, June 1962; C.R. Long, September 1964; E. Kridler, J.L. Sincock, and D. Herbst, August 1968; and D. Yen, May-June 1969.[23/]

The following annotated list includes all species of vascular plants known from Nihoa Island. Twenty species were collected during the Tanager Expedition visits of 1923-1924--three species and three varieties subsequently being described as new (Christophersen and Caum, 1931). Additional species collected subsequently and not previously reported were *Portulaca oleracea*, collected by Long in 1964, *Cenchrus echinatus* var. *hillebrandianus*, collected by Herbst in 1968, and *Setaria verticillata* and *Ipomoea pes-caprae*, collected by Yen in 1969. These, together with a sighting of a grass (*Paspalum* sp.), that has not been collected, bring the total number of species of vascular plants known to have grown on Nihoa to 25.

Magnusson (1942) published a list of lichens and Tsuda (1966) included two algae from Nihoa in his enumeration of the marine benthic algae from the Northwestern Hawaiian Islands. The specimens cited below are deposited in the B.P. Bishop Museum Herbarium (BPBM) or in the Herbarium of the University of Hawaii (UH).

Annotated Species List

Gramineae

Cenchrus echinatus var. *hillebrandianus* (Hitchc.) F.B.H. Brown
C. hillebrandianus Hitchcock

Herbst 1206 (UH), Yen 1010 (BPBM). Kramer (ms.) reported finding and burning, in 1961, six *Cenchrus* spikelets which were stuck to a towel of one of the HIRAN personnel. Herbst found two plants growing in a pocket of soil on the floor of Miller Valley in 1968. Both were removed and the area searched for seeds. Apparently these efforts were in vain, as this plant is included in the 1969 collections of Douglas Yen.

[23/] Plants were also collected in February 1916, August 1955, and in March 1964 (see Appendix Table 2) but we do not know the present disposition of these collections.

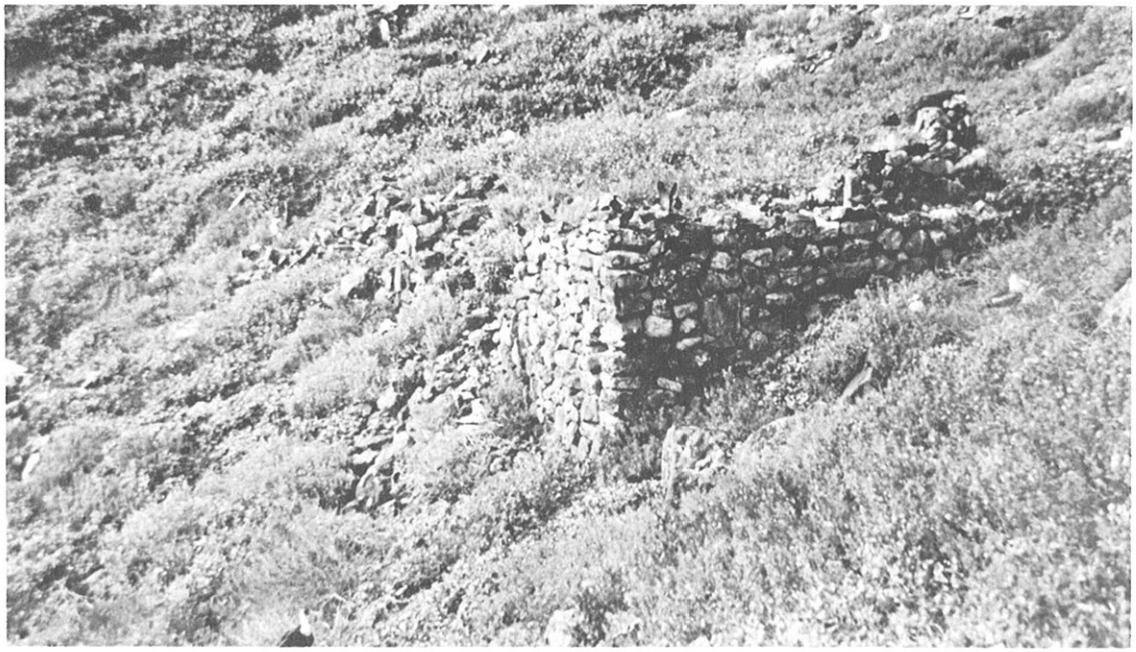

Figure 16. Remains of ancient house terrace in East Palm Valley, August 1968. Vegetation is chiefly *Chenopodium* shrubs with some *Sida*. Photograph by Derral Herbst.

Figure 17. Middle Valley, August 1968; vegetative cover--typical of the sides of the valleys--consists primarily of 2 to 3 foot tall *Sida* and *Chenopodium* shrubs. Photograph by Derral Herbst.

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The Bureau of Sport Fisheries and Wildlife (BSFW), now no longer a separate entity but subsumed within the U.S. Fish and Wildlife Service, assumed responsibility for the management, inspection, and patrol of the Hawaiian Islands National Wildlife Refuge in 1964 when a refuge manager was assigned to Honolulu. Since then at least one landing, and usually two, were made each year.[21] On six of these recent visits (Table 1) BSFW survey parties were composed in part of personnel from the Smithsonian Pacific Ocean Biological Survey Program (POBSP) which investigated the biota of the central Pacific from 1963 until mid-1969.

During these often brief visits Refuge personnel were primarily concerned with administrative and management duties, and with studies of the populations and breeding status of albatrosses, the Nihoa Millerbird, and the Nihoa Finch. POBSP activities were primarily directed towards obtaining data on occurrence, numbers, and breeding status of seabird populations. Data gathered during these visits, and much hitherto unpublished data from earlier visits, form the basis for the faunistic accounts presented in following sections of this report.

In 1967 Nihoa and other islands of the Refuge were designated a "natural area" by the Bureau of Sport Fisheries and Wildlife. This means that the Refuge management is seeking, as far as is possible, to prevent any disturbance of the ecology of the islands. Landings may be made only by permit from the Bureau, and visits are restricted to personnel involved in scientific studies.

VEGETATION
by Derral Herbst[22]

Low shrubs, seldom above 1 meter high, cover the sides and much of the floors of the valleys (Figs. 16-17). These consist primarily of *Solanum nelsoni*, *Chenopodium oahuense* and *Sida fallax*, and may be mixed or in almost pure stands. Less common elements include *Sesbania tomentosa*, *Euphorbia celastroides* and *Eragrostis variabilis*. Of the very few plants of the annual grass *Panicum torridum* sighted in August 1968, all but one were young seedlings. The shrubs are sparser and the tufts of *Eragrostis* more common on the ridges. Intertwining branches of the scrambling *Euphorbia* shrubs form dense mats around rock outcroppings along the edges of the north cliffs (Fig. 18). In August 1968 Herbst did not notice well defined vegetative associations, although these are found on other northwestern Hawaiian Islands.

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[21] Appendix Tables 1 to 3 summarize personnel, accomplishment, and papers resulting from these and earlier visits.

[22] Department of Botany, University of Hawaii, Honolulu, Oahu, Hawaii 96822.

of the Bishop Museum. Other objectives were the collection of plants, and the capture of frigatebirds for the Honolulu Zoo. The party arrived early on 21 August and visited the island daily until 24 August when a final departure was made at 1100 (Honolulu Advertiser, 28 Aug., 1955; Sheehan, 1966).

Dale W. Rice and Karl W. Kenyon made a low-level photographic aerial survey of Nihoa on 28 December 1957. Their purpose was an accurate census of the albatross and seal populations.

Visits During the 1960's

Nihoa was visited 5 to 15 March 1961 by the U.S.S. DUVAL COUNTY which was conducting the first phase of a military project to establish first order astronomic stations, HIRAN, and azimuth marks on the northwestern Hawaiian Islands in connection with the Hawaiian geodetic survey. Transportation between the ship and the island was by helicopter (Roach, ms.).

One of the more extensive surveys of Nihoa was made the following December by Raymond J. Kramer and Gerald Swedberg, biologists with the Hawaii Division of Fish and Game. They landed on the island by helicopter from the U.S.S. FLOYD COUNTY which was engaged in Phase II of the HIRAN project. They landed about noon on 9 December and left the island early in the morning of the 15th (Kramer, ms.).

During their stay detailed notes were made on the status of the two endemic landbirds, the Nihoa Finch and the Nihoa Millerbird, and on the status and distribution of the various species of vascular plants occurring on the island.

Several of their botanical observations are of particular interest since they indicate distinct changes in the vegetation since the detailed survey made by the Tanager Expedition in 1923. Kramer and Swedberg's careful count of the endemic palms (*Pritchardia remota*) revealed a total of 283 palms as compared with 515 in 1923.

Brief notes were taken on seabirds and shorebirds. Eleven species of seabirds and two of shorebirds were recorded.

At the time of the biologists' visit, they found four military personnel, two from the Air Force and two from the Army, who had been living on the island for 2 weeks and who left Nihoa with the biologists.

Kramer, accompanied by David H. Woodside, John W. Beardsley, and David B. Marshall, revisited Nihoa for about 7 hours on 10 June 1962 during the HIRAN II project. During their visit the biologists made brief notes on vegetation and birdlife, collected arthropods, and examined the island to determine what effect the HIRAN operations had had on its ecology. They found two species of plants (*Cenchrus* sp., *Paspalum* sp.), evidently introduced by the military, growing at the HIRAN antennae sites.

heavier surf than before discouraged any attempt at landing. On both visits the ITASCA circled the island and neither time found any evidence of recent landings (Baylis, ms.).

The ITASCA circled Nihoa again on 19 June during another inspection of the northwestern Hawaiian Islands. Later that year (10 December), while searching Hawaiian waters for a missing plane, the STAR OF AUSTRALIA, the ITASCA revisited Nihoa. A private vessel, the LANIKAI, also visited Nihoa during the search for the downed Plane (Honolulu Star Bulletin, 6, 9 Feb. 1935).

On 3 March 1936, A.D. Trempe, in cooperation with the Biological Survey and five crew members of the Coast Guard vessel RELIANCE, made a three-hour inspection of the birdlife of the island. Trempe (ms.) reported seeing 14 species of birds, six of them breeding.

Visits During the 1940's and 1950's

George Vanderbilt, his wife, and Clifton Weaver paid a visit to Nihoa from a private yacht in 1940. The party arrived at Nihoa on 7 August and completed landing their gear by the afternoon of that day. The ship then departed, returning to remove the party from the island on the 16th. The party was primarily interested in ornithological observations and collections (Vanderbilt and de Schauensee, 1941).

In July 1951 Vanderbilt revisited Nihoa on the George Vanderbilt Pacific Equatorial Expedition that was collecting fish and observing seabirds. With him were: Vernon E. Brock of the Hawaii Division of Fish and Game and Robert R. Harvy of Stanford University who served as naturalists; his wife Anita and daughter Lucille; Jack Lance, a sport-fishing guide; and T. Ivar Vatland and Baba Green, the captain and crew, respectively, of the PIONEER. Little has been reported about this visit and we know of no zoological publications resulting from it (see Herald, 1952; Harry, 1953).

Nihoa was visited twice in the early 1950's by Frank Richardson of the University of Washington. Richardson made observations on the occurrence and breeding activities of seabirds. Both visits, one 21 to 22 December 1953, the other on 18 March 1954, were made from the Coast Guard vessel BUTTONWOOD. Thirteen species of birds were recorded on the first visit and 11 on the second (Richardson, pers. comm.).

The AUKAKA, owned by a Honolulu insurance man, David G. Nottage, paid a visit to Nihoa in 1955. Aboard were Nottage and his brother Peter; George Carter, a Pearl Harbor mechanic; Ed Sheehan, a Honolulu radio announcer; and Ivan T. Rainwater, an airport supervisor with the plant quarantine branch of the U.S. Department of Agriculture. Rainwater, an amateur archaeologist, had been detailed to collect specimens of charcoal for radioactive carbon dating by Dr. K.P. Emory

party landed and established camp. The following day camp was set up on nearby Necker and radio communication[18] between the two islands was established. Part of the party subsequently sailed for Honolulu, another group remained on Necker, and a third crew stayed on Nihoa (Edward L. Caum, Harold S. Palmer, Charles S. Judd, and Bruce Cartwright). On 20 and 21 June the TANAGER removed the parties from Nihoa and Necker, respectively (Gregory, 1924: 21-22). During the protracted visit hydrographic work was done, plane table topographic surveys taken, and extensive collections and studies were made of the archaeology and biota (see Appendix Table 3).

The following year the TANAGER paid another visit to Nihoa (and Necker), primarily to follow up on the archaeological work begun the previous year. The party (see Appendix Table 1) was under the leadership of Harold S. Palmer, but archaeological work was directed by Kenneth P. Emory. Although the work done during the 4-day visit (9-13 July) was primarily archaeological, data were also obtained on topography, geology, and botany (Gregory, 1925: 19-20).

Visits in the Late 1920's and Early 1930's

The U.S. Coast and Geodetic Survey Ship GUIDE, commanded by Thomas Maher, visited Nihoa in April, May, and June 1928.[19] Most of the survey party's work was hydrographic in nature but at least one archaeological specimen was collected (Emory, 1928: 45).

On 19 August 1932 Nihoa was visited by the U.S.S. MONTGOMERY (DM 17) commanded by L.E. Clifford. The landing party saw many birds and noted a small lean-to facing south on the slope about 200 feet above Adams Bay. Remains of a radio receiver were found in the shack but no other evidence of human habitation was seen.[20] This shack may have been built by personnel from the GUIDE during its survey of the island a few years previously.

In 1934 the U.S. Coast Guard Cutter ITASCA paid a brief visit to Nihoa to observe conditions on the island. The ship arrived late in the afternoon of 8 February but, like many preceding visitors, the crew was unable to effect a landing. After visiting Necker and French Frigate Shoals, the ship returned to Nihoa on 11 February; an even

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18/ The exact itineraries of each individual are difficult to establish as several trips were made between the islands. Appendix Table I lists personnel known to have spent some time on Nihoa.

19/ Log of the U.S.S. GUIDE. Rec. Group 37, U.S. Nat. Archives, Washington.

20/ Report from the commanding officer, L.E. Clifford, Rec. Group 37, U.S. Nat. Archives, Washington.

of the boat and the coxswain severely injured his leg while trying to hold the boat in position. By the time the survey party returned the long-boat had been partially stove in and could not be used for transportation. Consequently the ship's officers had to jump into the sea from a low cliff and swim for a second long-boat.

The following year on 12 February a party from the THETIS again landed. Several officers, including Munter, again explored the island. Munter (ms.) recorded 13 species of birds, seven of which were breeding. He also collected five specimens of the then undescribed Nihoa Finch and made a collection of plant specimens.

In response to a request by the Department of Agriculture, the U.S.S. HERMES made a survey of the birdlife of the leeward chain in September 1918. Nihoa was visited on the second but, as had often happened before, heavy seas prevented a landing. White Terns, Sooty Terns, Wedge-tailed Shearwaters, albatross, and tropicbirds were noted from offshore, but no other bird observations were recorded (Diggs, ms.).

In 1919 Nihoa was visited by Gerrit P. Wilder, Warden of the Hawaiian Islands. He arrived offshore on 7 October aboard the lighthouse service tender KUKUI. The ship anchored in Adams Bay and a landing was made about 150 yards east of Derby's Landing (Anon., 1920: 560).

Visits by the Tanager Expedition

Nihoa was visited in 1923 and 1924 as a result of a cooperative scientific venture sponsored by the U.S. Navy, U.S. Biological Survey, and Bernice P. Bishop Museum. These visits, known collectively as the Tanager Expedition,[17] are by far the most important early scientific visits.

On 24 May 1923 the TANAGER sighted Nihoa. Commander King, Alexander Wetmore, leader of the scientific party, David L. Thaanum, Theodore Dranga, Chapman Grant, and Eric L. Schlemmer took a long-boat in to look over landing possibilities but found that high surf precluded landing the whole party (Wetmore, ms.). Grant, Thaanum, and Dranga got ashore for a brief period on the rock ledge and managed to collect some molluscs and echinoids. The following day Wetmore and others tried to get ashore but sea conditions had not improved. Finally on 26 May the attempt to land was abandoned and the TANAGER sailed for Honolulu (Ball, ms.).

The following month, on another of her several cruises along the chain, the TANAGER arrived the afternoon of 10 June and the field

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[17] The expedition received its name from the support vessel, the Navy minesweeper TANAGER, commanded by Samuel W. King.

Nihoa was sighted on 9 June 1904 but no landing was made since the ship was en route to Lisianski to apprehend Japanese who were killing birds there (Hamlet, ms.).[15/]

Another visit was made by the THETIS on 12 January 1910 but this time heavy seas prevented a landing. W.V.E. Jacobs (ms.), the vessel's commander, noted that he saw no birds except the Sooty [Black-footed] Albatross and no evidence of human habitation.

The THETIS passed offshore on numerous subsequent occasions between 1910 and 1912. On one of these offshore visits (17 December 1912), George Willett (ms.), who was engaged in surveying the northwestern Hawaaian Islands for the Bureau of Biological Survey, listed eight species of birds.

The THETIS sighted Nihoa twice in 1913 but no landing was made until 7 September 1914[16/] when crewmen swam ashore to collect rock specimens for Carl Elschner. One of those who swam ashore was Lt. W.N. Derby. The small sand beach on which they landed was named for him, "Derby's Landing" (Bryan, 1942: 170).

On 18 March 1915 six persons went ashore, landing on a bit of sandy beach on the south side of the island near the western end. During the day the officers made a bird survey, noting species and numbers and taking photographs.

One of the officers, Lt. W.H. Munter, later made a report in which he listed 14 species, nine of which were recorded as breeding (Munter, 1916). Two other species, the Christmas Shearwater and the Bristle-thighed Curlew, were seen by the ship's captain, J.H. Brown (ms.). Munter's obscure and little-known report was the first fairly comprehensive list of birds of Nihoa. His report also includes the earliest mention of the Nihoa Finch, later described by W.A. Bryan (1917). Although some of Munter's estimates seem high in view of more recent, detailed observations, others seem quite reasonable. On the whole the report was one of the most valuable early surveys of the birdlife of Nihoa, particularly when one considers the brevity of the visit.

While the landing party was making observations on the high slopes, the seas began to rise. The long-boat's crew lost control

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15/ Log of the U.S. Revenue Cutter THETIS. Rec. Group 26, U.S. Nat. Archives, Washington.

16/ Elschner (1915: 9) stated that sailors swam ashore at Nihoa in May 1910, but this is evidently incorrect as an examination of the logs of the THETIS for that period reveals no such landing. Probably Elschner confused Nihoa with Necker where a landing was made on 23 May 1910.

and his assistants who made topographic and geological observations, Sanford B. Dole, who made ornithological observations, Mr. Jaeger, a botanist, and Mrs. E.M. Beckley, representative of the Hawaiian Government Museum (Emory, 1928: 10). Mr. Williams[14/] and W.E.H. Deverill took photographs and the latter collected several archaeological specimens.

Bishop's statement that "the island had been ransacked for birds, skins, eggs, and feathers" (Bishop, 1885b: 5) suggests that quite a number of ornithological specimens were collected but the present whereabouts of these specimens is unknown. Possibly most were lost, as were most photographs and the cameras, when two boats swamped during the departure of the excursion party.

Toward the end of the visit a fire had broken out that evidently consumed much of the island's vegetation (Bishop, 1885a: 4).

The schooner KAALOKAI carrying the Rothschild Expedition was off Nihoa on 26 and 27 May 1891. No landing could be made because of heavy seas, but expedition personnel Henry C. Palmer and George C. Munro made observations of birdlife offshore. Seventeen different species were seen (Palmer *in* Rothschild, 1893-1900: vii; Munro 1941a: 41, 49; 1941b: 16).

Bryan (1942: 170) reported a visit to Nihoa in September 1894 by the H.M.S. HYACINTH; soundings were taken.

Nihoa was acquired by the United States as a part of the Territory of Hawaii on 7 July 1898.

In 1902 the U.S. Fish Commission ship ALBATROSS visited Nihoa twice, 1 to 3 June and 5 to 9 August, while engaged in deep-sea explorations off the Hawaiian Islands. No landing could be made on either visit. Walter K. Fisher, one of the biologists, subsequently reported observations of 19 species of birds that were seen on or around the island (Fisher, 1903). On both visits the ALBATROSS dredged offshore to collect marine organisms (see Appendix Tables 2 and 3).

In April 1909, by Executive Order 1019, Nihoa was included in the Hawaiian Islands Bird Reservation.

Visits by the Thetis - 1904-1916

During the early 1900's Nihoa was visited often by the U.S. Revenue Cutter THETIS. Most of these visits were casual inspections which were made to discover whether birds had been molested by feather poachers, a recurring problem on several of the other northwestern Hawaiian Islands. No evidence was ever found that poachers had visited Nihoa. Lack of poaching, in all probability, was not due to insufficient numbers of birds but rather to the difficulty of landing and working on the steep slopes.

14/ Possibly J.J. Williams who took bird photographs on Laysan Island in the 1890's.

circular appeared claiming Hawaiian dominion over Nihoa.[11]

The following spring an expedition was dispatched to Nihoa to annex formally the island to the Hawaiian Kingdom.

On 23 April 1857 Captain John Paty of the schooner MANUKAWAI, with King Kamehameha IV on board, landed and again annexed the island to the Hawaiian Kingdom. Paty's log describes the visit.

> At 10 a.m. went ashore (got upset in landing). The King and Governor landed at the same time in a canoe....
>
> I deposited a bottle at the foot of the pole near the landing place, containing notes agreeable to my instructions...also a plate of copper on which I scratched 23rd April A.D. 1857. King Kamehameha IV visited this Island, and took Possession.
>
> Not seeing anything to warrant my longer stay here, I got under way at 3 p.m. (Paty, 1857).

The EURYDICE, a French man-of-war, visited Nihoa at the same time and returned to Honolulu with the King and his party on board.

One of the primary purposes of the visit was to determine whether guano was present in sufficient quantity and quality for profitable mining. To Kamehameha's disappointment, Wm. Hillebrand, who analysed the samples brought back, concluded that the material was not valuable enough for shipping and export but that it might be of some use as a fertilizer in areas of the main Hawaiian Islands.[12]

On 30 December 1858, Nihoa was viewed offshore by Lt. J.N. Brooke of the U.S. Schooner FENIMORE COOPER while en route to French Frigate Shoals.[13]

In the early morning of 22 July 1885 an excursion party of over 200 people, including Princess Liliuokalani, landed on Nihoa from the steamer IWALANI. Others in the party included Sereno E. Bishop

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[11] D.L. Gregg to the U.S. Secretary of State, 17, 24 December 1856. State of Hawaii, State Archives, Honolulu.

[12] Report from W. Hillebrand to L. Kamehameha, Minister of the Interior, 26 August 1856. State of Hawaii, State Archives, Honolulu.

[13] Log of the U.S. Schooner FENIMORE COOPER. Rec. Group 37, U.S. Nat. Archives, Washington.

> [The following morning] When the captain saw the schooner approaching close in with the island, he made a last effort to launch his boat. They succeeded in getting her into the breakers but the first heavy roller that broke under them severed the boat amid-ships, and the captain upon end of her and a man that could not swim on the other, were hove up safely on the beach by the succeeding wave. The rest of the boat's crew were good swimmers and also landed in safety. Our boat was not far off when this occurred, and anchoring as near as possible to the shore, the men, all but one, swam off to her through the surf. The only way we could devise to get the captain and seaman off, was to float a cork-jacket on shore, at the end of a line, which being put on by the captain and seaman, afternately, and a rope tied around them, they were hauled through the surf without any other injury than swallowing a quantity of salt-water.
>
> Bird's Island is an uninhabited rock, about a league in circumference, and the highest part from five to eight hundred feet above the ocean. Where our boat landed, is the only spot where a landing could be effected, and upon that side alone it has an inclination by which it may be ascended. Every where else it is perpendicular, and at a distance, looks like the work of art. It has a scanty vegetation.

In the late 1850's many of the central Pacific islands became objects of commercial interest because of guano which was treated to make fertilizer. Most interest centered on the dry equatorial islands, many of which had substantial deposits, but the strong demand for guano and the potential for quick profits resulted in almost all central Pacific islands being investigated.

In December 1856 the Brisith warship HAVANA sailed from Honolulu to determine whether guano deposits were present on Nihoa. The ship arrived offshore on the morning of the eighth and remained offshore through the eleventh, but heavy seas prevented a landing. Captain Harvey went as close to shore as he dared but saw no guano, concluding that "from the formation of the rock and the large amount of heavy rain that falls in...[the island's] vicinity, I do not imagine it possible that any quantity could accumulate; --nor were birds seen in such quantities as to warrant the expectation" (Harvey, 1860: 423).

This expedition by a foreign ship in Hawaiian territory evidently alarmed the Hawaiian government, for shortly thereafter a

and annex it to the Hawaiian Kingdom (Thrum, 1893: 7; Emory, 1928: 8;9/ Bryan, 1942: 169). Adams, himself, states that he visited the island twice but never landed and further notes that "Kaahumanu visited the island in the Summer of 1822 and some of her natives landed on it...."10/

Another early landing was made by the crew of the U.S. Schooner DOLPHIN (Paulding, 1831: 192-195). Like many subsequent visitors they had considerable difficulty landing and returning from the island. Paulding's description follows.

> On the ninth of January, [1826] at eight in the morning...[Nihoa] was discovered close to us. We tacked and stood back close in with the south-west side, where was a small sand-beach, fifty to a hundred yards long.
>
> The captain, taking the Globe's whale-boat went in shore to fish, but seeing a few seal upon the sand beach was induced to land. It soon afterwards became squally and blew with great violence. The surf...rose with the wind, and,...the captain, after a short examination of the island...found it impossible to launch his boat...[and was forced to pass] the night on the island. It blew a gale and rained in torrents all night. The captain and his boat's crew took shelter in a cavern upon the sea-shore, where they had not been long by a comfortable fire they had made, when, by the rising of the tide the sea broke in upon them, and they with difficulty escaped to the side of the rocks, and thence upon the sand-beach. The island was high and almost perpendicular, and with the floods that fell and rushed down its steep sides, rocks of a large size were disengaged from their beds, and came tumbling down in every direction, to the great peril of the captain and his boat's crew....After a little search, they found an asylum in a cave at the side of the mountain, where they passed the night....

9/ Emory states also that Thrum's information about the 1822 visit was obtained from the journal of Captain Alexander Adams. This is impossible as the Adam's journal cited (Thrum, 1905: 66-74) covers only the period 16 January 1816 to 26 December 1817.

10/ Adams to L. Kamehameha, 18 March 1857. State of Hawaii, State Archives, Honolulu.

population which was part of the culture that also sprang up on Necker. He suggests that the permanent population of Nihoa arose when Nihoa was cut off from communication with the larger Hawaiian Islands.[6] He hypothesizes that the people of the Necker culture were forced out of the main Hawaiians and settled for a time on Nihoa. Emory concludes that the Necker culture was "a pure sample of the culture prevailing in Hawaii before the thirteenth century, and that prehistoric as well as the historic Hawaiian culture may be considered Tahitian in origin" (Emory, 1928: 122).

European Discovery and Early Visits

Europeans discovered the existence of Nihoa when the island was sighted by Captain William Douglas of the H.M.S. IPHIGENIA. The IPHIGENIA, sailing in company with the schooner NORTH WEST AMERICA, sighted Nihoa at three in the morning of 19 March 1779 and hove to until daybreak. Meares (1790: 212), who evidently owned the ship,[7] later reported that

> This island or rock, bears the form of a saddle, high at each end, and low in the middle. To the South it is covered with verdure; but on the North, West, and East sides, it is a barren rock, perpendicularly steep, and did not appear to be accessible but to the feathered race, with which it abounds. It was therefore named Bird Island.[8] It lies in the latitude of 23 degrees 07' North, and in the longitude of 198 degrees 10' East [161 degrees 50' West], by a medium of several observed distances of the sun and the moon.

During ensuing years a number of ships passed offshore without making a landing: in March 1794 the British ships the DISCOVERY and the CHATHAM, and on 1 August 1795 the British sloop PROVIDENCE (Buck, 1953: 44, 46); on 17 April 1817 the bark COLUMBIA (Corney 1896: 73); and on 1 July 1825 the TARTAR (Morrell, 1841: 216).

In 1822, Queen Kaahumanu, having heard about Nihoa, sent two or three vessels commanded by Captain William Sumner to find the island

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[6] Nihoa, but not Necker, was by tradition believed to have been known to the Hawaiians prior to the arrival of Europeans (Emory, 1928: 119).

[7] Buck, 1953: 38.

[8] A name by which Nihoa was best known through the first half of the 20th Century.

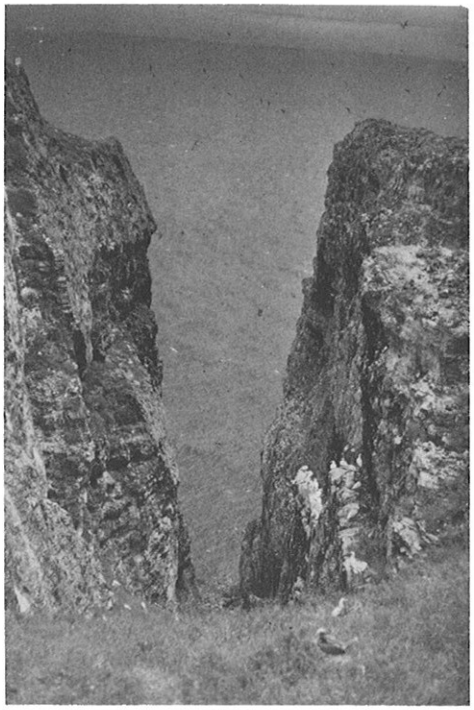

Figure 14. Looking north down the "Devil's Slide". BSFW photograph, 15 August 1970, by Eugene Kridler.

Figure 15. Native structure on the northeast corner of Miller's Plateau. BSFW photograph, 15 August 1970, by Eugene Kridler.

their relative frequency of occurrence, and discussions of relative wear and appearance may be found by consulting Palmer.

Magnetite in the rocks of Nihoa causes wide variation in local magnetic declination. The average declination on Nihoa, like that of the surrounding ocean, is about 11 degrees E of N. However, declination at 10 points on Nihoa ranged from 2 to 28.5 degrees E of N, these two extremes coming from stations only 800 feet apart.

HISTORY

Prehistoric Habitation

Nihoa, like nearby Necker Island, was once inhabited by Polynesians. Emory (1928)[5/] reported that of the many stone structures (Fig. 15) at least 25 were foundations of houses and about 15 were ceremonial structures. Fifteen bluff shelters were discovered. He thought that the island could have sheltered a population of up to 174 persons but believed that probably no more than 100 ever lived there.

A large number of artifacts from terraces, house sites, and bluff shelters was collected by the Tanager Expedition. Artifacts of rock included grindstones, hammerstones, bowls, jars, and a mortar.

Artifacts of plant origin included a bed and a pillow made of bunchgrass, a wooden netting shuttle, a piece of breadfruit wood which had been shaped into a crude tiller of European form, and ashes and charcoal.

Artifacts of animal origin included a coral rubbing stone and file, awls or needles made of bird bones, fragments of turtle shells, and a fishhook of bone, probably from a human femur. Cowries (*Cypraea mauritiana*) had been used as squid lures.

Human skeletal material was found at two sites. At one, in a recess on the east side of Dog's Head, the remains of four adults were found with petrels nesting among the skulls. At the other, on a ledge facing the sea, were partial remains of an adult and two children.

After comparing the archaeological materials collected on Nihoa and Necker, *inter se*, and with those from other areas of Polynesia, Emory (1928) concludes that at one time Nihoa supported a permanent

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5/ Emory (1928) gives an exhaustive account of the archaeology of Nihoa derived primarily from the results of the field work done by the Tanager Expeditions of 1923 and 1924.

> with acrid-tasting matter, presumably derived from the dejecta of the multitudinous birds and is nitrogenous and phosphatic in character (Palmer, 1927: 15).

Along the south shore lies a nearly continuous wave cut terrace, broken in three places, 4 to 8 feet above sea level and varying in width from 10 to 50 feet. Fragments of terrace also remain along other sides of the island.

At present wave action is cutting caves along the base of the north, northeast, southeast and particularly the west cliffs of the island. At the eastern end of the island a tunnel, through which small boats may pass, cuts through the 300 foot promontory (Palmer, op. cit.: 14).

Palmer found no slickensides, offset beds, or other signs of faulting.

The rocks of the island are mostly olivine basalts and occur either as dikes or flows. A few are olivine free basalts. No ash, bombs or tuff was found. Most of the rocks are medium gray except for a few which are dark brick red, due to oxide of iron. Oxidation is not restricted to the surface of the rocks and presumably occurred while the rock was still hot.

Olivine was found in at least 18 to 21 specimens examined by Palmer and occurred particularly commonly in the dike rocks. Feldspar (labradorite) phenocrysts were found in four sections. The ground mass of the rock consists primarily of elongated feldspar grains. Among the feldspar grains are augite grains, a few olivine grains and a little glass (Palmer, op. cit.: 16). Powers (1920) also briefly described a rock collected prior to the visits by the Tanager Expedition.

A detailed account of these rock specimens may be found in Washington and Keyes (1926). All the rocks examined by them were basaltic and occurred in four varieties: andesine basalt, olivine basalt, labradorite basalt and picrite basalt. In their chemical analysis of four specimens (one of each type of basalt) from 55 to 65 percent of the rocks consisted of SiO_2 and Al_2O_3 but appreciable quantities of FeO, MgO, and CaO were also present (Washington and Keyes, 1926: 344).

The rocks of Nihoa are of high specific gravity. Palmer weighed 11 specimens of dike rock and found specific gravities ranging from 2.53 to 3.06, with an average of 2.88. The varying abundance of olivine, a heavy mineral, accounts for the varying specific gravities.

Palmer also analyzed the sand from the beach in some detail. The principal components were grains of calcium carbonate, olivine and magnetite. Also found, but in much smaller amounts, were grains of feldspar, augite and lava. Details on the size of the grains,

> back most on its windward side both by wave attack and by stream erosion, and the last remnant should be a part of the original leeward quadrant.

Palmer noted that none of the original lava surface remained on Nihoa and stated that the flows were from 1 to 20 feet in thickness and exhibited considerable lateral extent.

Perpendicular or extremely steep cliffs are found on the east, west, and north sides of the island. Along the south shore cliffs are 50 to 100 feet high. These cliffs were caused by wave erosion which undermined higher layers of lava. Two other kinds of cliffs may be found on Nihoa. The more abundant type is found where massive, thick lava flows have resisted weathering and erosion more successfully than have adjacent flows, thus forming low cliffs. A third type of cliff is found where heavy dikes have protected the rock behind them while that in front was worn away. Palmer (1927: 13) described these as follows.

> In this way two great dikes northwest of the sand beach have formed a cliff 200 feet high, faced for nearly its full length by the dike material. The steep, chute like gash [the Devil's Slide, Fig. 14] which debouches through the north cliff near the northwest corner of the island has a steeply inclined floor and cliffs for side walls. The gash is due to the removal of the weaker flow lavas from the region between two dikes....A shallower chute on the west cliffs is due to the same processes working between the western extensions of the same dikes.

Nihoa has no permanent streams but Palmer thought that intermittent streams might be of considerable power, partly because of the scarcity of small boulders and gravel in the streamways and partly because the average slope of the island, excluding the cliffs, is about 23 degrees. Runoff is mostly to the south side of the island through the base of the valleys but the northwestern plateau drains mostly to the north. Palmer found three small seeps at the bottoms of streamways.

> [These seeps] represent ground water which is held up by relatively impervious layers of basalt, or which circulates through fissures in the basalt. The smallest seep is a little west of the head of the middle cove, and issues from crevices in the cliff behind the terrace. The second is at 270 feet elevation in the large valley to the east....The water here appears to be brought out by the overlying soil and rock by a massive and relatively impervious lava flow. The largest discharge of water is by seepage from the conglomerate body at the head of the west cove, and is brought to the surface in the same way. The water of all these seeps is heavily charged

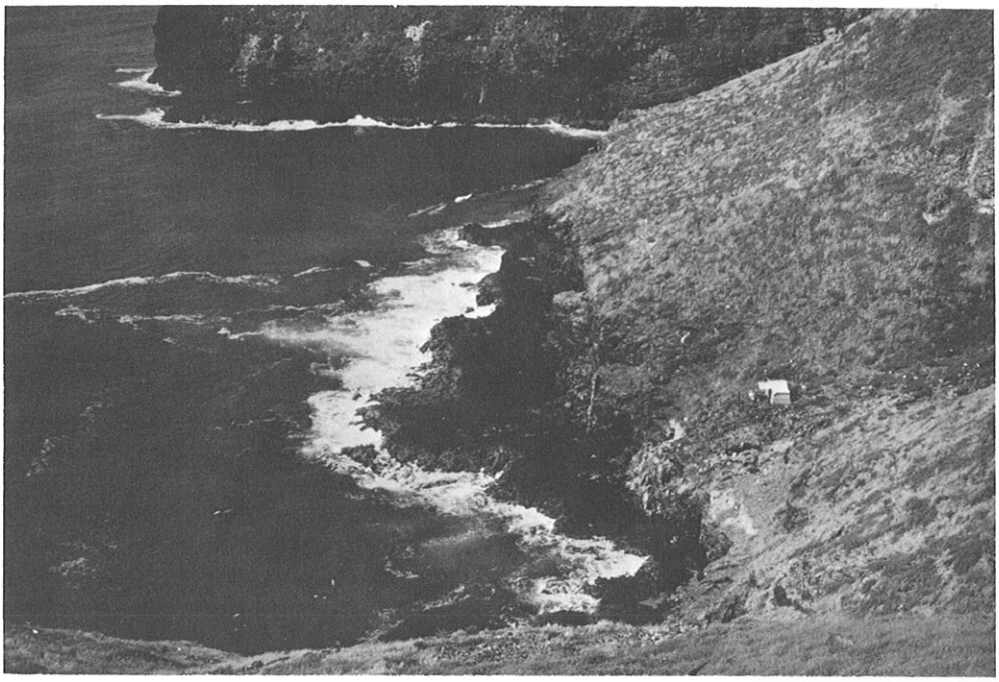

Figure 12. Best landing area is in the right foreground. Note the extent of rock terrace along the edge of the island. Camp is on a reasonably level spot near the base of Miller's Valley. POBSP photograph, 8 March 1968, by Roger B. Clapp.

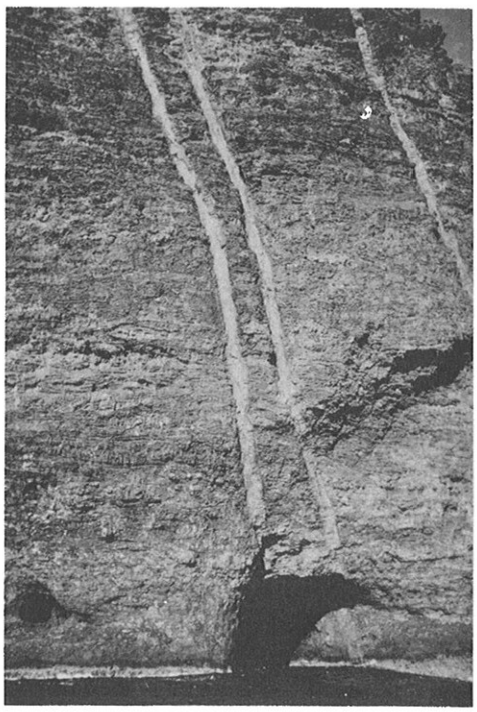

Figure 13. Three of the many dikes cutting the western cliffs. BSFW photograph, 15 September 1971, by Eugene Kridler.

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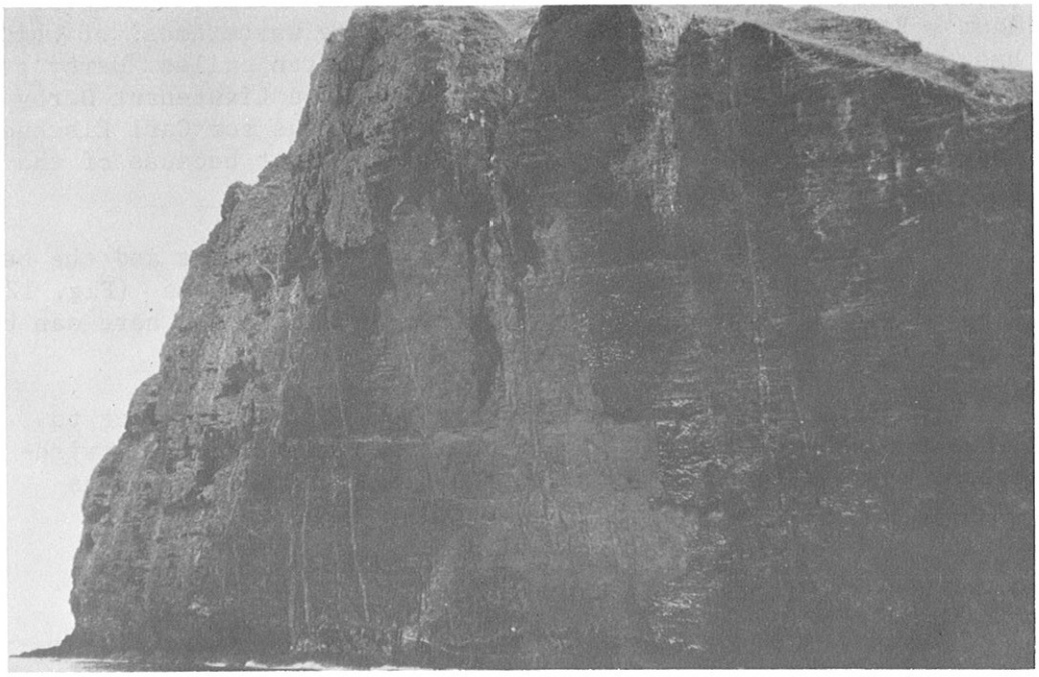

Figure 10. The steep west cliff of Nihoa Island. BSFW photograph, September 1971, by Eugene Kridler.

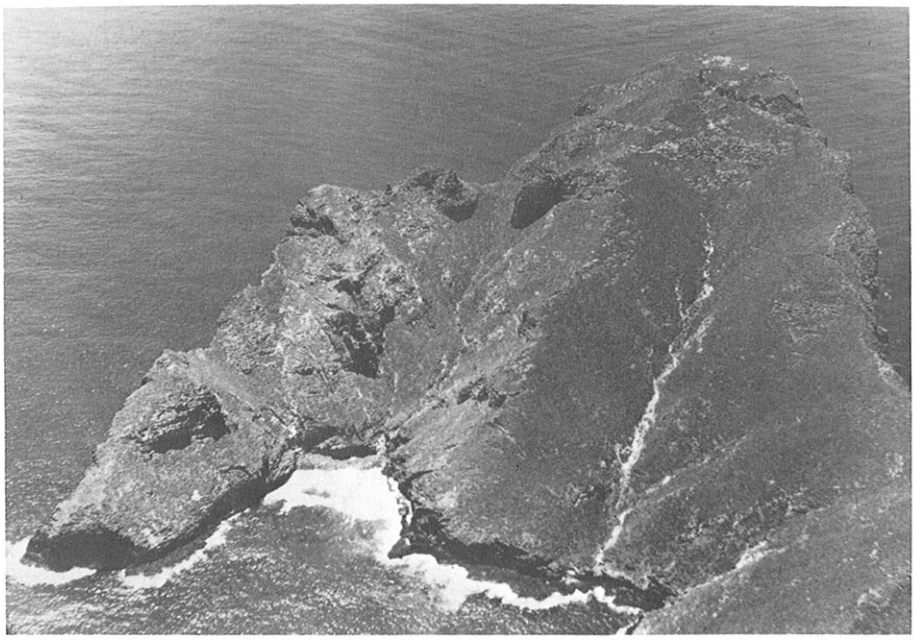

Figure 11. Western portion of island showing sandy beach in westernmost cove. Miller's Peak and Miller's Valley are to the right. In the center is Pinnacle Peak and West Palm Valley. To the extreme left is Dog's Head Peak. Just to the West of Dog's Head Peak is the small West Valley. BSFW photograph, June 1962, by David B. Marshall.

The irregular southern perimeter of the island, enclosing Adam's Bay, is divided into three coves, the westernmost of which has a small sandy beach (Fig. 11) that is often called "Derby's Landing." It received its name in 1914 when a Lieutenant Derby swam ashore there to obtain some rock specimens for Carl Elschner (Bryan, 1942: 170). This is a poor landing spot because of the presence of submerged rocks.

The coves to the west are edged by rock terraces and the best landing spot is on the eastern side of the middle cove (Fig. 12). Nonetheless, if the weather is not favorable, landing here can be extremely hazardous.

The island is well vegetated but occasionally subject to drought which changes its green appearance to a sere yellowish-brown. Grasses tend to dominate the ridges with the valleys covered by dense scrub.

GEOLOGY

The earliest geologic observations of Nihoa were made by Sereno E. Bishop during a one day visit on 22 July 1885. His observations were of some value but were very brief and essentially similar to those made later and in greater detail by Palmer (1927).

Carl Elschner, aboard the USCG ship THETIS in 1914, was unable to land on the island but a Lieutenant Derby swam ashore and obtained some rock specimens. Elschner (1915) described the island in some detail but his observations were much improved upon by Harold S. Palmer.

Palmer, geologist on the Tanager Expedition, visited the island in 1923 and 1924 and later wrote the only detailed account of the geology of Nihoa (Palmer, 1927). Our brief account here, unless otherwise indicated, derives largely from his report.

Utilizing observations on the strike and dip of the dikes and of the positioning of the some 25 dikes cutting the west cliffs (Fig. 13), Palmer (1927: 11) concluded that

> ...Nihoa is a portion of the southwest quadrant of the original cone. This is further corroborated by the fact that Nihoa lies near the southwesterly end of a submarine bank with depths of 20 to 40 fathoms. [The U.S. Coast and Geodetic Survey Chart No. 4181 indicates that the bank has a depth of 25 to 35 fathoms and extends 13 nautical miles from Nihoa in a northwesterly direction.] The survival of a part of the southwest quadrant may be the result of protection from the attack of waves driven by the northeast trades. If no other action interfered, a homogenous [sic] island should be cut

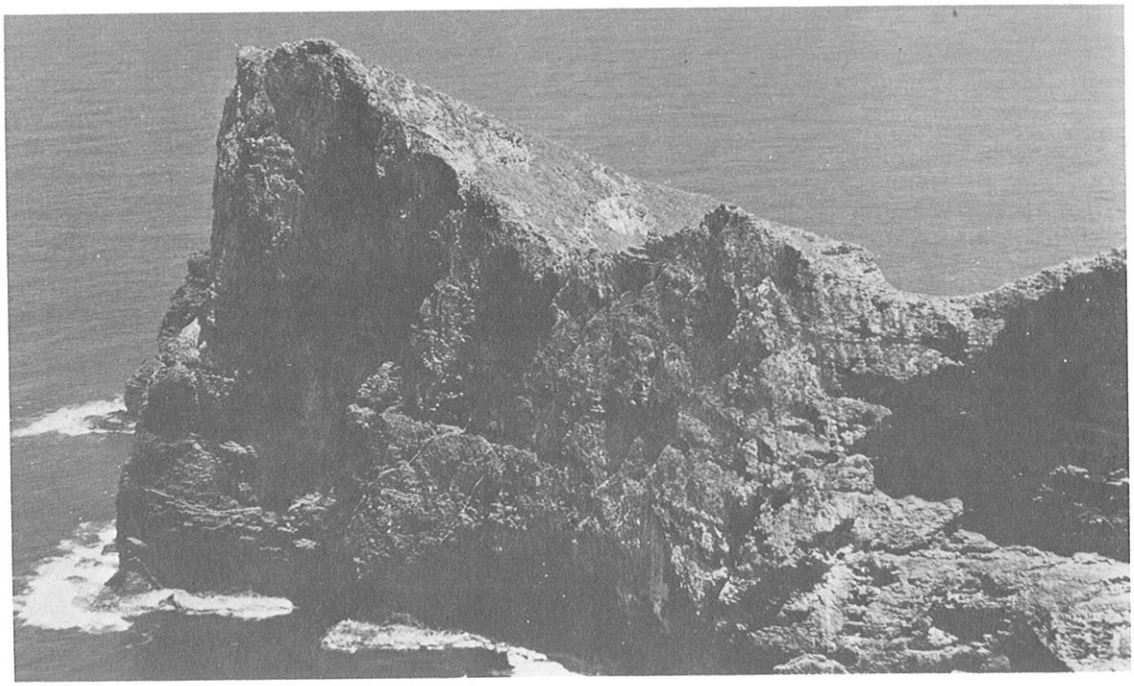

Figure 8. Tanager Peak as seen from the air. Note steepness of north cliffs. BSFW photograph, July 1962, by David B. Marshall.

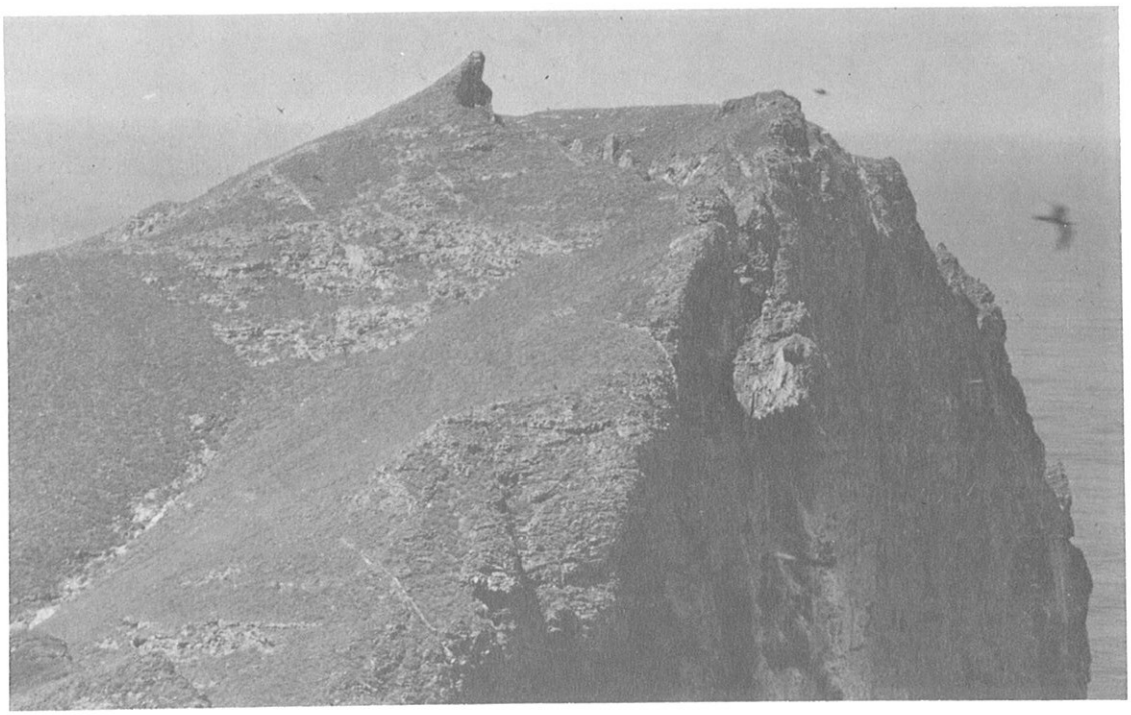

Figure 9. Miller's Peak as seen from the northeastern rim of the island, September 1964. BSFW photograph by Eugene Kridler.

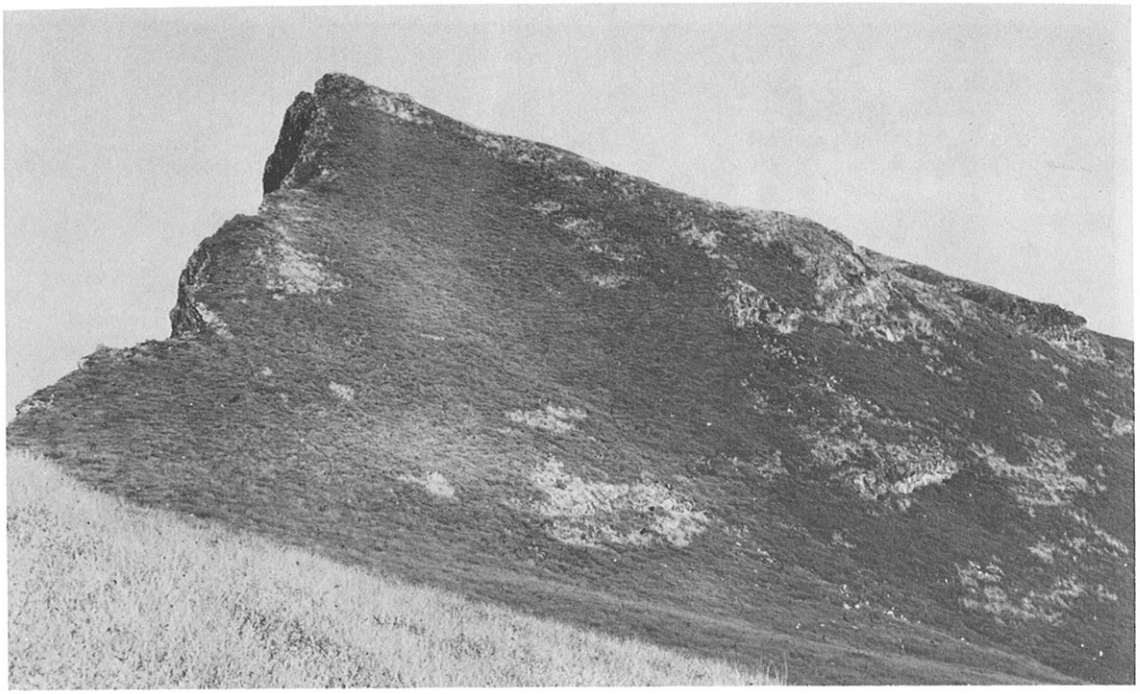

Figure 6. Viewing Tanager Peak from the top of Middle Valley. Note dense *Chenopodium* on slopes and dry *Sida* in left foreground. POBSP photograph, 8 March 1968, by Roger B. Clapp

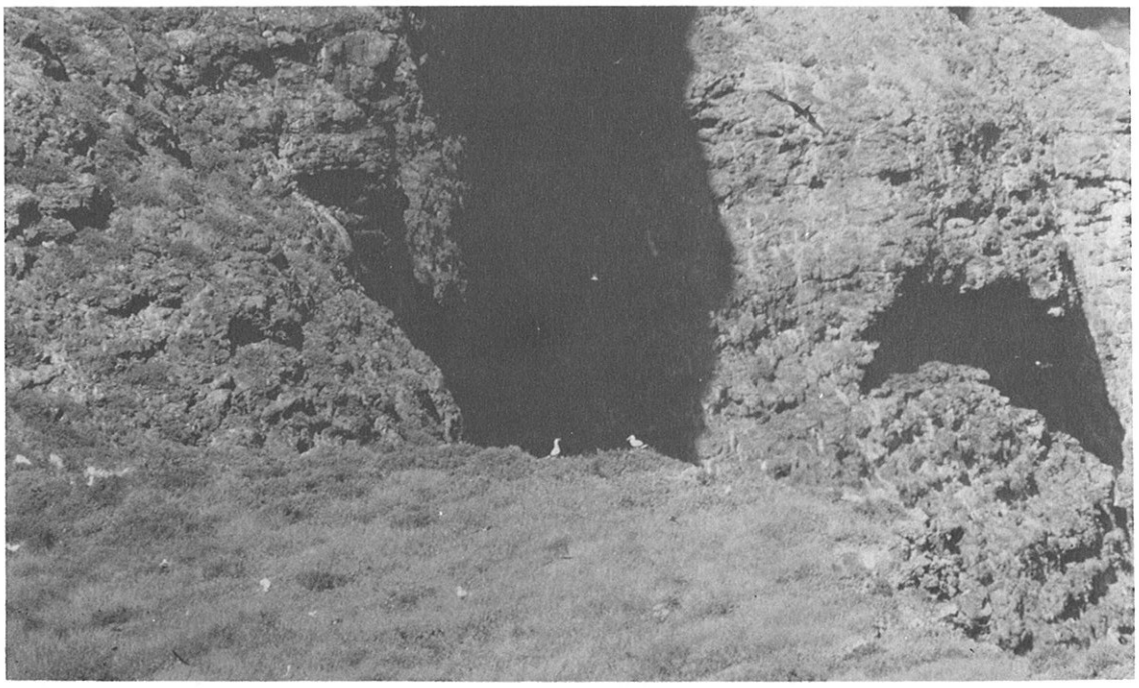

Figure 7. Low point along the north rim between Miller's and Tanager Peaks. POBSP photograph, 8 March 1968, by Roger B. Clapp.

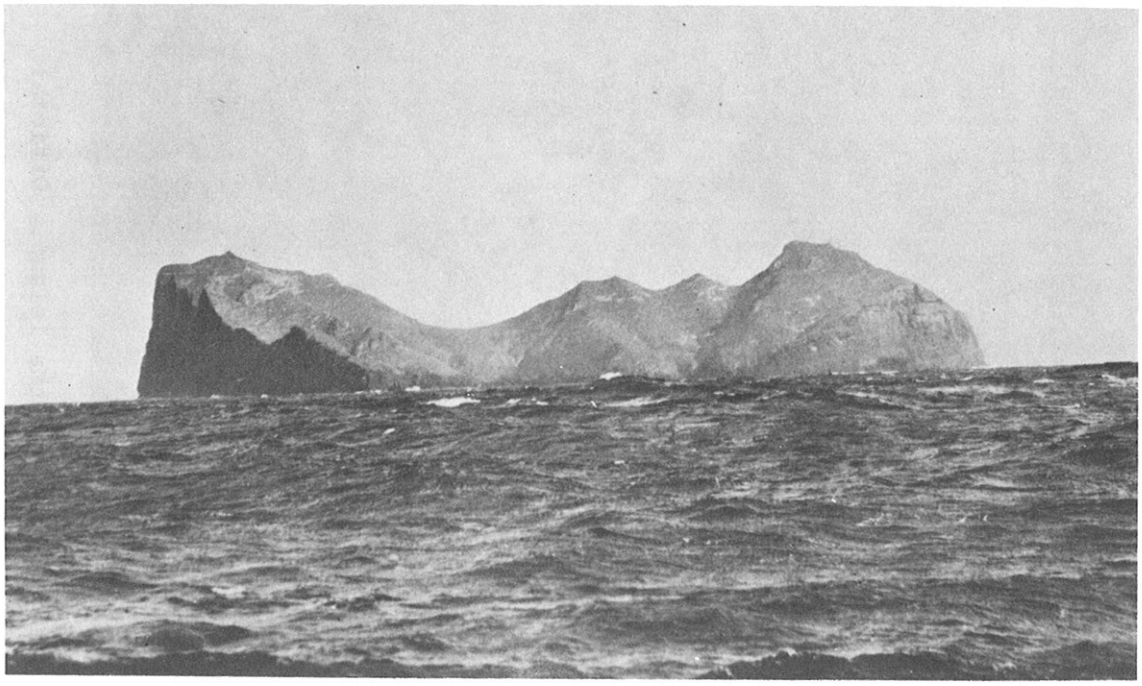

Figure 4. Looking at Nihoa Island from the south, December 1912. Photo courtesy of Virginia Frear Wild.

Figure 5. Viewing Miller Peak from the ridge west of Middle Valley. The dots in the right foreground are nesting Red-footed Boobies. POBSP photograph, 8 March 1968, by Roger B. Clapp.

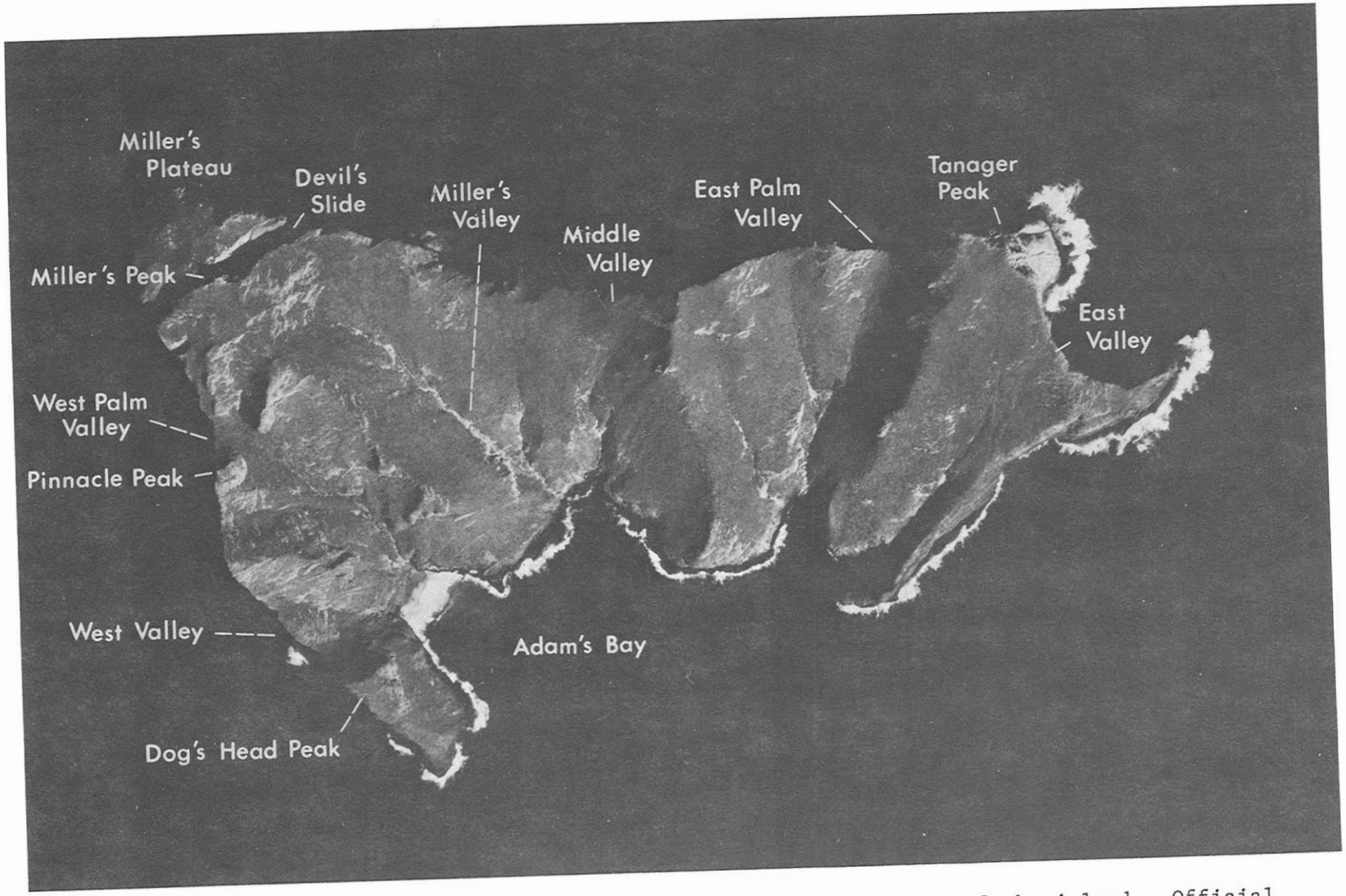

Figure 3. Aerial photograph of Nihoa Island showing prominent features of the island. Official U.S. Navy photograph, January, 1966.

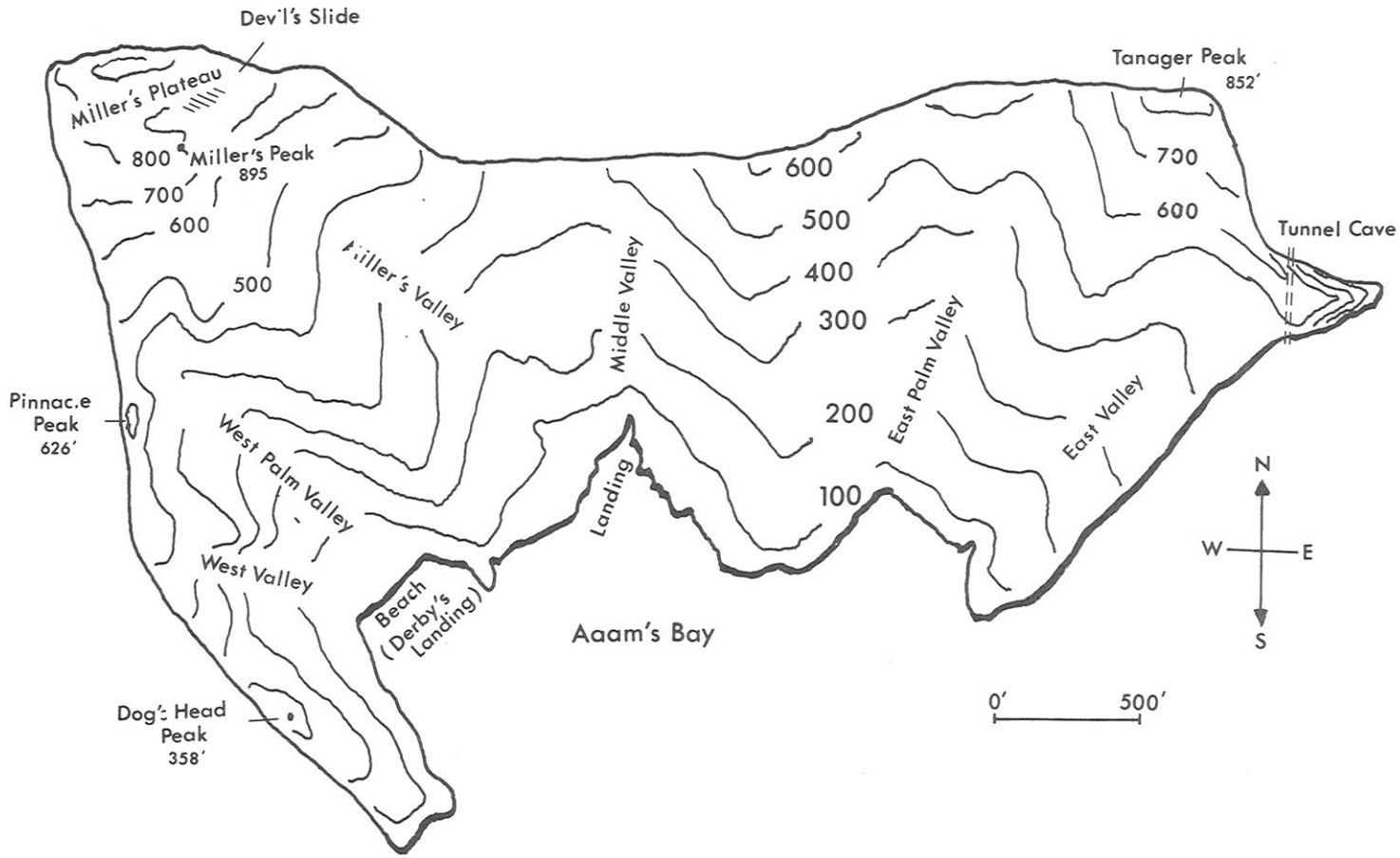

Figure 2. Map of Nihoa Island (after Christophersen and Caum, 1931: 5 and Bryan, 1942: 167).

The primary purpose of this report, one of a series on the northwestern Hawaiian Islands, is to summarize present knowledge of the vertebrate fauna and vascular flora of Nihoa Island. A considerable effort has been made to thoroughly document previous information and many of these unpublished notes, particularly those of Dr. Alexander Wetmore, who led the 1923 Tanager Expedition, add considerably to our knowledge of the island's biota.

Secondarily, this report should serve as a reference to papers (see Appendix Tables 2 and 3) dealing with other aspects of the island's biota.

The present report was largely in final draft form in late 1970 and includes only slight emendations and additions after that period. The tables of observations have been emended to include BSFW information available through 1973 but only seldom has this additional information made changes in the text necessary.

BSFW and POBSP field notes and trip reports concerning Nihoa are, respectively, stored in the Bureau of Sport Fisheries and Wildlife files, Kailua, Oahu, Hawaii and the Pacific Ocean Biological Survey Program files, National Museum of Natural History, Washington, D.C.

DESCRIPTION

Nihoa, remnant of a volcanic cone, is characterized by steep slopes, rocky outcroppings, well developed valleys, and precipitous cliffs. Figures 2 and 3 present a vertical overview of this island which measures about 1,500 yards east to west and from 300 to 1,000 yards wide (Bryan, 1942: 167).

From the south the island present a distinct saddle-shaped appearance (Fig. 4) with the highest peaks being found on the northeastern and northwestern corners of the island. The maximum elevation of 895 feet is to the northwest at Miller's Peak (Fig. 5). In the vicinity of Miller's Peak are several acres of reasonably level land which is much favored by albatrosses for nesting. At the northeastern corner of the island is Tanager Peak (Fig. 6), its 852 foot elevation only slightly lower than that of the peak to the west. Between the peaks the elevation of the ridge drops to 360 feet near the head of Middle Valley (Fig. 7). This area often has small nesting concentrations of Blue-faced Boobies.

Cliffs dominate the perimeter of the island. The north, west, and east cliffs (Figs. 8-10) are nearly perpendicular to the surface of the ocean and at times may exhibit a small overhang. The cliffs of the western perimeter decline rather irregularly in height and in a few places rise to small peaks. The decline in height of the eastern cliffs is far more uniform. The cliffs of the south side are only 50 to 100 feet high and may be relatively easily scaled. Six valleys, varying considerably in the steepness of the slopes of the bordering ridges, fan out radially to the center or south of a point in Adam's Bay.

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

Month	Year 1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	Total Days of Observation
March	BSFW POBSP (1.1)	BSFW POBSP (1.2)		BSFW POBSP (1.0)	BSFW POBSP (2.0)	BSFW (0.3)					5.6
May-June						BSFW (12.4)					12.4
July	BSFW (0.4)									BSFW (0.3)	0.7
July-Aug.			BSFW POBSP (4.0)								4.0
August					BSFW (3.2)		BSFW (0.3)	BSFW (1.1)			4.6
Sept.	BSFW POBSP (1.3)			BSFW (1.2)				BSFW (0.2)	BSFW (0.3)		3.0
Total Days of Observation	2.8	1.2	4.0	2.2	5.2	12.7	0.3	1.3	0.3	0.3	30.3

*POBSP is listed under BSFW when POBSP personnel accompanied BSFW field parties on one of their regular inspection trips. Figures in parentheses are the approximate number of days spent on the island.

THE NATURAL HISTORY OF NIHOA ISLAND, NORTHWESTERN HAWAIIAN ISLANDS[1/]

by Roger B. Clapp[2/], Eugene Kridler[3/], and Robert R. Fleet[4/]

INTRODUCTION

Nihoa Island, sometimes known also as Bird Island, is a precipitous remnant of a volcanic peak and is the easternmost of a chain of islands comprising the Hawaiian Islands National Wildlife Refuge (Figure 1). Approximately 156 acres in extent, it lies at 23°06'N, 161°58'W (Off. of Geogr., 1956: 58), about 250 miles from Honolulu (Bryan, 1942: 167). Its nearest neighbor in the northwestern Hawaiian Islands is Necker Island lying about 155 miles to the west-north-west.

Few reports have been made about the biota of the island. Most of our knowledge of the bird life stems from a report by Vanderbilt and de Schauensee (1941) as well as from several papers dealing with the two endemic forms of passerines found on the island (Bryan, 1916, 1917; Wetmore, 1924, Richardson, 1954). A considerable amount of information was also obtained by the Tanager Expeditions of 1923 and 1924, but the material dealing with the birds was never published.

Beginning in 1964 the Pacific Ocean Biological Survey Program (hereafter POBSP) of the Smithsonian Institution and the Bureau of Sport Fisheries and Wildlife (hereafter BSFW) began making periodic surveys of Nihoa. From 1964 through 1973, 16 visits were made, together totaling 30.3 days of observation (Table 1 and Appendix Table 1). In the tables the unpublished survey material obtained by the BSFW and POBSP can be located through reference to the date of the survey. Dates are listed in the Literature Cited section under BSFW and POBSP.

1/ Paper Number 76, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

2/ National Fish and Wildlife Laboratory, U.S. Fish and Wildlife Service, Department of the Interior, National Museum of Natural History, Washington, D.C. 20560.

3/ Office of Endangered Species and International Activities, U.S. Fish and Wildlife Service, Department of the Interior, 1311 Kapiolani Boulevard, Honolulu, Hawaii 96814.

4/ Department of Wildlife Sciences, College of Agriculture, Texas A & M University, College Station, Texas 77840.

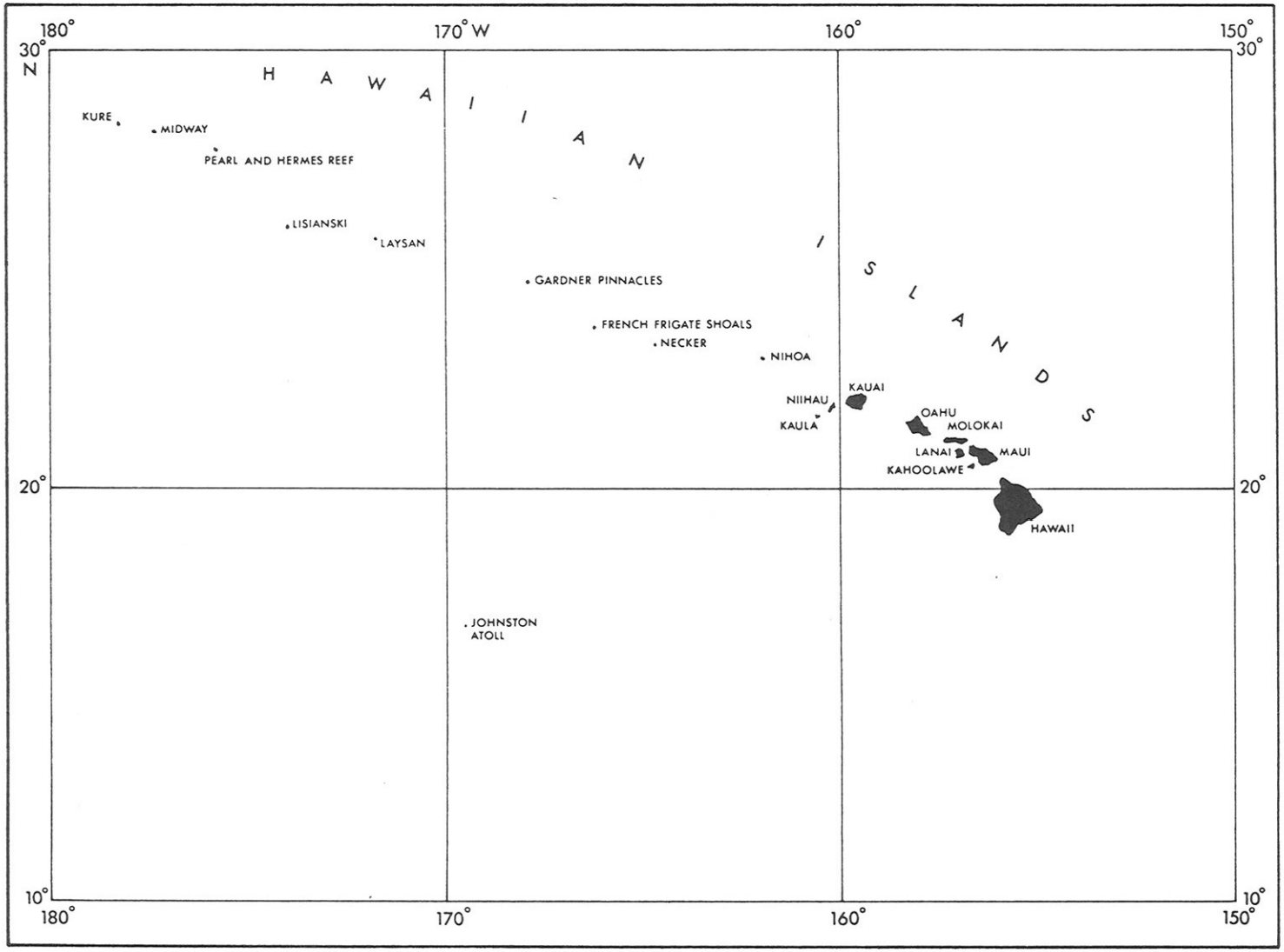

Figure 1 The Hawaiian Islands.

LIST OF APPENDIX TABLES

Table 8. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1971 15 Sept.	?	Active burrows were widespread. Occasional calling was heard (BSFW).
1972 16 Sept.	10,000	(BSFW).
1973 31 July	?	At least 500 birds were seen (BSFW).

* Stated to be most common bird on island.

Table 9. Wedge-tailed Shearwater Specimens from Nihoa Island

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and yg.	Museum Nos.	Date Collected	Collector
USNM	1	189399	2	189400-401			2 June 1902	Fisher
SUI	1	18592					3 June 1902	Nutting
USNM	1	300723	2	300724-725	1	146153	Aug. 1940	Vanderbilt

CHRISTMAS SHEARWATER *Puffinus nativitatis*

Status

Common breeder; maximum recent estimate: 800. Present from at least early March through at least early October; absent remainder of year. Most nesting probably occurs from April through September. Nests most frequently at higher elevations and on the ground.

Populations

Recent numerical estimates made in March and July and August (Table 10) suggest that less than a thousand birds nest on the island. These estimates are of low reliability, however, and it is possible that intensive censusing might reveal greater numbers present.

Annual Cycle

Information that would permit an analysis of the annual cycle is sparse but what is available suggests that this species' cycle

closely parallels, but is earlier than, that of the Wedge-tailed Shearwater. It is not known when these birds begin to return to the island, but most evidently return in early and mid-March. Eggs have been laid as early as late March (1969), but observations made in June and July suggest that most laying probably takes place in April or May. Considerably more detailed information is needed on the nesting status in April and May in order to document adequately the period of peak egg laying. Most eggs evidently hatch in late June and July but at least a few hatch by late May. Some fledging may occur in late August but most probably occurs in September. Judging from the available observations, the number of adults greatly decreases by mid-September, and it seems likely that most have departed by late September.

Breeding Habitat

A number of observers have indicated that this species nests on the higher elevations of the island. Many have recorded nests from such areas. Wetmore (ms.) found a number of pairs on the slopes of Miller's Peak at about 800 to 900 feet. Vanderbilt and de Schauensee (1941: 9) recorded their presence "at the peak of Middle Valley and along the cliff leading to Devil's Slide." Kridler found young among the rocks just below Miller's Peak in July 1964, on the ridge west of Miller's Peak in September 1967, and near Miller's Peak in August 1968. He noted in 1965 that this species was "commonly found at the higher elevations." In July and August 1966 most young were found on the ridges and peaks and along the ledges on the northern rim of the island between Miller's and Tanager Peaks. None was observed on the vegetated slopes of the valleys.

Few data are available on the nature of the nest sites. Wetmore (ms.) reported that Christmas Shearwaters nested "in little shelters beneath overhanging stones or tussocks of grass" where they might or might not be covered.

Banding

Eight adults, none of which has been recaptured, were banded by the BSFW: 1 in March 1964 and 7 in March 1965.

Specimens

Six specimens have been collected on Nihoa. Wetmore collected an adult female (USNM 300699) on 12 June 1923, a juvenile male (USNM 300700) on 14 June 1923, and an embryonic alcoholic (USNM 289399) the same day. The other three specimens (PAS 146165-167), not certainly sexed, were collected in August 1940 by the Vanderbilt Expedition.

Table 10. Observations of Christmas Shearwaters on Nihoa Island

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1891	26-27 May	?	Presence noted offshore (Munro, 1941a: 49).
1902	1-3 June	?	None seen from offshore (Fisher, 1903: 793).
	5-9 Aug.		A few seen offshore (Fisher, 1903: 793).
1915	18 Mar.	(100,000)	Estimate by Brown (ms.). is most likely erroneous.
1923	11-16 June	0?	*Ca*. 20 pairs found building nests; most birds prelaying or with eggs; one *ca*. 1 week old young found (Wetmore, ms.).
1940	7-15 Aug.	rarest bird on island	"No nests or eggs were observed but one nestling young was seen" (Vanderbilt and de Schauensee, 1941: 9).
1953	18 Mar.	0?	Only part of island surveyed (Richardson, pers. comm.).
	21-22 Dec.	0	Only part of island surveyed (Richardson, pers. comm.).
1961	2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	0	(Kramer, ms.).
1962	10 June	very abundant	"On eggs and with downy chicks" (Kramer and Beardsley, ms.).
1963	5-6 June	?	50-100 seen offshore (POBSP).
1964	6-7 Mar.	?	Courting behavior observed. No nests with eggs found (BSFW, POBSP).
	25 July	?	2 young noted. Both were nearly feathered with down remaining only on nape of neck (BSFW).
	23-24 Sept.	0	(BSFW, POBSP).
1965	13-14 Mar.	800	No eggs or young seen (BSFW, POBSP).

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Table 10. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1966 28 July-1 Aug.	500	*Ca.* 250 young, all older than 3 weeks (BSFW, POBSP).
1967 8-9 Mar.	1 seen	Most of breeding population not yet present (BSFW, POBSP).
13-14 Sept.	10	One young, feathered with down remaining on neck, noted (BSFW).
1968 7-9 Mar.	100	No nests found but 1 pair seen copulating by Kridler (BSFW, POBSP).
24-27 Aug.	6	3 adults and 3 chicks seen near Miller's Peak. Chicks in juvenile plumage except for scant down on top of head and nape of neck (BSFW).
1969 21 Mar.	50	3 found incubating eggs (BSFW).
1970 15 Aug.	50-100	(BSFW).
1971 18-19 Aug.	40	Downy to near-fledging young seen (BSFW).
15 Sept.	?	Several seen (BSFW).
1972 16 Sept.	30	(BSFW).

SOOTY STORM PETREL *Oceanodroma tristrami*

Status

Poorly known. Occurs on Nihoa, at least in small numbers, and apparently breeds there.

Observations

The Sooty Storm Petrel has been recorded thrice on Nihoa and once from offshore. Fisher (1903: 795) obtained an immature that retained a trace of down which flew aboard his ship on 1 June 1902. The present location of this specimen is unknown (Vanderbilt and de Schauensee, 1941: 9-10).

On 6 and 7 March 1964 POBSP personnel saw none but heard one calling from a burrow. In addition, they collected two very young

petrel chicks that were found dead. These specimens cannot be located but they were probably young Sooty Storm Petrels since no other species of petrel known to occur on Nihoa would be expected to have chicks at that time of year.

During the visit of 13 to 14 March 1965 Kridler banded one petrel and collected another. In March 1969 Kridler captured and banded two adults which were taken from a burrow about half-way up one of the canyons. Several other petrels were seen in crevices and hollows during this visit.

There are no other definite sightings but observations attributed to Bulwer's Petrel (see that species account) in March 1967 may have referred to this species. In March 1968 several small petrels which could not be positively identified were seen offshore.

This species is the least conspicuous of the petrels breeding in the northwestern Hawaiian Islands. Its call does not carry well and it tends to form localized colonies. Little attempt was made to make nocturnal surveys on some of the recent visits. Thus, if Nihoa has only a small population of these petrels, they could have been easily overlooked.

Banding

The BSFW banded 1 adult in March 1965 and 2 adults in March 1969.

Specimens

We have been unable to discover the location of any of the four specimens mentioned above.

RED-BILLED TROPICBIRD *Phaethon aethereus mesonauta*

Status

Vagrant; one specimen record from June 1923.

Observations

Wetmore collected an immature female (USNM 300997) as it flew over Nihoa on 15 June 1923. The specimen was identified as belonging to the race *P. a. mesonauta* (Clapp and Woodward, 1968: 10-11). (The specimen number was erroneously reported as 300977 in Clapp and Woodward (1968)). This race breeds in the Pacific from the Gulf of California and the Revilla Gigedo Islands to the Galapagos and islands near the coast of Ecuador (AOU, 1957: 27).

The only other specimen record for the central Pacific is one taken in 1968 at French Frigate Shoals (Amerson, 1971: 184). Recent sight records also exist for Johnston Atoll (Moynihan, 1957: 36; Amerson and Shelton, in press).

RED-TAILED TROPICBIRD *Phaethon rubricauda*

Status

Common breeder; maximum recent estimate: 375 to 625. At least small numbers (tens) present in all months, but more numerous from March through September. Known to nest from at least mid-March through at least early October. Nests on ground in shelter or rocks or vegetation.

Populations

Although of low reliability, the various population estimates (Table 11) indicate that less than a thousand tropicbirds breed on Nihoa. Wetmore's May and June 1923 estimate of 800 birds is probably not significantly different from the estimate of 375 to 625 birds made in July and August 1966 due to the low reliability of estimates.

The March 1965 estimate of 400 seems unusually large for that time of year--so large, in fact, that the difference from other years may be significant; possibly more birds initiated nesting earlier than usual. The March 1965 survey was the only recent March survey on which active nests were found.

Annual Cycle

Data are too scanty for detailed analysis of seasonal variation in numbers, but available observations indicate that maximal numbers are present in mid-summer and minimal numbers in mid-winter.

The earliest that eggs were recorded was 3 March and the latest they were recorded was 24 to 25 August. The largest number of eggs are probably present from mid- or late April through June. The presence of eggs in March 1936 and 1965 indicates that hatching those years could have occurred by early May. Most hatching probably occurs in late June and early July.

If the nests initiated in March were successful, young could have fledged by late July. Most fledging likely occurs from late August through September, with at least a few birds fledging in October.

Breeding Habitat

According to most observers, Red-tailed Tropicbirds are widely distributed over the slopes of the island. They are common in rocky crevices at the base of rimrock outcroppings at the west end of the island and in West Palm Canyon, and have been reported as abundant in the vicinity of the cliff face between Miller's and Tanager Peaks. Most nests are in rocky cavities but others are found under overhanging rock ledges. Some nest on the surface of the ground beneath dense vegetation such as *Chenopodium* and *Sida*.

Banding

Seven birds were banded by the POBSP and BSFW in 1964: 4 adults in March by the POBSP and 3 nestlings in September by the BSFW. No returns have been obtained.

Specimens

Two study skins collected by Wetmore in 1923 are apparently all that have been collected on Nihoa. Adult males (USNM 300998-999) were collected on 11 and 12 June; and a skull (USNM 289154) was collected on 15 June.

Table 11. Observations of Red-tailed Tropicbirds on Nihoa

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1891	26-27 May	?	Several seen displaying from offshore (Munro, 1941a: 50; Palmer *in* Rothschild, 1893-1900: vii-viii).
1902	1-3 June	?	Possibly seen from offshore (Fisher, 1903: 778, 796).
1915	18 Mar.	several	1 pair found nesting (Munter, 1915: 132).
1923	5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
	24-26 May	?	Seen from offshore (Wetmore, ms.).
	11-16 June	800	"Nesting" (Wetmore, ms.).
1936	3 Mar.	?	Nests with eggs found (Trempe, ms.).
1940	7-15 Aug.	fairly numerous	Mostly young nearly full grown but 2 nests with eggs found (Vanderbilt and de Schauensee, 1941: 10).
1953	21-22 Dec.	0	Only part of island surveyed (Richardson, pers. comm.).
1954	18 Mar.	0	Only part of island surveyed (Richardson, pers. comm.).
1961	2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	1	Seen flying high over island (Kramer, ms.).

Table 11. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1962	10 June	common	Many with eggs (Kramer and Beardsley, ms.).
1963	5-6 June	?	*Ca.* 20 seen from offshore (POBSP).
1964	6-7 Mar.	30	Birds at nest sites but no nests with contents (BSFW, POBSP).
	20 July	?	Eggs to nearly grown young (BSFW).
	23-24 Sept.	50	4 large downy young and 5 near-fledging young found (BSFW, POBSP).
1965	13-14 Mar.	400	Eggs but no young present (BSFW, POBSP).
1966	28 July-1 Aug.	*Ca.* 375-625	*Ca.* 100 nests with young; *ca.* 20% about 2-3 weeks old; *ca.* 80% older than 3 weeks (BSFW, POBSP).
1967	8-9 Mar.	20	No eggs or young found (BSFW, POBSP).
	13-14 Sept.	common	A few very large chicks observed (BSFW).
1968	7-9 Mar.	150-200	No nests with contents found. *Ca.* 50 seen in flight over the island at once but no more than 10 found on the ground (BSFW, POBSP).
1968	24-27 Aug.	200-300	From eggs to nearly fledged young. Over 50 nests recorded during course of other activities (BSFW).
1970	15 Aug.	100	Large feathered young noted (BSFW).
1971	18-19 Aug.	200	Young noted were from about 3 weeks old to nearly fledged (BSFW).
	15 Sept.	?	Near-fledging chicks seen (BSFW).
1972	16 Sept.	100	(BSFW).
1973	31 July	150	(BSFW).

BLUE-FACED BOOBY *Sula dactylatra*

Status

Common breeder; maximum recent estimate: 350. Probably present throughout year, but most nesting occurs from February through September or October. Nests on the ground, primarily in areas of higher elevation.

Populations

Recent estimates (Table 12) suggest a maximal population level of 300 to 400 birds. Wetmore's 1923 estimate is reasonably consistent with these estimates but Munter's 1915 estimate is inexplicably higher than recent estimates. Several recent estimates made during summer (1966, 1971) are lower than would be expected, judging from most of the estimates made during March, early in the breeding season. The variability in March and late summer estimates is apparently greater than for estimates from most other northwestern Hawaiian Islands at these times of year, and suggests that the population levels on this island may be more variable from year to year than on other northwestern Hawaiian Islands.

Annual Cycle

Numbers present and numbers breeding are probably considerably lower in late fall and winter but the absence of numerical estimates from these months makes it impossible to determine the degree to which the population varies throughout the year.

Eggs are laid primarily from February through March and at least a few are laid from April through July. In most years apparently little laying occurs in late summer or early fall but the presence of recently fledged young in mid-June 1923 indicates that some egg-laying took place 5 1/2 to 6 months earlier--November or early December. Kramer's observations in December 1961 and June 1962 indicate that some eggs were laid in January or February, and BSFW observations on 21 March 1969 suggest a laying peak about 2 months earlier (late January). Vanderbilt and de Schauensee's observations similarly suggest that laying took place very early in 1940.

Peak numbers of young are probably present from early May through July. Most young evidently fledge from late July through September with a few fledging in October and November.

Breeding Habitat

All observers who noted the location of Blue-faced Booby nests agree that most nests were in open areas (Fig. 24) on the ridges and slopes of the island. On many surveys (1923, 1964, 1965, 1966, 1970, September 1971) the largest concentration of nests or birds

Figure 24. Blue-faced Booby at nest on rocky outcroppings. POBSP photograph, 8 March 1968, by Roger B. Clapp.

was on Miller Plateau. On several surveys (July 1964, July-August 1966, March 1968) a small concentration of nests was located just above the cliff face on the ridge along the north side of the island between Miller's and Tanager Peaks.

In March 1968 a more detailed appraisal of the location of the nests was made. Of the 122 nests counted, 51 (42 percent) were found on Miller Plateau and the upper west slopes of the island; 12 (10 percent) were found on the lower west portion of the island (the area around West and West Palm Valleys); 11 (9 percent) were found on the upper central slopes from the ridge east of Miller Canyon across Middle Valley to the lower slopes of Tanager Peak; 3 (2 percent) were found on the upper east portion of the island (the area around Tanager Peak and the upper portions of East and East Palm Valleys); and 45 (37 percent) were found on the lower eastern slopes of the island (the area around East and East Palm Valleys). In summary, 53 percent were on upper slopes and 47 percent were on lower slopes.

Banding

Nine adults were banded in March 1964 by the POBSP (6) and the BSFW (3), but none has been recaptured. A Blue-faced Booby, banded (USFWS 568-71825) as a "local" at Trig Island, French Frigate Shoals, on 9 June 1967 by POBSP personnel, was found dead (age and sex unknown) at Nihoa on 24 August 1968 (Amerson, 1971: 143, 197, 356).

Specimens

Two adults, a male (USNM 300949) and a female (USNM 300948), were collected by Wetmore 13 June 1923.

Table 12. Observations of Blue-faced Boobies on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Noted as "common" from offshore (Fisher, 1903: 797).
5-9 Aug.	?	Common; numerous birds in juvenal plumage seen from offshore (Fisher, 1903: 797).
1915 18 Mar.	5,000	Eggs present (Munter, 1915: 131-132). Brown (ms.) gives an identical alternative estimate.
1916 12 Feb.	[apparently not very common]	Some found nesting (Munter, ms.).
1923 5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
11-16 June	250	Newly-hatched to recently fledged young observed (Wetmore, ms.).
1936 3 Mar.	?	Nesting; eggs noted (Trempe, ms.).
1940 7-15 Aug.	?	"The breeding season had just been completed" (Vanderbilt and de Schauensee, 1941: 10).
1961 2 Mar.	?	Seen on the island from offshore (Woodside and Kramer, ms.).
9-16 Dec.	very abundant	Birds paired but no nests noted (Kramer, ms.).
1962 10 June	?	Large downy young observed (Kramer and Beardsley, ms.).
1963 5-6 June	?	*Ca.* 20 seen from offshore (POBSP).

Table 12. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1964	6-7 Mar.	100	*Ca.* 40 active nests found: 90% with eggs, none with young (BSFW, POBSP).
	25 July	?	Nesting (BSFW).
	23-24 Sept.	50	14 immatures counted. No nests with eggs or downy young seen (BSFW, POBSP).
1965	13-14 Mar.	300	Eggs but no young observed. An estimated 150 nests present (BSFW, POBSP).
1966	28 July-1 Aug.	115-140	Sample count of 17 nests: 2 (12%) with heavily incubated eggs, 15 (88%) with 10-21 day old young. 24 immatures also counted (BSFW, POBSP).
1967	8-9 Mar.	2	None found nesting (BSFW, POBSP).
	13-14 Sept.	very common	Downy chicks observed (BSFW).
1968	7-9 Mar.	350	Only eggs present, most probably fresh or slightly incubated. 122 nests counted. Of 77 nests of which the contents are known, 3 (4%) were empty but active and 74 (96%) contained eggs. *Ca.* 300 nesting birds present (BSFW, POBSP).
	24-27 Aug.	200-250	Most abundant on Miller Plateau. Nests there contained eggs to nearly fledged young. Many young fledged (BSFW).
1969	21 Mar.	90*	Eggs to flying young. Most nests with small young (BSFW).
1970	15 Aug.	160	Estimate includes 30 flying young. No dependent young or eggs seen (BSFW).

Table 12. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1971 18-19 Aug.	80*	Most young seen were full grown (BSFW).
15 Sept.	?	Most birds were on Miller Plateau (BSFW).
1972 16 Sept.	300	At least 75 young were present (BSFW).
1973 31 July	300	(BSFW).

* Estimate is of the number of nesting birds only.

BROWN BOOBY *Sula leucogaster*

Status

Common breeder; maximum recent estimate: 225. Present throughout year with fewer present in winter. Most nesting evidently occurs from February through August but some may occur outside this period. Nests on the ground.

Populations

Recent numerical estimates indicate that peak populations comprise 150 to 225 birds (see Table 13). The estimates from September and December suggest that populations usually decrease during fall and winter. The only early estimate (1923) does not appear significantly different from most recent estimates. The March 1967 estimate is inexplicably small, which may be the result of observer error or possibly indicates a very late nesting season.

Annual Cycle

On Nihoa this species appears to nest earlier than its congener, the Blue-faced Booby. Observations of variously-sized young in March, and Kramer's observations in December 1961, indicate that laying may begin as early as November or December. Most eggs, however, are probably laid in February or March.

The occurrence of a nest with eggs in June (Wetmore, ms.) suggests that an occasional nest is started in May or June and a few nests are probably begun in April. These are possibly renesters.

Observations of the size of young made during the summer suggest that most hatching occurs from about April through May. Most fledging probably occurs from late July through August, with a few birds fledging in September or later; judging from recent observations fledging is largely completed by the end of August.

Breeding Habitat

Brown Booby nests are widely scattered over the slopes of the island and usually are found in locations overlooking rather sharp drops in elevation. Although Brown Booby nests are as restricted to the slopes of the island as are those of the Blue-faced Boobies, nests may often be found along the ridge above the cliff face on the north edge of the island. Some nest sites are possibly on the cliff face itself, but we lack information in this area. In March 1965 most nests were near Tanager Peak and along the western ridge from Miller's Peak to Dog's Head Peak.

In March 1968 we attempted to determine what proportion of the nests was found on Miller Plateau and the upper west slopes of the island; 14 (18 percent) were found on the lower west slopes of the island (in the area around West and West Palm Valleys); 6 (8 percent) were found on the upper west slopes (including Miller Plateau); 6 (8 percent) were found on the upper central slopes and the ridges east of Miller Canyon across Middle Valley to the lower slopes of Tanager Peak; 31 (40 percent) were found on the upper east portion of the island (the area around Tanager Peak and the upper slopes of East and East Palm Valleys; and 20 (26 percent) were found on the lower eastern slopes of East and East Palm Valleys and the surrounding area. In summary, 56 percent were located on upper slopes and 44 percent were on lower slopes.

Banding

The POBSP banded two nestlings, one in March 1964, the other in July 1966. Neither has been recaptured.

Specimens

Two males were collected by Wetmore: USNM 300878 on 14 June 1923, USNM 300880 the following day.

Table 13. Observations of Brown Boobies on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Presence noted from offshore (Fisher, 1903: 779).
5-9 Aug.	?	Numbers of young birds seen from offshore (Fisher, 1903: 798).
1923 11-16 June	100	Mostly young, many half-grown, but at least 1 nest with eggs present (Wetmore, ms.).
1940 7-15 Aug.	?	"Breeding was in a late stage, and large young were seen on the nests" (Vanderbilt and de schauensee, 1941: 10).
1953 21-22 Dec.	8-10	? (Richardson, pers. comm.).
1957 4 July	?	Two dozen birds followed ship as it passed island (Labrecque, 1957: 19).
1961 2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).
9-16 Dec.	relatively rare	"Females were on eggs" (Kramer, ms.).
1962 10 June	?	Large downy young observed (Kramer and Beardsley, ms.).
1963 5-6 June	?	*Ca*. 40 seen from offshore (POBSP).
1964 6-7 Mar.	150-200	*Ca*. 75 nests present, all with eggs except for 1 with a very large nestling (BSFW, POBSP).
25 July	?	Several nearly fledged and fledged young observed (BSFW).
23-24 Sept.	20	4 immature birds seen. No nests with eggs or downy young observed (BSFW, POBSP).

Table 13. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1965	13-14 Mar.	150	Eggs and young present. Most nests contained 2 eggs (BSFW, POBSP).
1966	28 July-1 Aug.	40-65	Near end of breeding cycle. *Ca.* 20 immatures on island (BSFW, POBSP).
1967	8-9 Mar.	15	"Nesting" (BSFW, POBSP).
	13-14 Sept.	100	About 50% seen were fledged immatures (BSFW).
1968	7-9 Mar.	225	Fresh eggs to medium-sized downy young. 77 nests counted. Of 38 nests whose contents were checked, 1 (3%) was empty but active; 32 (84%) contained eggs; 1 (3%) held an egg and a naked young; 4 (11%) contained a medium-downy young. *Ca.* 200 nesting birds present (BSFW, POBSP).
	24-27 Aug.	minimum of 50	No nests with eggs or downy young found. Flying immatures seen. 14 seen in one group on Tanager Peak (BSFW).
1969	21 Mar.	110*	Eggs to downy young. Some flying immatures seen.
1970	15 Aug.	135	Very large and fledged young seen (BSFW).
1971	18-19 Aug.	80*	Young from about a month old to fully-fledged birds were present (BSFW).
1972	16 Sept.	150	(BSFW).
1973	31 July	15	(BSFW).

* Estimate is of the number of breeding birds only.

RED-FOOTED BOOBY *Sula sula*

Status

Common breeder; maximum recent estimate: 3,500. Present throughout the year but most abundant in spring and summer. Breeding occurs

throughout year but most of the population breeds from February through October. Builds bulky nests in low bushes or *Pritchardia* palms.

Populations

Recent population estimates (Table 14) consistently indicate maximal populations of 3,000 to 4,000 birds. Surveys made towards the end of the year suggest a consistent decrease in the population, and the one available December estimate suggests that populations decrease markedly, to perhaps one-tenth of the peak.

Wetmore's 1923 estimate is almost twice as large as any recent estimate, but the absence of recent numerical estimates from June, a month when populations may well reach their zenith, precludes any conclusion that populations are smaller today.

Annual Cycle

Our data clearly indicate that laying usually begins in February, with the peak occurring in late February or March. A small downy young about 2 weeks old seen in March 1968 must have come from an egg laid in January, and observations from March 1969 suggest that fairly large numbers of birds laid eggs in January that year. Thus, a few eggs may be laid earlier in the year but the number nesting at this time must represent only a small proportion of the breeding population. Some laying also occurs in May and June but laying thereafter is apparently quite variable from year to year. Observations in July and August 1966 suggest that laying had been largely completed by early July, but observations in September 1967 and 1971 indicate that some laying had occurred in July or August. In September 1964 and August 1970, on the other hand, observations indicate that laying had been completed by late June.

Young are known to have hatched as early as late February and, if eggs observed in the fall were fertile, may have hatched as late as September or October. However, by far the largest proportion of the young probably hatch from May through June or early July.

Little data are available on fledging but a few young may fledge as early as June. (If eggs present in September were fresh, fledging could occur even earlier in the year.) Most probably fledge in August or September, and a very small proportion fledge in October or November.

Thus, breeding probably occurs in all months, but only a few birds breed from late September through early February.

Breeding Habitat

On Nihoa Red-footed Boobies nest on the slopes of the island in small colonies and in widely dispersed individual nests. A large proportion of the nests is found at middle and lower rather than at higher elevations.

A nesting concentration has several times been noted on Miller Plateau (= Albatross Plateau of Venderbilt and de Schauensee, 1941: 10) and in nearby areas. Vanderbilt and de Schauensee noted that they were most abundant there in August 1940 and Kramer stated that the main colony was found on the upper slopes of Miller Valley in December 1961. Kridler found a colony of about 100 nests on the Plateau in July 1964, and considerable numbers were found nesting in that general area in March 1965, July-August 1966, and March 1968. On the latter visit perhaps half the nests were found in the Miller's Peak-Miller Plateau area.

Considerable numbers also nest on slopes of the various valleys, and smaller numbers nest in groves of *Pritchardia* palms. Most nests are built from 3 to 4 feet above the ground in low *Chenopodium*, *Sida* and *Sesbania*.

Color Phases

No quantitative data are available on the proportion of the different color phases in the breeding population but observational data suggest that over 99 percent of the population consists of the white-plumaged morph (Fig. 25). Dark-plumaged morphs have been seen on three occasions. Wetmore (ms.) flushed a "bird in grey plumage with a pure white tail" from a nest with a newly hatched young in June 1923. Another dark-phase bird was noted in March 1964 and still another, evidently paired with a white-phase bird, was noted in March 1968 (Fig. 26).

Banding

Fifty-one adults and 7 nestlings were banded by the BSFW and POBSP on recent visits. Fifty nesting adults were banded by the BSFW in March 1965 and 1 adult and 7 nestlings were banded by the POBSP in July 1966. None has been recaptured.

Specimens

Three specimens were collected by Wetmore: two males (USNM 300912, 300915) on 12 June 1923, and an embryonic alcoholic (USNM 289297) on 14 June 1923.

Table 14. Observations of Red-footed Boobies on Nihoa

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore. Several captured as they roosted on the ship. An immature seen (Munro, 1941a: 49-50).
1902 1-3 June	plentiful	Seen sitting on nests from offshore (Fisher, 1903: 797).

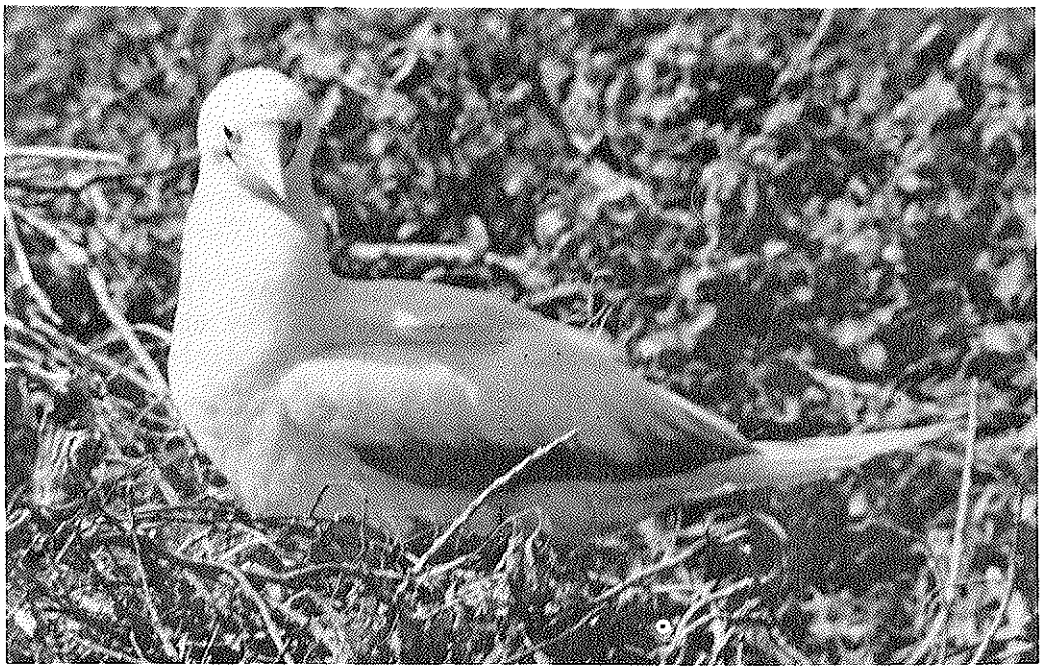

Figure 25. White-phase plumage morph of the Red-footed Booby, 8 March 1968. POBSP photograph by Roger B. Clapp.

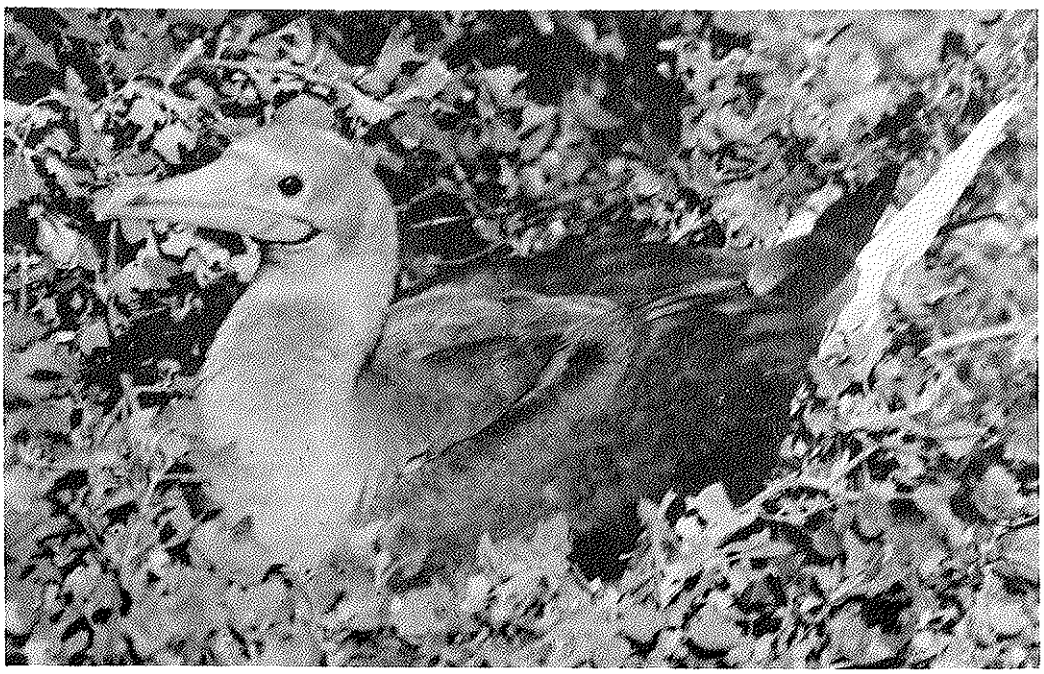

Figure 26. Dark-phase plumage morph of the Red-footed Booby, 8 March 1968. POBSP photograph by Roger B. Clapp.

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Table 14. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1902	5-9 Aug.	?	No adults certainly noted but immatures seen from offshore (Fisher, 1903: 797).
1915	18 Mar.	800 (20,000)	Eggs present (Munter, 1915: 131). Alternative estimate by Brown (ms.) seems much larger than credible.
1916	12 Feb.	?	Mating and building nests. Several fledged young seen (Munter, ms.).
1923	11-16 June	6,000	From recently completed nests through fresh and incubated eggs to recently-hatched through half-grown young (Wetmore, ms.).
1936	3 Mar.	?	Nesting, eggs noted (Trempe, ms.).
1940	7-15 Aug.	?	"Breeding seemed to be in all stages" (Vanderbilt and de Schauensee, 1941: 10).
1953	21-22 Dec.	200-300	? (Richardson, pers. comm.).
1954	18 Mar.	30-40	??? (Richardson, pers. comm.).
1961	2 Mar.	?	Seen on the island from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	?	"All young were nearly full grown and capable of flying" (Kramer, ms.).
1962	10 June	?	Young in various growth stages. No eggs observed (Kramer and Beardsley, ms.).
1963	5-6 June	?	*Ca.* 80 seen from offshore (POBSP).
1964	6-7 Mar.	2,600	*Ca.* 1,000 nests counted. Of those whose contents were checked, all contained eggs, none young (BSFW, POBSP).
	25 July	?	Eggs to well feathered young but most nests with young (BSFW).
	23-24 Sept.	900	15 large nestlings and 68 immatures counted. No nests with eggs or small young observed (BSFW, POBSP).

Table 14. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1965	13-14 Mar.	3,500*	*Ca.* 1,700 nests counted. All investigated contained eggs. None contained young (BSFW, POBSP).
1966	28 July-1 Aug.	2,800-3,000*	*Ca.* 1,400 nests counted: *ca.* 3-7% with incubated eggs, the rest with young. Of the young about 10% were recently hatched, 40% were about 2-3 weeks old, and 50% were more than 3 weeks old (BSFW, POBSP).
1967	8-9 Mar.	3,000	Only about 5% of nests with eggs, none with young (BSFW, POBSP).
	13-14 Sept.	very abundant	Eggs to near fledging young (BSFW).
1968	7-9 Mar.	3,000	*Ca.* 1,200 nests counted. Eggs to small downy young but most nests with contents had eggs. Sample count of 115 nests: 60 (52%) empty but active; 54 (47%) with eggs; 1(1%) with a small downy young (POBSP, BSFW).
	24-27 Aug.	hundreds	Eggs to flying young. Scattered throughout vegetated slopes of island. Large colony of 150 nests on Miller Plateau (BSFW).
1969	21 Mar.	1,050*	Most nests contained small young but a few held eggs (BSFW).
1970	15 Aug.	1,500	An estimated 500 young present, ranging in size from 3/4 grown to fully fledged. Most young had not yet fledged and no nests with eggs were seen (BSFW).
1971	18-19 Aug.	1,000	Most nests contained near-fledging young but a few nests with eggs were also present (BSFW).
	15 Sept.	?	A few nests contained eggs but most contained young of varying ages (BSFW).
1972	16 Sept.	1,500	Chicks seen (BSFW).
1973	31 July	?	A minimum of 350 birds was present (BSFW).

* Estimate is for the number of nesting birds.

GREAT FRIGATEBIRD *Fregata minor*

Status

Abundant breeder; maximum recent estimate: 10,000. Present throughout year but decidedly less abundant in winter. Some breeding birds present throughout the year but most breeding occurs from February or March through September. Builds bulky nests in low bushes.

Populations

Recent estimates place maximal population levels at about 10,000 (Table 15) but populations may be considerably smaller during late fall and winter. The only two early numerical estimates are not consistent with recent observations. Munter's estimate of 50,000 is much higher than any recent estimate, and Wetmore's estimate of 1,200 is considerably lower than any recent estimate made when a large proportion of the population was breeding. Recent estimates are subject to a degree of error but do not vary from one another enough to support either Munter or Wetmore's estimates.

Annual Cycle

Displaying males have been noted from early December to early June but the earliest that eggs have been known to be laid is about mid-January. The presence of recently hatched young in early March 1965 indicates that some eggs were laid as early as the second week in January. However, the egg-laying peak apparently usually occurs from late February through March with an undetermined number of eggs laid in April, May and perhaps June. Observations from early June 1923 indicate that some egg-laying must have occurred in April, May and June, and the presence of young about a week old in late July 1966 (Fig. 27) predicates laying in late May.

Most hatching probably occurs from April through June and the majority of the young probably fledge from September through October. An occasional bird may fledge as early as late August, and a few as late as November. Dependent immatures have been present in mid-March well into the succeeding nesting season.

Breeding Habitat

Munter (1915: 132) indicated that frigatebirds nested less commonly at high elevations, but most recent observers have found them common on most of the upper two-thirds of the island's slopes.

Vanderbilt and de Schauensee (1941: 10) stated that the "colonies appeared to be limited to localities half-way up most of the valleys." In March 1964 Kridler noted that nests were most abundant near the top of East Palm Valley, Middle Valley, and Miller Canyon, and in September 1967 found them most abundant in the former two areas. In March 1965,

1967, and 1968 these frigatebirds nested most densely on the upper slopes of Miller Valley up to Miller Peak.

On Nihoa these birds nest mostly in many small colonies containing a dozen to 30 nesting pairs, but are also found nesting in widely scattered individual sites. Most nests are placed in low, thick *Chenopodium* and *Sida*.

Banding

The POBSP banded 1 adult and 490 nestlings in July 1966 but none has been recaptured.

Specimens

Two specimens, an adult male (USNM 464440) and an adult female (USNM 464441) were collected on 14 June 1923 by Wetmore.

Table 15. Observations of Great Frigatebirds on Nihoa Island.

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1885 22 July	?	Large downy young (Bishop, 1885a: 2).
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Abundant, seen nesting in bushes from offshore (Fisher, 1903: 799).
5-9 Aug.	?	"Still to be seen in considerable numbers" [from offshore] (Fisher, 1903: 799).
1915 18 Mar.	50,000	Eggs and males with inflated throat pouches reported (Munter, 1915: 132). Brown (ms.) gives an identical alternative estimate.
1916 12 Feb.	very common	Breeding season apparently just begun but no eggs or young present (Munter, ms.).
1923 5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
11-16 June	1,200	Incubating eggs or with young from recently hatched to a few half-grown. Only 1 male with inflated throat pouch seen (Wetmore, ms.).
1936 3 Mar.	many	Many nests with eggs (Trempe, ms.).

Table 15. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1940	7-15 Aug.	"Small colonies were quite common"	"The nests contained almost mature young" (Vanderbilt and de Schauensee, 1941: 10).
1953	21-22 Dec.	700-900	? (Richardson, pers. comm.).
1954	18 Mar.	500-1,000	? (Richardson, pers. comm.).
1961	2 Mar.	?	Seen on the island from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	very abundant	Large flying young but no nests with eggs seen (Kramer, ms.).
1962	10 June	?	"Half grown downy young on nests. No males seen in nuptial displays" (Kramer and Beardsley, ms.).
1963	5-6 June	?	*Ca.* 20 seen from offshore (POBSP).
1964	6-7 Mar.	10,000	*Ca.* 4,800 active nests counted, most with eggs. 10 nests found with recently hatched young; courting birds observed (BSFW, POBSP).
	25 July	?	Downy to well-feathered young but most nests with downy young (BSFW).
	23-24 Sept.	6,000	167 large young counted. *Ca.* 1,000 already fledged young present (BSFW, POBSP).
1965	13-14 Mar.	5,200*	*Ca.* 2,500 nests counted about 70% containing eggs (BSFW, POBSP).
1966	28 July-1 Aug.	4,200-6,900	*Ca.* 2,500 young present, 10% recently hatched, 30% from 2-3 weeks old, and 60% older than 3 weeks old. No nests with eggs observed (BSFW, POBSP).
1967	8-9 Mar.	9,000	Initiating nesting. Of 31 nests checked, 10 (32%) were empty and 21 (68%) contained eggs, 43% of which were fresh and 57% were incubated (BSFW, POBSP).
	13-14 Sept.	very abundant	A few small downy young and many immatures notes (BSFW).

Table 15. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1968	7-9 Mar.	7,000-8,000	Only eggs present. A considerable proportion of population still in prelaying stages (30-40% of males with inflated throat pouches in some areas; 70-80% in others). Sample count of 55 nests: 26 (47%) empty but active, 29 (53%) with eggs. *Ca.* 2,000 nests counted and an estimated 4,000 nesting birds present (BSFW, POBSP).
	24-27 Aug.	?	From half-grown to fledged young (BSFW).
1969	21 Mar.	3,450*	Most nesting birds just beginning to incubate eggs (BSFW).
1970	15 Aug.	4,600	More than 1,100 young were counted. Most were very large and well-feathered but were not yet fledged (BSFW).
1971	18-19 Aug.	?	At least 1,200 present. Most young were about 3/4 grown (BSFW).
	15 Sept.	?	Young were from 1/2 grown to near-fledging size (BSFW).
1972	16 Sept.	3,000*	An estimated 1,500 young were present (BSFW).
1973	31 July	?	At least 2,000 present (BSFW).

* Estimate is for the number of breeding birds only.

PINTAIL *Anas acuta*

Status

Accidental; one record of two birds from September 1971.

Observations

On 15 September 1971 the BSFW survey party saw a female Pintail near a very small puddle of water about one-third of the way up East Palm Valley. The rotting carcass of a drake that had probably been

dead for 2 to 3 weeks was found in the same puddle and a wing (USNM 567292) was collected. Pintails have not previously been recorded from Nihoa but are of fairly regular occurrence on Laysan and Midway Atolls where much more extensive ponds or lagoons are to be found. The species has also been recorded from French Frigate Shoals (Amerson, 1971: 228), Pearl and Hermes Reef (Amerson, Clapp and Wirtz, 1974: 182) and from Lisianski Island (Kridler, unpub. observ.) in the northwestern Hawaiian Islands, as well as from Johnston Atoll (Amerson and Shelton, in press).

GOLDEN PLOVER *Pluvialis dominica*

Status

Uncommon but regular migrant; maximum recent estimate: 50. Recorded in February, March, June, August, September, and December. Largest numbers occurred in March.

Observations

All observations are listed in Table 16.

Specimens

Evidently only one specimen has been collected. The Vanderbilt Expedition obtained a female (PAS 146156) in August 1940.

Table 16. Observations of Golden Plovers on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1902 1-3 June	a few	Seen from offshore (Fisher, 1903: 778).
5-9 Aug.	a few	Seen from offshore (Fisher, 1903: 779).
1915 18 Mar.	several seen	Seen "on the plateau" (Munter, 1915: 133).
1916 12 Feb.	quite common	(Munter, ms.).
1923 11-16 June	3	Seen on rocks of Adams Bay 11 June (Wetmore, ms.).
1940 7-15 Aug.	a few	"not present in any numbers." Number of dead birds found (Vanderbilt and de Schauensee, 1941: 10).
1953 21-22 Dec.	0	(Richardson, pers. comm.).

Table 17. (Continued)

Date of Survey	Population Estimate	Observations, Remarks, and References
1968 7-9 Mar.	0	(BSFW, POBSP).
24-27 Aug.	0	(BSFW).
1969 21 Mar.	0	(BSFW).
1970 15 Aug.	1	(BSFW).
1971 18-19 Aug.	1	(BSFW).
15 Sept.	0	(BSFW).
1972 16 Sept.	0	(BSFW).

RUDDY TURNSTONE *Arenaria interpres*

Status

Common migrant, present in small numbers; maximum recent estimate: 200. Recorded in March, May, June, August, September, and December. Largest numbers occurred in spring (March) and fall (September).

Observations

All observations are listed in Table 18.

Specimens

We know of but one specimen, a female (PAS 146157), collected by the Vanderbilt Expedition in August 1940.

Table 18. Observations of Ruddy Turnstones on Nihoa Island

Date of Survey	Population Estimate	Observations, Remarks, and References
1891 26-27 May	?	2 small flocks seen from offshore (Munro, 1941a: 50).
1902 1-3 June	?	Seen from offshore (Fisher, 1903: 778).
4-9 Aug.	?	Seen from offshore (Fisher, 1903: 779).
1916 12 Feb.	a few seen	(Munter, ms.).
1923 24 May	2	Seen on ledges below western cliffs (Wetmore, ms.).

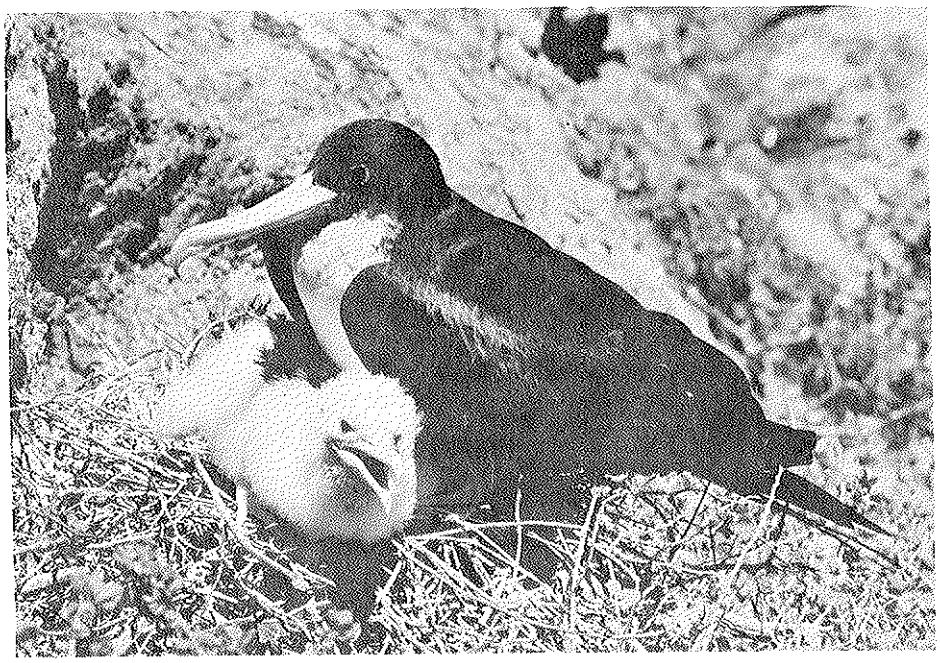

Figure 27. Nesting Great Frigatebird with downy young in July 1966. BSFW photograph by Eugene Kridler.

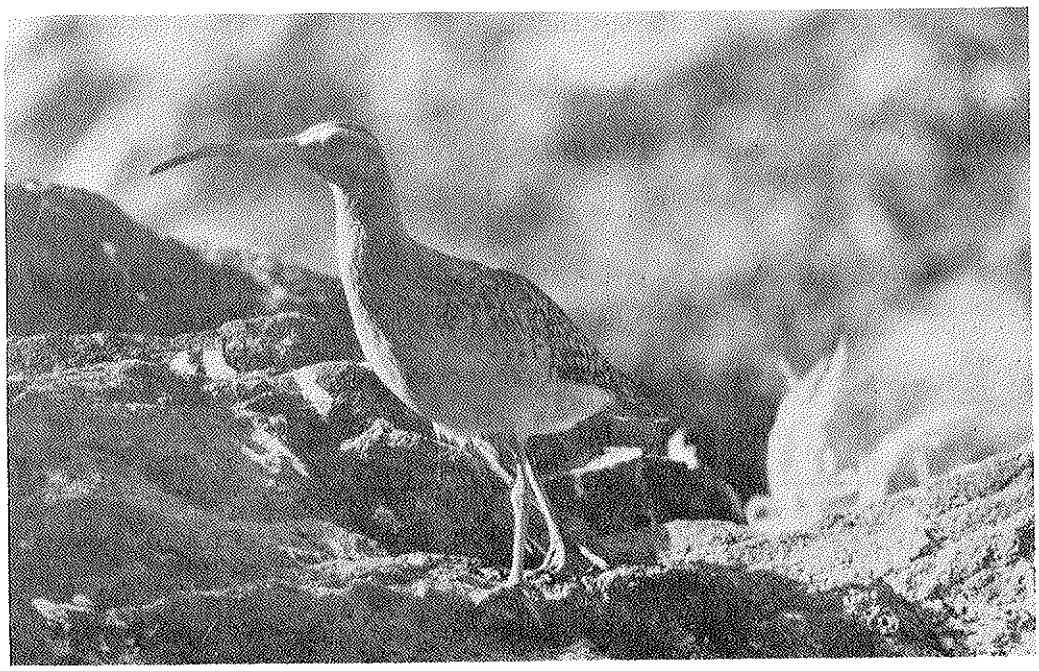

Figure 28. Bristle-thighed Curlew foraging among the rocks in lower Miller Valley, 8 March 1968. POBSP photograph by Roger B. Clapp.

1940. There are four more recent records. On 13 and 14 September 1967 Kridler saw a single Bristle-thighed Curlew. Two others were seen on rocks about 150 to 200 feet from the base of Miller Canyon 7 to 9 March 1968 (Fig. 28). Another was seen 18-19 August 1971 and five were present on 16 September 1972.

WANDERING TATTLER *Heteroscelus incanus*

Status

Uncommon migrant; maximum recent estimate: 2. Recorded in March, May, June, and August.

Observations

All observations are listed in Table 17.

Specimens

A single specimen was collected by Vanderbilt but we do not know the specific collection data.

Table 17. Observations of Wandering Tattlers on Nihoa Island

Date of Survey	Population Estimate	Observations, Remarks, and References
1923 24 May	2-3	(Wetmore, ms.).
11-16 June	1-2	Seen daily on rock ledges of Adams Bay (Wetmore, ms.).
1940 7-15 Aug.	very few	(Vanderbilt and de Schauensee, 1941: 11).
1953 21-22 Dec.	1	(Richardson, pers. comm.).
1954 18 Mar.	0	(Richardson, pers. comm.).
1961 9-16 Dec.	0	(Kramer, ms.).
1964 6-7 Mar.	0	(BSFW, POBSP).
23-24 Sept.	0	(BSFW, POBSP).
1965 13-14 Mar.	0	(BSFW, POBSP).
1966 28 July-1 Aug.	0	(BSFW, POBSP).
1967 8-9 Mar.	2	Along ledges on south side of island (BSFW).
13-14 Sept.	0	(BSFW).

Table 16. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1954 18 Mar.	0	(Richardson, pers. comm.).
1961 9-16 Dec.	12	(Kramer, ms.).
1963 5-6 June	1	Seen from offshore (POBSP).
1964 6-7 Mar.	25	(BSFW, POBSP).
23-24 Sept.	5	(BSFW, POBSP).
1965 13-14 Mar.	50	5 seen near Dog Head Peak (BSFW, POBSP).
1966 28 July-1 Aug.	0	(BSFW, POBSP).
1967 8-9 Mar.	5	(BSFW, POBSP).
13-14 Sept.	20	(BSFW).
1968 7-9 Mar.	50	Seen in small flocks but more often as individuals. Scattered all over island (BSFW, POBSP).
1968 24-27 Aug.	10-15	Individuals scattered over island (BSFW).
1969 21 Mar.	36	(BSFW).
1970 15 Aug.	2	(BSFW).
1971 18-19 Aug.	0	(BSFW).
15 Sept.	?	Rare (BSFW).
1972 16 Sept.	1	(BSFW).

BRISTLE-THIGHED CURLEW *Numenius tahitiensis*

Status

Uncommon migrant; five sight records; maximum recent estimate: 5. Recorded in March, August and September.

Observations

Vanderbilt and de Schauensee (1941: 10) reported a small flock of curlews seen "shortly after landing on Nihoa," presumably on 7 August

Table 18. (Continued)

Date of Survey		Population Estimate	Observations, Remarks, and References
1923	11-16 June	?	"One or two seen daily on the rocks of Adams Bay. Two seen resting on a cairn on Millers Peak 900 feet above the sea" (Wetmore, ms.).
1940	7-15 Aug.	"Probably... most common shorebird."	"Observed in small numbers everywhere, even on the highest peaks." Seen feeding on beetles as well as marine life (Vanderbilt and de Schauensee, 1941: 11).
1953	21-22 Dec.	a few	(Richardson, pers. comm.).
1954	6-7 Mar.	1	(Richardson, pers. comm.).
1961	9-16 Dec.	about 5 seen	(Kramer, ms.).
1963	5-6 June	1	Seen from offshore (POBSP).
1964	6-7 Mar.	10	Seen in gulches and sea cliffs (BSFW, POBSP).
	23-24 Sept.	30-75	(BSFW, POBSP).
1965	13-14 Mar.	100	(BSFW, POBSP).
1966	28 July-1 Aug.	0	(BSFW, POBSP).
1967	8-9 Mar.	75	Flocks of 17, 23, and 32 flying over water on south side of island (BSFW, POBSP).
	13-14 Sept.	75	Scattered small flocks from sea level to the top of the ridge between the peaks (BSFW).
1968	7-9 Mar.	200	Primarily in small flocks or scattered individuals in the lower areas of the island. Common along the rocks at the edge of the surf where a flock of about 28 birds seen bathing. Small flocks of 10-20 birds seen on the crests of some lower ridges (BSFW, POBSP).
	24-27 Aug.	30	Scattered. Most on rock shelf at sea level (BSFW).

Table 18. (Continued)

Date of Survey	Population Estimate	Observations, Remarks, and References
1969 21 Mar.	82	(BSFW).
1970 15 Aug.	8	One seen near the top of Miller's Peak (BSFW).
1971 18-19 Aug.	8	(BSFW).
15 Sept.	?	Rare (BSFW).
1972 16 Sept.	2	(BSFW).

HERRING GULL *Larus argentatus*

Status

Vagrant; one sight record in March 1965.

Observations

Kridler observed an adult near Derby's Landing on 24 March 1965. Subsequently, while attempting to photograph the bird, Kridler got close enough to make a positive identification. Herring Gulls are one of the several species of gull that occur fairly frequently in the northwestern Hawaiian Islands (Clapp and Woodward, 1968: 26; Sibley and McFarlane, 1968: 314-318). None has been reported previously from Nihoa.

GRAY-BACKED TERN *Sterna lunata*

Status

Abundant breeder; maximum recent estimate: 10,000. Present from February or earlier through September or October; probably absent during remainder of year. Breeds from at least March through September. Nests on the ground, usually in areas of sparse vegetation.

Populations

Recent population estimates and those from 1915 and 1923 agree reasonably well (Table 19) and suggest that maximal populations are about 10,000 birds. Estimates from various March visits are variable, but this may reflect differences in the timing of the breeding cycle from year to year as much as it does any inaccuracies in the estimates themselves.

Annual Cycle

The paucity of observations from January and February makes it impossible to tell when the first birds arrive at the island but the numbers and stage of breeding observed on various March surveys make it obvious that these terns usually arrive at least as early as February.

The initiation of laying apparently varies from year to year. Observations from March 1915, 1964, 1967, and 1968 indicate that the population was just beginning to breed and would probably reach an egg-laying peak later in the month or in April. In March 1965, however, at least several thousand eggs were present by mid-March, suggesting that some laying occurred in February and that the egg laying peak was earlier than on the other March visits. Laying may also occur in May or June but it is not known whether the Gray-backed Terns usually lay in large numbers during these months. Wetmore's 1923 observations indicate a laying peak in early June but the presence of half-grown young at that time shows that at least some eggs had been laid in April.

Hatching may occur from late March or early April through late July but most young probably hatch from about May through early June. The presence of slightly incubated eggs in early March suggests that some young could fledge by early or mid-June but the earliest report of flying young is early August.

Despite the lack of positive observations, it seems likely that most fledging occurs from mid-July through August. Small numbers of young are present on the island in September but by the end of the month almost all young have fledged and most adults have left the island.

Breeding Habitat

Gray-backed Terns are found in much the same areas as are Sooty Terns, but apparently prefer less densely vegetated areas and are much more prone to nest on rock ledges and ridges. Colonies were widely distributed over the slopes of the island (March 1965, July-August 1966, March 1967, 1968), but seem to reach maximum nesting densities in the various canyons and gulches (July-August, 1966; March 1968). On the latter visit they were apparently most abundant in the lower portions of Miller Canyon, Middle Valley, and the lower eastern slopes of the island. Vanderbilt and de Schauensee reported that in August 1940 they occurred in two small colonies, both of them in the upper portion of Middle Valley.

Banding

The BSFW and POBSP banded 119 Gray-backed Terns on recent visits. The BSFW banded 10 adults in March 1964 and 79 adults in March 1965. The POBSP banded 6 adults, 13 flying young, and 11 nestlings in July and August 1966. None has been recaptured.

Specimens

We know of four specimens from Nihoa: Wetmore in 1923 collected an adult male (USNM 300628) on 15 June, a female (USNM 300629) on 12 June, and an embryonic alcoholic (USNM 289312) on 13 June; another male (PAS 145155) was collected by the Vanderbilt Expedition in August 1940.

Table 19. Observations of Gray-backed Terns on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (as "Bridled Tern") (Munro, 1941a: 49).
1902 1-3 June	?	Common; seen from offshore (Fisher, 1903: 781).
5-9 Aug.	?	Common; seen from offshore. Numbers of flying young seen (Fisher, 1903: 781).
1915 18 Mar.	10,000	"...seen in scattered pairs....Two only were flushed from eggs" (Munter, 1915: 133). Brown (ms.) gives an identical alternative estimate.
1916 12 Feb.	not very numerous	No nests found (Munter, ms.).
1923 5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
11-16 June	10,000	Majority with fresh eggs but some recently hatched young and a few half-grown young seen (Wetmore, ms.).
1936 3 Mar.	?	No nests found (Trempe, ms.).
1940 7-15 Aug.	?	Found in two small colonies. "Breeding was in its last stages and only young were seen" (Vanderbilt and de Schauensee, 1941: 11).
1953 21-22 Dec.	0	Only part of island surveyed (Richardson, pers. comm.).
1954 18 Mar.	12-14	Only part of island surveyed (Richardson, pers. comm.).
1961 2 Mar.	?	Abundant, seen from offshore (Woodside and Kramer, ms.).

Table 19. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1961	9-16 Dec.	0	(Kramer, ms.).
1962	10 June	?	With eggs and downy young (Kramer and Beardsley, ms.).
1963	5-6 June	?	*Ca.* 40 seen from offshore (POBSP).
1964	6-7 Mar.	100	*Ca.* 25 nests with eggs observed (BSFW, POBSP).
	25 July	very common	Very small chicks to 2/3-grown young (BSFW).
	23-24 Sept.	50	6 immatures remaining on the island from the preceding season (BSFW, POBSP).
1965	13-14 Mar.	5,000-6,500	Nests contained only eggs. An estimated 2,500 nests present (BSFW, POBSP).
1966	28 July-1 Aug.	8,000*	*Ca.* 4,000 young; 5% recently hatched, 25% from 2-3 weeks old, and 70% older than 3 weeks (BSFW, POBSP).
1967	8-9 Mar.	10,000	On fresh to slightly incubated eggs (BSFW, POBSP).
	13-14 Sept.	very common	Some near fledging young noted (BSFW).
1968	7-9 Mar.	2,000	Only 1 nest with egg found. Most birds evidently pre-nesting (BSFW, POBSP).
	24-27 Aug.	low thousands $< 3,000$	A very few 3/4 feathered young but most young flying (BSFW).
1969	21 Mar.	350	? (BSFW).
1970	15 Aug.	6,000	Young ranged in size from about 1/4 grown to fledging. The great majority of birds was near fledging (BSFW).
1971	18-19 Aug.	7,000	Young were from about 1/2 grown to fledging (BSFW).
	15 Sept.	?	Small numbers of near-fledging young were present (BSFW).

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Table 19. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1972 16 Sept.	4,000*	Young were present (BSFW).
1973 31 July	?	At least 1,500 birds were present (BSFW).

* Estimate is of the number of breeding birds only.

SOOTY TERN *Sterna fuscata*

Status

Abundant breeder; maximum recent estimate: 100,000. Usually present from at least mid-February through late September or October but breeds primarily from late February through July or August; probably absent during much of remainder of year. Nests on the ground (Fig. 29), often in areas of dense vegetation.

Populations

Recent population estimates fairly consistently suggest population levels in the low tens of thousands, and do not indicate any difference from estimates made earlier in the 20th century (Table 20). The estimate from March 1965 is considerably higher than any other but it is based on better data. On that visit the portion of the population breeding near Miller's Peak was censused by making a nest density count and applying the density figure to the approximate area covered by nesting birds. (No details on methods employed are available.) That area was estimated to contain about 27,000 breeding birds. This figure, representing only about one-fourth of the total breeding population, is still higher than any other population estimate that has been made on Nihoa. We believe that this datum indicates that many of the other population estimates may have been too low and that total breeding populations are usually 50,000 to 100,000 birds. (Date on the reliability of visual estimates of Sooty Terns, obtained on other islands by the POBSP, suggest that populations of this species are more often underestimated than overestimated.)

Annual Cycle

The initiation of the breeding season may vary by several months from year to year. In at least three years (1915, 1967, 1969) laying evidently began in late February or early March. In 1964, however, the presence of week-old chicks in early March indicates that laying began as early as late January or early February. The presence of young (of unspecified size) in mid-March 1965 and Munter's observations in

February 1916 indicate laying occurred by mid-February in those years. The size of young seen in March 1968 (Table 19) indicates that some egg-laying must have begun by the second or third week of December and continued until the first or second week of January. On the latter visit the distinct hiatus between stages of breeding in different colonies suggested that no eggs were laid in late January or early February. In 1964, 1966, and 1967 only a very small porportion of the breeding population laid before late February, however. Thus, data from five years indicate that the majority of the breeding population begins to lay in late February and early March.

The winter breeding in 1967-1968 probably was an exceptional occurrence as winter breeding populations have not been reported from any of the other northwestern Hawaiian Islands. However, a winter breeding population was reported from Moku Manu in the main Hawaiian Islands (Richardson, 1957: 24).

Some laying occurs in April and May and fresh eggs were reported in June (Wetmore, ms.). Observations made in mid-August 1940 indicate that some eggs were laid as late as mid-July. On Nihoa Sooty Terns have thus exhibited a laying span of about seven months (mid-December to mid-July).

Hatching has occurred from at least January through late August but probably occurs primarily from late March through May. Fledging may occur as early as early March but in most years most fledging probably occurs from late May through July. Fledging possibly occurs as late as October (1940) but is evidently usually completed by August or mid-September.

The absence of breeding birds in late July and early August 1966 is puzzling and may indicate that the population did not breed or that early breeding attempts were entirely unsuccessful. It is also possible that laying began as early as in 1967-1968 and that the breeding season had been completed prior to the survey.

Also puzzling is the paucity of birds in March 1954. Richardson's observations suggest that not only had nesting not begun but that the birds had not begun to return to the island. Clearly, much may yet be discovered about the nature and variability of the Sooty Tern breeding cycle on Nihoa.

Breeding Habitat

Sooty Terns nest in a wide variety of situations on Nihoa but a number of observers noted that they were more common at higher elevations. Munter (1915: 132) found the birds "in ever increasing numbers" as he ascended the slopes. Wetmore (ms.) found them nesting "from the lower rock cliffs clear to the higher summits." He also noted that they occurred in a number of small colonies on the lower slopes but formed larger colonies on the highest slopes. The two colonies reported by

Vanderbilt and de Schauensee (1941: 11) were also found at higher elevations, the larger colony near the top of Middle Valley, the smaller high up in East Palm Valley.

Recent observations confirm that these terns tend to nest in a number of colonies and in larger numbers at higher elevations. In March 1964 BSFW personnel found large colonies on the east slopes of Middle Valley and on Miller Plateau and noted that birds were found nesting elsewhere as well. In July 1964 a large colony was found along the top of the ridge between Miller's and Tanager Peaks, and in March 1965 birds nested there, on Miller Plateau, and on the east slope below Tanager Peak. In March 1968 these birds nested on the slopes at the base of Miller Canyon, near the top of Middle Valley, on the slopes of East Palm Valley, on Miller Plateau, and in a number of other areas. In August 1970 the last few nesting birds were present on the upper slope of the saddle between Miller's and Tanager Peaks.

Most eggs are laid in small depressions on bare ground but are occasionally found on small amounts of dead vegetation. Typically nests are placed beside tufts of grass or under dense vegetation, such as *Chenopodium*, *Sida*, or *Solanum*.

Banding

Two adults were banded by the BSFW in March 1964. Neither has been recaptured.

Specimens

We have found records of five specimens from Nihoa. Four, two adult males (USNM 300548, 300550), an adult female (USNM 300549) and a juvenile female (USNM 300551), were collected by Wetmore between 12 and 15 June 1923. A female (PAS 146154) was collected by the Vanderbilt Expedition in August 1940.

Table 20. Observations of Sooty Terns on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Abundant, seen from offshore (Fisher, 1903: 780).
5-9 Aug.	?	Abundant, seen from offshore. Many flying young seen (Fisher, 1903: 780).
1915 18 Mar.	20,000 (10,000)	Only eggs found (Munter, 1915). Alternative estimate by Brown (ms.).

Table 20. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1916	12 Feb.	in large numbers	Only eggs found (Munter, ms.).
1923	11-16 June	12,000	Majority of nests with fresh eggs but fledged young present in some parts of colony (Wetmore, ms.).
1936	3 Mar.	?	No nests found (Trempe, ms.).
1940	7-15 Aug.	?	2 colonies, 1 large, 1 small, present. "Nesting was in all stages from unhatched eggs to fully fledged young" (Vanderbilt and de Schauensee, 1941: 11).
1953	21-22 Dec.	15-20	? (Richardson, pers. comm.).
1954	18 Mar.	6-8	? (Richarcson, pers. comm.).
1961	2 Mar.	?	Abundant, seen from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	2	Seen soaring over cliffs (Kramer, ms.).
1962	10 June	?	With eggs and fledged young (Kramer and Beardsley, ms.).
1963	5-6 June	?	Hundreds seen from offshore (POBSP).
1964	6-7 Mar.	10,000-15,000	*Ca.* 6,000 nests with eggs, *ca.* 100 week-old chicks found (BSFW, POBSP).
	25 July	very common	Downy chicks to fledged young (BSFW).
	23-24 Sept.	1	Heard flying overhead. Not breeding (BSFW, POBSO).
1965	13-14 Mar.	100,000	*Ca.* 90% with eggs, 10% with young (BSFW, POBSP).
1966	28 July-1 Aug.	500	Not breeding. 2 groups of birds observed on ground (BSFW, POBSP).
1967	8-9 Mar.	*Ca.* 25,000	On eggs, no young found (BSFW, POBSP).
	13-14 Sept.	?	Only a few adults and flying young noted (BSFW).

Table 20. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1968	7-9 Mar.	*ca.* 20,000	*Ca.* 2,000 to 4,000 nests with fresh to slightly incubated eggs. 2 small colonies with large young also present. 1 contained several hundred young from 1/2 grown (*ca.* 4 weeks old) to near fledging young (*ca.* 6-7 weeks old). The other contained about 50 young (*ca.* 4-5 weeks old). The majority present was not yet nesting (BSFW, POBSP).
	24-27 Aug.	?	? (BSFW).
1969	21 Mar.	6,800	Most incubating eggs; no young seen (BSFW).
1970	15 Aug.	2,000-3,000	A few very large young were still present (BSFW).
1971	18-19 Aug.	1,000	Young were fully feathered (BSFW).
1972	16 Sept.	20	No breeding birds were found (BSFW).
1973	31 July	3,000	(BSFW).

BLUE-GRAY NODDY *Procelsterna cerulea*

Status

Common breeder; maximum recent estimate: 2,500. Present throughout year but evidently more common in spring and summer. Breeds throughout year but majority of birds apparently breeds during spring and early summer. Lays single egg in holes and niches under ledges in cliff faces and rock outcroppings (Fig. 30).

Populations

Most recent estimates and the one made by Wetmore in 1923 suggest that the maximal population level is in the low thousands (Table 21). Considerable variability is found in estimates made at the same time of year but this probably only indicates the low level of reliability of the estimates.

Annual Cycle

Too few detailed observations are available to document completely the breeding cycle; available observations indicate an extended breeding

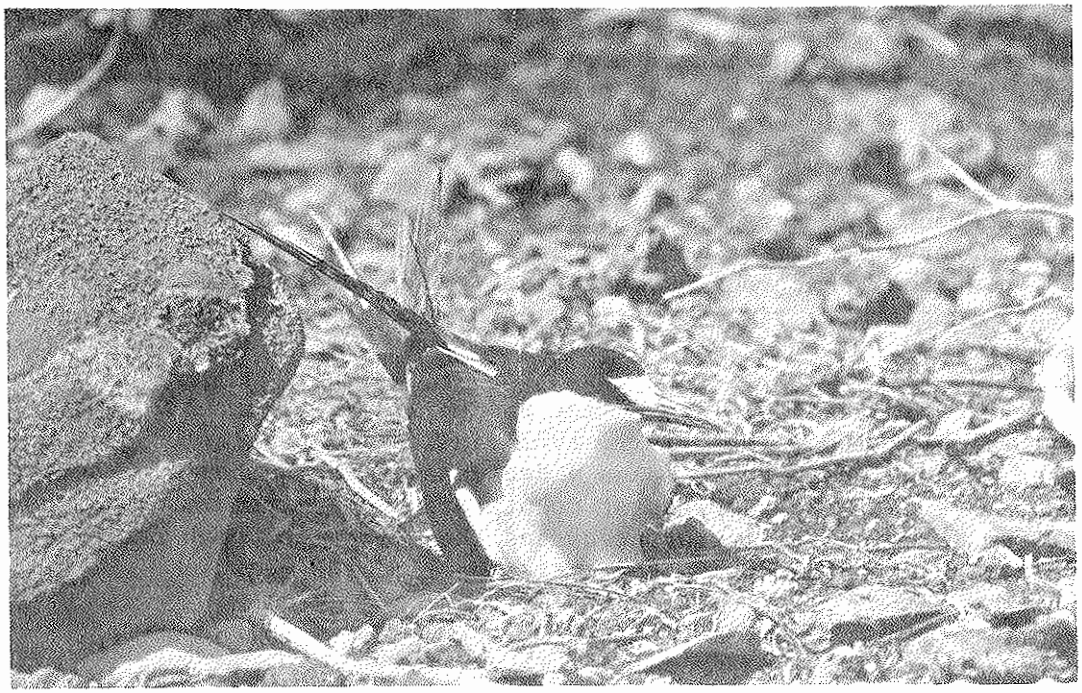

Figure 29. Sooty Tern incubating egg in lower part of Middle Valley, 9 March 1968. POBSP photograph by Roger B. Clapp.

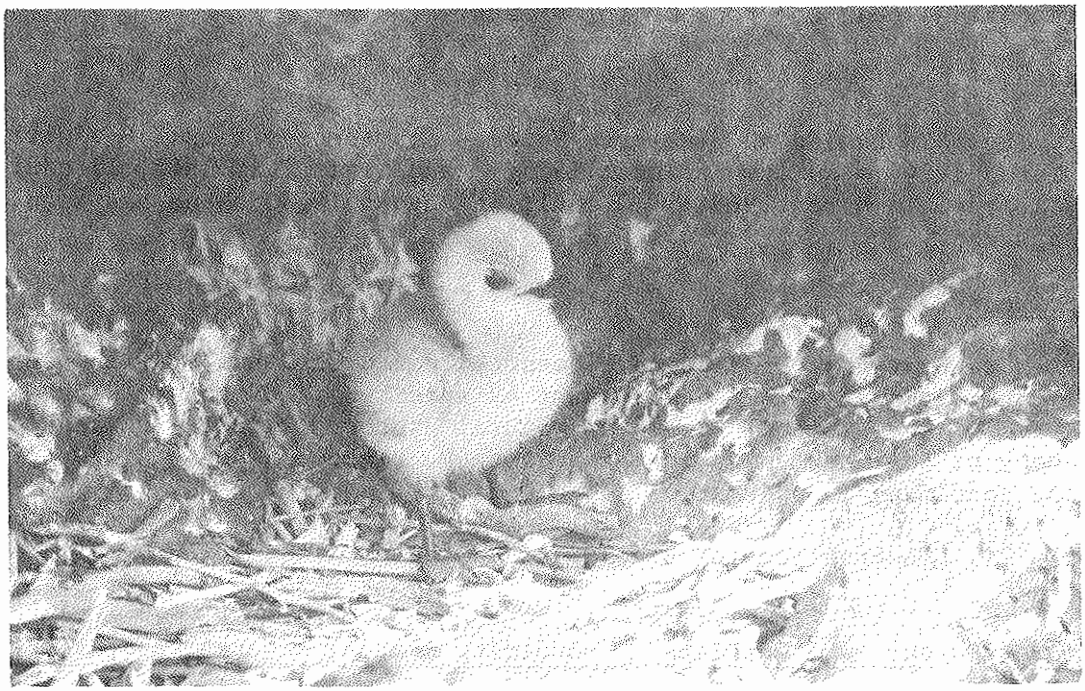

Figure 30. Blue-gray Noddy chick at nest site in niche in rock wall, 9 March 1968. POBSP photograph by Roger B. Clapp.

season from at least December through October or November in some years (1964, perhaps 1940). In other years (1967, 1968, 1971, 1972) observations from late summer and early fall indicate that nesting had probably been completed by August or September. In March 1964, 1965, and 1968 an estimated 50, 90, and 88 percent, respectively, of the nests contained eggs which suggests a laying peak then or in February. Observations made in December 1953, and reports of variously sized young on a number of March visits (1964, 1965, 1967, 1968), indicate that some laying normally occurs as early as December or January.

Most estimates from late summer and fall (mid-August 1970 and 1971; September 1964, 1967, 1971, 1972) indicate a population decrease at that time which probably means a decrease in the number of breeding birds. More detailed sample nest counts are needed from most seasons to better document the laying peaks and the degree to which breeding activity may diminish during the latter part of the year.

Breeding Habitat

Blue-gray Noddies, like White Terns, nest in considerable abundance on the north rock cliffs of the island but unlike that species nest commonly in various areas on the south slopes of the island. Nests are particularly abundant in niches and cavities in the rock outcroppings just above the shoreline, but many nests are also present on the rock faces and under ledges along the sides of the valleys and in rock outcroppings near the tops of the ridges.

Banding

The BSFW banded 32 Blue-gray Noddies on recent visits: 6 adults in March 1964, 5 adults in March 1965, 2 adults in July 1966, 17 adults and 1 local in March 1968, and 1 adult in August 1968. None has been recaptured.

Specimens

More Blue-gray Noddies have been collected on Nihoa than almost all other species combined--at least 42 specimens. Of these, 33 are located in the National Museum of Natural History, 2 in the Philadelphia Academy of Science, and 7 in the Bernice P. Bishop Museum. A list of these specimens is presented in Table 22.

Table 21. Observations of Blue-gray Noddies on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1903 1-3 June	?	Abundant; seen from offshore (Fisher, 1903: 781).

Table 21. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1902	5-9 Aug.	?	Abundant; seen from offshore (Fisher, 1903: 779).
1915	18 Mar.	"Several"	2 young birds found (Munter, 1915).
1916	12 Feb.	5-6 seen	A nest with an egg found (Munter, ms.).
1923	5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
	24-26 May	100 noted	Associated in pairs (Wetmore, ms.).
	11-16 June	1,600	From slightly incubated to heavily incubated eggs and from recently hatched to fledged young (Wetmore, ms.).
1936	3 Mar.	?	Presence noted (Trempe, ms.).
1940	7-15 Aug.	rather rare	"Nesting" (Vanderbilt and de Schauensee, 1941: 11).
1953	21-22 Dec.	150-200	"Nesting and laying were apparently just starting" (Richardson, 1957, pers. comm.).
1954	18 Mar.	100-150	? (Richardson, pers. comm.).
1961	2 Mar.	?	Abundant; seen from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	not too common	? "Paired" (Kramer, ms.).
1962	10 June	abundant	"Breeding...one dead chick seen" (Kramer and Beardsley, ms.).
1963	5-6 June	?	Thousands seen from offshore (POBSP).
1964	6-7 Mar.	thousands	From eggs to fledged young found (BSFW, POBSP).
	25 July	fairly common	? (BSFW).
	23-24 Sept.	150-300	Eggs to fledged young (BSFW, POBSP).
1965	13-14 Mar.	500-600	*Ca*. 250 nests, 5% with young (BSFW, POBSP).

Table 21. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1966	28 July-1 Aug.	2,500	? (BSFW, POBSP).
1967	8-9 Mar.	several thousand	From eggs to 1/2 grown young (BSFW, POBSP).
	13-14 Sept.	very common along cliffs	No eggs or young found (BSFW).
1968	7-9 Mar.	2,000	Fresh eggs to near fledging young. Sample count of 34 nests: 30 (88%) with eggs; 3 (9%) with small downy chicks; and 1 (3%) with a near-fledging young (BSFW, POBSP).
	24-27 Aug.	high hundreds <1,000	A special effort made to find nests but no nesting activity noted (BSFW).
1969	21 Mar.	85	? (BSFW).
1970	15 Aug.	75-100	No nests were found (BSFW).
1971	18-19 Aug.	20	(BSFW).
	15 Sept.	0?	None was seen (BSFW).
1972	16 Sept.	50	(BSFW).
1973	31 July	150	(BSFW).

Table 22. Blue-gray Noddy Specimens from Nihoa Island.

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and yg.	Museum Nos.	Date Collected	Collector
USNM	13	300383, 434,436, 437,440, 441,443-450	6	300384-386, 438,442	3	300451-453	12-15 June 1923	Wetmore
USNM	1	289216*	2	289214-215*			12-15 June 1923	Wetmore
USNM					7	289305-308** 323-325***	11,15 June 1923	Wetmore

Table 22. (Continued)

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and yg.	Museum Nos.	Date Collected	Collector
PAS	2	146162, 164					Aug. 1940	Vanderbilt
BPBM					7	4850-852, 7846-850	??	??
USNM	1	493275+					6 June 1963	POBSP

* Skeletons.

** Embryonic alcoholics.

*** Older alcoholics.

+ Shot from offshore.

BROWN NODDY *Anous stolidus*

Status

Abundant breeder; maximum recent estimate: 20,000. Present throughout the year but most numerous in summer and fall. Breeds throughout the year but in greater numbers from spring through early fall. Builds nest on the ground in both vegetated and open areas (Fig. 31).

Populations

The general trend of estimates (Table 23) shows that birds number at least in the low thousands in summer and fall and that considerably fewer birds are present in March.

The early estimates (1915 and 1923) do not appear to be significantly different from recent estimates, although Wetmore's estimate of 4,000 for June 1923 is a little lower than we would expect, and Brown's estimate for March 1915 is probably erroneously large. The population estimate for July and August 1966 seems particularly large compared with other numerical estimates, but no other estimates have been made at that time of year.

Figure 31. Brown Noddy at nest with egg, March 1967. BSFW photograph by Eugene Kridler.

Annual Cycle

This species shows a less clearly defined breeding cycle than that of any other species breeding in the northwestern Hawaiian Islands. On Nihoa eggs have been laid in all months from December through August and some may have been laid in the other months as well. The more quantitative data suggest that the numbers of laying birds increase considerably during March and several succeeding months, with little laying occurring after mid-August. Observations indicate periods of peak laying as: 1923-June, 1964-July, 1966-June or July, and 1967-late July or early August.

Greatest numbers probably hatch from late June through mid- or late August, and largest numbers probably fledge from late August through October. Judging from data gathered on other northwestern Hawaiian Islands, probably relatively little breeding occurs from November through February.

Breeding Habitat

Brown Noddy nests are widely dispersed over the slopes of the island but tend to be most numerous in ravines. Nests consist primarily of loose aggregations of sticks, weed stems, and straws, and occasionally contain feathers, bones, or pebbles. All nests whose actual locations were reported were found on the ground but the sites varied considerably. Many of the nests were under thick shrubs such as *Chenopodium*, and others were on rock outcroppings, ledges, and in shallow holes in the cliffs.

Banding

In all, 37 Brown Noddies were banded on recent visits to Nihoa: 3 adults by the BSFW in March 1964 and 34 large young by the POBSP in September 1964. None has been recaptured.

Specimens

We have found records of six specimens. Wetmore collected two adult females (USNM 300499-500) on 12 June 1923 and an embryonic alcoholic (USNM 289399) on 14 June. In August 1940 the Vanderbilt Expedition collected two others, a male (PAS 146159) and a doubtfully sexed female (PAS 146158). A third specimen from 1940 is listed by Vanderbilt and de Schauensee (1941: 12) but we do not know its present disposition.

Table 23. Observations of Brown Noddies on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Seen flying offshore and on island (Fisher, 1903: 778-783).
5-9 Aug.	?	Seen flying offshore and on island (Fisher, 1903: 779-783).
1915 18 Mar.	500 (5,000)	?, no nests noted (Munter, 1915: 133). Alternative estimate by Brown (ms.).
1916 12 Feb.	very numerous	Fresh eggs found. Many young from preceding breeding season seen (Munter, ms.).

Table 23. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1923	11-16 June	4,000	Mostly with fresh or partly incubated eggs (Wetmore, ms.).
1936	3 Mar.	?	No nests found (Trempe, ms.).
1940	7-15 Aug.	extremely plentiful	"Breeding was in all stages" (Vanderbilt and de Schauensee, 1941: 12).
1953	21-22 Dec.	200-250	"a dedinite breeding season had started" (Richardson, 1957 and pers. comm.).
1954	18 Mar.	200-300	? (Richardson, pers. comm.).
1961	9-16 Dec.	?	Eggs and downy chicks (Kramer, ms.).
1962	10 June	?	From eggs to fledged young (Kramer and Beardsley, ms.).
1963	5-6 June	?	Thousands seen from offshore (POBSP).
1964	6-7 Mar.	600	1 nest with eggs and 2 with young found. Courtship behavior observed (BSFW, POBSP).
	25 July	very abundant	Eggs to near-fledging young but *ca.* 99% of nests with eggs (BSFW).
	23-24 Sept.	7,000*	*Ca.* 3,500 young, mostly large chicks or flying immatures. A few nests with eggs or smaller young (BSFW, POBSP).
1965	13-14 Mar.	1,000	90% with eggs, 10% with young (BSFW, POBSP).
1966	28 July-1 Aug.	20,000*	*Ca.* 10,000 nests, 90% with eggs, 10% with young. *Ca.* 75% of young recently hatched, 25% from 2-3 weeks old (BSFW, POBSP).

Table 23. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1967	8-9 Mar.	several thousand	From eggs to 3/4 grown young. Most chicks from 1/3 to 3/4 grown (BSFW, POBSP).
	13-14 Sept.	common	Eggs to flying young but *ca.* 75-80% of nests with small downy chicks (BSFW).
1968	7-9 Mar.	1,000	Fresh eggs to young about 3-4 weeks old. Most of population not nesting (BSFW, POBSP).
	24-27 Aug.	low thousands <5,000	Eggs to flying young (BSFW).
1969	21 Mar.	2,000	Eggs to flying young (BSFW).
1970	15 Aug.	5,000	In a sample of 100 nests, 84 contained eggs, 14 had small downy chicks, and 2 had large near-fledging young. Recently fledged young were also seen (BSFW).
1971	18-19 Aug.	5,000	From eggs to fledged young (BSFW).
	15 Sept.	thousands	(BSFW).
1972	16 Sept.	15,000	(BSFW).
1973	31 July	>4,000	(BSFW).

* Estimate is of number of breeding birds only.

BLACK NODDY *Anous tenuirostris*

Status

Poorly known. Birds probably present throughout the year but changes in population level unknown. Maximum recent estimate: several thousand or low thousands. Only once found breeding (August 1940) but almost certainly breeds on Nihoa every year.

Populations

Virtually nothing is known of the population size since these birds occur primarily on the nearly inaccessible north cliff face, and to a lesser extent on the eastern and western cliff faces. Since the north cliff face cannot be carefully observed, differences in population estimates from survey to survey are nearly meaningless. Estimates (Table 24) indicate that this species is fairly common during the spring.

Annual Cycle

Vanderbilt and de Schauensee (1941: 12) were the only observers who found nests of this species. They noted that this species "nested particularly in Middle Valley." The validity of this observation seems questionable since no other observer has found them nesting in this area. They also noted that there were "no distinct colonies and the bird seemed to mix freely with the...[Brown] Noddy."

Table 24. Observations of Black Noddies on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Presence noted from offshore (Fisher, 1903: 778).
5-9 Aug.	?	Presence noted from offshore (Fisher, 1903: 779) but the comment that they were seen in August (*loc. cit.*, p. 784) might suggest they were not seen in June.
1923 24 May	?	? (Wetmore, ms.).
11-16 June	small numbers	Seen in small numbers in the rock shelves below the cliffs on the western side of the island (Wetmore, ms.).
1936 3 Mar.	?	No nests found (Trempe, ms.).
1940 77-15 Aug.	fairly abundant	"Breeding was in all stages" (Vanderbilt and de Schauensee, 1941: 12).
1953 21-22 Dec.	4-8	? (Richardson, pers. comm.).
1954 18 Mar.	2	? (Richardson, pers. comm.).
1961 2 Mar.	?	Not noted from offshore (Woodside and Kramer, ms.).

Table 24. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1961	9-16 Dec.	0	(Kramer, 1961).
1962	10 June	?	? Seen only on cliffs (Kramer and Beardsley, ms.).
1963	5-6 June	?	*Ca.* 100 seen from offshore (POBSP).
1964	6-7 Mar.	*Ca.* 1,000	? (BSFW, POBSP).
	25 July	?	(BSFW).
	23024 Sept.	*Ca.* 250	? (BSFW, POBSP).
1965	13-14 Mar.	700	No eggs or young seen (BSFW, POBSP).
1966	28 July-1 Aug.	6	? (BSFW, POBSP).
1967	8-9 Mar.	several thousand	? (BSFW, POBSP).
1968	7-9 Mar.	at least several hundreds	? No nests found on accessible part of island (BSFW, POBSP).
	24-27 Aug.	?	? Seen in area of northern cliff face (BSFW).
1970	15 Aug.	1,000	(BSFW).
1971	15 Sept.	low thousands	(BSFW).
1972	16 Sept.	1,000	(BSFW).

WHITE TERN *Gygis alba*

Status

Common breeder; maximum recent estimate: 3,000. Present throughout the year but apparently less abundant in fall and winter; probably breeds throughout the year but data are too few to establish when breeding peaks occur. Lays single egg on rock outcroppings and in holes in cliff face.

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Populations

Most recent estimates of the population place it in the low hundreds (Table 25) but these estimates are quite subjective. Since many surveys covered only part of the area where these birds occur most densely, we suspect that many of the estimates are low and that the maximal populations are in the low thousands. Both Munter's and Wetmore's early estimates are considerably larger than any recent estimate, the former so much so that we suspect it was highly inaccurate. Wetmore's estimate is also larger than recent estimates but he may have seen more of the northern cliff face than did observers on more recent trips.

Annual Cycle

Many, if not most, White Terns, nest on the nearly inaccessible north face of the island and many surveys have been unable to find any nests although they were probably present. Consequently we know little about the breeding cycle of this species on Nihoa.

Eggs have been found in March, June, August, and September and pre-fledging young have been found in March, May, June, and August, indicating that laying has occurred in at least February, April, and July. It is likely that at least a small proportion of the population breeds throughout the year.

Breeding Habitat

The great majority of White Terns nests on the sheer cliffs of the north, east, and west sides of the island. A much smaller number nests on the rocky outcroppings of the south slopes of the island. Wetmore (ms.) noted that those on the north cliff face tended to nest below 500 feet and that most nested between 20 and 250 feet above the sea.

Specimens

Four specimens were collected by Wetmore on 13 June 1923: an adult female (USNM 300417), an adult male (USNM 300418) and 2 alcoholics (USNM 289327-328).

Table 25. Observations of White Terns on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1891 26-27 May	?	Presence noted from offshore (Munro, 1941a: 49).
1902 1-3 June	?	Common; seen from offshore (Fisher, 1903: 785-786).

Table 25. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1902	5-9 Aug.	?	Common; seen from offshore (Fisher, 1903: 785-786).
1915	18 Mar.	50,000 (100,000)	? (Munter, 1915: 133). Alternative estimate by Brown (ms.).
1916	12 Feb.	seen occasionally	Stated to be not as numerous as on the March, 1915, survey (Munter, ms.).
1923	5 Apr.	?	Occasionally seen offshore (Wetmore, ms.).
	24-27 May	abundant	Eggs and young found (Wetmore, ms.).
	11-16 June	8,000	Some beginning to breed; "other seemed to have young" (Wetmore, ms.).
1936	3 Mar.	?	No nests found (Trempe, ms.).
1940	7-15 Aug.	not particularly abundant	"Breeding was in an early stage, the eggs just commencing to hatch" (Vanderbilt and de Schauensee, 1941: 12).
1953	21-22 Dec.	20-30	? (Richardson, pers. comm.).
1954	18 Mar.	20-30	? (Richardson, pers. comm.).
1961	2 Mar.	?	Abundant; seen from offshore (Woodside and Kramer, ms.).
	9-16 Dec.	?	"Many flying immatures seen" (Kramer, ms.).
1963	5-6 June	?	Thousands seen from offshore, including many young birds (POBSP).
1964	6-7 Mar.	thousands	Eggs to fledged young (BSFW, POBSP).
	25 July	?	(BSFW).
	23-24 Sept.	350	Eggs to fledged young (BSFW, POBSP).
1965	13-14 Mar.	800	? No attempt made to look for nests (BSFW, POBSP).
1966	28 July-1 Aug.	500	? (BSFW, POBSP).

Table 25. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1967	8-9 Mar.	600	? (BSFW, POBSP).
	13-14 Sept.	?	One found incubating an egg (BSFW).
1968	7-9 Mar.	many hundreds	? No nests found on accessible part of island (BSFW, POBSP).
	24-27 Aug.	many hundreds	Eggs to flying young (BSFW).
1961	21 Mar.	30	? (BSFW).
1970	15 Aug.	100-200	(BSFW).
1971	18-19 Aug.	3,000	Near fledging young seen (BSFW).
1972	16 Sept.	300	(BSFW).
1973	31 July	2,000	(BSFW).

MOCKINGBIRD

Status *Mimus polyglottos*

Vagrant; one sight record in August 1971.

Observations

Robert J. Shallenberger observed and photographed a Mockingbird that he saw on Miller Plateau during the BSFW survey of 18-19 August 1971. The species has not been recorded previously from Nihoa but is well established in the main Hawaiian Islands and has previously wandered to both French Frigate Shoals and Necker Island in the northwestern Hawaiian Islands (Amerson, 1971: 302; Berger, 1972: 215).

NIHOA MILLERBIRD *Acrocephalus familiaris kingi*

Status

Common endemic breeder; maximum recent population estimate: 625. Present throughout the year but infrequently seen because of its tendency to skulk in dense shrubbery. Nests in low bushes and probably breeds from at least February through late August or early September.

Populations

Recent population estimates, based primarily on transect censuses, have varied widely (Table 26) but this variation is more likely attributed to inadequacies of the censuses than to very marked changes in the populations of Millerbirds. In any case it seems likely that the population consists of at least several hundred birds.

Annual Cycle

Little is known of the reproductive habits of the Nihoa Millerbird since only four active nests had been found through July 1973 (Table 26). What little evidence is available suggests that the species nests primarily during the northern hemisphere spring and summer.

Breeding Habitat

This species occurs widely throughout the island but seems to prefer areas of dense *Sida* and *Chenopodium*. Berger (1972: 110) has pointed out that of all nests found to date, two were in *Sida* and the rest were in *Chenopodium*. Berger (*op. cit.*: 110) has described old nests seen by him as averaging "about 3 by 4 inches in maximum diameter and were composed primarily of strips and pieces of grass stems and blades, with varying amounts of rootlets. All of the nests contained some feathers of other species of birds, white being the predominant color used."

Banding

Thirty-two Millerbirds have been banded on Nihoa by the BSFW: 8 in September 1964, 1 in March 1965, March 1967, March 1968, 4 in August 1968 and 17 in June 1969.

Specimens

We know of 26 study skins of the Millerbird from Nihoa Island. These are listed in Table 27. There are, in addition, a skeleton (USNM 289276) and an alcoholic (USNM 289299), both collected by Alexander Wetmore in June 1923.

Table 26. Observations of Nihoa Millerbirds on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1923 11-16 June	near 100	Described as a new species *Conopoderas kingi* by Wetmore (1924). The breeding season had ended and young were fully grown.
1940 7-15 Aug.	?	No nests or young birds seen (Vanderbilt and de Schauensee, 1941: 13).
1953 21-22 Dec.	?	Only two individuals seen (Richardson, 1954: 224).

Table 26. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
1961	9-16 Dec.	200	"Pairing appeared to be taking place" (Kramer, ms.).
1962	10 June	?	Many males singing. One nest containing one egg was found (Kramer and Beardsley, ms.).
1964	6-7 Mar.	?	7 birds seen. No nests found (POBSP, BSFW).
	25 July	?	3 birds seen, 2 of which appeared to be paired (BSFW).
	23-24 Sept.	150	No evidence of nesting found (POBSP, BSFW).
1965	13-14 Mar.	100-150	No nests found (BSFW, POBSP).
1966	28 July-1 Aug.	150	Six old nests found 1 August (Berger, 1972: 110).
1967	8-9 Mar.	?	Ten to 15 birds seen. Some singing males heard (POBSP, BSFW).
	13-14 Sept.	625	Estimate based on transect censuses (BSFW).
1968	7-9 Mar.	615	Estimate based on transect censuses. No nests found but a recently fledged young observed (POBSP, BSFW).
	24-27 Aug.	?	A nest with two eggs found 25 August (Berger, 1972: 1101.
1969	21 Mar.	41 (0-123)*	Based on transect censuses. No evidence of nesting was found (BSFW).
	29 May-10 June	498 (211-785)*; 493 (285-701)*	1st estimate based on transect censuses 30 May; 2nd estimate based on transect censuses 6 June (BSFW). A nest with two small young found 30 May and one with a near fledging young found 2 June (Berger, 1972: 110).
1970	15 Aug.	384 (134-477)*	Based on transect censuses. No nests found (BSFW).

Table 26. (Continued)

Date of Survey	Population Estimate	Breeding Status, Remarks, and References
1971 18-19 Aug.	273 (91-454)*	Based on transect censuses (BSFW).
15 Sept.	?	About 10 birds seen (BSFW).
1972 16 Sept.	592 (334-850)*	Based on transect censuses (BSFW).
1973 31 July	198 (46-350)*	Based on transect censuses (BSFW).

* Figures in parentheses represent confidence limits for the population estimate at a 95% confidence level.

Table 27. Nihoa Millerbird specimens from Nihoa Island

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and imm.	Museum Nos.	Date Collected	Collector
USNM	5	287888 (type), 301126, 301138-140	1	301127	10	301128-137	12-15 June 1923	Wetmore
PAS	4	146144-145, 146149, 146152	5	146143, 146146-148, 146150			16 Aug. 1940	Vanderbilt
AMNH					1	325832	16 Aug. 1940	Vanderbilt

NIHOA FINCH *Psittarostra cantans ultima*

Status

Abundant endemic breeder; maximum recent population estimate: 6,686. Present throughout the year. Commonly seen because of their confiding nature. Prefers to nest in rocky outcroppings and nests principally from late February through at least April.

Populations

Although recent estimates are variable, they suggest a population on the order of 3,000 to 5,000 birds (Table 28). These estimates are consistently higher than those estimates made by earlier observers but we believe that this difference may be attributed to more reliable recent estimation techniques than to any inherent change in the population levels of this finch. Recent estimates do not suggest any pronounced seasonal changes in populations.

Annual Cycle

Available evidence suggests a fairly pronounced spring breeding season. A near fledging young seen by Richardson on 18 March 1954 indicates that egg-laying may begin in late February. This is corroborated by the presenceof young early in March during 1967 and 1969. No data is available for nesting activities during April and nests have not been recorded later in the year. Observations by Berger (1972: 159-161) on captive Nohia Finches may suggest the potential extent of the breeding season in the wild. He recorded eggs during a period extending from 17 December 1969 through 27 July 1970.

Breeding Habitat

Nihoa Finches are widespread over the island but often occur commonly near the rocky outcroppings (Fig. 32) which serve as their principal nesting sites. Several observers have noted that these birds often congregate near seeps or pools of water with Wetmore noting that as many as 50 could be seen in such situation at one time.

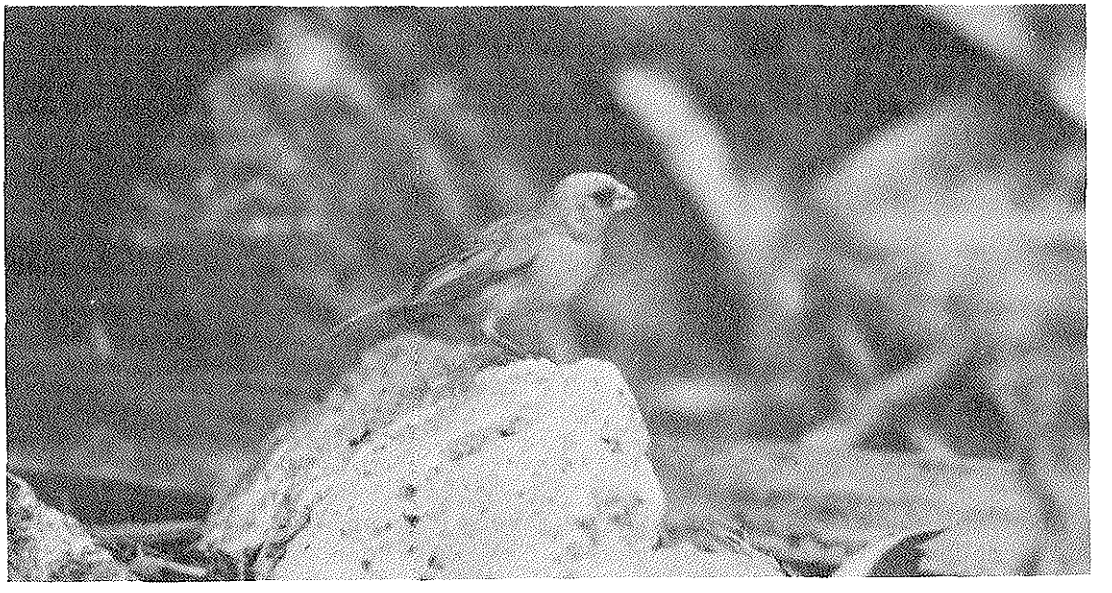

Figure 32. Nihoa Finch on rocky outcropping, 16 September 1972. BSFW photograph by Eugene Kridler.

Food Habits

Like the related subspecies on Laysan Island, Nihoa Finches are avid egg eaters, a behaviorism that has been recorded by many observers. In 1923 Wetmore noted that literally thousands of tern, shearwater, and petrel eggs had had their sides cut open by the finches. In July and August 1966 both Berger (1972: 157) and Heiden (POBSP) noted this species feeding on eggs of the Brown Noddy. In one instance Berger noted 20 finches within 30 feet of a single broken egg. Heiden also observed this species feeding on the eggs of the Gray-backed Tern, Red-footed Booby, and Wedge-tailed Shearwater.

The only other information available on the food habits of this species comes from Vanderbilt and de Schauensee (1941: 13) and Richardson (1954: 224). The former noted that several stomachs contained "...a gelatinous yellow substance (probably yolk of egg), minute black seeds and microscopic pebbles." Richardson repeatedly observed these finches "eating the small, green flower heads of *Chenopodium sandwicheum*...[and noted]...one bird picking out the still partly green seed of *Portulaca caumii*".

Banding

A total of 336 Nihoa Finches have been banded by the BSFW. Four adults were banded in September 1964; 8 nestlings were banded in March 1965; 12 adults were banded in July 1966; 46, all adults except for one immature, were banded in March 1967; 22 nestlings were banded in March 1968; 37, including 7 adults and 30 immatures were banded in August 1968, and another 207 were banded in June 1969. Forty-five of the 46 birds banded in March 1967 were shipped by BSFW to French Frigate Shoals with 32 later being introduced to Tern Island and with 10 being introduced to East Island. The East Island population did not survive. As many as 9 were still present on Tern Island in September 1971 (BSFW).

Specimens

Fifty-nine specimens of Nihoa Finches are listed by location in Table 29. There are in addition a skeleton (USNM 289277) and an alcoholic (USNM 289329) both of which were collected by Wetmore in June 1923.

Table 28. Observations of Nihoa Finches on Nihoa Island

Date of Survey	Population Estimate	Breeding Status, Remarks and References
1885 22 July	?	Species seen by Sanford B. Dole (Munro, 1960: 130).
1915 18 Mar.	"1,000 or more"	(Munter, 1915: 132). The presence of this bird was later noted by Bryan (1916).
1916 12 Feb.	?	5 specimens collected by Munter (ms.) were later described as a new species *Telespiza ultima* by Bryan (1917).
1923 11-16 June	800	Birds had finished breeding and adults were in molt (Wetmore, ms.).
1940 7-15 Aug.	500-1,000	Birds not nesting but 2 old nests found (Vanderbilt and de Schauensee, 1941: 13).
1953 21-22 Dec.	"reasonably numerous"	2 old nests found (Richardson, 1954: 224).
1954 18 Mar.	-	1 near-fledging young found in 1 of the nests seen the previous December (Richardson, 1954: 224).
1961 9-16 Dec.	800-1,200	No nests found (Kramer, ms.).
1962 10 June	"as abundant as in December 1961"	No nests found (Kramer and Beardsley, ms.).
1964 6-7 Mar.	2,500-5,000	1 bird seen nest building (POBSP).
23-24 Sept.	4,500-5,000	No evidence of nesting found (POBSP, BSFW).
1965 13-14 Mar.	4,000	6 nests with young and 1 containing 3 eggs found. Of 4 nests examined, 2 contained 2 young and 2 contained 3 young. 8 nestlings were banded (POBSP, BSFW).
1966 28 July-1 Aug.	5,000	No evidence of breeding found (POBSP, BSFW).
1967 8-9 Mar.	5,000	42 birds captured for introduction to Tern and East Islands, French Frigate Shoals (POBSP, BSFW). Eggs and young found (Berger, 1972: 158).

Table 28. (Continued)

Date of Survey		Population Estimate	Breeding Status, Remarks, and References
	13-14 Sept.	5,000	Estimate based on transect censuses (BSFW).
1968	7-9 Mar.	6,600	Estimate based on transect censuses. Birds apparently at a peak of nesting. Birds seen building. 13 nests found with a total of 28 nestlings and 10 eggs. The maximum number of young in a nest was 4. 22 nestlings were banded (POBSP, BSFW).
	24-27 Aug.	6,686 (4,881-8,491)*	Estimate based on transect census (BSFW).
1969	21 Mar.	2,993 (1,913-4,073)*	Estimate based on small number of transect censuses and possibly subject to error. 2 nests found, 1 with 1 egg and 1 with 1 young (BSFW).
	29 May	2,987 (2,206-3,948)* 1,528 (924-2,132)*	1st estimate based on transect censuses 30 May; 2nd estimate based on transect censuses 6 June (BSFW).
1970	15 Aug.	2,341 (1,637-3,045)*	Estimate based on transect censuses. Several old nests found; no evidence of breeding noted (BSFW).
1971	18-19 Aug.	3,759 (2,707-4,811)*	Estimate based on transect censuses. No active nests found (BSFW).
	15 Sept.	common everywhere	(BSFW).
1972	16 Sept.	3,799 (3,009-4,589)*	Estimate based on transect censuses (BSFW).
1973	31 July	1,318 (892-1,744)*	Estimate based on transect censuses (BSFW).

* Figures in parentheses represent confidence limits for the population estimate at a 95% confidence level.

Table 29. Nihoa Finch specimens from Nihoa Island

Museum	Males	Museum Nos.	Females	Museum Nos.	?? and imm.	Museum Nos.	Date Collected	Collector
BPBM?					1*		12 Feb. 1916	Munter
LACM	2	20243 (holotype) 20244 (paratype)	1	20244 (paratype)	1	20246 (paratype)	12 Feb. 1916	Munter
USNM	10	301144,301147, 301150,301159 301167,301171** 301174-177	5	301148,301160-161,301170**, 301180	26	301145,301146, 301149,301151-154,301156**, 301157-158, 301162-169, 301172-173, 301178-179, 301181-184	11-15 June 1923	Wetmore
PAS	3	146136,146138-139	1	146141	6	146133-135, 146137-140, 146142	16 Aug. 1940	Vanderbilt
AMNH					1	325831	16 Aug. 1940	Vanderbilt
USNM	1	531868					8 Mar. 1967	Kridler
USNM			1	531869			15 Sept. 1967	Kridler

* One of the original five specimens preserved in spirits and may still be in the Bishop Museum.

** This bird was later exchanged to the Museum of Comparative Zoology.

Mammals

Only one species of mammal is known to occur at Nihoa and its appearance there is uncommon.

HAWAIIAN MONK SEAL *Monachus schauinslandi*

Status

Uncommon visitor. Not known to breed at Nihoa.

Observations

All observations of this species at Nihoa are summarized in Table 30.

Table 30. Observations of Hawaiian Monk Seals at Nihoa Island

Date of Survey	Number Seen	Remarks and References
1857 23 Apr.	about a dozen	On beach. Several shot by King Kamehameha IV (Paty *in* Emory, 1928: 9).
1940 7-15 Aug.	0	(Vanderbilt and de Schauensee, 1941: 8).
1953 21-22 Dec.	0	(Kenyon and Rice, 1959: 217).
1954 18 Mar.	0	(Kenyon and Rice, 1959: 217).
1957 28 Dec.	0	(Rice, 1960: 377).
1964 6-7 Mar.	1	1 lying on small beach on west side of Adam's Bay 6 March. Adult seem swimming offshore later in day (POBSP).
23-24 Sept.	1	Adult swimming near landing site (BSFW, POBSP).
1965 13-14 Mar.	6	3 seen each day: 2 adults, male and female; 4 subadults, 1 female (BSFW, POBSP).
1966 28 July-1 Aug.	0	(BSFW, POBSP).
1967 8-9 Mar.	0	(BSFW, POBSP).
13-14 Sept.	0	(BSFW).

Table 30. (Continued)

Date of Survey	Number Seen	Remarks and References
1968 7-9 Mar.	0	(BSFW, POBSP).
24-27 Aug.	0	(BSFW).
1969 21 Mar.	0	(BSFW).
29 May	1	(BSFW).
1970 15 Aug.	0	(BSFW).
1971 18-19 Aug.	0	(BSFW).
15 Sept.	1	Found basking on sandy beach (BSFW).
1972 16 Sept.	3	(BSFW).
1973 31 July	4	Basking on sandy beach (BSFW).

Reptiles

Two species of reptiles, a lizard and a turtle, are known to occur at Nihoa. Both are uncommon and there is no adequate evidence that either species has ever bred there.

MOURNING GECKO *Lepidodactylus lugubris*

Status

Uncommon resident; probably a recent introduction that may not be established.

Observations

This species has only been twice seen on Nihoa. A single specimen was collected in *Eragrostis* clumps in September 1964 (Beardsley, 1966: 160) and another specimen was collected in March 1965 by Walker. The absence of observations from earlier visits, particularly those in 1923 and 1940, suggests that the species is probably a recent introduction, most likely stemming from 1961 and 1962 when oil barrels, boards, and much other miscellaneous material was ferried to the island by the helicopters of the HIRAN operation. The absence of more recent observations suggests that the gecko may not have become established on the island.

GREEN TURTLE *Chelonia mydas*

Status

Uncommon visitor.

Observations

Emory (1928: 8) remarked that "Turtles are fairly common [at Nihoa]" but we have been unable to find any historical basis for his statement. Perhaps some were seen during his visit in 1924. Recent observations of turtles at Nihoa are few (Table 31) and indicate the species is only an occasional visitor to the island. They are most likely visitors from the nearby large breeding colony at French Frigate Shoals (see Amerson, 1971: 79-92).

Table 31. Observations of Green Turtles at Nihoa Island

Date of Survey		Number Seen	Remarks and References
1964	6-7 Mar.	0	(BSFW, POBSP).
	23-24 Sept.	2	Seen just offshore (BSFW, POBSP).
1965	13-14 Mar.	1	About 2 1/2 feet long (BSFW, POBSP).
1966	28 July-1 Aug.	0	(BSFW).
1967	8-9 Mar.	1	1 large turtle seen offshore on 9 March (BSFW, POBSP).

Table 31. (Continued)

Date of Survey	Number Seen	Remarks and References
1967 13-14 Sept.	0	(BSFW).
1968 7-9 Mar.	1	Seen swimming offshore on 8 March (BSFW, POBSP).
24-27 Aug.	0	(BSFW).
1969 21 Mar.	0	(BSFW).
1970 15 Aug.	0	(BSFW).
1971 18-19 Aug.	0	(BSFW).
15 Sept.	3	2 were on a low rock at the base of the northwest cliff; the other was seen swimming around the ship (BSFW).
1972 16 Sept.	1	(BSFW).
1973 31 July	0	(BSFW).

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Appendix Table 1. Scientific visits to Nihoa Island, 1885-1973

Date	Personnel	Vessel
1858?	Dr. Rooke	?
1885* 22 July	Princess Liliukolani E.M. Beckley Sereno E. Bishop W.E.H. Deverill Sanford B. Dole Mr. Hall Mr. Jaeger Mr. Williams Some 200 others	IWALANI
1891* 26-27 May	Rothschild Expedition Henry C. Palmer George C. Munro	KAALOKAI
1902* 1-3 June 5-9 Aug.	Albatross Expedition Charles H. Gilbert (SU)*** Walker K. Fisher (SU) Charles C. Nutting (SUI) John O. Snyder (SU)	ALBATROSS
1912* 17 Dec.	George Willett (BBS)	THETIS
1914 7 Sept.	Capt. James H. Brown (USCG) Carl Elschner	THETIS
1915 18 Mar.	Capt. James H. Brown (USCG) Lt. William H. Munter (USCG) 4 members of crew	THETIS
1916 12 Feb.	Lt. William H. Munter (USCG) Crew of THETIS	THETIS
1923 24-25 May	Tanager Expedition David L. Thaanum (BPBM) (conchologist) Theodore T. Dranga (conchologist) Chapman Grant (naturalist)	TANAGER
11-20 June	Tanager Expedition Alexander Wetmore (BBS) (ornithologist) William G. Anderson (collector) A.L.C. Atkinson (HBAF)	TANAGER

Appendix Table 1. (Continued)

Date		Personnel	Vessel
		Edwin H. Bryan, Jr. (BPBM) (entomologist) Bruce Cartwright (BPBM) (assistant in hydrographic work) Chapman Grant (BBS) (naturalist) Charles J. Judd (forester) Edward L. Caum (BPBM) (botanist) Harold S. Palmer (BPBM) (geologist) Eric L. Schlemmer (assistant to Wetmore) David L. Thaanum (BPBM) (conchologist) George Higgs (cook) C. Montague Cooke, Jr. (BPBM) (malacologist)	
1924	9-13 July	Tanager Expedition	TANAGER
		Harold S. Palmer (BPBM) (geologist) William G. Anderson (collector) William Bush (collector) Erling Christophersen (BPBM) (botanist) Theodore T. Dranga (BPBM) (conchologist) Kenneth P. Emory (BPBM) (archaeologist) Kenneth I. Hobson (collector) A. Landgraf (topographer)	
1936	3 Mar.	A.D. Trempe B.L. Bassham (USCG) Other members of crew	RELIANCE
1940	7-16 Aug.	Mr. and Mrs. George Vanderbilt Clifton Weaver	NAVIGATOR
1951	July	George Vanderbilt Pacific Equatorial Expedition	PIONEER
		George Vanderbilt Vernon E. Brock (HDFG) B. Green Robert R. Harry (SU) Anita Vanderbilt Lucille Vanderbilt T. Ivar Vatland	
1953	21-22 Dec.	Frank Richardson (UW)	BUTTONWOOD
1954	18 Mar.	Frank Richardson (UW)	BUTTONWOOD
1955	21-24 Aug.	Ivan T. Rainwater (USDA) George Carter David G. Nottage Peter Nottage Ed Sheehan	AUKAKA

Appendix Table 1. (Continued)

Date	Personnel	Vessel
1957 28 Dec.	Karl W. Kenyon (BSFW) Dale W. Rice (BSFW)	Aerial Survey
1961* 2 Mar.	David H. Woodside (HDFG) Raymond J. Kramer (HDFG)	PLANETREE
10-15 Dec. (1600-0830)**	Raymond J. Kramer (HDFG) Gerald Swedberg (HDFG) HIRAN II personnel	FLOYD COUNTY
1962 10 June (0615-1345)	David B. Marshall (BSFW) John W. Beardsley (HSPA) Raymond J. Kramer (HDFG) David H. Woodside (HDFG)	STONE COUNTY Helicopter
1963* 5-6 June	A. Binion Amerson, Jr. (POBSP) Fred C. Sibley (POBSP)	TAWAKONI
1964 6-7 Mar. (1000-0800)	Eugene Kridler (BSFW) A. Binion Amerson, Jr. (POBSP) Loren Kroenke (UH) Edward O'Neill (BSFW) Ronald L. Walker (HDFG) George S. Wislocki (POBSP)	PLANETREE
25 July (*ca.* 1000-1500)	Eugene Kridler (BSFW)	CHARLES H. GILBERT
23-24 Sept. (0930-1700)	Eugene Kridler (BSFW) John Beardsley (UH) Robert R. Fleet (POBSP) Charles R. Long (POBSP) Ronald L. Walker (HDFG)	BASSWOOD
1965 13-14 Mar. (1045-1545)	Eugene Kridler (BSFW) Winston Banko (POBSP) Chandler S. Robbins (BSFW) Ronald L. Walker (HDFG)	BLACKHAW
1966* 18-20 Mar.	Eugene Kridler (BSFW) Andrew Berger (UH) Nelson Rice (HDFG) Ronald Walker (HDFG)	BUTTONWOOD
28 July- 1 Aug.	Eugene Kridler (BSFW) Andrew J. Berger (UH) Richard S. Heiden (POBSP) Ernest Kosaka (HDFG)	CHARLES H. GILBERT

Appendix Table 1. (Continued)

Date	Personnel	Vessel
1967 8-9 Mar. (0945-1040)	Eugene Kridler (BSFW) C. Douglas Hackman (POBSP) Ernest Kosaka (HDFG) John Maciolek (BSFW) Richard Wass (UH)	BASSWOOD
13-14 Sept. (0855-1420)	Eugene Kridler (BSFW) Robert Ballou (BSFW) John L. Sincock (BSFW) Ronald L. Walker (HDFG)	BUTTONWOOD
1968 7-9 Mar. (1130-1030)	Eugene Kridler (BSFW) Roger B. Clapp (POBSP) Karl W. Kenyon (BSFW) Ernest Kosaka (HDFG) John L. Sincock (BSFW)	IRONWOOD
24-27 Aug. (0900-1400)	Eugene Kridler (BSFW) G. Brent Dalyrymple (USCG) Richard R. Doell (UDCG) C. Robert Eddinger (UH) Derral Herbst (UH) John L. Sincock (BSFW)	BUTTONWOOD
1969 21 Mar. (0900-1730)	Eugene Kridler (BSFW) Karl W. Kenyon (BSFW) George Laycock (NAS) David L. Olsen (BSFW) John L. Sincock (BSFW)	BUTTONWOOD
29 May-10 June	David L. Olsen (BSFW) Ernest Kosaka (HDFG) James McVay (UH) William Patzert (UH) John L. Sincock (BSFW) Douglas Yen (BPBM)	MAHI
1970 15 Aug. (0830-1600)	Eugene Kridler (BSFW) Joseph Mazzoni (BSFW) David L. Olsen (BSFW) John L. Sincock (BSFW) David H. Woodside (HDFG)	BUTTONWOOD
1971 18-19 Aug. (0800-1230)	David L. Olsen (BSFW) David Childs (SI) Richard Grigg (HIMB) Robert J. Shallenberger (OI) James Vansant (UH) William Worcester (UH)	TERITU

Appendix Table 1. (Continued)

Date		Personnel	Vessel
	15 Sept. (1300-1800)	Eugene Kridler (BSFW) Erwin A. Bauer Kenneth S. Norris (OI) John L. Sincock (BSFW) Eric L. Schlemmer	BUTTONWOOD
1972	16 Sept. (0700-1500)	Eugene Kridler (BSFW) Russel Apple (USNPS) Bruce Benson (HA) Ernest Kosaka (HDFG) David L. Olsen (BSFW) John L. Sincock (BSFW)	BUTTONWOOD
1973	31 July (1030-1830)	David L. Olsen (BSFW) John L. Sincock (BSFW) Leighton Taylor (BSFW) Thomas Telfer (HDFG)	BUTTONWOOD

* No landing made on island.

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

*** Glossary of Abbreviations: BBS, Bureau of Biological Survey; BPBM, Bernice P. Bishop Museum; BSFW, Bureau of Sport Fisheries and Wildlife; HA, Honolulu Advertiser; HBAF, Hawaiian Board of Agriculture and Forestry; HDFG, Hawaii Division of Fish and Game; HIMB, Hawaii Institute of Marine Biology; HSPA, Hawaiian Sugar Planters Association; NAS, National Audubon Society; OI, Oceanic Institute, Waimanalo, Hawaii; POBSP, Pacific Ocean Biological Survey Program; SI, Smithsonian Institution; SU, Stanford University; SUI, State University of Iowa; UH, University of Hawaii; USDA, United States Department of Agriculture; USCG, United States Coast Guard; USCGS, United States Coast and Geodetic Survey; USNPS, United States National Park Service; UW, University of Washington.

Appendix Table 2. Results of scientific visits to Nihoa Island, 1885-1973

Date		Results
1858	?	According to Hillebrand (1888: 451), seeds of the endemic palm were brought to Honolulu by a Dr. Rooke. We know nothing further of this visit.
1885	22 July	Topographic and geologic observations. Observations and collections of birds, none of which was subsequently reported. Archaeological material collected included a stone bowl and dish, a coral rubbing stone, and a coral file.
1891	26-27 May	Birds observed from offshore. 3 Red-footed Boobies collected and other birds observed (Munro, 1941a: 1941b).
1902	1-3 June	Observations of birds from offshore (Fisher, 1903).
	5-10 Aug.	Collected offshore: corals, molluscs, hydroid, schizopod, crabs, fish, echinoderms, and bird specimens (at least 6 birds skins representing 3 species).
1912	17 Dec.	Observations of birds from offshore.
1914	7 Sept.	Island and its geology described; seeds and portions of *Pritchardia* taken to Honolulu. Plants collected.
1915	18 Mar.	Observations of birds and estimates of the numbers present; first published mention of the Nihoa Finch, palm seeds collected (Munter, 1915).
1916	12 Feb.	Observations of birds; photographs of flora and fauna; collected: plants; 5 specimens of the Nihoa Finch, reported and later described by W.A. Bryan (1916, 1917).
1923	24-25 May 11-16 June	Observations of birds and description of the Nihoa Millerbird (Wetmore, 1924, 1925). A new bird distributional record from the June 1923 visit was later reported by Clapp and Woodward (1968). 109 bird specimens (skins) of 17 species collected. Collections of: crustacea, echinoderms, foraminifera; fish, mollusca; marine algae, insects, vascular plants, rocks. Geology, topography, and archaeology described.

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Appendix Table 2. (Continued)

Date		Results
1936	3 Mar.	Observations of birds and their breeding status.
1940	7-10 Aug.	Observations and annotated bird list (Vanderbilt and de Schauensee, 1941); photographs taken and color movie of birds made. 48 birds of 12 species collected.
1951	July	Fish collected; 12 Nihoa Finches captured for transport to Honolulu Zoo of which 6 evidently reached the zoo (Herald, 1952: 15).
1953	21-22 Dec.	Observations of seabirds and their breeding status (Richardson, 1957); seal census taken but none found.
1954	18 Mar.	Observations of seabirds and their breeding status (Richardson, 1957); seal census taken but none found. Notes on status of Nihoa Finch and Millerbird (Richardson, 1954).
1955	21-24 Aug.	Charcoal collected for radioactive carbon dating; 3 or 4 Great Frigatebirds captured for transport to Honolulu Zoo; plants collected; an unfinished adz and a stone bowl collected; movies, photographs and tape recordings made.
1957	28 Dec.	Seal census taken but none found; aerial census of albatrosses (Rice and Kenyon, 1962).
1961	2 Mar.	Bird observations from offshore.
	10-15 Dec.	Observations of birds with particular emphasis on Nihoa Finches and Millerbirds; survey of vegetation with particular emphasis on status of Nihoa Palm; vegetation photostations established; effect of military activities investigated; plants collected; seeds of *Pritchardia* and *Chenopodium* collected for artificial propagation.
1962	10 June	Observations of birds with particular emphasis on the Nihoa Millerbird; brief notes on vegetation; collection of 15 species of insects and plant associates; effect of military activities investigated; photographs taken.
1963	5-6 June	Birds observed offshore; 2 Bulwer's Petrels collected.

Appendix Table 2. (Continued)

Date		Results
1964	6-7 Mar.	Observations of birds; seals and turtles censused; refuge signs erected; vegetation photographed. Collected: plants; limpets, and algae by Walker; 2 petrel chicks; arachnids. 99 birds of 11 species banded.
	25 July	Observations of birds and their breeding status.
	23-24 Sept.	Observations of birds with particular emphasis on the millerbird; census of turtles and seals; 57 birds of 5 species banded. Collected: plants, isopods, arachnids, insects, 1 lizard.
1965	13-14 Mar.	Observations of birds; turtles and seals censused; 312 birds of 9 species banded. Collected: 1 Sooty Storm Petrel, 1 lizard.
1966	28 July-1 Aug.	Observations of birds with particular emphasis on surveys of Nihoa Finch and Millerbird; turtles and seals censused; photographs taken of terrain; refuge sign erected. Collected: bird specimens; limpets by Berger. 1,544 birds of 8 species banded.
1967	8-9 Mar.	Observations of birds; turtles and seals censused; 45 Nihoa Finches captured by BSFW for introduction to French Frigate Shoals; 1 Millerbird and 46 Nihoa Finches banded. Collected: marine inshore organisms, hippoboscid flies, 1 finch.
	13-14 Sept.	Observations of birds with particular emphasis on Nihoa Finches and Millerbirds; transect censuses made of finch and Millerbird populations; 1 gecko and 1 finch collected.
1968	7-9 Mar.	Observations of birds with particular emphasis on Nihoa Finches and Millerbirds; transect censuses made of finch and Millerbird populations; turtles censused; plants collected; 105 birds of 5 species banded.
	24-27 Aug.	Observations of birds with particular emphasis on Nihoa Finches and Millerbirds; transect censuses made of finch and Millerbird populations; turtles and seals censused; collection of rock samples for analysis of magnetic properties; observations of vegetation; ectoparasites collected from finches; 42 birds of 3 species banded.

Appendix Table 2. (Continued)

Date		Results
1969	21 Mar.	Observations of birds, censuses of turtles and seals; island vegetation cover mapped; partial censuses made of finch and Millerbird populations. 2 Sooty Storm Petrels banded.
	29 May-10 June	Observations of birds with particular emphasis on Nihoa Finches and Millerbirds; transect censuses of finch and Millerbird populations; ethnobotanical surveys, marine survey of surrounding waters, retrieval of current meters, vegetation photostation photographs obtained. 224 birds of 2 species banded.
1970	15 Aug.	Observations of birds, transect censuses of finch population.
1971	18-19 Aug.	Observations of birds; transect censuses made of finch and Millerbird populations. Offshore marine observations.
	14-15 Sept.	Cursory observations made of birds, seals and turtles. Several archaeological samples obtained for Carbon-14 dating.
1972	16 Sept.	Observations of birds, seals and turtles; transect censuses made of finch and Millerbird populations.
1973	31 July	Cursory observations of birds. Seals noted; transect censuses made of finch and Millerbird populations.

Appendix Table 3. Publications on collections and studies (with the exception of birds) made on Nihoa Island,. 1885-1973*

Protozoa	
Cushman in Edmondson *et al.*	Reports 15 species of foraminifera collected offshore by the Tanager Expedition.
Coelenterata	
Nutting, 1905.	Reports 1 species of hydroid collected south of Nihoa by the Albatross Expedition.
Vaughan, 1907.	Reports 6 species of corals (Madreporia) collected offshore by the Albatross Expedition.
Nutting, 1908.	Reports 11 species of coral (Alcyonaria) collected by the Albatross Expedition; most are described as new species.
Mollusca	
Pilsbry, 1927.	Lists a barnacle collected by the Tanager Expedition.
Dall, *et al.*, 1938.	Lists two species of pelecypods collected offshore by the Albatross Expedition.
Annelida	
Hartman, 1966.	Summarizes published records of polychaetes (1 species); gives current taxonomy.
Arthropoda	
Arachnomorpha (Arachnida)	
Bryan, *et al.*, 1926.	States that bird ticks were found abundantly.
Jacot, 1929.	Reports an orabatid mite (Acarina) from collections made by the Tanager Expedition.
Beardsley, 1966.	Reports 5 Araneida and an undetermined pseudoscorpion from collections made in September 1964. First record of the occurrence of pseudoscorpions.
Amerson, 1968.	Reports the distribution and hosts of ticks from collections made by the POBSP.

Appendix Table 3. (Continued)

Crustacea

Ortman, 1905.	Reports a single species of schizopod collected in the vicinity of Nihoa by the Albatross Expedition.
Rathbun, 1906.	Reports brachyuran and macruran crabs collected offshore by the Albatross Expedition.
Edmondson *in* Edmondson *et al.*, 1925.	Reports 3 species of decapods collected by the Tanager Expedition.
Bryan *et al.*, 1926.	Indicates that isopods were collected by the Tanager Expedition.
Beardsley, 1966.	Lists 2 species of isopods from collections made in September 1964.

Labiata (Hexapoda - Insects)

Timberlake, 1924.	Records a chalcid fly collected by the Tanager Expedition.
Bryan *et al.*, 1926.	Reports *ca.* 67 species of insects collected by the Tanager Expedition.
Wheeler, 1934.	Lists 4 species of ants on the basis of earlier publications.
Lopes, 1938.	Describes a new species of sarcophagid fly from collections of the Tanager Expedition.
Usinger, 1942.	Reports 3 species of *Nysius* (Hemiptera: Lygaeidae), 2 described as new, from collections by the Tanager Expedition.
Zimmerman, 1948a.	Lists 8 species of insects (1 thysanuran, 4 cockroaches; 1 embiopteran, and 1 earwig. Zimmerman's various distributional records in the Insects of Hawaii series derive from the Tanager collections, but extensively revise taxonomy, reidentify specimens, and identify to species hitherto unidentified specimens; several new distributional records are listed in the series.
Zimmerman, 1948b.	Lists 6 species of Hemiptera (4 lygaeids, 1 nabid, and 1 anthocorid).

Appendix Table 3. (Continued)

Ross, 1951.	States that the embiopterid collected by the Tanager Expedition and reported as *Oligotoma insularis* (Bryan *et al.*, 1926) is actually *Oligotoma (Aposthonia) oceania* Ross sp. nov.
Zimmerman, 1958a.	Lists 2 species of noctuid moths.
Zimmerman, 1958b.	Lists 1 pyralid moth and 1 pterophorid moth.
Maa, 1962.	Reports specimens of Hippoboscidae collected by the Tanager Expedition.
Hardy, 1964.	Identifies a dolicopodid fly not specifically identified in Bryan *et al.*, 1926.
Yashimoto, 1965.	Lists 2 species of eulophids (Hymenoptera: Chalcoidea).
Hardwick, 1965.	Describes a noctuid moth from specimens collected by the Tanager Expedition.
Beardsley, 1966.	Reports 110 species of insects collected in June 1962 and September 1964, 41 of them new distribution records. Lists earlier records of insects but does not include Mallophaga.
Maa, 1968.	Reports POBSP collections of hippoboscid flies.
Echinodermata	
Fisher, 1906.	Reports 9 species of starfishes (Asteroidea) from collections made by the Albatross Expedition offshore.
Fisher, 1907.	Records 3 sea cucumbers (Holothuroidea) collected by the Albatross Expedition.
Agassiz and Clark, 1907-1912.	Records 9 species of Echinoidea collected by the Albatross Expedition.
Clark, 1908.	Reports a crinod collected from offshore by the Albatross Expedition.
Clark *in* Edmondson *et al.*, 1925	Reports 3 species of Echinoidea collected by the Tanager Expedition

Appendix Table 3. (Continued)

Clark, 1949.	Reports 10 brittle stars (Ophiuroidea) collected by the Albatross Expedition. Summarizes previous records for echinoderms.
Chordata	
Vertebrata	
Pisces	
Snyder, 1904.	Reports 1 species collected by the Albatross Expedition.
Gilbert, 1905.	Records 22 species of deep sea fishes collected in the vicinity of Nihoa by the Albatross Expedition.
Fowler and Ball, 1925	Reports 7 species of fish collected by the Tanager Expedition.
Strasberg, 1956.	Revises taxonomy of Hawaiian blennioid fishes and records 1 species from Nihoa.
Reptilia	
Beardsley, 1966.	Gives first record of a lizard, *Lepidodactylus lugubris*, from a collection made in September 1964.
Mammalia	
Paty, 1857.	First report of seals at Nihoa.
Kenyon and Rice, 1959.	Reports no seals seen during visits by Richardson in 1953, and 1954.
Rice, 1960b.	Reports no seals seen on aerial survey December 1957.
Tomich, 1969.	Reports occurrence of monk seal in March 1965.
Flora	
Beccari, 1889.	Describes endemic palm (*Pritchardia remota*) from cultivated specimen from Honolulu.
Bryan, 1916.	Indicates palm seeds were collected during the April 1915 cruise of the THETIS. The

Appendix Table 3. (Continued)

	THETIS visited Nihoa in March not April 1915 and two reports of the visit give no indication that plants were collected then. In actuality the seeds were collected in September 1914 (see next entry).
Beccari and Rock, 1921.	Remarks on *Pritchardia* specimens collected in September 1914.
Christophersen and Caum, 1931	Reports 20 species of vascular plants collected by the Tanager Expedition.
Magnusson, 1942	Lists 19 species of lichens collected by the Tanager Expedition.
Lamoureux, 1964.	Reports that the 11 species of vascular plants collected by the HDFG in 1962 are represented in the 20 species collected by the Tanager Expedition in 1923.
Tsuda, 1966.	Reports 2 species of marine benthic algae from collections made in July 1924 and March 1964.
Geophysical	
Bishop, 1885a and b.	Gives geological and topographical observations made in 1885.
Elschner, 1915.	Gives descriptions and geological comments from observations made offshore in September 1914.
Powers, 1920.	Records observations on a rock specimen stated (erroneously) to have been collected by W.A. Bryan.
Washington and Keyes, 1926.	Reports results of studies of rocks collected in 1914 and 1923.
Palmer, 1927.	Gives geological and topographical observations made by the Tanager Expedition.
Kroenke and Woollard, 1965.	Reports gravity observations made in March 1964.
Archaeology	
Emory, 1928.	Reports on archaeological work conducted by the Tanager Expedition and summarizes all available information.

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