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CPSU/UH Avian History Report 13A

**HISTORY OF ENDEMIC HAWAIIAN BIRDS
POPULATION HISTORIES—SPECIES ACCOUNTS**

Scrub-Grassland Birds: Nene - Hawaiian Goose

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December 1990

UNIVERSITY OF HAWAII AT MANOA
NATIONAL PARK SERVICE Contract No. CX 8000 8 0012

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Abstract

The Nene or Hawaiian Goose (*Nesochen sandvicensis*) is a medium-sized brownish goose with black on chin and throat, distinctively textured black-naped neck, long legs, and half-webbed feet. Endemic to Hawaii, and reportedly Maui, this unique terrestrial goose was recognized as "emblematic" of Hawaii by the Territorial Legislature in 1957. Exhaustive search of literature and field journals uncovered some 1,464 observational records, reports, recollections and related statements on relative abundance and geographical distribution of this species from 1778 to 1948. Records are serially numbered, arranged in geographical and chronological order, referenced as to source, and systematically documented.

The history of Nene populations in the Hawaiian Islands is presented in four parts. Part I documents the geographical distribution and relative abundance of this species from 1778 to 1959, including an introduction; sightings by early Europeans; later observations and recollections; rediscovery and initial research; distribution of relict populations; and the chronological and geographical distribution of records. Part II addresses the Hawaii State restoration program from 1949 to 1988, including the historical background from 1902 to 1959; initial propagation, field activity and funding; establishment and management of sanctuaries; reporting of field investigations; data analysis by W. S. Devick; and supplemental management papers. Part III presents an analysis of Hawaii State Division of Forestry and Wildlife field observations from 1954-55 through 1987-88, including a comparative analysis of populations data; production, release, movement and behavior of captive-reared stock; release and rearing backgrounds of wild-breeding Nene; fidelity of captive-reared breeding pairs to area of release; breeding observations; captive vs. wild-reared population re-

placement rate; survival of captive-reared stock released in the wild; observed mortality, disablement and emaciation; island-wide population size; Nene seen outside sanctuary boundaries; and summary conclusions. Part IV details the cooperative National Park Service program in Hawaii Volcanoes and Haleakala National Parks from inception in 1972 through 1988.

Scrub-Grassland Birds

1. *Nesochen sandvicensis* Nene or Hawaiian Goose

Introduction

Nesochen sandvicensis is a medium-sized brownish goose with black on chin and throat, uniquely patterned black-naped neck, and long legs with half webbed feet first described by Vigors (1833).

Miller (1950) examined the anatomy of this goose in detail, stating that it was "as distinct from *Branta* as is *Chen*", concluding that "the species most probably arose from *Branta* stock with its structure modified for running and climbing over rough ground, and with its swimming, and especially flight power materially reduced." The Nene is endemic to Hawaii and reportedly Maui.

Numbers and principal repositories of 91 *Nesochen sandvicensis* specimens are as follows: Rijksmuseum Van Natuurlijke Historie (26), American Museum of Natural History (11), National Museum of Natural History (11); 43 others are scattered in 16 other U.S. and foreign museums (Banko 1979 report). In presenting results of research on the origin of the type specimen now in the Liverpool Museum, Olson (1989) recognized the scientific name of the Nene as *Branta sandvicensis*.

Wilson and Evans (1893), Rothschild (1900), and Henshaw (1902), documented most of what was known about Nene in the late 19th century. Based on information supplied by G. C. Munro, Elliott (1942) helped draw public attention to the Nene's precarious status. Baldwin (1945, 1947) provided a detailed account of its historical distribution, population decline, and food. Schwartz and Schwartz (1949), Smith (1952), Elder (1958a, b), and Elder and Woodside (1958) proposed specific measures for the preservation of the remaining wild population. The Nene was declared "emblematic" of the Territory of Hawaii on 17 April 1957 by H.C.R. 52 (T. K. Pratt, pers. comm.)

More recently, Berger (1972) wrote a contemporary overview of this species. Kear and Berger (1980) authored a book on the role of The Wildfowl Trust in restoring Nene populations. P. Banko (1980) and P. Banko and Manual (1982 unpub.) presented preliminary data on Nene productivity and management in Hawaii Volcanoes National Park. Olson and James (1982) identified fossil remains of the Hawaiian Goose from Molokai, Oahu, and Kauai. Stone, et al (1983) summarized research and management progress and outlined future needs. P. Banko (1988 Univ. of Washington PhD dissertation) conducted extensive field research into the breeding biology and conservation of this species. Finally, almost everything written about the release, distribution and survival of some 2,000 captive-reared Nene released on Hawaii and Maui during the 1949 to 1988 period is contained in a 40-year accumulation of Federal-Aid progress reports authored by the following Hawaii State Division of Forestry and Wildlife biologists: E. L. Andrade, W. S. Devick, E. Kosaka, J. S. Medeiros, N. Santos, M. L. Ueoka, R. L. Walker, and D. H. Woodside. Appreciation is expressed to the Hawaii State Division of Forestry and Wildlife and the National Park Service for furnishing us with copies of official reports for analysis and interpretation.

Synthesis of such a large quantity and diversity of historical and observational information requires that data be chronologically ordered and geographically arranged as outlined in the Introduction to Part I (CPSU/UH Avian History Report 4). Records presented in the various Appendices satisfy criteria necessary for basic documentation, comparative analysis, and drawing of conclusions.

In the following account, sources of published information are cited by author and year in the usual style. One to four digit numbers in parentheses refer to specific records in Appendix A. Sources of published and unpublished information listed in Appendix A. may be traced to complete references in the Bibliography. First names or initials of Nene observers cited in Appendix A. are given in Appendix B.

Part I. GEOGRAPHICAL DISTRIBUTION AND RELATIVE ABUNDANCE (1778-1959)

1. Sightings by Early Europeans(1778-1886)

Island of Hawaii

Kona District:

The assistant surgeon on Captain James Cook's third and last voyage, William Ellis, was the first European to note the existence of the Hawaiian Goose. Ellis (1783) wrote, "Upon our first arrival at Karacacooah (Kealakekua) Bay, the natives brought off several geese, which were quite tame; they were not unlike the Chinese geese; they called the Na-na" (309). Becalmed at sea off the Kona Coast on 23 December 1778, Cook (1784) noted "... islanders came off with hogs, fowls, fruit ... out of one canoe we got a goose; which was about the size of a Muscovy duck ... plumage dark grey ... bill and legs black ..." (101). Stresemann (1950) recognized Cook's discovery of Nene and expressed the opinion that this

species may have been encountered “possibly during several days excursion into the interior from Kealakekua Bay” during January and/or February 1779 (102). A decade later, in 1789, Captain John Meares of the *Iphigenia* noted in the ship’s log that 12 geese were received aboard at Kawaihae (Locey 1937) (88).

A few years later, on 3 March 1792, while the *Chatham* was hove to and surrounded by an “amazing number of canoes” near Kealakekua Bay, the following account was penned in the ship’s log, “. . . bought one or two geese that were tame ... small and not very unlike a wild goose ... from Mr. Portlock’s account who carried six dozen to sea with him we expected to procure a tolerable supply ...” (Bell 1929) (310). Holland (1971), from his research of the livelihood along the Kona Coast in the early 1800’s, thought that Nene traded to passing mariners during this period were most probably taken when young and reared in captivity (103). The fact that six dozen Nene were involved in trade to a single ship suggests that the practice of procuring and keeping Hawaiian geese may well have been more widespread and intensive than previously believed.

In his diary for 1792, the explorer Menzies (1920) seems to have been the first European to record the occurrence of Nene in their natural habitat when he “saw some” at about 5000 feet elevation in the high “desert valley” between Hualalai and Mauna Loa (231). Wilkes (1845) noted that 2 Nene were shot in November 1840 “near the temple of Kaili” (Ahuaumi Heiau) in the saddle between Hualalai, Mauna Loa, and Mauna Kea (231).

Brigham (1868), exploring the elevated plain between Hualalai, Mauna Loa and Mauna Kea on 29 July 1864, wrote “... shot 2 ... number has been much underrated ... admits of the annual slaughter of several hundred without diminution ...” (42). In a less explicit statement pertaining to the southern portion of the same elevated

plain, Pope (1932) cites C. Wall’s report that Nene were abundant between Hualalai and Mauna Loa between 1859 and 1875 (43).

Kohala District:

In the sole report for the 1778-1886 period, Baldwin (1945) cites R. von Holt as saying that Kaiamakini “used to herd” flocks of Nene at Kahua about 1880 (83). The apparent practice of native Hawaiians to keep Nene in numbers thus persisted for a hundred years after they were bartered aboard ships of exploratory mariners in the late 1700’s and early 1800’s.

Kilauea District:

Ellis (1833) observed two flocks of Nene near the eastern side of Kilauea Crater in 1823 (997), and was told by natives of “vast flocks in the interior” (Ellis 1917) (38). Bloxam (1825) reported that in traveling along the trail from Hilo to Kilauea some 5 or 6 to 9 miles from the volcano, he passed by “several pools of water which are often the resort of wild geese which frequented this part of the country and live on purple berries” (39, 1031). In December 1840, Wilkes (1845) reported that “mountain geese” were shot about 6,071 ft. elevation along the Kilauea-Mauna Loa summit route (867) near what is now the junction of Keauhou Nene Sanctuary and the trailhead of the National Park Service leading up Mauna Loa toward the summit.

Reporting on the history of the Volcano House (an early hotel perched on the edge of Kilauea Crater) Olson (1941) stated that Nene frequently appeared on the Volcano House bill-of-fare, quoting a visitor in 1874 who “... found a very tempting repast ready, and amongst other luxuries was a strawberry-fed goose ... Hawaiian wild geese frequent these mountains in great numbers and are sure to be found feeding on the wild strawberries which abound in the neighborhood ... from a little patch of ohelo bushes I had the satisfaction of putting up 3 of the birds—small-sized fellows not much bigger than a large

duck ... they proved to be a sure sign of strawberries and the native who was with me quickly filled a basket with them ... " (998).

MacFarlane (1887) in his account of birds seen on the cruise of the *H.M.S. Constance* in the Western Pacific Ocean, noted in September 1884 that Nene were "still to be found in fair numbers on the hills above the renowned Volcano Kilauea" (999), affirming their presence there, though in diminished numbers, in the late 1880's. MacFarlane's use of the phrase "still to be found in fair numbers" supports the statement by Baldwin (1945) that the initial reduction of the Nene population which began in the late 1700's was noticed shortly after 1850 and progressed rapidly to 1900 (27).

Mauna Kea:

Although Pickering (1841 field journal) and Wilkes (1845) reported that no Nene were seen on the journey from Hilo to the summit of Mauna Kea in January 1841, the most detailed first-hand account of early abundance was described by an anonymous writer who spent 9 days with Sam Parker and native guides traveling around the base of Mauna Kea on foot. This early account (Anon. 1847) told of the shooting of 16 Nene with muzzleloaders in a single day, concluding at trip's end that they had "shot more geese in these wild regions that had ever before been done by Europeans" (1037).

Maui, Lanai, Molokai, Oahu, Kauai, Niihau

Findings of the U.S. Exploring Expedition in the early 1840's were reported by Peale (1848) who wrote, "what is most remarkable is the story related to us by natives, and which we have every reason to believe is a fact, that this Goose, which has the powers of flight which would enable it to move to as great distances as any other of the genus, is limited to the single island of Hawaii; rarely visiting any other islands of the group, although several are in sight" (3). In a separate report of the Expedition, Cassin (1858) also left

the impression that the Nene was limited to the island of Hawaii, writing that "these geese" were seen in the mountains, "especially above 7,000 feet above the sea" where they were noticed "repeatedly" by naturalists of the Expedition (4).

Later statements by Brigham (1868) and Dole (1869, 1879), indicated that Nene were also found on the island of Maui "in the highlands", but provided no explanatory evidence. However, Finsch (1880), an itinerant ornithologist who journeyed to Maui, left a more substantive record, stating that the Nene "breeds in the gigantic crater Haleakala" (1342). Except for the statement by Pease (1867) that Nene were occasionally "blown off" the island of Hawaii to reach Maui and "very rarely" Kauai there seems to have been no inference that Nene were found on other islands during the early 1778-1886 period (5).

2. Later Observations and Recollections (1887-1936)

Island of Hawaii

Although such early ornithologists as S. B. Wilson, H. C. Palmer, G. C. Munro, R. C. L. Perkins, and H. W. Henshaw spent many months collecting birds on Hawaii from 1887 to 1902, their attention was directed almost wholly towards the rapidly disappearing species of forest birds rather than Nene. In fact, Nene were neglected for an extended period of 35 years after the turn of the century by an almost complete lack of any ornithological investigations at all.

Among the several accounts of Nene written in the half-century between 1887 and 1936, Perkins (1903) left the most detailed general description, noting that this goose was "widely distributed on Hawaii, and in some localities ... a fairly common bird ... In the winter months large numbers of these upland geese resort to the lowlands and remain there for such time as the vegetation is fresh and green, and they are said to breed during this season ... becoming less common than in

former years and unless stringently protected at all seasons will probably become extinct ... a source of much regret, for apart from the scientific interest ... its appearance is striking and beautiful ... and it is highly characteristic of some localities, themselves remarkable ... " (9).

Compared with the foregoing account by Perkins (1903), the brief statements by Palmer (1898, 1934) (10, 26), and Grosvenor (1924) (12) seem trivial and hardly worth repeating. Henshaw (1902) however, made the first positive conservation suggestion, writing " ... it would be an easy matter to introduce the Nene from Hawaii into other islands ... especially Maui ... (where) no doubt the bird would thrive, if properly protected" (11).

Some accounts during the 1887-1936 period are so vague and general as to be of little value in assessing the status and distribution of Nene during this period. For example, Wilson and Evans (1893) quote S. B. Dole as saying that the Nene "... builds its nest on old lava fields - 5000-7000 feet elevation" (46), and is "to be found in June and July showing a preference for the clinker beds of the old lava flows at some 5000 feet elevation" (47). Likewise, the note by Bryan (1915) that Nene " ... lead a life of seclusion high up on the mountainside, seldom if ever descending to the sea level" (53) is not very enlightening.

Henshaw (1902, 1903) was more specific, writing that Nene were "now found chiefly if not wholly on Hawaii ... becoming scarcer and scarcer every year ... found for the greater part of the year from about 5000 feet upwards ... range ... quite extensive ... from the district of Kona to the northeast flanks of Mauna Kea" (24, 25, 67). Baldwin (1945) concluded from the remarks on the decreasing supply of Nene by Henshaw (1902), Perkins (1903), and others that "the great decline in numbers had occurred by 1900 ... (and) ... tapered off slowly from 1900 to 1930" (23, 27).

Kohala District:

R. von Holt's earlier statement that Kaiamakini herded Nene flocks at Kahua around 1880 (Baldwin 1945) (83) is substantiated by Elder (1956 field journal) who cites A. Ruttle's recollection that a captive flock of Nene were kept at Kahua (Ranch) in the 1890's (84). Also, A. Ruttle's cousin, C. Stillman, stated that cowboys brought Nene eggs thought to have been found makai and originating from the flying flock fed in the 1890's, to the ranchhouse at Puu Hue (a few miles north of Kahua) (Elder 1956 field journal) (86). E. Thompson stated that he saw Nene several times a half-mile below Kahua Ranch many years later in 1921 (Elder 1956 field journal) (85).

Henshaw (1902) noted that a Nene nest was found by Palmer Wood of Kohala in a lava flat (81), presumably the basis for his statement that this species was to be found in Kohala District nesting in barren flats near the sea (66).

Farther south, D. Lima (born 1872) told T. Vrendenberg that Nene were once to be found "in thousands" and that Hawaiians collected eggs but tabooed (protected) this species which lived in pili grass from Waimea to the sea (Elder 1956 field journal) (82). T. Lindsey reported that he "saw some" in Waiulaula Gulch in Lalamilo at 2,000 feet elevation in the early 1900's (Baldwin 1945) (93). According to A. Ruttle, Mrs. K. Lindsey kept a flock of 40 captive full-winged flying Nene at Waiaka (where the Waimea road forks to Kohala and Kawaihae) until 1912 (Elder 1956 field journal) (94). Some 5 miles northeast of Waimea at Puu Kapi (Puukapu) Reservoir, flocks of 40 to 50, and many smaller ones, visited "from September on" ca. 1910, according to W. J. Payne (Elder 1956 field journal) (99).

Kona District:

The most comprehensive statements on the early-day distribution of Nene in North and South Kona seems to be that of D. Paris who told

1887-1936

Baldwin (1945) that this species was "... always to be found throughout the upper (elevation) parts of the Kona districts ... in the later part of the 1800's (112), and that C. Kaa told him (Paris) that in the early days flocks used to fly from "above" over the lower elevation forests in Kona, including those in central Kona (115). A. Wall made virtually the same statement to Baldwin (1945), stating that Nene in the 1890's were to be "found everywhere between Mauna Loa and Hualalai, and along the west slope of Mauna Loa to the south end of the mountain" (71).

Baldwin (1942 field journal) expressed some skepticism that Nene were widely distributed in Kona, writing on 21 November 1942, "... my guess ... if this (species was) present at all (south of Hualalai) ... it occurred up around 7,000 ft. or so on the Kona slopes of Mauna Loa" (110). But perhaps Baldwin's field journal note was made before he talked with D. Paris and A. Wall, there being no entry for the dates of these interviews.

Wilson and Evans (1893) brief note that this goose "exists" in fair numbers on old lava flows, Kona" (106), is too general to shed light on their status in the many possible habitats which exist over such a broad area.

In the extreme northern part of Kona (officially South Kohala) District, in ANAEHOOMALU and PUU HINAI quadrangles, Baldwin (1945) cites R. von Holt as saying that Nene were "noticed near the seashore near Puako until 1915" (138). Elder (1956 field journal) was told by E. W. Low that Nene were hunted yearly at Keawiki (just south of Puako) about 1907 (118), while J. Paulo who kept 2 non-breeding captive pairs from 1925-1935 at Kaiwiki, told Elder that about 1917 he saw 6 Nene come to spend the night at Kalahui Pond below Puako on the F. Brown Ranch (119, 121). Reinforcing the impression that the Puako area was home range to Nene during the 1887-1936 period were two obviously old, but undated recollections recorded by Baldwin (1945) of natives telling R.

von Holt that Nene once came to Puako and that this goose was used for food in nearby Kalahuipuaa land divisions (139, 140). J. Kobayashi reported seeing 2 Nene at Puako (Elder 1956 field journal) (141). E. Paulo is the source for the observation of Nene on Pueo Pond, F. Brown Ranch near Puako, in the 1930's (Elder 1956 field journal) (122). Baldwin (1945) cites F. I. Brown's recollection that Nene were known from several grassy kipukas some miles above the shore in Waikoloa and Puunahulu (113). Somewhere in Parker Ranch, perhaps around Waimea, A. Lindsey (son of W. Lindsey) kept a flock of Nene and used surplus for the table in the early 1900's, noting that some 24 pairs remained at the time of his father's death in 1907 (Elder 1956 field journal) (50). A. Ruttle displayed a photo of sister Irene Dixon and Sam Parker, Jr. with 2 Nene shot in the summer of 1904 (Elder 1956 field journal) (49).

Seemingly related to the preceding reports of the early 1900's are the various recollections documented by Elder (1956 field journal) of Mrs. von Holt, J. Paulo, F. I. Brown, L. Wishard, and J. Goto who reported in separate interviews of seeing 2 Nene at Parker Ranch fish pond, 2 to 3 pairs at Anaehoomalu fish ponds (and catching them there at night with a jack light), seeing 2 and finding 2 nests at Weliweli, and an occasional visit by a wild pair to a captive trio (originating from the State Game Farm at Mokapu, Oahu) at von Holt's ranch (132-137).

Farther to the south, in KIHOLU and PUU ANAHULU quadrangles, the record continues to support the impression that Nene flourished in appropriate habitats not far from the sea all along the Kona coast in the late 1800's and early 1900's. For example, S. Wilson noted during his visit of 1887, that a pair bred near Kiholo (Wilson and Evans 1893) (149); while A. Ruttle recalled that from 1898 to 1900 her father, E. W. Low, often shot as many as 12 or 14 on hunting trips from Kiholo west to Luahinewai. She herself often saw this goose flying in wedges when

1887-1936

riding as a girl from Puu Waawaa to Kiholo from 1894 to 1903 (Elder 1956 field journal) (150, 151). In a separate interview, E. W. Low went on to say that he hunted Nene every year at Kiholo and Luahinewai until 1907 (Elder 1956 field journal) (152, 153). W. Paris, Sr. recalled years later that he saw 6 to 12 Nene around Kiholo ponds when Eben Low hunted in the early days (Elder 1956 field journal) (170).

From 10-14 December 1891, H. C. Palmer and G. C. Munro collected at least 6 adult, half-grown, and young Nene on Hualalai's rough lava flow of 1801, from near sea level to 2,200 feet elevation in the vicinity of McGuire's (Huehue) Ranch. Here they saw 1 nest with 4 eggs, caught 2 young goslings, and were followed around camp by imprinted youngsters they had captured (Elder 1956 field journal) (Munro 1944) (Baldwin 1945) (143-148). Munro (1952) later recalled that "sportsmen brought down a young bird, 2 little downy goslings, and 4 eggs from a nest" on Hualalai in December 1891 (105), while Rothschild (1900) reported that he received 9 adult Nene specimens taken from Hualalai and vicinity by Palmer in December 1891 (104). Munro (1944) termed Nene "not at all uncommon" on the northwest slope of Hualalai in 1891 (111).

In this same general area, Captain Freeman shot 9 Nene along the Kaupulehu coast in 1896 (Locey 1937) (107). Baldwin (1945) reported that D. Paris found Nene at the Kaupulehu lava flow along the road to Waimea about 1910; and Pope (1932) found a nest at about 3,000 feet elevation on the same lava flow in the late 1920's (154, 156). K. Simeona told Elder (1956 field journal) that in 1925 and 1926 from 2 to 15 Nene were seen in summer feeding on Elamo berries just north of the Kaupulehu lava flow at 1,000 feet elevation (155).

It was to Hualalai, and presumably to this early period in the late 1800's and early 1900's that H. Wassman and Mrs. R. Wall, Sr., referred in

recalling capture of Nene by E. W. Low and C. Kaa, the latter keeping the resultant flock for 10 years at Kenolia (Elder 1956 journal) (108, 109).

Recollections of Nene by long-term residents in PUU ANAHULU quadrangle are especially abundant, specific references being made to this species clustering about Puu Waawaa Ranch on the north slope of Hualalai and adjoining Puu Anahulu. Delacour (1928), from a visit to Hawaii in the late 1920's, stated that R. Hind, Sr. reported Nene to be very abundant in the Puu Waawaa Ranch area about 1898 (173). In stating that Nene were reported to be very abundant on Puu Waawaa Ranch about 1900 (174), de Schauensee (1941) seems to repeat the earlier observation by Delacour (1928). W. Paris, Sr. told Elder (1956 field journal) that in the early 1900's a captive pair led young to Waihou on Puu Waawaa Ranch and returned each year with more birds until the flock numbered 40 (175).

Baldwin (1938-1949 field notes) queried F. Greenwell in September 1943 and learned that Nene were seen frequently in Puu Anahulu Homesteads in 1906; and that they were seen (and E. W. Low told Paris, Sr. that they bred) both above and below the Belt Road in the Homesteads area in the years around 1906 (176, 177).

The following sightings of Nene in the Puu Anahulu - Puu Waawaa area are undated but are presumably related to the early 1900's: from 86 year old Lona (first name unknown) - Nene nests and eggs seen and young captured as pets in Puu Anahulu; E. W. Low - singles and pairs possibly nesting on the flats below Puu Anahulu on the Keamoku side; and F. R. Greenwell - ate Nene twice from E. W. Low's bag(s) of 12-15 Nene shot at 2,500 feet elevation below Puu Waawaa (Elder 1956 field journal) (208-210).

Reports on presence and nesting of Nene in Puu Waawaa Ranch and Puu Anahulu Homesteads areas continued in the 1920's and 1930's. Gregory (1924), relaying a report from G. C.

1887-1936

Munro, stated that "a small flock" of Nene flew into "Mr. Robert Hind's home station" (Puu Waawaa Ranch) in 1923 (178). Mrs. M. Holmes told Elder (1956 field journal) that young were captured on Puu Waawaa Ranch and reared, and that up to 84 pairs (some of them imprinted on her) nested around her house for years - until 1925 to 1927 (179). J. Podmore told Elder (1956 field journal) that Nene were seen near Puu Waawaa at Keau about 1927 (180), after which R. Hind, Sr. reported that the "only important flock left" was on Puu Waawaa Ranch (Elder 1956 field journal) (181).

A year later Delacour (1928) reported that R. Hind, Sr. told him that "only about 50" remained at Puu Waawaa Ranch (182), apparently the principal residue of flocks in that area. G. Kawaha, age 72 when interviewed by Elder (1956 field journal), stated that he saw 7 Nene at (cattle watering) tanks on Puu Waawaa Ranch in the 1923 to 1929 period when "Hind then had 14 fliers" (183).

Over a 15 year time span beginning in 1915, E. Horner saw occasional pairs in the vicinity of the 1859 lava flow above and below the Belt Road in the Homesteads area, the last being seen in 1930 (Elder 1956 field journal) (184). W. Paris, Sr. found a nest with 4 or 5 eggs near Puu Paha, 2 miles SE of Puu Waawaa Ranch Headquarters in the fall of 1936 (185), the year that Munro last saw "half-tame Nene" at Puu Waawaa Ranch (Elder 1956 field journal) (185, 186).

Game Warden J. Perez confiscated 2 captive Nene near Kapalau, Puu Anahulu, about 1936 and sent them the State of Hawaii Game Farm at Mokapu, Oahu (Elder 1956 field journal) (187). Munro (1946) reported that 3 Nene were seen at Puu Waawaa from 1935 to 1937 (188); and E. Paulo stated that this species was seen "below Puu Anahulu" in the 1930's and earlier (Elder 1956 field journal) (189). W. Banko was told by R. Hind, Jr. (24 Sept. 1969 interview) that in the 1930's flocks up to 20 and 30 ranged chiefly

around Puu Waawaa hill, Puu Henahena, and at that elevation (4300 feet) around the northwestern slopes of Hualalai to Huehue Ranch - an area of several square miles (Banko 1969 field notes) (114).

Farther south along the lower slopes of Hualalai, in KAILUA quadrangle, a report by a native Hawaiian to R. von Holt told of Nene coming to the seashore at Makalawena, presumably in the late 1800's or early 1900's (Baldwin 1945) (221).

There are many reports dating from earliest times of Nene inhabiting the comparatively remote, high (5000+ feet elevation), sparsely vegetated, low-relief cinder and lava plains which occupy the saddle between Hualalai and Mauna Loa within HUALALAI quadrangle. As previously related, Menzies (1920) saw "some" Nene in this area in 1792 (230), and Wilkes (1845) "shot two" in November 1840 near the temple of Kaili (Ahuauuni Heiau) (231).

Baldwin (1945) reported that Palmer and Munro failed to find Nene between Mauna Loa and Hualalai in 1891 (45), though they were undoubtedly present. In 1910, P. Beamer heard geese, presumably nene, calling high on the north slopes of Hualalai some 5 miles above Puu Waawaa (Elder 1956 field journal) (232). Baldwin (1945) stated that A. Wall caught goslings on the north slope about 1913 (233), and that somewhere between Hualalai and Mauna Loa J. D. Johnson and C. Kaa obtained live young in the 1890's (44).

Baldwin (1945) learned from W. J. Payne via W. Donaghho that, sometime before 1937, 19 Nene were seen between Mauna Kea and Hualalai (59).

On the south slope of Hualalei, on Huehue Ranch, E. E. Marks stated that he saw Nene "above pigeon cave" in an undated observation (267); while J. Greenwell saw flocks since

boyhood in the 1920's and 1930's (mostly in summer) in the adjacent Kealakekua Ranch (Elder 1956 field journal) (235). In another observation, J. M. Gouveia mentioned seeing 6 or Nene "several times" at 6,500 ft. elevation on the Kaupulehu lava flow above the Greenwell Ranch in the Hualalai Forest Preserve during the 1927-1936 period (Elder 1956 field journal) (222).

In the Ahuaumi Heiau area, J. Henriques saw "1 big pair" a half-mile from the ancient Hawaiian temple in 1924 (234). In several undated observations, presumably made years ago, M. Kaeo observed this goose at Kahuahoikekanapa, 1 mile north-northwest of Ahuaumi; at Waikulukulu (cave with drip), 0.5 mile northeast of Ahuaumi Heiau; at Puu Hale; and at Puu Ikaaka (Elder 1956 field journal) (263 - 266). K. Simeona recalled seeing pairs of Nene flying mauka (up and mountain) from the Judd trail 2 miles below Ahuaumi Heiau (262). Elder also cites F. Greenwell who stated that he recalled finding Nene nests with 2 to 3 eggs (apparently years ago), but never saw young in the Hualalai-Mauna Loa saddle area (268).

Proceeding to the more heavily pastured and wooded region to the south of HUALALAI sector, in the adjacent PUU LEHUA quadrangle, there seem to be only a few records of Nene from 1887 to 1936. H. W. Baybrook observed Nene nesting at Pohakuloa in Keauhou 2 from 1929 to 1931, according to Baldwin (1945) (283, 284), while Elder (1956 field journal) logged the testimony of R. Wall who saw Nene frequently between Monohaa and Hualalai (in the same general area as Baybrook's nesting recollection) in the 1920's and early 1930's (282). M. Greenwell reported seeing Nene ca. 1932 somewhere between their upper ranch house at Pulehua and Ahuaumi Heiau (Elder 1956 field journal) (56).

In KEALAKEKUA quadrangle, which is even more heavily grazed and forested (except at higher elevations) than the Hualalai-Mauna Loa

saddle, Nene records are few and fragmentary. C. Thompson reported that Nene landed on his barn some 3 miles above the community of Kealakekua in the 1880's. Mrs. R. Wall (who raised captive Nene for many years) reported that her father had a pet Nene for several years that flew up and down the mountain and followed his horse (Elder 1956 field journal) (276, 281).

Still farther south, in KAUNENE quadrangle, much more convincing evidence of early-day Nene usage was related to interviewers. J. Johnston recalled that he shot Nene for W. Paris, Sr. mauka (toward the mountain) of the forest line in McCandless Ranch, from 1915 to 1917 (312); and E. Thomson related that at Kaunene he saw 5 to 15 Nene near pools and the Calendula patch in the 1920's, shooting 2 in 1921 from a flock that circled and landed again (Elder 1956 field journal) (313, 315). E. G. Wingate reported seeing young Nene at Puukinikini in 1926 (Baldwin 1945) (314). Some years later, in 1935, F. Henriques saw 2 Nene above McCandless Ranch (Elder 1956 field journal) (316). D. Paris encountered pairs of Nene at 7,000 and 7,250 feet elevation 2 miles east of Komakawai waterholes, as well as 2 miles east of Keanapaakai, as late as 1936 (Baldwin 1945) (317, 318).

At the southern end of Kona District there seem to be no early-day (1887-1936) records of Nene in PUU POHAKULOLOA sector, and only 1 in PAPA quadrangle where, in the early 1930's according to Elder (1956 field journal), O. Breithaupt recalled seeing "up to a dozen Nene in the ohelo" on pumice flats makai (toward the sea) of Puu Ohohia (327).

Kau District:

A number of observations, including several of goslings, establish the Nene as an early-day breeding resident in KAHUKU and KA LAE quadrangles at the southern end of Hawaii Island. For example, W. Meinecke recalled that 2 of "several" goslings accompanying a female

1887-1936

were captured at 611 feet elevation along the road from Waiohinu to Kaalualu sometime during the 1896-1898 period (345). J. Yates recalled that ca. 1900 Nene were hunted 2 miles mauka (up the mountain) from Waiakinu (Waiohinu) (Elder 1956 field journal) (346). Later, on 9 January 1907, G. Kawaha recalled seeing about 7 Nene some 2.5 miles below Kahuku Ranch (347), and R. Kahakua remembered flushing about 12 Nene in the summer of 1913 when quail hunting near Kahuku Ranch (Elder 1956 field journal) (346).

Additionally, Henshaw (1902) stated that a Nene nest was found by S. Kauhane on the lava below Kahuku, presumably around the turn of the century (329). D. Paris recalled that he encountered pairs on Kahuku as late as 1936 (332), but M. Martinson did not remember seeing any in frequent visits to the Kahuku lowlands in Kau since 1931 (Baldwin 1945) (336).

Other early-day recollections include those of R. Richards who saw 15 Nene a half-mile above Kahuku Ranch ca. 1915; B. McCumber's observation ca. 1924 of a female and 2 half-grown young in pili grass between Kahuku Ranch (buildings) and the beach, 2 1/2 miles from the 1907 lava flow; O. Breithaupt's March 1929 sighting of an old female and 2 young (all 3 captured) in Kipuka Kekake, Kau side of the 1907 lava flow; and M. Martinson's capture of some goslings below Kipuka Kapulehu, Kahuku lowlands, in 1931 or 1932 (Elder 1956 field journal) (348-352).

Much higher on the flank of Mauna Loa to the north, in PUU O KEOKEO quadrangle, similar reports establish the Nene at substantial population levels during the early days. G. Kawaha recalled eating Nene from a bag of 12 shot with a rifle by pig hunters at Kipuka Nene in 1902 (358); while W. Meincke remembered that many of his friends hunted and shot Nene at Kipuka Nene up until 1908 (Elder 1956 field journal) (359). On 9 October 1919 Jagger (1919) noted

a pair while riding northward from a campground ca. 6,000 feet elevation near a good spring to the southwest of the aa lava flow, Pohaku (Ke A) Pohina (360), apparently the same sighting credited later by Baldwin (1945) (361).

Several other early-day Nene records from nearby KEAIWA RESERVOIR quadrangle, especially along the Kahuku-Ainapo trail, were related to interviewers. Baldwin (1945) learned from E. Horner that J. Pritchard found Nene scattered along the Ainapo trail below timberline in 1899 (328). E. Y. Hosaka reported that 2 Nene were seen in the spring of 1936 along the Kahuku-Ainapo trail (Donaghho 1937 report) (330); these were perhaps related to the 3 reported by Hosaka on this trail on 27 July 1936, according to Donaghho's mentor, G. C. Munro (1946) (331). Donaghho (1937 report) also stated that Nene visited a water tank along the Ainapo-Mauna Loa trail prior to 1937 (333).

Additionally, E. G. Wingate saw 2 or 3 repeatedly in 1925 at Anipeahi where Ainapo trail crosses the stone wall (376); in the spring of 1926 NPS Rangers caught 1 of 2 flightless Nene at Punaluu Kakawai on the trail from Anipeahi to Kahuku (337); in 1937-1938, J. Silva saw 4 Nene 1.5 miles beyond the Kahuku forestry cabin (378); one summer in the 1930's C. P. Iaukea saw 2 above the Forestry cabin, Kahuku Ranch (379); and sometime from 1932 to 1936, O. Breithaupt (confirmed by CCC crew) saw Nene at the Holewai Waterhole, Ainapo trail (380) (Elder 1956 field journal). The foregoing records, when coupled with those cited for the preceding PUU O KEOKEO sector, indicate that Nene were resident of a rather narrow 10 to 15 mile long upper elevational belt on the southeast flanks of Mauna Loa, from Kipuka Nene (ca. 5,800 ft. el.) to Anipeahi (ca. 6,800 ft. el.).

Some 15 miles to the northeast, at about 4,000 ft. elevation, a number of observations in the 1920's and 1930's establish the occurrence of Nene on both sides of Hawaii Volcanoes National Park, in

KILAUEA CRATER quadrangle. Adjacent to the Park on the south at Ohaieka Ranch, M. Miranda saw 5 Nene on the ground in 1924, while H. Kimi "frequently" saw a small flock there about 1930 (Elder 1936 field journal) (406, 410).

To the north of Hawaii Volcanoes National Park, the earliest records of the 1887-1936 period attest to sightings along the 25 mile or so trail from Keauhou Ranch northward through KULANI and PUU OO quadrangles to Puu Oo Ranch on the slopes of Mauna Kea. A. Waipa, 77 years old when interviewed by Elder (1956 field journal), recalled that about 1895 he saw Nene "often", including families up to 5 in number, in Keauhou between the Ranch house and the "mauka" mountain house at Keawewai along the Keauhou-Puu Oo trail (401). P. Beamer in 1899, Sheridan (1912), and L. W. Bryan on 17 January 1929, all reported hearing or seeing Nene at undescribed locations along the Keauhou-Puu Oo trail (Elder 1956 field journal) (48, 52, 54).

Not far from the Keauhou ranch house itself, at the old (U. S. Army) Bates Camp (4,998 ft. el. waterhole near the present Hawaii Volcanoes National Park boundary), two residents familiar with this area recalled seeing Nene frequently years ago. W. Meinecke stated (no doubt from notes) that he saw from 2 to unspecified numbers of Nene at Bates Camp in 1909, during July and August of 1916, on 27 and 30 July 1922, on 22, 23, 26 July 1924, and on 11 August 1925 (402-405, 407); F. Waltjen recalled that 3 Nene were seen several times in an open kipuka 1 mile toward Kulani from (?Bates) camp along the old Mauna Loa trail in 1927; and that in June and August 1930 Nene came every night from the direction of Kulani to roost near their camp where a stone wall met Mauna Loa trail (Elder 1956 field journal) (408, 409). The latter observation may, in fact, have been made at ca. 6,600 ft. elevation in the extreme upper right hand corner of KIPUKA PAKEKAKE quadrangle where the map shows a stone wall intersecting

the boundary of Hawaii Volcanoes National Park 3.1 miles above Bates Camp.

The historical recollections documented by Baldwin (1945) and Elder (1956 field journal) in KILAUEA CRATER quadrangle support the impression of frequent encounters with Nene flocks along the Keauhou-Puu Oo trail in KULANI sector. H. Shipman related that in 1901 Nene were "often seen" on this trail, and that his father frequently shot 1 or 2 near Waiakea Camp for family use (Elder 1956 field journal) (825). Baldwin (1945) cites A. Wall that Nene occurred "in flocks" above Waiakea in the early 1900's, and D. Paris saw "flocks" at Keawewai waterhole (826, 827). H. Kimi, age 65 in 1956, remembered flushing 12 on Keawewai Pond in 1924 (Elder 1956 field journal) (828).

Hawaii Volcanoes National Park:

Reports by Ellis (1833), MacFarlane (1887), and Olson (1941), as cited earlier, established the presence of Nene around the summit of Kilauea volcano and adjacent slopes of Mauna Loa from 1823 to 1884 (997-999). S. Konanui, an old resident of Puna who traveled across the Puna lowlands to Kau around 1894, stated that Nene were plentiful above the inshore cliffs around 1,500 to 2,000 feet but not on the flats which line the shore, and that were seen as far to the east as Panau (Baldwin 1945) (341, 859). Elder (1956 field journal) learned from B. Beck via W. Meinecke that, years ago, Nene bred commonly from Puu Nahanaha near Great Crack, Pahala, west to South Kona District (342).

Later, around Kilauea volcano, Perkins (1903) reported that "flocks of some size" (were) occasionally seen near the "Crater of Kilauea about 2 miles from the Volcano House" (1000). Black (1901) noted that Nene "fly around the crater when the volcano is usually active" (1001). Baldwin (1945) stated that G. Lycurgus "knew of flocks coming ... in the vicinity of the sulphur banks" during the period 1904 to 1907 (1002). Elder (1956 field journal) recorded E.

Thompson's recollection that he saw Nene mauka (toward the mountain) of the horse pasture, Kipuka Kulalio, in the 1920's (1003).

In 1926, high along the trail to the summit of Mauna Loa, F. Peter reported shooting 1 of 10 flying Nene seen southwest of the halfway cabin at Red Hill (Elder 1956 field journal) (957). National Park Service files contain a report of 2 Nene seen somewhere along the Mauna Loa summit trail in 1931; while staff member K. J. Williams wrote in 1936 that Nene were reported along Mauna Loa trail "from time to time" (958, 959).

Much earlier, along the lower flanks of Kilauea Crater, Henshaw (1902) reported that Nene nested "in barren flats near the sea" in Puna and Kau Districts, an observation that could not have failed to encompass habitat later included in Hawaii Volcanoes National Park (66). Mrs. G. Pea saw a Nene "family with young", her sole sighting of these geese, at Kipuka Nene in 1920 (1019); and G. Pea recalled that 2 Nene visited their farmyard 9 miles above Kalapana before World War I (Elder 1956 field journal) (1029). H. Kimi, however, stated that from 1914 to 1930 he "never saw Nene" in Hawaii (Volcanoes National Park (858).

Kilauea District:

A. Bloxam's 28 June 1825 note that pools of water along the Hilo-Volcano trail were the "resort of wild geese" was previously cited (1031). Over 100 years later, Elder (1956 field journal) noted (no doubt from memory of H. Shipman), that a free-flying captive Nene flock kept at Keaau Ranch from 1918 to 1949, regularly visited such areas as Mountain View, Happy Home (north of Kurtistown), Makuu (6 miles north of Pahoa), and Poki (1032, 1269).

Mauna Kea District:

In traversing the southeastern slopes of Mauna Kea on a route from Hilo to the summit in January 1841, Pickering (1841 field journal)

(Wilson and Evans 1893) reported that no geese were seen, as previously cited (1035, 1036). However, a few years later Anon. (1847) found many Nene in the same general area (1037). Decades later, H. Wassman told C. Kaa, that Nene were commonly seen in the early 1900's from Laumaia, some 4 miles northeast of Puu Oo Ranch, to Pohakuloa on Mauna Kea's southern flank (Elder 1956 field journal) (1052). Similarly, A. Wall reported Nene along the Humuula Road and "all over the country between Mauna Loa and Mauna Kea" in the 1890's (Baldwin 1945) (70, 1039).

There are a few other records of Nene frequenting the eastern and northeastern flanks of Mauna Kea around the turn of the century. E. Horner recalled that 2 Nene were received as pets on Kukaiiau Ranch (UMIKOA quadrangle) in 1893, but that they "flew off" when grown (Elder 1956 field journal) (1328). C. L. Murray saw 1 in 1935 2 miles from the sea in the land division of Piha (PAPAALOA quadrangle); while C. E. Blacow relayed a report from a rancher some 10 years previously, that Nene had been seen near the Hopuwai Ponds (PUU AKALA quadrangle) about 1905 (Elder 1956 field journal) (1323, 1330). A. McKenzie reported seeing Nene ca. 1935 at Hopuwai Pond and 0.2 mile makai (toward the sea) on sand flats below Nauhi Forest Station (PUU AKALA quadrangle) (Elder 1956 field journal) (1325, 1326). Baldwin (1945) reported that judging from the lack of observations of Nene in early-day accounts of travel along the trail around the north side of Mauna Kea, Nene range ended on the northeast flank (1040, 1324).

To the south, other observers interviewed by Elder (1956 field journal) testify to the existing of Nene flocks on and around Puu Oo Ranch (PUU OO quadrangle) in the early 1900's, as follows: W. Paris, Sr. recalled seeing "many flocks of 6-8" on Puu Oo Ranch in October or November 1910; H. Kimi stated that he frequently flushed Nene at Waikoloa Pond (Puu Oo

1887-1936

Ranch) from 1914 to 1920; F. Waltjen saw Nene on Puu Oo Flat in 1922; H. Haa saw Nene on Puu Oo Ranch at Waikoloa and Hilopa near Parker Ranch fence, and Hilopa and Omao Ponds from 1923 to 1925; while T. Immoto recalled seeing "plenty big flocks" at Omaha (?Omao) below Waikoloa on Puu Oo Ranch ca. 1926 (1119-1125). Farther south in Aina Hou, A. Wall recalled seeing flocks of 30 to 40 Nene in the 1890's; and D. Paris stated he saw "comparatively many" there in the early 1900's (1069, 1070).

An early traveler from Humuula to Kona (Sheridan 1912) wrote that far in the night he "heard a flock of Hawaiian geese far overhead" and reported hearing them again the next day (51).

High above Pohakuloa near the summit of Mauna Kea at around 13,000 ft. elevation, J. Rock recalled seeing Nene flying near Lake Waiiau in September 1910 (Elder 1956 field journal) (1322). Much lower in elevation and somewhere along the trail from Humuula to Kona, Sheridan (1912) saw and heard a flock of Nene about 1912. During the summers of 1936 and 1937, W. J. Payne witnessed flocks of 4 to 12 Nene flying toward Hualalai from the Saddle Road almost daily in the afternoon, and occasionally east in the morning (Elder 1956 field journal)(1062). On the lower southwestern slopes of Mauna Kea in KEAMOKU quadrangle, T. Vredenberg recalled that 30 to 40 Nene came to the old water trough near Puu Keekee, Parker Ranch, where they were fed weekly from 1914 to 1915 (Elder 1956 field journal) (1272). T. Vredenberg also recalled seeing a few pairs frequently up until 1918 at Puu Kapele on the Saddle Road (Elder 1956 field journal) (1273).

In 1925 T. Lindsey saw Nene south of Waiulaula Guleh at Keamuku, Waikoloa, at about 3,250 ft. elevation (1274); while in 1936 H. Kawai, a life-long employee of Parker Ranch, recalled seeing Nene only once in 1936, near Keamuku House (Elder 1956 field journal) (1275). E.

Horner also remembered seeing a pair of Nene at close range near Keamuku house on the Puu Waawaa side of the Keamuku lava flow in 1936 and following years (Elder 1956 field journal) (1276).

Two other records may be tentatively assigned to NAOHUELEELUA quadrangle, that of Simeona who recalled seeing Nene in January years ago between Ahuaumi and Puu Oo (1060), and W. Paris, Sr. who remembered observing this species along the trail from Waikii to the Judd Trail (a long time ago) (Elder 1956 field journal) (1060, 1061).

Farther to the south, perhaps in NAOHUELEELUA quadrangle, L. W. Bryan recalled that in 1932 he saw a few Nene in the "driest part" of the plateau between Mauna Kea and Hualalai (Baldwin 1945) (55).

Island of Maui

S. B. Wilson was the first to comment on the status of Nene on Maui during the 1887-1936 period, stating (Wilson and Evans 1893) that he "heard that it nested" in the crater of Haleakala (1343). Henshaw (1902) wrote that the Nene was "said to have nested" in the past in the crater of Haleakala, but that inquiry in 1891 (? H. C. Palmer) failed to disclose that it had been seen there in several years (1344). Perkins (1903) wrote that the Nene was "said to have formerly frequented Haleakala ... though neither in my many visits to the summit, nor when camping in the bottom of the great crater did I myself get sight of one ... its scarcity on Maui at the present time (if indeed it still exists there at all) is remarkable ... other islands are quite unsuited to its natural habitats and it is not found on these ... " (9).

Recollections of a number of residents recorded years later establish that Nene were at least occasionally encountered on Maui around the turn of the century. W. Aiken, 84 years of age in 1956,

remembered seeing a few Nene near Olinda in 1897; while some time from 1889 to 1905 C. Thompson recalled flushing 15 at Waianapanapa and another nearby pond, and saw them flying at Kaunene above the highway camp on the north side of Wailuku District (Elder 1956 field journal) (1338, 1366). Though C. Thompson did not specify the year, it seems likely that his recollection of Nene seen several times at Hana, and their flight reported by oldtimers over Keokea-Ulupalakua may have been during this same 1889 to 1905 period (Elder 1956 field journal, USFWS 1983) (1371, 1373). B. Malia recalled, in apparently yet another early day observation, Nene sighted on the 1857 (1790) lava flow near the coast south of Kula, most likely in the 1889-1905 time frame (Elder 1956 field journal) (1372).

Baldwin (1945) states that L. von Tempsky's father saw Nene at "Waikanene" at 7,700 feet elevation on the north slope of Haleakala ca. 1900 (1365). C. Thompson recalled seeing 3 Nene at Kahikinui in 1904 (Elder 1956 field journal) (1381). J. A. Casewell, born 22 March 1898, remembered seeing Nene when a small boy (ca. 1905), and his parents speaking of this goose nesting on Puunene (now the name of a residential community) (Pratt 1972) (1333, 1340). Mrs. Happy Kaopuiki, who was raised on Maui, remembered seeing 4 captive Nene around the Keakai's family pond at Lahaina ca. 1905 (Elder 1956 field journal) (1337); Anonymous (1902) stated that a "flock of half a dozen" Nene had been domesticated by Dr. Edward Armitage of Wailuku "some years since" (1339). J. J. Fleming, no doubt speaking of the period around the turn of the century, told G. C. Munro that the last Nene on Maui was shot (Elder 1956 field journal) (1334). In fact, J. J. Fleming told Baldwin (1945) that he shot one above "Paia" on the slopes of Haleakala ca. 1906 (1348), perhaps one of about 6 that D. Fleming told of seeing that year by small ponds on Laie Flats in Haleakala Crater (1367).

In 1912, R. von Tempsky saw Nene at Lake Waiale, and that same year, or in 1914, he saw 2 of these geese at one of the ponds—Waianapanapa or Waiale (? Wai Ele'ele) high on the northwest slope of Haleakala (1341, 1368). W. Aiken saw Nene "once in 63 years" in 1912, flying over near the summit of Haleakala heading toward Mauna Loa (1345).

Island of Molokai

D. Paupu, 77 years old when interviewed in 1956, recalled that "small noisy bunches" of Nene visited ponds seasonally near Kalamaula and Palaau until 1922 (Elder 1956 field journal) (1403). Munro (1952) was told by "three persons independently" that Nene frequented a hill called Keono Kuino near Kamalo, presumably years previously (1409) when G. McCorriston as a small boy living in Kamalo "thought there were about half a dozen birds that frequented a fish pond on the Coast" (1408).

F. Whyte saw 2 adult Nene, one on a nest at 2,000 ft. elevation somewhere on the south side of Molokai in January 1926 - most likely the pair J. Wilder recalled that year as having "nested 2 or 3 seasons back" (1395, 1396). Smith (1952) reported that 4 pairs of Nene were released on Molokai ca. 1936 (1398), possibly those G. C. Munro saw on a pond at Fagan's Ranch in 1936 (Elder 1956 field journal) (1397).

Islands of Kauai and Niihau

There seems to be only three statements concerning Nene on Kauai and Niihau during the early days: the comment by S. B. Wilson (Wilson and Evans 1893) that these geese were observed occasionally but did not breed there (1415, 1463); the statement by Henshaw (1902) that Nene occurrence on either island would be in the nature of an accident - if indeed such reports were not a case of mistaken identity (1416, 1464); and A. Holt's recollection that his mother, who lived on Kauai, apparently years before the mid-1940's interview, spoke of seeing Nene there (Baldwin 1945) (1417).

3. Rediscovery and Initial Research (1937-1948)

Island of Hawaii

Kohala district:

Local residents recalled seeing Nene a total of 6 times in Kohala District from 1937 to 1948 according to interviews conducted by Baldwin (1945) and Elder (1956 field journal). In KAWAIHAE quadrangle, R. von Holt told Baldwin (1945) that he (von Holt) disturbed a pair in Kapole (Waikapole) Gulch, Makaloa, at 800 ft. elevation in 1938 (89); while according to Elder (1956 field journal), F. I. Brown saw 3 to 4 pairs on the Kona side of the jeep trail between Kawaihae and Waimea in January or February 1943 (90).

In KAMUELA sector, F. I. Brown learned of 7 Nene in Waiulaula Gulch in Lalamilo at 2,000 ft. elevation in 1941 (Baldwin 1945) (95). Elder (1956 field journal) states that D. Kauae, Sr., a life-long employee of Parker Ranch, told him that he (Kauae) saw Nene only once - at Waimea Pond - an old Hawaiian home site, ca. 1946; while E. E. Marks mentioned that he last saw Nene when 12 stopped at a reservoir above the stables 3 miles above Kamuela, sometime ca. 1946 or 1947 (96, 97).

In KUKUIHAELE quadrangle, W. J. Payne told Elder (1956 field journal) that 3 Nene came to the Ou Ranch, 5 miles NE of Waimea in 1939 or 1940 (100).

Kona District:

Some 8 observations of Hawaiian Geese in ANAEHOOMALU quadrangle were remembered as occurring in the 12-year 1937-1948 period. W. Akau saw 12 flying back of Weliweli about 1937 (Elder 1956 field journal) (120). E. Paulo recalled that 10 captive pairs on F. Brown's Ranch were released before 1940, while F. I. Brown stated that 3 wild pairs nested successfully on Pueo Pond before 1941 (Elder 1956 field

journal) (123, 124). S. Akau stated that 14 Nene in captivity at the F. Brown Ranch, Keawaiki, before 1940 (when all were released) were from the State Game Farm at Mokapu, Oahu (Elder 1956 field journal) (125). S. Akau went on to say that 7 Nene from Puu Waawaa occasionally visited Keawaiki before 1940 when the captive flock was present (126). G. Kaono was cited as remembering that a captive flock of about 24 Nene on the F. Brown Ranch was released in 1942 (Elder 1956 field journal) (127). F. I. Brown and R. von Holt told Baldwin (1945) that they encountered Nene "occasionally" near the shore ponds just north of Keawaiki Bay during the past few years (1940-1944) (128). J. Paulo recalled seeing 8 to 10 Nene roosting in pens at night on the Weliweli Ranch in the 1940's (Elder 1956 field journal) (129).

Local residents recalled seeing Nene many times during the 1937-1948 period in the area covered by KIHOLE quadrangle. In or about 1937 L. Hind observed 19 Nene at Luahinewai (Puuwaawaa shoreline) (Baldwin 1945) (157); F. Henriques saw 2 on the Kaupulehu lava flow between Puuwaawaa and Huehue ranches; and C. Stanley saw 4 flying toward Mauna Loa from the Kona road at the 1801 (Kaupulehu) lava flow (Elder 1956 field journal) (158, 159). In 1939, J. Perez (Game Warden) saw 2 Nene flying across the highway where the 1800 (1801 Kaupulehu) lava flow crosses above Huehue Ranch (Elder 1956 field journal) (160).

T. Lindsey recalled seeing 16 at Waiho, 3,000 feet elevation, (Puuwaawaa Ranch) in April 1942, while T. Vredenberg remembered that 14 came to a watering trough 1 mile from the Huehue ranch house in November of that year (Baldwin 1945) (161, 162). T. Vredenberg additionally recollected that "fair numbers" of Nene used to be seen along the edges of the Kaupulehu Lava Flow from 2,550 to 4,400 feet elevation in 1942, frequenting the grassy pahoehoe lava 2 miles east of the Huehue ranch house (163). Also, D. Paris saw 1 or 2 along the

1937-1948

road by the Kaupulehu flow about 1944 (Baldwin 1945) (164). A. Ruttle told Elder (1956 field journal) that a relative, F. I. Brown, manager at Keawiki Ranch, kept Nene in stone pens about 6 feet square, above Koholo from 1925 to 1945 (165).

Inland, and to the north of the Kaupulehu lava flow, E. Horner remembered that during the period 1930 to 1940, a pair of Nene frequently flew makai (toward the sea) in the morning, and mauka (toward the mountain, Hualalai) in the afternoon below the Kona Road north of the 1855 (1859) lava flow (Elder 1956 field journal) (190). In November 1941, T. Lindsey recalled Nene nesting above Halekula (Puuwaawaa Ranch) and L. Hind saw a flock of 33 near the hill Puu Waawaa that same year (191, 192).

Continuing with recollections of Nene on and around Puuwaawaa Ranch in the 1940's, L. Hind recalled their continuous presence, including young, from 1900 to 1944 (Baldwin 1945) (Smith 1952) (201, 202). Such sweeping statements seem well born out by the facts of the 1937-1948 and previous periods. At unspecified times, but presumably prior to 1948, S. Kahola saw 2 Nene at Puu Anahulu by the trail to Kiholo, and obtained eggs from a nest 3/4 mile above Puu Waawaa ranch house for some 6 or 7 years (204, 205); and W. Paris, Sr., frequently saw Nene in the open kipukas of Kuainiho near pigeon caves, and found 1 nest with 2 eggs on a crater hill 1.5 miles above Puu Waawaa (Elder 1956 field journal) (206, 207).

In 1942, P. H. Baldwin himself saw 5 adult Nene at 3700 feet elevation near Poohohoo on 11 April (193), while that same year (in March), T. Lindsey noted several at Halekula, and L. Hind saw 26 near the hill Puu Waawaa (Baldwin 1945) (193-195). A. Cambra stated that from 1936 to 1943 he remembered Nene being frequently hunted in the third kipuka above the road halfway between the 1859 lava flow and Kuainiho (196). L. Hind recalled that the largest

flock of Nene at Puuwaawaa Ranch by 1943 was 13, and that they nested especially in Waiho and Halekula paddocks between Puu Waawaa and Hualalai, from about 2,300 to 4,000 feet elevation (Baldwin 1945) (197, 200). R. Hind, Jr. believed the Nene population declined in the late 1930's and early 1940's (W. Banko 1969 field journal) (198), while Baldwin (1945) thought that the total population of the island "about 50, centered in Puuwaawaa, appears to have remained constant from 1930 to 1945" (27). R. Hind, Jr. told W. Banko (1969 field journal) that the "last 2" Nene on Puu Waawaa Ranch were killed by World War II pilots on leave on the Ranch in 1943 (199), perhaps that referred to by Schwartz and Schwartz (1949) (62).

On the north flank of Hualalai, south of Puu Waawaa Ranch, C. L. Murray saw 5 or 6 Nene in 1938 some 3 miles south of Puu Waawaa (238) (Elder 1956 field journal); and R. Hind, Jr. saw "a few" at Kileo in open grassy areas in the 1930's (W. Banko 1969 field journal) (239). Baldwin (1945) also reported that T. Lindsey saw an adult Nene with young at Poohohoo in February 1940 (246); while H. Yamayoshi saw a pair of Nene on the Puu Waawaa side of Hualalai at 6,500 feet elevation on 1 August 1945 (Elder 1956 field journal) (250).

To the south of Puu Waawaa Ranch, in KAILUA quadrangle, Nene were reported seen at Puu Laalau by M. Kaeo; and a pair with 18 (?) young was seen by E. E. Marks somewhere above Huehue Ranch, on unspecified dates, possibly years before 1937 (Elder 1956 field journal) (226, 227). Elder (1956 field journal) learned from C. Kaa via H. Wassman, that Nene were often seen on Hualalai near Puu Laalau, not lower than 6,500 feet elevation, until 1950 (253). M. Kaeo also recalled, from 30 years work on the F. Greenwell Ranch, seeing from 2 to 6 Nene many times (but no nests, young or flightless adults) at Honokohau, 1,250 feet elevation (Elder 1956 field journal) (224). Higher up on Hualalai, around 6,000 feet elevation, Donaghho

(1940) reported that Ranger Marteen knew of a dozen Nene in the Sheep Station area which had slowly increased since he first knew them in May 1940 (223). Baldwin (1942 field journal, 1945) cites F. Greenwell as saying that Nene were never seen on the south flank of Hualalai below 5,000 feet (249).

Still farther south, in KEALAKEKUA quadrangle, A. Cambra recalled seeing Nene many times, 15 on one occasion, on the Sherwood Greenwell Ranch above Kealakekua, from 1936 to 1943 (Elder 1956 field journal) (277). G. Henriques recalled seeing Nene only twice on the Greenwell Ranch, both times in 1939 (Elder 1956 field journal) (280).

On the eastern flanks of Hualalai and the broad plains stretching to Mauna Loa, recollections of Nene from 1937 to 1948 are numerous. Donaghho (1937 report, 1951a) wrote in 1937 that W. J. Payne told him of 19 between Mauna Kea and Hualalai; that a "flock of 6 were reported where a number live" in the Great Central Plain between Mauna Loa and Hualalai, and that this species was present near the east slope of Hualalai (58, 236, 237). Baldwin (1945) wrote that F. Greenwell knew of small flocks, but no nesting, on the southeast flank of Hualalai just above the plateau (identified in field notes as being in Keauhou 2, north of the Judd trail below 6,000 feet elevation, and between Ahuaumi Heiau and Pohakuloa (6,050 feet elevation) through the years up to 1940 (240, 242). J. Greenwell last saw 10 to 12 Nene flying south from Ahuaumi to Pulehua Ranch in 1940, about the same year that he found a Nene nest in pukiawe at Ahuaumi (Heiau) (243, 244). H. W. Baybrook told of seeing a single Nene near Ahuaumi Heiau in 1941 (Baldwin 1945) (245); while Baybrook and Nick saw Nene in the same area as recently as 1942 (Baldwin 1942 field notes) (245, 247). J. D. Johnson and C. Kaa obtained young between Hualalai and Mauna Loa in 1945 (Baldwin 1945) (251), though F. Greenwell said he found Nene between Hualalai

and Mauna Loa to be "comparatively scarce" since the turn of the century (Baldwin 1942 field journal, 1945) (248, 252). On his bird survey in November 1942, P. Baldwin (1942 field journal) stated that he did not find any droppings or see any Nene between Pohakuloa through Kanahaha and even to Puu Lehua, and that although "all this country appears an excellent potential Nene breeding and feeding area", this species was "obviously rare here" (68).

To the south of Hualalai and the Hualalai-Mauna Loa plain, in and near Puu Lehua Ranch, H. W. Baybrook remembered seeing 3 Nene near Puu Keanui in 1941, but knew of no observations on the Puu Lehua Ranch lower than ca. 5,000 feet elevation during the 1923-1942 year period (Baldwin 1942 field journal, 1945) (285-287). B. Matsuoka, a Greenwell Ranch cowboy, recalled seeing 3 flying over the old sheep station at Kanahaha, and from 3 to 4 in the kipuka above Kanahaha sometime from 1944 to 1946 (Elder 1956 field journal) (288, 289). M. Kaeo recalled seeing Nene at Kanahaha, and N. Greenwell a pair at Kanahaha near Pohakuloa, apparently years ago (Elder 1956 field journal) (294, 295).

Much farther to the south in KAUNENE quadrangle, W. Thompson recollected seeing 3 Nene on the lava above Komakawai water holes early in 1944 (Baldwin 1945) (319); while an unspecified number of years before 1956, K. Simeona told of seeing paired Nene at 7,000 feet elevation, just above the forest line above Puu Pohakuloa (Elder 1956 field journal) (326). O. Crosby recalled seeing a pair of Nene just above the Polewai Waterhole in May 1937. R. von Holt remembered seeing several flocks of 5 to 8 from the Alike Lava Flow north to Hooper Camp (6,750-8,000 feet elevation) in 1940 (Baldwin 1945 field journal) (322, 323). Elder (1956 field journal) logged Y. Chee's remembrances of seeing Nene near the old Kaohe Ranch sometime from 1927 to 1948, and seeing 6 flying south toward Keanapaakai from the Kaohe Ranch at 6,300 ft. elevation in 1948 (324, 325).

Kau District:

Contrary to many reports of Nene in KA LAE, KAHUKU, PUU O KEOKEO, and KEAIWA RESERVOIR quadrangles from 1887 to 1936, comparatively few observers recalled seeing this species over the same broad area on the southern flank of Mauna Loa from 1937 to 1948. For example, M. Martinson reported seeing none in frequent visits to the Kahuku lowlands (KAHUKU quadrangle) from 1931 to 1944 (336), although W. Meinecke told Elder (1956 field journal) that B. Beck captured young Nene some 4 miles west and below the road to Kahuku Ranch some time before 1950 (353).

In PUU O KEOKEO sector, Smith (1952) stated that 17 Nene were seen at 6,500 ft. elevation, Kipuka Nene, in 1948 (362), perhaps the same flock as that reported by C. Glover to Elder (1956 field journal) as occurring in August 1949 (363).

Only a single report from the 1937 to 1948 period was reported for KEAIWA RESERVOIR sector - that of M. Martinson who saw 2 Nene at Punaluu Kahawai at 7,250 ft. elevation in November 1942 (Baldwin 1945) (381). It is not known where E. Y. Hosaka told W. Donaghho Nene were sighted in 1937 on the slopes of Mauna Loa above Kau Forest Reserve (Baldwin 1945) (335).

In WOOD VALLEY quadrangle, W. Paris, Sr., recalled that his father hunted Nene at Ainapo in the 1930's (Elder 1956 field journal) (387).

Farther north, just outside Hawaii Volcanoes National Park in KILAUEA CRATER quadrangle, A. McKenzie reported seeing a pair with a nest (2 young, 1 dead embryo, and 1 infertile egg) near Bates Camp during the winter of 1940-1941 (Elder 1956 field journal) (411). It was perhaps during this period that T. Lindsey referred to seeing 24 Nene fly over the Keauhou Ranch house (Elder 1956 field journal) (414).

Still farther to the north, in KULANI quadrangle, many observers recalled seeing Nene from 1937 to 1948, particularly around Keawewai. L. W. Bryan reported Nene were seen in the 1930's on the south side of the 1852 lava flow along the Puu Oo-Volcano Trail toward Kilauea from Aina Hou (Baldwin 1945) (833); while former Superintendent of Hawaii Volcanoes National Park, E. G. Wingate, recalled that from 1935 to 1938, Nene were sighted in the Park area from 5,000 to 7,000 ft. elevation and above Keawewai (Elder 1956 field journal) (832). Donaghho (1937 report) stated that Park Ranger J. H. Christ and State Forester L. W. Bryan reported that Nene were nearly always seen at Keawewai from June to August 1937 (829); and L. W. Bryan reported 2 along the Puu Oo-Volcano trail during this period (57). On a 12 September 1937 hike along Puu Oo trail above Keawewai, Donaghho (1951c) first saw 6 Nene, then 2 more farther along the trail toward Mauna Kea (830, 831). The National Park Service stated in an internal report that a small flock of Nene were seen 27 July 1940 at Keawewai (834), but that on 6 August 1941 no droppings or other signs of use were found at (Keawewai) waterhole, nor any seen on a survey from the end of Mauna Loa Strip Road to Keawewai and return (836). Baldwin (1945) reported that ranchers encountered a small flock and told of seeing others at Keawewai during the 1940-1944 period (837); D. Forbes reported seeing several flocks of up to 11 birds along the Puu Oo trail from Keawewai to Puu Kipu during the 1937 to 1947 period (838). L. W. Bryan is cited by Elder (1956 field journal) as saying that Nene were "always seen" from June to September 1926 to 1940 where the Puu Oo trail crosses the 1852 lava flow (835). In several undated early recollections Elder (1956 field journal) learned from T. Lindsey, K. Manaapu, and R. Kahakua that, presumably in the 1940's, Nene frequently flew over their camp at Keawewai, 2 were seen about 1 mile above Keawewai, and that young were "always raised" on hill Kipuka Nene near Keawewai (844-846). An illegally captured Nene was seized, presumably from a

hunter, on October 30, 1949, near the Puu Oo trail and 1852 lava flow, Waiakea Forest Reserve, according to Elder (1956 field journal) (839).

Hawaii Volcanoes National Park:

In KIPUKA PAKEKAKE quadrangle, Donaghho (1951) mentions an unsuccessful search for Nene conducted by himself and others on 20 July 1937 when the party hiked from the end of the Mauna Loa truck trail (now Strip Road) south to Kipuka Kaunaiu (actually Maunaiu) (868). Extending the hike on 21 July 1937 to a small grassy kipuka (christened 3-Trees Kipuka) located about 0.9 mile slightly southwest from the end of the truck trail and about halfway between Kipuka Maunaiu and Kipuka Kulalio, H. G. Craddock and W. Donaghho discovered a flock of 8 Nene which they thought existed only in captivity (Craddock 1937 report) (Donaghho 1937 report, 1951a) (Baldwin 1945) (334, 869-872). The discovery prompted return trips to 3-Trees Kipuka where the presence of Nene was reported on 22, 23, and 26 July (Donaghho 1951a), (1937 Superintendent's Report) (Elder 1956 field journal) (873-875). Fresh Nene droppings were also noted at 3-Trees Kipuka on 30 August 1937 (Donaghho 1937 report) (876).

There are only 3 records of visits to the 3-Trees Kipuka area in 1938, as follows: 5 Nene were noted in eastward flight at 6,250 feet elevation, Kipuka Kulalio, on 25 August; flock of 6 seen somewhere along the Mauna Loa trail in September; and the finding of no droppings in 3-Trees Kipuka on 27 November 1938 (Baldwin 1945) (1938 Superintendent's Report) (Baldwin 1938 field journal) (874-877).

In 1939, the results of 4 possibly 5 visits to the 3-Trees Kipuka area were noted, viz. the finding by Baldwin of only old feces on 6 February; and many old, as well as "moderately recent" (some possibly weeks old) droppings on 6 July; 5 Nene reported seen by National Park Service personnel at the end of the Mauna Loa truck trail on 7

July - no doubt the 5 noted the same day at 6,700 feet elevation, by P. E. Schulz, Kipuka Kulalio (Baldwin 1939 field journal) (1939 Superintendent's Report) (Baldwin 1945) (880-883).

Records of Nene seen at 3-Trees Kipuka and Kipuka Kulalio abound for 1940. At 3-Trees Kipuka, Baldwin (1945) saw a flock of 3 Nene on 3 days in April; a flock of 2 on 2 days, and 1 on 1 day in May; plus a flock of 3 at 6,500 feet elevation, and a flock of 8 in flight at 6,000 feet elevation, Kipuka Kulalio, on 16 June (885-887). An internal National Park Service report stated that no Nene were found on frequent visits to 3-Trees Kipuka and Kipuka Kulalio in July (1940 Superintendent's Report) (888, 889). Baldwin (1945) saw a small flock of Nene in the underbrush at Kipuka Kulalio, 6,700 feet elevation, on 31 July; and 2 in 3-Trees Kipuka on 22 October (890-892), later reporting that 2 roosted in the latter kipuka on 27 November (893).

Donaghho (1940), following a visit to the Park in May 1940, wrote of the Nene as follows: ... "though I saw none ... numbers on Mauna Loa have apparently dwindled to 6" (860). Baldwin (1941), referring to the 1937-1940 period, summarized his knowledge of their population status in the Park by saying that a small flock roosting regularly winter and spring at 3-Trees Kipuka had dwindled from 8 to 2 individuals since 1937, and that "recent" impressions (with W. Donaghho) were of "about a dozen ... seen from time to time ... in flocks of 2 to 5 individuals around the Park .. most commonly ... between elevations of 6,500 to 7,500 feet on Mauna Loa but occasionally at lower elevations" (861, 894). However, S. Kaawaloa, interviewed by Elder (1956 field journal) said he "frequently" saw bunches (of Nene) up to 12 in number, flying near the end of the Mauna Loa truck trail at 6,500 feet elevation, in the CCC days (late 1930's or early 1940's) (884).

1937-1948

Results of some 5 visits to the 3-Trees Kipuka area were recorded in 1941 by Baldwin (1941 field journal, 1945), and the National Park Service (1941 Superintendent's Report), as follows: the finding of an abundance of Nene signs in 3-Trees Kipuka in June, indicating heavy use in May after little use in previous months; discovery of droppings from 6,250 to 6,500 feet elevation near the lower end of a pahoehoe strip east of the 1881 flow, not far from the west (north) Park boundary on 21 July; seeing few signs at 3-Trees Kipuka in October (the first since May); sighting of 1 at 3-Trees Kipuka on 28 November; and finding only evidence of limited use at this kipuka in December (895-900, 1078).

The National Park Service stated in a March 1942 internal report that no Nene were seen on a visit to "areas of former use", presumably all in or near the Park (60).

The only report of Nene activity in 1943 seems to be the report by Baldwin (1945) that a Nene was flushed from ohelo shrubs in Kipuka Kulalio at 6,800 feet elevation on 18 December (901).

In 1944, Baldwin (1945) noted that 2 Nene flushed at 6,500 feet and circled higher in Kipuka Kulalio on 13 January; while on 19 January, 2 were seen on 3 days just above or below the end of the Mauna Loa truck trail (Strip Road) (1944 Superintendent's Report) (902, 903).

Only 2 records of Nene activity were noted from 1945 to 1948, the observation by B. Sumner that 3 were seen in Kipuka Maunaiau at 5,500 feet elevation in 1946 (Elder 1956 field journal) (904); and droppings found at 3-Trees Kipuka in October 1947 (1947 Superintendent's Report) (905).

Not far from 3-Trees Kipuka however, in PUU ULAULA sector, observations of Nene were recorded along the Mauna Loa trail from 6,700 to between 8,000 and 9,000 feet elevation from

approximately 1937 to 1948, as follows: 3 or more from 1935 to 1938 (960-962); 2 in 1939 (963, 964); 6 in 1940 (965-970); 1 in 1942 (971); 4 in 1943 (972-975); 1 in 1944 (976); and 1 in 1946 (977) (Baldwin 1941, 1945) (1939, 1940, 1943 Superintendent's Reports) (Elder 1956 field journal). Young were seen once at 7,500 feet elevation on 16 July 1940 (968), while numbers of adults seen from 1937 to 1948 varied from 1 to 5. Sightings made during the months of February, March, April, July (3), August (2), September, October (2), were perhaps more a reflection of reporter frequency than seasonal use by nene.

Farther downslope, in KILAUEA CRATER quadrangle, Baldwin (1945) reported that a Nene was seen standing on a lava flow in the Koa forest at 5,750 feet elevation, Kipuka Kulalio, on 28 August 1938 (1004). B. Waltjen, an old-time employee of Hawaii Volcanoes National Park saw Nene only once, when 6 landed at "Six Tanks" on the truck trail, 3 miles above Bird Park sometime in 1946 or 1947 (Elder 1956 field journal) (1006). Baldwin (1945) was told by C. Kauhi, presumably ca. 1944, that Nene occasionally visited the barren Kau desert to the southwest (of Kilauea Crater), though not the so-called Kipuka o Nene due south of the crater (1005).

In KAU DESERT quadrangle itself, Warden (A. B.) Medeiros reported a young Nene seen on 22 July 1940 with 3 adults, at about 2,000 feet elevation in Kipuka Pepaiau (Pepeiau) (Pepeiau) (Baldwin 1941, 1945) (1940 Superintendent's Report) (1020-1022). Baldwin (1941 field notes) noted that a search for signs of Nene in Kipuka Pepeiau on 26 June 1941, following up a previous sighting by J. H. Christ, was unsuccessful (1023). In August 1941, P. H. Baldwin collected "perhaps month-old" droppings at 3,400 feet elevation in "Koa Oasis", 2 miles south of Kilauea Crater (Baldwin 1945) (1941 Superintendent's Report) (1024, 1025).

1937-1948

In 1944 or 1945, P. H. Baldwin wrote that Nene "have now abandoned" all of Puna and parts of Kau Districts, with concentrations "nowhere to be found" (Baldwin 1945) (69). A year or so later, in 1946, A. B. (Tony) Medeiros reported flushing 3 or 4 Nene at Kipuka Pepeiau (1026). Without mentioning locality, J. Baker (1951) noted that groups of 12 and 5 were seen in the Park on 1 April 1949, while Smith (1952) wrote that a group of 5 were reported seen in Kipuka Maunaiu by the Park Superintendent in April 1949 (862, 863, 906).

Kilauea District:

There seems to be only a single report of Nene in Kilauea District during the period 1937 to 1948, the observation of a small flock in 1937 (presumably from H. Shipman's Keaau Ranch) flying toward the Nobriga (Keaouhou) Ranch from a point just below Mountain View village (1033).

Mauna Kea District:

In KEAAU RANCH quadrangle, Smith (1952) stated that (H.) Shipman's Nene flock (kept at Keaau Ranch on the west coast of Hawaii Island) grew from 2 pairs in 1918 to 42 individuals in 1949, when the flock was reduced to 11 by a tidal wave and other tragedies (1269). Earlier, Munro (1944) referred to the few Nene still in the wild and the fact that semi-wild stock raised by ranchers had helped preserve the species (61).

In the only report from HILO sector, Elder (1956 field journal) states that a man reported shooting a Nene in the late 1930's where Hilo High School "now stands" (1267). Not much farther up the slopes of Mauna Kea, in PIIHONUA quadrangle, J. Veriato saw 2 Nene in 1941 at Pukamaui Falls, north of the Saddle Road above Kaumauna (1266).

Higher up the Saddle Road, in PUU Oo Ranch (UPPER PIIHONUA) quadrangle, several observers recalled seeing evidence of Nene activity from 1937 to 1948. Donaghho (1937 report)

cited W. J. Payne as the source of a report that a flock of 9 was seen sometime between June and August 1937 near the Waikoloa ponds on the southeast flank of Mauna Kea (1126). T. Bell saw small flocks "repeatedly" at Omaha (Omao?) ponds, Puu Oo Ranch, in the 1940-1941 period (Elder 1956 field journal) (1127). Baldwin (1942 field journal, 1945) found Nene droppings at various locations on a 3 to 4 mile hike through ohia and koa kipukas between 5,400 and 6,000 feet elevation on the Puu Oo Ranch, beginning at 5,600 feet elevation on the Saddle Road (1128-1130). T. Lindsey recalled Nene flying over Puu Oo trail in the moonlight at Kipuka Nene in June or July 1947 or 1948 (Elder 1956 field journal) (1131). Somewhere in this general area, Donaghho (1951) reported that he learned from W. J. Payne via Mr. and Mrs. Nicholson, that the former (Payne) had seen Nene "many times" while surveying in the land of Humuula along the proposed Hilo to Kona (Saddle) Road in 1937 (1038).

There are many recollections of Nene activity from 1937 to 1948 in the principal Puu Oo Ranch area (PUU OO quadrangle) to the west of the preceding records. W. J. Payne told Donaghho (1951b) that Nene had been seen near the Puu Oo Ranch on 3 August 1937 (1071), while Lamb (1937 ms.) states that J. J. Ignacio observed 18 in August 1937 in Ainahou kipuka (1072), a report cited later by Baldwin (1945) (1073). R. von Holt recalled "seeing a number" of Nene in Kipuka o Nene (6300-7000 feet elevation), a grassy kipuka above Aina Hou in the 1930's, while D. Paris saw "comparatively few" in Aina Hou itself in that same decade (Baldwin 1945) (1074, 1075). Baldwin (1945) also learned from W. Kaneho via R. von Holt that Nene were found "frequently" on regular trips to Kipuka o Nene during 1940 to 1941, P. H. Baldwin himself finding signs of use in this vicinity during May/June 1941 on the 1881 lava flow at 6,500 feet elevation (1076, 1077). Baldwin (1941 field journal) found droppings in November 1942 at several places along the edge of a lava flow and

1937-1948

near small ponds 3 miles south of the Puu Oo Ranch house at 5,400 to 5,750 feet elevation (1081). T. Bell saw 2 to 3 Nene at Kipuka Aina Hou above Puu Oo trail and bunches up to 11, and flightless, 3 to 4 miles west in Kipuka Aina Hou from 1940 to 1941 (Elder 1956 field journal) (1079, 1080).

From 1933 to 1942 H. Kubo saw 5 to 6 Nene "frequently" in Kipuka (o) Nene (Elder 1956 field journal) (1082). In April 1943 (S.) Nakamura saw 6 Nene in Puu Oo lands along the Keanakolu road past the (Puu Oo) ranch house (Baldwin 1943 field journal) (Baldwin 1945) (1083, 1084). About 1943, A. Awai saw a small flock of Nene 2 miles past the Puu Oo Ranch gate (Elder 1956 field journal) (1085). H. Shipman saw Nene occasionally on the Puu Oo Ranch during the past 15 or 20 years, but did not say where (Baldwin 1945) (1086). J. Paulo recalled seeing 6-8 Nene on upper Ainahou, but did not mention the year (Elder 1956 field journal) (1100).

A. Wall recalled seeing flocks of 30 to 40 Nene at Aina Hou at 6,000 feet elevation during the past decade, 1934-1944 (Baldwin 1945) (1087); and T. Lindsey saw 12 to 14 on the ground to the left of the horse trail on Puu Oo Ranch ca. 6,000 feet elevation about 1944 (Elder 1956 field journal) (1088). W. Kamau Sr., who spent many years on Mauna Kea, stated that he saw Nene only once - on the Saddle Road south of Puu Oo Ranch - in June or July 1944 or 1945, when his dog caught one of a pair and other flew off (Elder 1956 field journal) (1089). T. Lindsey saw pairs of Nene on several ponds three-fourths of a mile above Puu Oo trail in 1948 (Elder 1956 field journal) (1090).

To the west, in PUU KOLI quadrangle, W. J. Payne saw flocks of 4 to 12 Nene in late afternoon, almost daily, flying toward Hualalai from the Saddle Road, and occasionally flying east in the morning in the summer of 1937 (Elder 1956 field journal) (1062). Baldwin (1943 field jour-

nal) failed to find signs of Nene on 17 April 1943 in a large kipuka between Puu Koli (7,341 feet elevation) and Kokoolau cone on the north flank of Mauna Loa (1063), but reported that S. Nakamura of Pohakuloa and a Hawaiian boy saw several Nene early on an April 1943 morning at Red Hill on the cones about 2 miles west of Puuhuluhulu (1064).

In KEAMUKU quadrangle, to the west of PUU KOLI sector, Nene were also apparently well established. In 1936 and following years, E. Horner saw a pair at close range near Keamuku House on the Puu Waawaa side of the Keamuku lava flow (Elder 1956 field journal) (1276). In the June to August period of 1937, W. J. Payne saw 1 or 2 "other flocks" near Puu Ka Pele (Donaghho 1937 report) (1277). W. Richard noted one in 1939 circling in flight over the Parker Ranch cabin a few miles east of Puu Ka Pele (Baldwin 1945) (1278). That same year T. Bell saw a flock of about 30, three to four times, 1 mile south of Keumoku (Keamuku) House, a few miles from Puu Waawaa (Elder 1956 field journal) (1279).

In 1940, D. Paris stated that a pair built a nest on rough ground 3 miles northeast of Keamuku at 3,750 feet elevation; while in 1942 T. Vredenberg saw a small flock on the Keamuku lava flow immediately south of the cinder cone Puu Ka Pele at 6,700 feet elevation (Baldwin 1945) (1280, 1281). T. Vredenberg reported seeing a flock in 1942 at Puu Ka Pele, just outside and to the east of the Parker Ranch sheep-proof fence, in the land of Waikoloa, but neither he nor P. H. Baldwin, returning to the same area on 13 April 1943, were able to find any sign of activity though they did not make an exhaustive search (1282).

T. Vredenberg reported "flocks of Nene" in Waikii Gulch at 4,150 feet elevation, and this species as having occurred in the mamane groves above Kipuka Kalawamauna during "recent years" (Baldwin 1945) (1286, 1287). Searching

1937-1948

Kipuka Kalawamauna and vicinity in the land of Puunahulu with T. Vrendenberg and L. W. Bryan on 15 April 1943, Baldwin (1943 field notes) was unsuccessful in finding signs of Nene where they had been seen about 1942 by his companions (1283, 1284). In another nearby area, A. Cambra recalled seeing up to 15 Nene many times 7 miles SE of the road between the 1859 lava flow and Kuainiho during the period 1936 to 1943 (Elder 1956 field journal) (1285).

Island-wide Distribution and Population Status:

Of several references to the population status and range of the Nene during the 1937-1948 period, Elliott (1942); Munro (1944), Elder (1958a), only that by P. H. Baldwin summarizes the essential details known at that time (13, 14, 15). Baldwin (1945) stated that the population was "now reduced to about 50 birds ... centered in Puuwaawaa ... (that its) present range encircles Mauna Loa .. between roughly 5,000 and 7,500 feet elevation and extends to or near the seashore in parts of Kau, North Kona and south Kohala" (27). Later, in his work on food habits of the Nene, Baldwin (1947) modified his statement on their range by saying that this species "inhabits barren lowlands from sea-level to 3000 feet, and from 3000 to 9000 feet elevation on Mauna Loa and Hualalai", concluding from his extensive food habits studies that the "greater availability of food in the interior uplands may have favored the retreat of the remnant population to the uplands rather than to the lowlands" (28).

Maui, Lanai, Molokai, Oahu, Kauai and Niihau

The only reference to Nene on any of the above islands from 1937 to 1948 seems to be that of A. Smith who stated that he shot one on Molokai while poaching ducks at the brackish pond Kalaupapa sometime during the period 1940-1945 (Elder field journal). (1404).

1949-1959

4. Distribution of Relict Populations (1949-1959)

Island of Hawaii

Kohala and Kona Districts:

Smith (1952) documents the liberation of 14 Nene, having produced no young, from the beach home pen of an unnamed State senator near Kawaihae, "several years" after 1935 (91), the senator (F. Brown, Keawaiki) being the recipient of part of the flock disbursed from Oahu in 1935 by the Territorial Board of Agriculture and Forestry. S. Ahau recalled that 14 Nene from the "State Game Farm" at Mokapu, Oahu were kept in captivity at the F. Brown ranch at Keawaiki until 1940 when all were released (Elder 1956 field journal) (125), as previously cited.

This release apparently survived and possibly reproduced. A. Ruttle recalled seeing a Nene flying south over Waimea Road a few miles from Kawaihae in 1955, and W. Wiley saw a Nene on the ground near Reservoir No. 12, 1.5 miles north on Airport Road near Hawi, 20 October 1956 (Elder 1956 field journal) (87, 92). G. Kaono saw 2 Nene at Pueo Pond, F. Brown ranch, 0.5 mile mauka (towards the mountains) of Weliweli Ranch in 1955, and 2 flying at Anaehoomalu on 25 November 1956 (Elder 1956 field journal) (130, 131). Also, J. Andrews saw 8 Nene in single file flight over the beach at Puako headed for Kailua on 30 September 1956 (Elder 1956 field journal) (142).

Farther south, along the coast at Luahinewai, C. Kahola frequently saw a pair in 1950; F. Brown reported that from 1 to 6 visited regularly in the 1950's; and J. Paulo heard this species departing sometime in June or July 1955 (Elder 1956 field journal) (166, 168, 169). Even farther south, ca. 1951, C. Kahola recalled seeing 2 pairs of Nene at water tanks 2 miles mauka from the Huehue Ranch house; while not far away, R. Punihaole saw 5 Nene on the ground 2 miles mauka of the highway along the south edge of the Kaupulehu

lava flow on 2 September 1956 (Elder 1956 field journal) (167, 225). C. Davis noted a Nene flying towards Hualalai from Keauhou Bay at 2:30 p.m. on 2 September 1955 (278); while a year later in September 1956, Mrs. Seigfried saw a flock of 12 or more large birds, apparently Nene, flying in formation some 2 miles south of Kailua near the coast (Elder 1956 field journal) (279).

Inland, in the Puu Waawaa area, Smith (1952) learned from ranch hands that they usually saw at least a few geese prior to 1949, but none (for several years) since, concluding that Nene "have now vanished" from the entire Hualalai-North Kona region (116, 203). But a spate of subsequent recollections shows Smith's pessimistic conclusions to have been premature. Elder (1956 field journal) learned from C. Kaa via H. Wassman, that Nene were often seen near Puu Laalau on Hualalai higher than 6,500 ft. elevation until 1950 (253); while N. Greenwell recalled seeing a pair 2.5 miles Kona side of Ahuami Heiau about that same year (254). E. Pung (Game Warden) remembered seeing 3 Nene once near Puu Hale in Keauhou-2 (F. Greenwell's place), 2.5 miles southeast of the forest cabin on 23 May 1951; and M. Greenwell flushed a female Nene from a nest with 2 eggs near Ahuami Heiau sometime between 1932 and 1952 (Elder 1956 field journal) (255, 256). T. Hocaba remembered seeing groups of 4, 6, and 3 Nene on the trail below Ahuami Heiau during the period 1947-1952 (Elder 1956 field journal); and a brood was reported at the 5,000 to 6,000 ft. elevation level on the southeast flank of Hualalai in 1953 (HDFG 1957-1958 report) (257, 258). Even higher up the flank of Mauna Loa in PUU O UO quadrangle (Kau District), J. Greenwell recalled seeing a group of 6 Nene sometime between 1932 and 1952 at the forest line around 7,000 ft. elevation (Elder 1956 field journal) (440).

Memory recall of local residents preserved by Elder (1956 field journal) contribute to

knowledge about distribution of Nene to the south of Hualalai, in and around Pulehua Ranch, from 1952 to 1955 as follows: J. Henriques reported a "smallish" Nene seen 2 or 3 miles makai of Ahuami (Heiau) at Kanahaha in October or November 1952; M. Greenwell recalled seeing Nene flying 3 times in the morning from SW to NE over the Pulehua Ranch house sometime during the period 1932-1952; J. Silva recollected a pair seen near Pulehua at Kipuna tanks (Keakanoopuna) in June 1955; and R. Wall reported seeing 3 or 4 fly over high at noon at Monohaa at 4,000 ft. elevation mauka from Kainaliu in August 1955 (290-293).

Following up on two reports of a pair seen by Y. Yamamoto about 7 weeks previously, Woodside (1955 field notes) failed to find them in the reported area "a mile past the end of the Hilo-Kona Road and a little mauka" on 5 August 1955 (KOOKOLAU quadrangle) (Kau District) (441, 442). E. Pung recalled flushing a Nene in 1955 when he shot a pheasant along a trail to the Puu Hale forest cabin at 6,000 ft. elevation, southwestern flank of Hualalai (259); and N. Greenwell remembered seeing 2 small young Nene - the first in 10 years - at Ahuami Heiau in February 1956 (Elder 1956 field journal) (260). Elder (1958) also noted that E. Pung reported seeing a Nene on the south slope of Hualalai on 27 November 1956 (261).

Information from various sources combine to yield a composite picture of Nene activity in the cinder and lava plain between Hualalai and Mauna Loa sometime between 1958 to 1960, as follows: Elder (1958) reported that months later than the sighting of a Nene on the south slope of Hualalai on the 27th of November, "numerous scattered Nene droppings were found near Ahuami's temple" (Heiau), indicating that "another family or two as yet unseen or the breeding season resort of the unemployed birds" used the Ahuami Heiau area in 1957/58 (269). "Plentiful recent droppings" found in July 1958 indicated that several Nene used the southeast

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flank of Hualalai at 5,000 to 6,000 ft. for both feeding and roosting in May and June (HDFG 1957/58, 1958/59, 1963 reports) (270, 272, 273). Meanwhile, Woodside (3 August 1958 field notes) logged a report from N. Greenwell that a cowboy saw 2 Nene on pahoehoe (lava) somewhat earlier - about 3 June - just south of the water tank above the windmill at Keikiaeae 2 miles SE of Pulehua ranch house (296); while Woodside himself reported finding "only old droppings" at Ahuaumi Heiau, and droppings "more than 30 days old" at "3 hills" near the gate on the drive from Puu Lehua, Ahuaumi Heiau, and an area he termed the "race track" (3 green hills) (271).

Later, Woodside (19 November 1958 field notes) recorded that a check for Nene sign yielded negative results at the "mauka kipuka" just past Nenenui Gate, and again about 1 and 2 miles beyond Nenenui Gate and Ahuaumi Heiau. Woodside reported finding only two fairly recent droppings on a small knoll at the lower end of the "race track", and no recent droppings but "lots" several months or more old on a hike that same day around "3 green hills" (296-301).

Woodside's 11 and 12 January 1959 field notes add to knowledge of Nene distribution in the Hualalai-Mauna Loa plain when he reported searching for droppings with negative results at Kahana (Kahahaha), Nenenui Gate, Ahuaumi Heiau, and from Halelaau to the 1859 flow; and found no recent sign on a hike along the contour from the "race track-3 green hills" area around Hinau and back to the jeep (302-304, 306, 308). In other searches, Woodside found somewhat more encouraging indications of Nene presence finding "only old droppings" and "a few Nene bones" in a shelter cave near (Ahuaumi) Heiau. Checking the area west and north of Heiau to the cave, Woodside found "only old droppings ... no birds have been in the area (from the end of the sand above Ahuaumi Heiau to the race track-3 green hills) since the last two visits" (305, 307). HDFG (1959/60, 1963 reports) confirmed that

Nene again moved into the plains area and on Hualalai during the summer of 1958 (117), but indicated that field trips to Ahuaumi in the summer of 1959 and 1960 failed to result in actual sightings, though droppings and feathers were reported found on the southeast slope of Hualalai near the Judd Trail (274, 275).

Several miles to the south near Pulehua Ranch (PUU LUHUA quadrangle), H. Hayes saw a Nene flying south near the Keokea Road junction about 5 p.m. on 25 October 1950 (Elder 1956 field journal) (311). Later, K. Isenberg recalled seeing 3 or 4 Nene at a pond on a jeep trail, McCandless Ranch (KAUNENE quadrangle) in February 1956; plus 6 flying makai from Keanapaakai - 4 miles south of Greenwell Ranch boundary - sometime in 1956 (Elder 1956 field journal) (320, 321).

Kau District, except PUU ULAULA quadrangle:

Near the southern tip of the island of Hawaii in POHUE BAY quadrangle, Elder (1956 field journal) learned from R. Nakamura via D. Woodside, that a single Nene was seen on the 1907 lava flow one-half mile north of Manuka State Park at noon on 9 September 1955 (344).

To the northeast and much higher up on the slopes of Mauna Loa, and around Kahuku Ranch (PUU O KEOKEO quadrangle), Nene appear to have been well established during the 1949 to 1959 period. C. Glover recalled counting 17 on the ground in Kipuka Nene, Kahuku Ranch, in August 1949 (Elder 1956 field journal) (364). Smith (1952) reported 3 seen at 6,500 ft. elevation, Kipuka Nene, in January 1949 but none after that sighting to 1951 (364, 365). A HDFG 1953 progress report stated that the last reported sighting of Nene on the upper Kahuku Ranch was in 1952 (339), perhaps that of T. Freitas who remembered seeing 7 Nene in Kipuka Nene (Kahuku Ranch) in March 1952 (366).

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Later, in January of February 1953, E. Molcilio recalled seeing 3 flying towards Kipuka Nene from Mauna Loa near Keapohina, Kahuku Ranch (Elder 1956 field journal) (367). T. Freitas also remembered that he witnessed 3 Nene flying down Mauna Loa from somewhere on Kahuku Ranch in February 1954, and 1 flying up the mountain on the Ranch in early April 1954 (Elder 1956 field journal) (368, 647). E. Y. Hosaka stated that he never saw Nene at Kipuka Nene but heard from many old timers that in years past they were often seen there (Elder 1956 field journal) (370). O. Breithaupt, a fence rider for various Kau ranches for 20 years, recalled seeing 1 to 17 Nene many times at Kipuka Nene, 1,000 ft. elevation above the forest line and below Kahuku Ranch fence line in June 1956 and earlier years (Elder 1956 field journal) (371). In the summer of 1956, E. Wagner reported seeing 4 or 5 Nene on Kahuku Ranch where the last lava flow crosses the jeep road at 5,000 ft. elevation (372); while far downslope and to the east, F. Schattauer remembered seeing a Nene at edge of Maniania Pali (NAALEHU quadrangle) on 6 June 1957 (Elder 1956 field journal) (355).

Even higher up the slopes to the northeast in KEAIWA RESERVOIR quadrangle, T. Sumner recalled seeing Nene near Punaluu Kahawai, State Forestry cabin, at 6,167 ft. elevation in 1949; at Kipuka Aiaka Alala, Kahuku, above the jeep trail at about 7,300 ft. elevation around 1950; and at Anipeahi, proximate to a waterhole near the Kau boundary, Kapapala, some time between 1949 and 1951 (W. Banko 1965-1978 field notes) (382-384). W. Paris, Sr., reported seeing Nene above the forest line, Kapapala Ranch, apparently in or prior to 1956 (Elder 1956 field journal) (385); while about the same year, A. McKenzie reported seeing Nene 2 miles NE of the mauka cabin, Kipuka Nene, KEAIWA RESERVOIR quadrangle (Elder 1956 field journal) (386).

Farther north in WOOD VALLEY quadrangle, T. Sumner did not recall ever seeing Nene at Puu

Kaunene (2,825 ft. elevation), Kapapala, when he worked on the Ranch from 1949 to 1951, and thought it only legend that Nene sometimes landed there (W. Banko 1965-1978 field journal) (388). However, there is no shortage of Nene being seen in other areas of Kapapala Ranch during the 1949-1959 period. E. B. Medeiros and M. Fontes saw 2 Nene at the Stone Wall sometime during June or July ca. 1954, and remembered a single bird being seen elsewhere on the Ranch 2 years later; while E. Horner was told by an old Hawaiian hunter that he had killed a "pack horse load" of flightless Nene in the Ainapo area of the Ranch in years past (Elder 1956 field journal) (389, 391).

Higher up on Kapapala Ranch in MAUNA LOA quadrangle, E. B. Medeiros and M. Fontes recalled seeing 5 Nene "in the flats above the stone wall" sometime in June or July ca. 1954 (394); while J. Armitage reported seeing some 15 Nene on the ground 1 mile above Halewai Tank along Ainapo Trail in 1956 or 1957 (Elder 1956 field journal) (394, 396). L. W. Bryan recalled flushing 7 Nene along the Ainapo Trail at the Halewai water tank at Anipeahi, 7,700 ft. elevation, apparently during this same period (Elder 1956 field journal) (395). Farther north in KIPUKA PAKEKAKE quadrangle, just outside of Hawaii Volcanoes National Park, 12 Nene were reported seen in Kapapala Ranch at about 4,500 ft. elevation some 5 miles southwest of the Mauna Loa Strip (Road) flying toward the Park in May 1949 (Superintendent's 1949 report) (397). T. Sumner recalled that in 1949 "large groups" of Nene were seen near Pahuamimi, Kapapala, on two small hills near a large water hole about 7,000 ft. elevation (W. Banko 1965-1978 field journal) (398). Sometime in years past, possibly before 1949, B. Sumner saw "about 9" Nene calling from the top of a knoll near Halewai cabin on two different occasions (Elder 1956 field journal) (399). Woodside (1955-1958 field notes) found many old-to-fresh droppings on pahoehoe lava around tube "cave ins", while on a hike along the Park-Kapapala

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Ranch boundary in Kipuka Maunaiu, past some "seeps" on aa lava to 6,500 ft. elevation (400).

Still farther north in KILAUEA CRATER quadrangle just outside Hawaii Volcanoes National Park, A. McKenzie remembered seeing 4 young Nene with parents on Bates Trail near Bates Camp in 1950; and 2 young with parents on Bates Trail that same year (Elder 1956 field journal) (412, 413). The observation of 2 young with parents on the Bates Trail was similar to that indicated in 1950 by Smith (1952) who also noted that 3 Nene were reported in May, and a flock of 7 in June 1950 near the eastern boundary of the National Park (337, 338). T. Lindsey recalled seeing 2 adults and 2 flightless young below Bates Camp on the Keauhou side of Kipuka Kekekaniho (Kipuka Kulalio), apparently some time in 1956 (Elder 1956 field journal) (415). On 30 October 1958 the Superintendent of Hawaii Volcanoes National Park reported that a total of 9 Nene were observed north of the Park in much the same area (340).

Several recollections of Nene in VOLCANO quadrangle outside Hawaii Volcanoes National Park were preserved as a result of Elder's wide-ranging interviews. J. Verbiske stated that Nene were frequently seen flying mauka at about milepost 25 along the Hilo-to-National Park highway from 1940 to 1955 (433), and that sometime in September or October 1956 he saw 12 flying makai at milepost 26 (435). A. McKenzie recalled seeing 8 Nene flying towards Bates Camp, presumably from somewhere in the Volcano area, on 19 October 1956 (434); and later on 7 December 1956 remembered seeing 6 (2 young with "fuzzy heads" able to fly) at McCake Ranch at the end of Wright Road (436). A. McKenzie saw 9 Nene from Wright Road, 1.5 miles above the Volcano Road (Hilo to National Park highway) on 25 February 1957 (438). A few years later, Hawaii Division of Fish and Game (1959-1960 report) received several scattered reports of 9 Nene flying in the Volcano area, but none were ever verified (439).

Farther to the north in KULANI quadrangle, J. Ah San, R. Woodworth, and L. W. Bryan reported that 2 Nene had been seen on the Puu Oo trail 2 miles south of the 1942 lava flow on 24 January 1950 (840,841), while in 1952 or 1953, W. Paiva recalled seeing 14 Nene flying towards Hawaii Volcanoes National Park from Keawewai (842,843) (Elder 1956 field journal).

Prof. Elder's 1956 field journal also contained many other references to Nene being seen around Keawewai and farther north along the Puu Oo trail in the 1950's, as follows: At the extreme north end, perhaps even in PUU OO quadrangle, a pig hunter by the name of Silver (? Silva) - first name not noted, recalled seeing 2 Nene between the 1881 and 1852 lava flows near Kipuka Aina Hou in 1955 (443). D. Woodside and A. F. Lee told Elder that they saw 12 Nene at a camp on the 1852 lava flow on 8 August 1956 (847); while A. McKenzie recalled that he saw 2 or 3 Nene flying over Keawewai towards Bates Camp on 20 December 1956 (848). W. Paiva reported seeing 2 Nene on the Puu Oo trail above Keawewai in February 1957, and that he often saw them at Puu Kipu waterhole during the 1952-1957 period (849, 850).

Kau District, incl. PUU ULAULA quad. and Keauhou Nene Sanctuary:

On 9 November 1956 D. H. Woodside and W. H. Elder discovered a nest in a small kipuka on Keauhou Ranch immediately adjacent to Hawaii Volcanoes National Park (Woodside field notes) (Elder 1956) (444-448). Subsequent field work revealed a small but coherent group of Nene nesting on the Ranch in a 2.5 mile long complex of lava flows and kipukas straddling the 6,500 ft. elevation contour north of the Park. Woodside (field notes) and Elder (1956) spent many days in this area searching for Nene during the fall, winter, and spring of 1956-1957. Elder summarized results of 22 days field work by stating that of a total of 17 adults seen, 6 pairs produced 12 young from 5 broods, while Woodside (HDFG report) concluded that he had seen only

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4 or 5 broods during the 1956-1957 breeding season (72, 73, 75, 444-534).

During the next (1957/1958) breeding season, Woodside, in a preliminary search on 11 September 1957 was able to find only 1 pair of Nene on the Keauhou breeding grounds, but a check on 8 November revealed that 6 or possibly 7 had returned (534-541). Later, during the peak of nesting and brood rearing, R. Walker and associates Nichols and McKenzie, found only 2 successful nests, banding 2 goslings of 1 brood during 7 days of field work from 19 December to 9 February (542-553). Time available for field work was reported limited (Walker field notes) (HDFG report).

Investigations the following summer (actually only the date of 1 August is mentioned in field notes) turned up only 1 Nene and "a few rather fresh droppings for certain, plus some old sign" (Woodside field notes) (554-558). Later observations in September and October, showed a slow build-up in Nene numbers just prior to the breeding season when at least 9, including 2 banded as goslings the previous year, were found in the Keauhou area by 1 November 1958 (559, 560, 567-576). Search for nesting Nene and results of breeding intensified from 20 November to 26 April 1959 with a total of 33 days search effort (561-566), 578-780, 783-791). Of 8 active nests found, 2 were destroyed by predators, 3 were deserted, while 3 hatched out a total of 11 young (HDFG report); however, the number of pairs producing the 8 nests was in doubt since the eighth nest may have been the result of re-nesting by the goose which deserted Nest No. 2. Thus possibly only 7 pairs nested during the 1958/1959 breeding season.

The 1959-1960 breeding season which followed was noticeably less successful. Summer observations again revealed a largely vacant breeding ground until 18 September when the first pair was flushed (Woodside field notes) (781, 782, 792-799, 800, 801). However, 11 days of field

work from 30 September 1959 to 26 April 1960 turned up no active nests and only 5 young in 3 broods of 2, 2, and 1 goslings (802-824). Unusual dryness and perhaps a dense volcanic haze which lasted for about a month in January were mentioned as possible reasons for the decline in productivity (HDFG report) (824).

Hawaii Volcanoes National Park:

As might be deduced from the numerous records of Nene and their droppings seen at 3 Trees Kipuka in the late 1930's, as previously cited, most Hawaiian Geese observed in the Park in the 1950's were found in adjacent areas of PUU ULAULA and KIPUKA PAKEKAKE quadrangles not far from the end of the Mauna Loa Strip Road. A. B. Medeiros recalled seeing 1 or 2 Nene to the right of the truck trail at about 7,000 ft. elevation some 1.5 miles from the trailhead shelter, on or around January 1950 (Elder 1956 field journal) (978). Smith (1952) stated that 2 goslings and 1 adult were seen in 1950, and 3 reported in 1951 at the 6,500 ft. level in the same general area near the eastern boundary of the Park (907, 908). A flock of 7 Nene were variously reported seen and photographed near the end of the Mauna Loa truck trail (Strip Road) and the eastern boundary of the Park in June 1951 (Smith 1952, Anonymous 1952, Baker 1951, NPS report) (864, 909-911). A. B. Medeiros saw an unrecorded number of Nene at 3 Trees Kipuka in 1952 (Elder 1956 field journal) (912); and on 22 September 1958 saw 8 Nene near the silver sword plantation high up (8,500 ft. elevation) along the Mauna Loa trail (NPS report) (979).

Some 3 years later, Elder (1956 field journal) logged the sighting by D. Forbes of an adult with 1 gosling seen at 6,500 ft. elevation along the Mauna Loa trail about 8 October 1956 (913). On 28 April 1957, Woodside (field notes) saw 6 Nene flying low from 3 Trees Kipuka across the truck trail below the last bend toward "nest kipuka" in Keauhou Sanctuary (914). In November and December 1958 a series of some 21 observations of an unsuccessful nesting pair

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and searches of nearby areas were recorded by Woodside (field notes) and NPS personnel (915-923, 935, 980-982). In the same area near the end of the Strip Road, Woodside (field notes) checked twice for Nene in January 1959 along the "boundary flow" with negative results (933, 934). A NPS report stated that a pair was seen in that area in February (936), but the following year added that 3 Trees Kipuka was one of the few places that wild birds were seen during the 1959-1960 nesting season (937).

Lower down, in KILAUEA CRATER quadrangle, P. Breese saw a flock of 8 to 12 Nene flying on a course across the Kau Desert between the Crater Rim Road and Halemaumau on 25 September 1951 (1007). Anonymous (1952) mentions 5 Nene seen flying across Halemaumau Crater on 31 August 1952. A NPS report logged in Elder's 1956 field journal repeats this record and adds that a flock of 6 was seen the same day at a lower elevation at Hilina Pali (1008, 1009, 1027). A NPS report and Anonymous (1952) also recorded that 1 Nene was seen 5 September 1952 near the entrance to Bird Park (1010, 1011), the latter source stating that the observation of 7 in flight "over Kilauea" occurred on 11 September 1952 (1012). However, F. Waltjen reported that he never saw Nene in his 13 years of employment in the Park between 1944 and 1956 (Elder 1956 field journal) (865).

Kilauea District:

B. Waltjen reported seeing 2 Nene, perhaps from H. Shipman's flock at Keaau Ranch, in the Mountain View area on 25 March 1958, in the only record of Nene in this District during the 10-year period cited (NPS report) (1034). However, on 26 June 1956 A. DeLeres recalled seeing a Nene on the ground, perhaps a distant visitor from Shipman's flock, near the home of Manual (of Kukaiau) (Elder 1956 field journal) (1331).

Mauna Kea District:

UPPER PIIHONUA

The initial record of the 1949-1959 period seems to be the report by L. W. Bryan, relayed by R. Woodworth to Elder (1956 field journal), of 10 Nene seen by hunters on 13 July 1951 some 13 miles above the (Ola'a) flume Saddle Road crossing (1132). It is not known whether E. Wagner's sighting of 15 Nene in the Big Paddock of Puu Oo Ranch sometime in 1950 or 1951, preceded or followed the report by L. W. Bryan (Elder 1956 field journal) (1133). In June or July 1953, G. Halawaty saw 3 Nene several times and heard them at other times just south of the Saddle Road some 8 miles makai of the Humuula Road (Elder 1956 field journal) (1134).

Then, in the summer of 1954, HDFG discovered from a series of 20 field trips in July, August, and September that from 19 to 24 Nene habitually spent the night on a roosting ground near the junction of the 1935 lava flow and the Hilo Forest Reserve boundary fence along Puu Oo Ranch (HDFG report 1954) (1135). J. Lindsay noted 12 Nene flying across the Saddle Road near the Shipman telephone line that same year (1954) (Elder 1956 field journal) (1137).

The following summer and fall, from 28 July to 27 October 1955, D. H. Woodside and J. Ah San conducted a series of field observations that resulted in a much better knowledge of the Nene's flight pattern between their night roost on Puu Oo Ranch and their feeding grounds to the south, principally on the 1852 lava flow (1014, 1046-1048, 1053-1055, 1138-1179). The highest of some 25 daily tallies of Nene seen flying across the Saddle Road between roosting and feeding grounds that year was 24 observed near milepost 20 in July (Woodside) (1543); however, J. Veriato recalled later that he counted 28 some 1.5 miles south of the 18 mile marker on 7 August 1955 (Elder 1956 field journal) (1151).

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Observations of the periodic flight between feeding and roosting grounds continued by D. H. Woodside, A. F. Lee and E. Uemura during the summer and fall of 1956 resulted in a maximum of 28 Nene being seen during any one day (HDFG report) (1201). Recollections of various observers serve to amplify and confirm daily counts during this season (Elder 1956 field journal) (1182, 1184, 1185, 1187, 1191, 1193, 1194, 1197, 1199, 1200). Observations and recollections in 1956 extended over a period from late June to 10 September (HDFG report) (1045, 1056, 1180-1201). However, J. Veriato stated that although he spent 2.5 months at Ainahou and the balance of the year (1956) camping and surveying from Hilo to Kona, he saw no Nene (Elder 1956 field journal) (74).

A year later, Elder (1958c) stated that a cowboy reported 16 Nene counted in flights along the Saddle Road on 26 June 1957 (1203).

In 1959, no doubt as a result of sightings by Woodside and others, HDFG reported that 15 was the highest number of Nene counted on the Puu Oo Ranch roosting area or flying over the Saddle Road (1227), and added the following description of the annual Nene movement cycle (1227, 1228):

The bulk of the wild Nene on Hawaii followed the same general pattern of movements and activities as has been observed the last four years. They moved north of the (Keauhou) breeding grounds to the lava fields and Puu Oo Ranch lands during the summer, establishing a daily pattern of roosting north of the Saddle Road and flying south to the various flows mostly within the Upper Waiakea Forest Reserve in the mornings. After spending the day on the flows, they would return to the ranch area before dark. By September they began to return to Keauhou Sanctuary.

PUU OO

Sightings of Nene along the Puu Oo-Volcano trail south of Puu Oo Ranch to the Puu Kipu-Keawewai area are not usually specific enough as to locality to permit certain placement in any

one of three possible quadrangles - PUU OO, UPPER PIIHONUA, or KULANI. Because the Puu Oo-Volcano trail traverses only a corner of UPPER PIIHONUA quadrangle, and sightings in KULANI are normally referable to Keawewai in Kau District, observations of Nene along the Puu Oo-Volcano trail south of Puu Oo Ranch to Puu Kipu are included with sightings known to have occurred in Puu Oo quadrangle, as follows:

The initial record of Nene along the Puu Oo trail in the 1949 to 1959 period seems to be that of an illegally-captured Nene seized by HDFG personnel near the Puu Oo trail and 1852 lava flow (Waiakea Forest Reserve) on 30 October 1949 (Elder 1956 field journal) (839). Later, Elder (1956 field journal) logged a report that 2 Nene were seen along the Puu Oo trail by State Forestry people 2 miles south of the 1942 lava flow on 24 January 1950 (840, 841), apparently the same sighting cited later by Smith (1952) (1041, 1092).

Elder (1956 field journal) also documented several other observations of Nene flocks along the Puu Oo trail - the 3 October 1951 sighting of 10 by H. Baldwin, the 1953 Christmas season observation of 10 by H. Awai, and Awai's report that he saw a "small flock" in February 1954 (1043, 1097, 1098).

Nene were observed in many other localities in PUU OO quadrangle during the 1949 to 1959 period. R. Woodworth reported that hunters with binoculars saw a Nene on a cinder cone east of Pohakuloa on 17 November 1950 (Elder 1956 field journal) (1091). National Park Service files contain a report by P. Baldwin of a flock of 10 seen in the Humuula Saddle in August (1951), and another by A. Epes of 6 in flight in the same area on 24 February 1952 (1093, 1094).

In 1953 there were three reports of Nene in PUU OO quadrangle, all from observers interviewed by Elder (1956 field journal). L. W. Bryan saw

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5 including 3 young, all able to fly, at Puu Huluhulu in January; and H. Awai saw 6 on the ground above Ainahou (between Puu Huluhulu cinder cone and the old prison road camp) in October, as well as 10 on Ainahou Ranch 2 to 3 miles mauka of the Puu Oo trail at Christmas (1095-1097).

During the spring and summer of 1957, Elder (1958) recorded the size of Nene families observed flying across the Saddle Road on July 2, 7, 8, 9, 10, 14, 17, 23 and again on 10, 11, and 27 August (1204, 1206-1218). Interviews with local residents developed related information on their distribution including sighting of 16 on the ground on flats below (seaward of) Puu Oo Ranch below the telephone line (Elder 1956 field journal) (1202). At the conclusion of summer, Elder (1958) stated that the largest count was 35 ... "probably all or nearly all that remain alive in the wild today" (1219). The greatest number censused by HDFG biologists in the Puu Oo roosting area or flying over the Saddle Road in 1957 was 22 - a tally which HDFG stated should "not be considered a complete count" (1220, 1221). In 1958 HDFG reported finding evidence of Nene roosting on 1881 and 1852 lava flows which in past years were normally thought to be visited only during the day (1221-1223), thus reducing the significance of flight counts in estimating population size.

H. Baldwin (1958), after conducting unsuccessful watches for morning and evening flights for 3 days in mid-August at milepost 15 on the Saddle Road, cited D. H. Woodside as the source for saying that "nobody ... had seen the Nene use the flyway this year" (1224, 1225). HDFG later reported that the highest count of Nene flying from the Puu Oo roosting area over the Saddle Road in 1958 was 3 (1226), thus confirming the report cited earlier by H. Baldwin.

Reports of Nene in PUU OO quadrangle continued to be recorded by Elder (1956 field journal) from 1954 through 1956. H. Awai recalled

that in February 1954 he saw "a small flock" in the same locality where he spotted 10 a month or so previously (1098). In the summer of 1955, W. Kaneho remembered seeing 2 Nene flying to a cinder cone just north of the road to Pohakuloa (1099). J. Silva recalled seeing 8 Nene at the makai end of Kipuka Ainahou while hunting pigs in that area (1136). E. Uemura saw 3 Nene at Ainahou on 1 August 1955 (1101), and F. Pavao spotted 4 on Ainahou mauka on 30 July 1956 (Elder 1956 field journal) (1102), about the same time that D. H. Woodside found plentiful signs - droppings, down, and contour feathers - at most of the water holes near the jeep trail in the mauka section of Kipuka Ainahou (Woodside field notes) (1103).

Nene were seen in the summer range - 3 in Kipuka Ainahou in July 1957 and again in the summer of 1958 - which, along with droppings and small contour feathers, indicated considerable use of numerous semi-permanent water holes which had attracted Nene for many years (HDFG report) (1104, 1105). In the inspection visit to Kipuka Ainahou sometime during the 1 July 1958 to 30 June 1959 report period, droppings and feathers were again found in Kipuka Ainahou but no Nene were observed there (HDFG report) (1109). However, H. Shipman reported that his cowboys saw 2 adults and 4 young at 5,700 ft. elevation on neighboring Puu Oo Ranch a week or so prior to 25 April 1959 (Woodside field notes) (1108).

PUU KOLI

Farther to the west, A. Holt recalled seeing 2 Nene on a cinder cone opposite Pohakuloa from the old Saddle Road in the fall of 1949; while Y. Yamamoto remembered seeing 2 Nene 1 mile west and mauka of the end of the Kona-Hilo Road some 6 years later on 15 June 1955 (Elder 1956 field journal) (1065, 1066). In August 1958 3 Nene were found to roost on Omaokoili hill near the Saddle Road. Attempts to capture them at night with lights and nets were unsuccessful as the trio failed to return on successive nights

(HDFG report) (1106, 1107). H. Baldwin (1958) stated that 3 Nene were reported seen between Pohakuloa and Humuulu in September 1958 (1049). HDFG noted that 3 Nene, probably non-breeding 1-year olds, were seen on a small hill in the Saddle area in February 1959 (1050). While guiding a hunting party on 8 February 1959, J. Hansen reported approaching to within 3 feet of 2 adult Nene observed on top of an unnamed 6,515 ft. elevation volcanic cone 1.25 miles south of and bearing 216(degrees) (SW) from the junction of the Saddle Road and a lava road (in Mauna Loa hunting area adjacent to Pohakuloa) (Woodside field notes) (1057). A few days later, on 10 February 1959, Victorino (first name unrecorded) reported that he saw 5 Nene fly over the Saddle Road at about the 32 mile marker (Woodside field notes) (1068).

NAOHUELEELUA

Still farther to the west, L. W. Bryan remembered that he saw a pair of Nene along a military jeep trail near Greenwell Ranch in September 1950 (Elder 1956 field journal) (1058), probably a duplicate record of his recollection (Banko 1978 field notes) that he (Bryan) saw 2 Nene in a several hundred acre mamane-naio kipuka (Kipuka Alala) about 6,000 ft. elevation, land of Kaohē, on 19 September 1950 (1059). Simeona recalled seeing Nene in January years ago between Ahuaumi and Puu Oo, and Wm. Paris Sr. remembered observing this species along the trail from Waikii to the Judd Trail a long time ago (Elder 1956 field journal) (1060, 1061).

KEAMUKU

Elder (1956 field journal) recorded interviews with four local residents who recalled seeing Nene in KEAMUKU quadrangle. E. W. Low remembered seeing this species, presumably years previously, in the upper Keamuku lava flow at Kalawamauna in the saddle between Hualalai and Mauna Kea; T. Bell told Elder that he saw 2 or 3 some time in 1948 or 1949 at a tank near Puu Keekee only a few miles from the flock sighting of 1939 (1674) which was, he thought,

the probable remains of the flock after military occupation. R. Woodworth reported that R. Walker saw 12 fly makai at Waikii near the end of October 1951; and S. Kahola found a nest, presumably in 1956, on the trail mauka of the prison water tank near Kuaniho, some 4 miles from the main road (1288-1291).

Maui, Lanai, Molokai, Oahu, Kauai, and Niihau

There seems to have been no sightings of Nene reported on Niihau, Kauai, or Oahu during the 1949-1959 period. On Molokai, E. Meyer recalled seeing Nene at Rice Pond, Kawelo (?Kawela), and at the fish ponds at Kamilo (?Kamalo), presumably years previous to Elder's 1956 field journal entry (1411, 1412). Three Nene were reported seen by J. S. Medeiros in 1950 (once on 14 April) who expressed the view that they were a product of the flock established on Fagan's Ranch about 1936 (1398-1400). However, G. Schattauer told W. Banko in September 1989 that all of Fagan's Nene flock were ultimately returned to the donor, H. Shipman on Hawaii, and not released on Molokai. N. Carlson told C. Sundquist that he saw a pair of Nene at Meyer Lake (1,700 ft. elevation) ca. 1950; while Sundquist himself saw 1 at the brackish pond at Kalaupapa in 1951 (Elder 1956 field journal) (1404, 1405). Also, some time before the 1956 interview by Elder, E. Meyer stated that he saw Nene at the pond at Kamaloloa (Kamaloloa) (1406). C. Meyer reported seeing 3 Nene several times above Meyer Lake ca. 1954, and G. Robbins stated that he also saw 4 on the ground near Meyer Lake about the same year (1409, 1410).

On Lanai, 1 gander and 2 geese were released and seen for one month, presumably in 1951, with no other follow-up sightings reported on that island (Smith 1952) (1393). On Maui, however, J. Baker (1951) reported that 3 Nene were seen on the slopes of Haleakala (1346), thus raising the possibility that these were the same individuals released earlier on Lanai.

5. Chronological and Geographical Distribution of Records (1778-1959)

The vast majority of distributional records arranged chronologically below in Table 1 represent sightings of Nene raised in the wild. The thousands of sightings made of captive-reared stock liberated since 1959 contribute little to knowledge of the natural distribution of nene, and their chronology is therefor not considered here.

The pattern of records in Table 1 reflects the comparative fewness of reports from 1778 through the 1880's when populations were more abundant, a noticeable increase in sightings reported from the 1890's through the 1920's, and a veritable explosion of observations due to recollections and actual sightings compiled during the early phase of the research and restoration work carried out from the late 1930's through the 1950's.

1770's	3	1870's	4
1780's	1	1880's	5
1790's	2	1890's	41
1800's	0	1900's	45
1810's	0	1910's	32
1820's	5	1920's	56
1830's	0	1930's	127
1840's	10	1940's	169
1850's	1	1950's	612
1860's	5		

The eightfold increase of records from the 1890's through the 1920's was stimulated largely by visiting British scientists. Prof. W. H. Elder was responsible for interviewing scores of senior residents who recalled from personal experience the distribution of Nene from the late 1800's through the 1940's. The increase in actual Nene sightings in the 1930's and 1940's was due lar-

gely to the pioneering work of W. Donaghho, H. G. Craddock, and P. Baldwin in and near Hawaii Volcanoes National Park where Nene were "rediscovered" in July 1937 after a decades-long lapse in published field reports. The large upswing in records compiled in the 1950's largely mirrors the vigorous field activity which preceded and followed discovery of the first wild Nene nest in November 1956.

GEOGRAPHICAL DISTRIBUTION OF RECORDS (1778-1959)

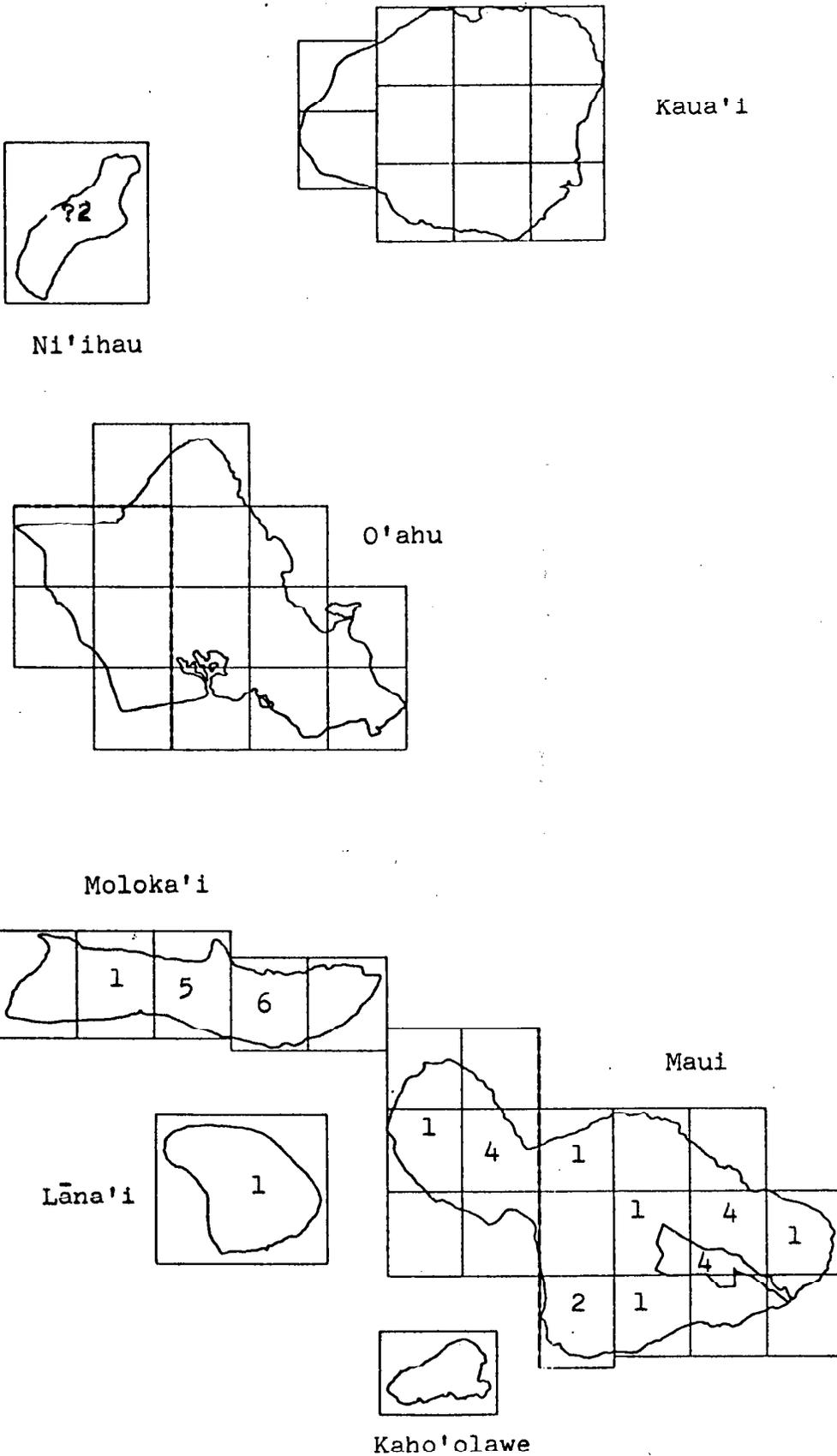
Geographical distribution of Nene observations and reports in the Hawaiian Islands is exhibited in Figs. 1 and 2. Of a total of some 1,464 serially numbered records on the major Islands from 1778 to 1959, some 1,007 (69 percent) are referable to single quadrangles on the island of Hawaii. The distribution of the 1,007 Nene records on the island of Hawaii by quadrangle in Fig. 2 exhibits the free-flying proclivities of this species which is actually faithful to a much more limited home range.

COMPLETENESS OF DATA, BIAS, ERRONEOUS AND DOUBTFUL RECORDS

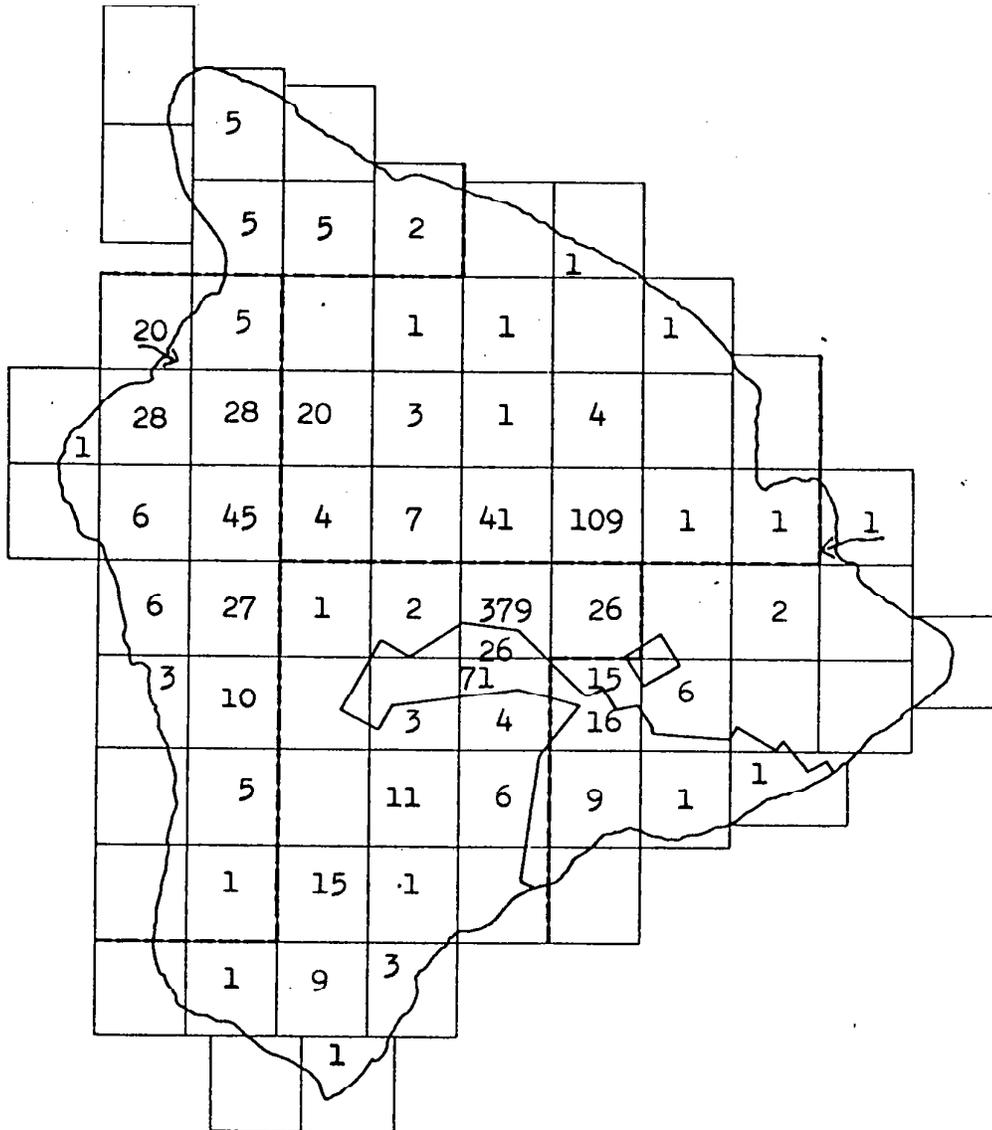
Lacking a practical definition of the term "record", it should be understood that the large accumulation of historical information contains a few negative, duplicate, and overlapping reports, questionable references from unstated sources and other qualified bits of information. It is believed preferable to treat all such "records" more or less equally with observations known to be fully creditable, rather than attempt to evaluate each one subjectively. While all information is obviously not of equal value, evidence based on weak records is usually readily apparent or supported by notes or recollections from other sources.

It should also be pointed out that summaries of Nene records presented in Table 1, Fig. 1 and Fig. 2 reflect an unnatural upward skewing of reports in and near Hawaii Volcanoes National Park.

Distribution of 34 Observations, Reports and Museum Records of *Nesochen sandvicensis*, per USGS quadrangle, on Major Hawaiian Islands (except Hawaii) from 1778 to 1959.



Distribution of 1,007 Observations, Reports and Museum Records of *Nesochen sandvicensis*, per USGS quadrangle, on the Island of Hawaii from 1778 to 1959.



This bias is due to increased reporting of government biologists and citizen Christmas Bird Counts following discovery of Nene in and near the Park in 1937.

Part II HAWAII STATE NENE RESTORATION PROGRAM (1949 to 1988)

1. Background (1902-1959)

In late December 1894 or early January 1895 H. W. Henshaw, an early-day naturalist of the Wheeler Survey (later the U. S. Geological Survey) arrived in Hilo, Hawaii in search of better health (Henshaw 1920). During his ten years of residence in Hilo, Henshaw (1902) became concerned over the dwindling numbers of Nene and began proposing various conservation measures to promote their welfare. For example, he seemed to be the first to suggest establishing Nene populations on other islands, stating "It would be an easy matter to introduce the Nene into the other islands, especially Maui, and no doubt the bird would thrive, if properly protected". Henshaw (1902) also proposed better laws to protect this species, stating:

... the districts frequented by the bird most of the year, though remote and inaccessible, are now often visited by sportsmen, and the Nene is rapidly diminishing in numbers ... as the present law stands, the open months ... from September 15 to February 1 ... when the killing of this goose is permissible, are almost precisely the ones in which it rears its young ... the law ... protects the bird when it least needs protection, and exposes it to slaughter when it is laying its eggs and leading about its young.

Blackman (1944) indicated that the doubly harmful open season was discontinued in 1907 "when protective measures were introduced". Further archival research is needed before a definitive description of hunting laws affecting Nene in the early 1900's can be written (R. L. Walker, pers. comm.).

The Territory of Hawaii's Board of Agriculture and Forestry became directly involved in Nene conservation when it decided to establish a captive flock at the Territorial Game Farm, Mokapu, Oahu in 1927 (Smith 1952). But by 1935, after the captive flock had increased to 42, the Board decided to distribute the captive birds among various plantation managers and Territorial senators, ostensibly, according to Smith (1952), not only to prevent disease from wiping out the flock, but "to stimulate interest in the Nene and to establish many small captive flocks from which breeding stock would always be available should the Board again decide to raise Nene under wire". However, after tracking the fate of some 31 of the captive Nene sent from Oahu to Lanai, Molokai, and Hawaii in 1935, Smith (1952) termed the effect of breaking up the flock "a distinct failure", and voiced suspicions that "political considerations" had entered into the decision to distribute the captive flock among private landowners.

Word of the Nene's precarious position began to trickle to the outside world in the late 1930's and early 1940's. Sir Peter Scott, Director of The Wildfowl Trust, Slimbridge, England became aware of the Nene's vulnerability during this period and arranged to borrow breeding stock from Herbert Shipman in Hilo to propagate this species for future release of the young in Hawaii. Progeny resulting from this transoceanic effort eventually resulted in release of progeny on Maui. Historical background and details of this experiment were later documented by Kear and Berger (1980). In the U.S., the National Park Service became concerned with the plight of endangered species on a national scale in the early 1940's sponsoring the book "Fading Trails" (Elliott 1942). A chapter devoted to the predicament of the Nene attracted the attention of conservationists and, in effect, supported the efforts of P. H. Baldwin who was already engaged in the initial investigation.

1902-1959

Baldwin (1945) was the first professional biologist to conduct serious field research on the precarious status of the Nene. His scientific investigations (Baldwin 1945, 1947) were carried out while employed by the National Park Service during the late 1930's and 1940's in what is now Hawaii Volcanoes National Park. He combined a scholarly search of the literature with citizen interviews and field observations to draw important conclusions regarding the Nene's past population size, distribution, and chances for survival. Baldwin's work thus furnished a solid, if limited, scientific base of information on which a sound Nene restoration program might be established.

The Territorial Board of Agriculture and Forestry's attention was again drawn to the plight of the Nene in the late 1940's as a result of an authorized survey. From February 1946 through July 1947, at the Board's request, C. W. and E. R. Schwartz (1949) conducted an 18-month game-bird inventory of the Hawaiian Islands, the stated objectives being to "ascertain the game-bird species present on the major Hawaiian Islands, their distribution and abundance, and factors upon which their welfare depends". The Schwartzes did not observe any Nene during their field survey but did recognize the practical problems involved in coping with the many inimical factors apparently causing the decline of this species, concluding that:

The most practical means for its restoration seems to be to secure breeding stock from captive birds and propagate this species as intensively as possible. An immediate study should be undertaken of this bird's life history and means of survival ... this wildfowl is the next Hawaiian, if not world, species facing imminent extinction ... to permit this tragedy to occur without exerting more effort than has been done to date is unparadonable.

Costs associated with the Schwartzes 18-month (1946-1947) game bird survey were borne by the federal government and marked the first of many annual grants made first to the Territory and then to the State of Hawaii for wildlife conservation

purposes. In return, the Territory and State were required to submit annual Federal-Aid Progress Reports to the appropriate federal agency - U. S. Fish and Wildlife Service - on all such cooperative projects. The Division of Fish and Game (re-named the Division of Forestry and Wildlife in 1979) was the agency designated by the State for the conduct of cooperative projects and submission of the necessary annual Progress Reports. The terms HDFG (Hawaii State Division of Fish and Game) and HDFW (Hawaii State Division of Forestry and Wildlife) are used interchangeably hereafter.

A short time later, in 1948, J. Donald Smith became the first full-time Federal-Aid biologist to serve the Territory of Hawaii. Although he took an active role in the establishment of Nene breeding flocks, he was not unaware of the many difficulties which would have to be surmounted in carrying out a successful long-range Nene field research and restoration program. He had already investigated the abortive Mokapu Game Farm experiment, reporting that when Nene were needed to start up the breeding program at Pohakuloa in 1950, only 1 gander (at the Honolulu Zoo) of the 42 distributed in 1935 and 1936 was available for transfer (Smith 1952).

Smith (1952) set forth his frank opinion of the problems involved in restoring Nene populations, as follows:

The establishment and operation of the present Nene farms (at Pohakuloa, Hawaii and Slimbridge, England) is only a partial solution to the problem of averting the Nene's extinction. No matter how successful this phase becomes (and it is very likely that many geese will be produced by this work as they are not difficult to raise) the danger of the Hawaiian Goose becoming extinct will not be removed.

There are two basic reasons for this: (1) the same influences operating against the Nene's survival will continue to affect the Nene released into the wild and perhaps even to a greater extent than on the existing wild birds; and (2) the continuity of the restocking phase at Pohakuloa depends upon the attitude of the successive Commis-

1949-1959

sioners of the Board of Agriculture and Forestry. Since the members of the Board once before successfully raised Nene at their game farm and then discontinued the program after seven years, the example appears to prove that the present venture cannot be considered basically stable. The history of European Nene propagation also demonstrates serious basic shortcomings in the attempts to save the Nene by producing them under wire.

The only effort which is likely to produce lasting and concrete results in conserving the Nene is that directed toward discovering the factors responsible for the nene's population decline. An ecological study properly conducted of the wild Nene will produce a knowledge of the nene's life history that no change in attitude of a political agency can effect. It will provide a foundation upon which public service agencies and private organizations can act swiftly and surely either in cooperation or singly to form a Nene conservation program basically sound and continuous in duration and effort.

In his pioneering paper proposing restoration of wild Nene flocks, Smith (1952) outlined the parameters and ultimate goal of a successful rehabilitation program, concluding:

Apparently this entire program is slowly being shaped, and it is hoped that within a few years Hawaii can boast of a sound Nene conservation program that will make possible substantial and rapid progress toward the ultimate objective of building the wild Hawaiian Goose population to a satisfactory level and maintaining that level through intelligent management.

Thus it was that a dedicated long-term involvement of the National Park Service, Sir Peter Scott of The Wildfowl Trust, and financial support from the U.S. Fish and Wildlife Service coalesced under the leadership of J. Donald Smith (Territorial Division of Fish and Game) to initiate a program of restoration and maintenance of wild Nene populations. Conservation forces which had been only intermittently active during the preceding 50 years had finally established a unified program with cohesive goals. J. Donald Smith's leadership unfortunately ended in 1952 when he accepted a position with the USFWS. Smith served that agency with distinction until 1967 when he died in a tragic helicopter crash

while conducting a waterfowl survey in Minnesota.

In the mid-1950's actual field work was notably slow in getting underway following authorization of federal aid for Nene surveys by the Hawaii State Division of Fish and Game. HDFG Project 5-R-6, Job 24, report stated that a "Limited Ecological Survey of the Hawaiian Goose" was scheduled for fiscal year 1954-1955, but results were simply reported as "inactive most of the year". Not much progress was reported in 1955-1956 either, only a few sparse notes on Nene foods and behavior being recorded, though local residents were urged to furnish information on Nene numbers and habitat. No field observations were reported the third year, 1956-1957, but it is known that D. H. Woodside carried out extensive field surveys - some in conjunction with Prof. W. H. Elder who arrived in the summer of 1956 to devote a year's sabbatical leave to Nene research.

During his brief stay in Hawaii, Prof. Elder extended the scope of Baldwin's population studies, collected food habits material, conducted field surveys and interviews and, most importantly, made the results of his technical investigations quickly available in the form of conservation suggestions. Results of Prof. Elder's work proved pivotal in establishing the early scientific thrust of the State's field research effort.

On 17 April 1957 the Territorial Legislature declared the Nene "emblematic" of Hawaii.

Serious biological investigations of wild populations began to be reported in 1957-1958 with the appointment of D. H. Woodside as HDFG field biologist. According to successive annual Federal Aid reports in the late 1950's, Woodside was not only directed to conduct Nene field surveys during this early period, but to coordinate all activities with that of the Pohakuloa propagation project and other less well-defined

1949-1959

duties of the Division as well. These added responsibilities significantly reduced time available for field investigations as the less informative reports of the late 1950's bear witness.

While the attempt to restore wild Nene populations actually began with the assembly of breeding birds at Pohakuloa in 1949, the release of captive-raised stock was not initiated until 1960. There was thus a period of some 11 years after Nene were first placed in pens at Pohakuloa before their progeny were released in the wild - a period when all field observations and recollections of their former presence applied exclusively to natural wild stock. To preserve the identity of this body of information all of the population and distribution data, collected mostly by Elder and Woodside, was organized by district and locality and presented earlier (Part I.(4) Distribution of Relict Populations, 1949-1959). Population data resulting from direct observations by Woodside and successive HDFG biologists from 1957 to 1988 were reorganized for the comparative analysis presented later.

2. Initial Propagation, Field Activity and Funding (1949-1975)

Smith (1952) credited the Territorial Board of Agriculture and Forestry with establishing a Nene propagation facility at Pohakuloa in 1949. Elder and Woodside (1958) recognized the efforts of J. Donald Smith in motivating the Board to act.

To follow the suggestion by Schwartz and Schwartz (1949) that Nene be propagated "as intensively as possible", two pairs of Nene were obtained on loan from Herbert Shipman and placed in pens at Pohakuloa, Hawaii in August 1949 (Smith 1952). A third pair composed of a gander loaned by the Honolulu Zoo, and a wild-caught goose was added to the small flock in 1950. The immediate objective of this propagation venture was to "produce 50 geese a year to be released into the wild to restock the natural

1949-1975

range". However, only one of the captive pairs proved productive and only 5 goslings were produced during the first two years of operation.

Although details are lacking, a "Nene Advisory Committee" was established in the early 1950's to guide management of the captive Nene flock at Pohakuloa. As Chairman of the Advisory Committee, Paul L. Breese's reports to then HDFG Director Vernon Brock, included detailed descriptions of problems in producing Nene at Pohakuloa (for further information on Pohakuloa's early history see State files).

The first Federal-Aid report following Elder's year of field effort (1956-1957) documented a greatly increased level of observational activity, including habits of Nene where they had previously been observed, investigations of areas where they had been reported seen by others, and banding wild goslings in the newly established Keauhou Sanctuary. Supplemental federal funding for the burgeoning program was discussed for the first time, as follows:

The Territory of Hawaii, under a separate Federal contract, has embarked on a new five-year program for the restoration of the nene. This program has three areas of activity: 1) raising of captive nene for release into the wild, 2) the management of areas set aside as Nene sanctuaries, and 3) determining numbers, movements and ecological data of wild nene.

A biologist and an assistant are assigned full time to the program; however, there will be times when additional field personnel will be necessary.

It is recommended that this job be continued but reduced in scope to include assistance to the overall nene program in area 3 of the above activities. Future work under this job would then be integrated with the overall program.

The ambiguity of the last paragraph tended to obscure rather than reveal where the emphasis of the proposed increased effort was to be placed. However, the fact that the Pohakuloa breeding flock had been increased to nearly full strength - a total of 39 Nene had been reared by 1957/58 -

1949-1975

indicated that the two full-time biologists and necessary additional personnel were to be assigned exclusively to studies of wild nene.

A later staff report, "The Hawaiian Goose Project", presumably written in late 1959 or early 1960, proposed a contract with the federal government which would allot the State of Hawaii \$15,000 annually for Nene research, propagation and management. Inspection of work and audit of funds was to be accomplished through the Regional Office, U.S. Fish and Wildlife Service, Portland, Oregon. Proposals for continuation of work were to be prepared annually by the Contractor (State of Hawaii) with progress reports to be submitted by the State to the federal government on a quarterly basis. The initial proposal was scheduled to reach the Regional Director's office by 1 March 1961.

A short time later a staff report dated 3 May 1961, sought then-Governor Quinn's support for U.S. Senate Bill 997 which proposed elevation of the annual budget of \$15,000 allotted in 1958 to a new \$25,000 5-year program. The staff report stated that the \$15,000 sum "had been deemed inadequate by U.S. Fish and Wildlife Service officials in charge of the project", and that "in order to do both phases of the job properly, the propagation phase ... as well as the ecological study ... additional personnel are needed". The report continued:

At the present time, two people are assigned to this project and we do not get enough time in the field and it is extremely hazardous and dangerous to the men to go out in the lava country alone in search of wild birds and nests. Therefore, they recommend the increased appropriation so that a third person can be put on the job, new equipment can be obtained, and money can be made available, if necessary, for leasing or purchasing sanctuary sites to protect the nene.

The plea for more monetary support was evidently satisfied, at least no call for additional funding was found in reports for the 13-year 1961/62 to 1973/74 report which followed.

The Federal-Aid Report for 1974/75 briefly reviewed the history of funding the Nene Restoration Program, acknowledged that it was supported by an annual appropriation of \$25,000 beginning in 1968, but made no mention of field studies, stating:

The availability of funds permitted the development of a plan to study the ecology of the nene, as well as continue with the propagation of nene at the Pohakuloa facility for release to the wild. An integral part of the restoration program was the establishment of sanctuaries to protect areas of significant value to nene, and to provide release sites for pen-reared nene.

The subject of federal financial help was not addressed again in Federal-Aid reports, leaving in perpetual doubt the number of biologists, if any, ever assigned to full-time field studies. In fact, the absence of any account of the State Nene field study effort in any professional journal during the 40+ year history of Nene restoration effort indicates that over a period of many years, successive biologists have been assigned to study Nene only on a part-time basis.

3. Establishment and Management of Sanctuaries (1958-1988)

The seeds of the present Nene sanctuary system were sown by Smith (1952) who pointed out the need to acquire and manage such areas. Elder and Woodside (1958) justified creation of Nene sanctuaries by making protection of Nene on their breeding grounds a management cornerstone, writing:

First - The only known breeding ground (Keauhou Ranch) must be kept intact and relatively free of disturbance from September through April each year to protect nests, flightless young and molting parents ... agreement has already been established between the Bishop Estate owners of the land - C. Brewer and Co. who are managing the area as a cattle ranch under a 30-year lease, and the State Board of Agriculture and Forestry ...

For this area to function, it should have vigorous control of exotic predators - cats, dogs, pigs, and mongooses - all of which are nearly universal in Hawaii ...

1958-1988

The 4th and last objective of Federal-Aid Progress Report W-5-R-8, dated 15 March 1957, also recognized a need to liberate captive-raised stock in "suitable, protected Nene habitat".

Brief descriptions of the four Nene sanctuaries subsequently established and their current status are as follows:

A. Keauhou Nene Sanctuary:

Keauhou Ranch, owned by the B. P. Bishop Estate, is a multi-thousand acre cattle operation located roughly between 1219 and 2438 m. (4000-8000 ft.) elevation on the northeast slope of Mauna Loa adjacent to Hawaii Volcanoes National Park. The 10-year cooperative agreement referred to by Elder and Woodside (1958), granted Territorial biologists access to some 3,281 hectares (8,100 acres), more or less, of Keauhou Ranch lands "for the purpose of preserving, protecting, conserving and propagating the nene (or Hawaiian goose) ...". By Agreement signed April 2, 1958, it was mutually understood and agreed that the Territory would administer and use the land for a wildlife refuge only; post warning signs, patrol and exclude unauthorized persons; retain the right to conduct research including trapping, banding and other protective wildlife practices, and to control all feral animals (goats, pigs, dogs, cats, etc.) by poisoning or shooting. For its part the Ranch owners and Manager agreed to obtain advice from State officials on how best to minimize inimical effects on Nene prior to permitting hunting or making any major changes in the area. The owner and manager also retained the right to invalidate the Agreement for any portion of land described in the Agreement for any purpose whatsoever provided the Territory was given 30 days notice prior to such invalidation.

The Agreement duly expired in 1968. State officials have been unsuccessful in negotiating for renewal in recent years.

B. Keauhou 2 Nene Sanctuary:

Keauhou 2 Sanctuary lies at 1581 m. (5,200 ft.) elevation on the flat plain between the western flank of Mauna Loa and the eastern slope of Hualalai. This vast 5,135 hectare (12,678 acre) Sanctuary is superimposed on lands leased from the owner, B. P. Bishop Estate, by W. H. Greenwell, Ltd., for cattle range.

The understanding reached in the Keauhou 2 Nene Sanctuary Agreement was much the same as that stipulated for Keauhou Ranch. Additionally, W. H. Greenwell, Ltd. required that in each and every instance, it be notified prior to entrance on its leased lands by any designated person; that use of Greenwell, Ltd. roads would not constitute the general opening of such road to the public or the State; that an annual rental fee based on taxes for the area be paid; that Greenwell, Ltd. and Trustees would not be held liable for any fence construction or maintenance cost; that not more than one cabin be built; and that the Agreement would be subject to any interests which the United States Government may have in the areas covered. The foregoing Agreement became effective on the day executed, May 11, 1961, but coverage was not to extend beyond December 31, 1965, the expiration date of the Greenwell, Ltd. lease from B. P. Bishop Estate.

A similar Agreement, retroactive to January 1, 1966, was executed February 14, 1975. This second Agreement is currently in effect, terminating December 31, 1999.

In January 1977, the Division of Fish and Game became interested in acquiring a large parcel of land, including lands in the Keauhou 2 Sanctuary, for Nene preservation and hunting of feral animals, but this acquisition was never consummated.

C. Kahuku Nene Sanctuary:

Superimposed on the lands of Kahuku Ranch, the 8,100 hectare (20,000 acre) Nene Sanctuary

includes only a roughly 2,430 hectare (6,000 acre) strip of significant Nene range between 914 and 2,134 m. (3,000 and 7,000 ft.) elevation along the upper edge of the Ranch pasturelands. A 10-year Agreement between the Samuel Mills Damon Estate and the State Board of Land and Natural Resources, technically similar to those for the Keauhou and Keauhou 2 Sanctuaries, was executed April 15, 1967. State officials have been unsuccessful in negotiating for renewal in recent years.

D. Kipuka Ainahou Nene Sanctuary:

The 15,552 hectare (38,400 acre) Kipuka Ainahou Nene Sanctuary was created by the State of Hawaii in 1973 by combining some 11,047 hectares (27,277 acres) of Mauna Loa and Upper Waiakea Forest Reserve lands with 4,505 hectares (11,123 acres) of Hawaiian Homes Land which had already been set aside for a Public Hunting Ground and Game Reserve. Lying between 1,707 and 2,743 m. (5,600 and 9,000 ft.) elevation in the saddle between Mauna Loa and Mauna Kea, this large Sanctuary provides Nene with year-round habitat comparatively near its principal breeding grounds to the south in Keauhou Sanctuary and Hawaii Volcanoes National Park. Along with other wildlife sanctuaries cited in Title 13 of Hawaii State Code, the Kipuka Ainahou Nene Sanctuary is administered under rules intended to "conserve, manage and protect indigenous wildlife." Exceptions to a long list of prohibitions in the Sanctuary include permission for archers without dogs to hunt for feral pigs, sheep and goats from March to October each year, and travel at any time by foot or horseback along the Puu Oo-Volcano trail, including during the Nene breeding season (November through February).

E. Haleakala National Park:

Hawaii State Nene restoration activities on the island of Maui were initiated in 1962 when captive-raised stock were first released in Haleakala National Park by pre-arrangement with the National Park Service. Verbal agreements between

State and Federal officials served to support the necessary conservation activities until December 20, 1979, when representatives of the appropriate agencies signed an automatically renewable 5-year agreement for inter-agency cooperation, presently in force.

Under the terms of the Inter-agency Cooperative Agreement, the Park Service essentially agrees to permit the State to release Nene, conduct censuses, and trap or shoot feral predators in the Park (subject to regulations); use the Paliku Patrol Cabin under certain conditions; and otherwise materially support State Nene restoration activities on a time and resources available basis. In return, the State agreed to submit an annual report of its activities in the Park to the Superintendent, Haleakala National Park, and conduct all activities in accordance with all applicable State and Federal laws and regulations.

4. Habitat Surveys - Island of Hawaii

Promising survival and breeding success of captive-reared stock released in the 1960's led naturally to the need for more sanctuaries, hence the habitat surveys of the early 1970's. Three studies drafted for execution in 1970/71, 1971/72 and 1972/73 (Projects 1958-1988 W-15-1 to W-15-3), proposed the "Evaluation of habitat conditions as related to nesting and seasonal movements of known populations of Nene on the island of Hawaii", but all three were rejected after re-evaluation of research objectives and job priorities. Three similar studies (Projects W-15-1/I-D,1,2,3) with the long title "Inventory of habitat not currently being surveyed which may be utilized by Nene and may be suitable for restocking with pen-reared Nene on the island of Hawaii", restated the forseen need by suggesting that Nene range could be delineated by using cover-type maps and conducting surveys by helicopter and on foot. Objectives of the three studies were to 1) survey areas not currently being monitored for the presence of Nene, 2) inventory habitat for re-

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stocking with pen-reared Nene, and 3) recommend portions of these areas for preservation as Nene sanctuaries. After approval, the foregoing projects were pursued in 1970/71, 1971/72, and after a year's delay, again in 1973/74.

A base map showing potential Nene habitat was developed in 1970/71 from Forest Cover Type maps prepared by the Division of Forestry showing potentially useful habitat around the periphery of Mauna Loa. Maps were prepared delineating habitats to be surveyed by helicopter and on foot.

Surveys of new and previous surveyed habitats were carried out in 1971/72. The areas most intensively searched were the northeastern and eastern slopes of Mauna Loa. After searching for Nene in this vast area however, biologists concluded that the area was of only marginal value to Nene. Sparsely scattered old droppings and feathers, indicating only sporadic use by Nene, were found in the Hawaii Volcanoes National Park area to the west and south of Keauhou Sanctuary. The western slopes of Mauna Loa were also examined. Habitat on the C. Q. Yee Hop Ranch was judged inadequate, but pastures between 6,500 and 8,000 ft. elevation on the McCandless Ranch appeared to be more promising though no Nene were actually observed. In conclusion, surveying biologists felt that McCandless Ranch lands held "the greatest promise of making a good Nene sanctuary and should be explored further".

In 1973/74, resurvey of the western portion of Kahuku Ranch south of C. Q. Yee Hop Ranch, turned up only scattered signs, indicating that Nene used this area only occasionally, "probably during their summer wandering period." Survey of Milolii farm lots in South Kona was negative. The most promising area monitored in 1973/74 was the eastern portion of the U.S. Army's Pohakuloa Training Area on the gentle north-facing slopes of Mauna Loa where "a brood and an old nest were discovered on an unnamed hill

at the edge of the impact area." Other observations indicated that Nene used this habitat throughout the year, particularly during the breeding season, and that there was other suitable habitat on hills and kipukas along the eastern edge of the Army impact area. The proximity of the Kipuka Ainahou Sanctuary and release pen, reporting biologists felt, diminished the value of this area as a potential release site, but "Nene can be expected to extend their range into this area as the Kipuka Ainahou Nene Sanctuary becomes saturated with stock."

In 1975/76, marginal habitats in South Kona were examined and more comprehensive surveys of McCandless Ranch lands were made. Although McCandless Ranch lands again appeared to be the most likely candidate, Ranch management was found to oppose "development of a Nene sanctuary on any part of their holdings."

R. Shallenberger (1977) and associates conducted a biological survey of the U.S. Army Pohakuloa Training Area, island of Hawaii, from late November 1976 to January 1977, stating of Nene that:

None were seen on the survey but their droppings were present in the east end of Area 1, in the SW portion of the Impact Area, and in Area 9. Nene leg bones were among the skeletal material found in an early Hawaiian sleeping cave in Area 7. Extensive survey with the assistance of State biologists Nelson Santos and Miles Nakahara failed to turn up any other recent evidence of Nene at PTA. However, the condition of typical food species (i.e. ohelo, kukae-nene, etc.) was very poor during the survey. Santos (pers. comm.) suggested that Nene probably would not use habitat within PTA regularly unless there was adequate food to sustain them over extended periods. Although our survey was extensive, the atypical rainfall conditions make it unwise to conclude that PTA is not important Nene habitat.

Four State Nene sanctuaries have been established within suitable habitats around Mauna Loa. Two of these (Kipuka Ainahou and Keauhou 2) are very close to PTA on

east and west boundaries ... 1 record of nesting near the east PTA boundary is noteworthy. Two nests were found during the 1974-1975 season on a small puu (Puu 6677) just east of the Area 8 boundary (Grid 37, 38-78, 79). This puu, sparsely vegetated with mamane and naio, is isolated by a wide expanse of barren pahoehoe lava. An adult pair with 2 young were observed on the puu. State biologists indicate (Job Progress Report W-15-4, Job I-D-3) that "other hills and kipukas along the eastern edge of the Impact Area also have suitable habitat" (77).

A Federal-Aid Progress Report filed by HDFG biologists during the 1976-1977 period (Project W-18-R-2, Job R-I-B) commented on Shallenberger's survey of PTA as follows:

Extensive surveys were made into nene habitat that is part of the Pohakuloa Training Area, and also areas adjacent to it. The field staff accompanied Department of Defense personnel who were collecting data for an environmental study of the training area. Two helicopters were made available for these surveys, making it possible to search the more remote areas for signs of nene. The entire portion of this slope of Mauna Loa thought to provide adequate nene habitat was thoroughly searched on foot. No droppings, feathers, or any other signs of nene were discovered by the members of the search crew. Apparently nene fly over this area but there was no evidence discovered to show that they utilized this habitat (78).

On the windward flank of Mauna Loa, working over a period of many weeks in 1977, members of a USFWS forest bird inventory team reported (Scott, et al 1986) a total of 133 Nene sightings, 90 made during an unstated number of eight minute counts and 43 during off-period tallies. During their survey members of the team made many observations of Nene flying between foraging and roosting areas throughout the study area (mostly at elevations above 5,000 ft.) on 7 of 21 transects but only 0.86 percent of an unstated number of 8-minute counts conducted (79, 80). No estimate of the total wild population utilizing the study area on Mauna Loa's windward flank resulted from this survey.

5. Habitat Surveys - Maui

Habitat surveys on Maui were initiated in June 1960 when a HDFG field biologist from the island of Hawaii paid a visit to Haleakala National Park. The pertinent Federal-Aid progress report furnishes no details of what was probably only a brief "eyeball" evaluation, stating "it was determined that there are still some 9,000 acres of excellent nene habitat ... and an additional 30,000 acres of poor to good habitat ... and that releases of pen-reared nene should have a good chance of success." The initial introduction of captive-reared Nene was made in Haleakala Crater two years later, in July 1962.

Although habitat surveys on Maui were not conducted as systematically as on Hawaii, Nene were eventually sighted in habitats other than in Haleakala Crater where the original releases of captive-raised stock were made. For example, the 1977/78 Federal-Aid Progress Report noted:

1. A 1976-released Nene was sighted during a survey of Kaupo Ranch lands. Ranch residents reported that this particular individual had been observed for nearly a year, and in the company of another bird on several occasions.
2. Another 1976-released Nene was captured by a farmer on his Kihei property in July 1977 and again released by HDFG at Paliku. A few months later a Haleakala National Park released individual was caught in an unreported locality and re-released in the crater.
3. On a survey trip of Haleakala's southern slope, 3 nene were seen in flight over the Waiapai area of Haleakala Ranch below Kahikinui forest.
4. Two nene were observed near the Kahua's hunter shelter and others were heard in the area below but were never located during several survey trips into the Kahua and Kahikinui areas.
5. Recommendations were made at conclusion of reporting year 1977/78 that more surveys should be conducted the fol-

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lowing year on lands of Haleakala, Ulupalakua and Kaupo Ranch. In 1978/79 most of the Nene observed in habitats outside Haleakala Crater were seen in mid to late fall, for example:

A pair of birds was observed flying over the Haleakala Highway below Pukalani headed in the direction of the Crater. In November, while manning the Kula hunter check station, a pair was sighted on several occasions flying over the Kula Game Management Area. Bird hunters reported sightings of a pair of Nene along the access road above the Polipoli State Park and an area known as "Baseball Park". During survey trips into the Kahua and Kahikinui areas, two birds were seen again in the vicinity of the Kahua hunter's shelter. Several follow-up checks of these various areas of nene sightings indicated that the birds were not permanently established in a new area. However, the sightings seemed to indicate frequent nene movements outside of the Crater area prior to the breeding season. Speculation is that these flight movements may be part of the pre-nesting courtship behavior of Nene in the "wild".

As reported the previous year, most Nene sighting outside Haleakala Crater in 1979/80 were made in mid to late fall.

Several pairs were seen flying over the Kula Game Management Area in November during the game bird hunting season. An immediate check verified a report of three unbanded Nene at "Baseball Park". Tracks and droppings indicated that the birds had been there for at least a week. A search of the area produced no evidence of nesting. No birds were seen following a check three days later, and these birds were never seen again on subsequent visits. It appears that the greatest movements by Nene in terms of distance occur immediately prior to the onset of the breeding season.

In 1980/81 several pairs of Nene were seen flying over the Kula Game Management Area in November, and a pair of 1977 Hawaii (Pohakulo-reared) released birds attending 2 fledged goslings were seen 25 June 1980 in the "Ballpark" area.

In 1981/82, Nene were seen in flight over the Kula Game Management Area by the person

manning the hunter check station in November. A pair of Nene reported by a hunter near the shelter could not be found during a check of the area. Thus, as in previous years, Nene were sighted outside of Haleakala Crater most frequently just prior to the onset of the breeding season.

In 1982/83 Nene were heard flying over the Kahikinui Game Management Area on the southern slopes of Haleakala in October.

The birds could not be seen due to a thick cloud cover. The occasional presence of nene in the area was evidenced by their droppings and feathers in the higher grassy meadows. Sightings of nene in flight over the public hunting area continue to be reported in November. Again, as reported in previous reports, nene sightings outside Haleakala Crater most frequently are made just prior to the onset of the breeding season.

In June, a single unbanded nene was seen for at least three weeks in the upper pasture of Haleakala Ranch along the Crater Road. This nene could be one of the wild birds frequenting the National Park Headquarters' yard area.

In February 1984 a pair of Nene, one banded, was observed in the lower pastureland of Kahikinui. A search of the immediate area resulted in no evidence of nesting.

In February 1985, unbanded Nene were observed in the Haleakala Ranch pasture above the eucalyptus grove. They remained in the area for about two weeks.

The foregoing records indicated that at the outset of the breeding season liberated captive-reared Nene frequently ranged beyond the confines of the Crater to the outer slopes of Haleakala.

6. Habitat Improvement - Island of Hawaii

As will be shown later, the period from the late 1970's to mid-1980's was characterized by a prolonged drought which resulted in a severe shortage of Nene foods. Federal-Aid progress reports describe the effects of the drought, not

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only in reducing productivity of breeding pairs but in causing their widespread dispersal from traditional breeding grounds. This prolonged emergency resulted in a sustained effort by HDFG biologists to supply survivors and newly-released Nene in the sanctuaries with food and water by whatever means necessary.

The earliest effort to furnish wild Nene with additional nutrition was the packing of scratch feed to young wild goslings and their parents in the Kipuka Ainahou area in 1979/80. The Federal-Aid progress report of this period describes the decision which followed discovery of 2 breeding pairs and their young on a small isolated hill located on the eastern edge of the U.S. Army (Pohakuloa Training Area) impact area about 1 mile south of the Saddle Road and Puu Nene, as follows:

This small Puu (6677) was rather barren and surrounded by miles of aa and pahoehoe lava; therefore, it was decided that supplement feedings were the best way to insure the survival of the two broods totaling 5 goslings. Scratch feed was packed in weekly and scattered in various locations ... accepted immediately by the adults and, apparently, by the goslings as well ... all five goslings survived and fledged.

Habitat improvement of Puu 6677 continued in the years that followed. A water unit was installed in 1981/82 and frequent use was subsequently noted. Pualele was harvested by hand at Pohakuloa and Puu Nene and back-packed to Puu 6677 to supplement scratch feed. Adults and goslings were observed feeding on these greens as soon as they were offered. In 1982/83 a U.S. Army helicopter crew assisted in transporting a 450 gallon fiberglass water tank to Puu 6677. Installation of an automatic float valve in 1983/84 made water available to Nene on a continuous basis. Supplies of crushed coral which had become depleted were also replaced with an additional 50 pounds in 1983/84. Some 50 pounds of scratch feed was being taken every 2 weeks in 1984/85, and the feeder was serviced regularly the next 3 years. A 900-gallon water tank, catchment, and feeder was set up in

1987/88. With the successful fledging of the 5 goslings at Puu 6677 in 1979/80, recommendations were made to implement habitat improvement practices at other sanctuaries.

At Kahuku Sanctuary approximately 3 tons of crushed coral and 18 bags of fertilizer (0.75 ton) was spread over 3 acres around the release pen in January 1981. This attempt to improve Nene nutrition may have been influenced by capture of 2 adults in emaciated condition (diagnosed as a vitamin deficiency) at Kahuku in 1968/69. Vegetative samples taken after fertilization showed an increase in protein, fat, and mineral content, especially phosphorus and potassium over samples previously obtained. Sites for improvement at Kahuku were plotted and prepared again in 1981/82. Habitat improvement activities were increased in 1982/83 when a 3-acre enclosure was fenced and planted with kikuyu grass; a self-feeder was established and filled with scratch feed; a reservoir site was deepened; and crushed coral was made available. Evidence later indicated that Nene visited the enclosure but did not stay apparently due to a periodic lack of water. Nor was any sign of nesting noted among the several groups of Nene observed. In 1985/86 the reservoir installed in 1982/83 was re-lined with a different fabric and recovered with Chevron Industrial Membrane. Self-feeders were serviced regularly that period and for the following two years.

At Keauhou Sanctuary, previously established food plots and a water impoundment were monitored in 1981/82. In 1982/83 the impoundment site was cleaned, lined with Chevron Industrial Membrane and equipped with two layers of fog condensation netting for a water source. The resulting water impoundment was later found to have received very heavy usage by Nene during the entire year. The self feeder was also found to have been visited daily by Nene with 50 pounds of scratch feed being consumed in a 2-week period. The kikuyu grass plot showed signs of heavy grazing, requiring fre-

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quent fertilization. Kukae-nene (*Coprosma er-nodeoides*) was also planted in the enclosure in 1982/83. Inspection of the area in 1983/84 revealed that the reservoir was visited extensively by Nene and that consumption of scratch feed at the self-feeder continued at the heavy rate of 50 lbs. every 2 weeks. Use of the reservoir, scratch feed, and kikuyu grass was also reported heavy the following year - 1984/85. In 1985/86 the reservoir at Keauhou was relined with a different fabric and recovered with Chevron Industrial Membrane. Self-feeders were serviced regularly in 1986/87 and 1987/88.

7. Predator Control

Smith (1952) seems to have been the first to recognize the "almost hopeless" vulnerability of Nene to dogs and pigs during their annual month-long moult of flight feathers. Elder and Woodside (1958) were also well aware that for the sanctuary concept to fulfill its intended purpose, establishment and maintenance of an effective predator control program, as well as exclusion of hunters and dogs was essential, stating:

Effective control of all 4 species (cats, dogs, pigs and mongooses) could be attained by systematic spreading of poisoned meat baits in the little isolated kipukas utilized by Nene ... but out of sight of the Hawaiian Hawk ... one hunter was apprehended with a live Nene which his dog had caught there October 30, 1949. Two other first-hand accounts of dogs catching wild, full-winged Nene were secured.

Elder (1958c) added, "it is regrettable that (effective predator control) was not carried out before the last breeding season and it is strongly recommended that this not be permitted to escape attention again."

In spite of the foregoing statements, the various Federal-Aid Progress Reports from 1960 (when captive-reared stock was first released at Keauhou Sanctuary) to 1987/88 contain only intermittent references to control of predators in various units of the sanctuary system. Table 2 lists original language reports of predator control

activities carried out on the various sanctuaries by report year.

The type of predator control activity, such as poison, trap or gun, which was carried out on each sanctuary from the year of initial study to the most recent year of operation in 1987/88 are exhibited in Table 3. The pattern of activity is shown to be characterized by flexible practices, long multi-year gaps (at least in reporting) and the apparent abandonment of the use of poison on the island of Hawaii after 1970/71, and on Maui after 1972/73. Although nests (and presumably nesting females) and released captive-raised Nene are both named target beneficiaries, the necessary protection of post-nesting females, goslings, and moulting (flightless) individuals emphasized earlier by Smith (1952), and Elder and Woodside (1958) seems to have been overlooked.

Smith (1952), Elder and Woodside (1958), and Elder (1958c) all pointed out that Nene required protection from ground predators during the breeding and moulting seasons. Though typically seasonal, nesting and moulting of individual Nene are known to occur almost year around. It therefore seems that an effective predator control program should be operational from October through February to protect nests, nesting females and young goslings, and from March through June to protect late hatched goslings and flightless moulting juveniles and adults. In addition, captive-raised Nene require protection after release until they have adapted to their new environment and are capable of flight.

In 1970/71 HDFG biologists made a mid-program attempt to evaluate the effectiveness of their control efforts. Federal-Aid Project W-15-1/IC(1) was established to "evaluate the effectiveness of the poisoning program on reduction of nesting mortality" and presumably (if found effective), to "expand this program into other areas utilized by Nene for nesting". The resulting evaluation was accomplished by simply

Table 2

Predator Control on HDFG Sanctuaries, Hawaii and Paliku, Haleakala National Park, Maui 1959/60-1987/88

1959-1960

Keauhou*: No activity reported.

1960-1961

Keauhou; Keauhou 2*: No activity reported.

1961-1962

Keauhou; Keauhou 2: . . . 73 feral pigs, 9 feral goats, 6 feral cats, 3 mongooses and 1 feral dog were destroyed . . .

Paliku*, Maui: No activity reported

1962-1963

Keauhou; Keauhou 2: . . . measures intensified, especially at Keauhou 2 to protect flightless adults from wild dogs . . . 15 pigs, 9 mongooses, 3 dogs and 1 cat were destroyed.

Paliku, Maui: No activity reported.

1963-1964

Keauhou: No activity reported.

Keauhou 2: ... poison baits extensively scattered throughout ... prior to placement of the young Nene in the release pen ... additional treated bait put out when the Nene were placed in the pen ...

Paliku, Maui: ... a heavy poisoning program which had been initiated earlier was continued to prevent further mortality.

1964-1965

Keauhou: No activity reported.

Keauhou 2: ... poisoned baits were spread throughout ... especially in favored nesting areas, prior to the nesting season ... 2 applications, 3 weeks apart were made ...

Paliku, Maui: No activity reported.

1965-1966

Keauhou; Keauhou 2; Paliku (Maui): No activity reported.

1966-1967

Keauhou; Keauhou 2: Poison baits were liberally scattered throughout the Keauhou and Hualalai (Keauhou 2) Sanctuaries. Goat flesh ... 4-5 ounce chunks injected with 1080 ... placed in locations for dogs, cats, rats and mongooses ... apparently ... effective as no predator was seen ... nor was any nest molested.

Kahuku*; Paliku (Maui): No activity reported.

1967-1968

Keauhou; Keauhou 2: As in previous years, poisoned baits were scattered throughout ... prior to the breeding season ... same method ... continued because of their apparent success ... in addition ... more baits were liberally scattered around areas with active nests during the breeding season ... to eliminate any predators that may have filtered into the area after the initial application.

Kahuku; Paliku (Maui): No activity reported.

*year captive-reared stock first released

1968-1969

Keauhou; Keauhou 2: Poison baits were liberally scattered throughout ... before the breeding season ... as in previous years ... goat flesh treated with 1080 poison ... successful technique during the last 3 seasons ... A dog was shot in the Keauhou Sanctuary as it walked up the jeep road toward the cabin ... other ... activities ... include dissemination of ... baits around the release pen at Keauhou 2 prior to the April 22, 1969 release ... dogs had been heard barking ... on several occasions ... a dog was shot.

Keauhou: Hav-A-Hart traps were used initially at the Kahuku Sanctuary until all of the ranch employees could be warned of the predator control program.

Paliku, Maui: No activity reported.

1969-1970

Keauhou: ... 1080 poison ... baits ... routinely ... scattered throughout ... before ... (and during) nesting season (around) nests or suspected nesting sites ... program needs to be expanded to provide year-round protection ... barking dog found ... shot and killed ... 1080 poison baits subsequently scattered ... investigation of barking dogs 2 months later precipitated an attack by a pack of 5 dogs ... 2 shot and killed ... more poisoned baits disseminated ... 2 of the 3 dogs which survived attack response later found dead ... apparently victims of the poisoned baits.

Keauhou 2: ... 1080 poison ... baits ... routinely ... scattered throughout ... before ... (and during) nesting season (around) nests or suspected sites ... program needs to be expanded to provide year-round protection ... 4 dogs seen on road to Sanctuary ... they fled ... 6 weeks later same pack observed chasing a herd of sheep ... 1 dog shot and killed ... poisoned baits scattered throughout to eliminate this pack ... baits were effective or the dogs moved out as they were not seen again.

Kahuku: ... 1080 poison ... baits ... routinely ... scattered throughout ... before ... (and during) nesting season (around) nests or suspected nesting sites ... program needs to be expanded to provide year-round protection ... Hawaiian hawk observed chasing a Nene in flight ... targeting its head ... Nene flew fast with evasive maneuvers, but could not entirely elude the hawk ... until lost from sight beyond the tree tops ... this is second incident observed ... in neither case was final result witnessed.

Paliku, Maui: No activity reported.

1970-71

Keauhou: ... scattering of 1080 poisoned baits ... restricted by tropical storm Maggie during the month of August and (program) was consequently extended through September and October ... nest and suspected nest sites received additional applications ... no evidence of predation discovered during year ... wild dogs appear to have been effectively eliminated ... terrain in Keauhou normally restricts movements of dogs to certain areas ... where they are more vulnerable to poisoned baits than at other Sanctuaries.

Keauhou 2: ... scattering of 1080 poisoned baits ... restricted by tropical storm Maggie during the month of August and (program) was consequently extended through September and October ... nest and suspected nest sites received additional applications ... 1 dead dog was found in the shed at Puu Keanui campsite ... apparently a victim of poisoned baits ... adjacent ranchers reported several packs of wild dogs harassing their cattle ... but no dogs were detected during Nene surveys ... packs of dogs are a chronic problem in this area and a concerted effort by ranchers and the Division is needed if control is to be achieved.

Kahuku: Poisoned baits and traps utilized ... traps emphasized because of greater human activity and lack of evidence that wild dogs, cats, mongooses and rats are present ... major predator is the feral pig ... responsible for (destruction) of 2 nests this year ... use of poison to control feral pigs appears to be ineffective ... There is also the potential hazard of cowboys taking a pig which has consumed a number of poisoned baits ... recommended that feral pig populations be reduced in the Sanctuaries through shooting, especially in Kahuku ... the ranch manager will be asked to have his cowboys hunt (without dogs) in the Sanctuary during the summer months and up to October.

Paliku, Maui: ... a poisoning program for cats, dogs, and mongooses was initiated before each nesting season and stepped up during the nesting season.

1971-72

Keauhou; Keauhou2; Kahuku: No activity reported.

Paliku, Maui: ... a poisoning program for cats, dogs and mongooses was initiated before each nesting season and stepped up during the nesting season.

1972-1973

Keauhou; Keauhou 2; Kahuku; Kipuka Ainahou: No activity reported.

Paliku, Maui: ... a poisoning program for cats, dogs and mongooses was initiated before each nesting season and stepped up during the nesting season.

1973/74-1977/78 (5 years)

Keauhou; Keauhou 2; Kahuku; Kipuka Ainahou*; Paliku (Maui): No activity reported.

1978-1979

Keauhou: No activity reported.

Keauhou 2: ... dog signs ... encountered ... on nearly every trip ... dogs sighted on several occasions ... dogs ... usually heard barking ... evenings ... as they chased sheep ...

Kahuku; Kipuka Ainahou; Paliku (Maui): No activity reported.

1979-1980

Keauhou; Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: Two live-traps were packed into the Puu (south of Puu Nene in Army Impact Area) and set as soon as the first nest was discovered ... monitored weekly whenever scratch feed was packed in to feed the Nene. One mongoose was trapped 4 weeks after the traps were set and on the fifth week a large cat was trapped ... nothing thereafter.

Paliku, Maui: No activity reported.

1980-1981

Keauhou; Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: Two live-traps on the Puu (6677) were continuously set with various baits ... one cat trapped in April 1981 ... apparently, these predators cover the 1-mile distance across the aa and pahoehoe lava to reach this kipuka and ... fall victim to the live-trap.

Paliku, Maui: No activity reported.

1981-1982

Keauhou; Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: Traps for predator control set in areas of nesting activity were monitored for effectiveness. ... On March 17 ... one gosling was discovered in a Hav-A-Hart live trap ... set the previous weekend by the boy scouts ... gosling emaciated and taken to Pohakuloa to recuperate ...

Paliku, Maui: No activity reported.

1982-1983

Keauhou: A string of 15 conibear snap traps ... set up around the release pen, self-feeder, reservoir and selected nesting areas ... caught 4 mongooses and 3 rats.

Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: Two Hav-a-hart live-traps on Puu 6677 (Army Impact Area) did not catch any predators, although 4 mynas were trapped when they were attracted to the scraps of goat meat used for bait ... a wild dog was sighted in the (Puu Oo) pasture after it had just killed and eaten a young calf; subsequent trips to eliminate this dog proved unsuccessful.

Paliku, Maui: No activity reported.

*year captive-reared stock first released

1983-1984

Keauhou: ... nest discovered ... Nov. 28 ... about 200 yards from the exclosure and self-feeder ... 4 eggs being incubated ... following day 3 eggs remained and egg fragments a short distance from the nest suggested mongoose predation ... 4 conibear snap traps were moved closer to the nest ... this proved unsuccessful and by 12 December the nest was completely destroyed and the pair had left ... 3 of the 4 traps had been sprung but no predator was caught ... traps baited and re-set but still no mongoose was ever trapped in that vicinity ... a trap-line of 15 conibear snap traps were checked monthly and rebaited ... these traps were moved frequently to cover as large an area as possible and ... accounted for 2 mongoose and 3 rats ...

Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: The two Hav-a-hart live traps set on Puu 6677 did not account for any predators.

Paliku, Maui: No activity reported.

1984-1985

Keauhou: Snap traps that were set around the reservoir and the self-feeder were routinely checked and rebaited ... accounting for 2 mongoose this year.

Keauhou 2; Kahuku: No activity reported.

Kipuka Ainahou: The two Hav-a-hart live traps set on Puu 6677 did not account for any predators trapped.

Paliku, Maui: No activity reported.

1985-1986

Keauhou; Keauhou 2; Kahuku; Kipuka Ainahou; Paliku, Maui: No activity reported.

1986-1987

Keauhou; Keauhou 2; Kahuku; Kipuka Ainahou; Paliku, Maui: No activity reported.

1987-1988

Keauhou; Keauhou 2; Kahuku; Kipuka Ainahou; Paliku, Maui: No activity reported.

Table 3

**Predator Control Methods Reported Used on HDFG Sanctuaries, Hawaii
and Paliku, Haleakala National Park, Maui
1959/60-1987/88**

Report Period	Keauhou	Keauhou 2	Kahuku	K. Ainahou	Paliku
1959-60	—				
1960-61	—	—			
1961-62	U	U			—
1962-63	U	U			(P)
1963-64	—	P			P
1964-65	—	P			—
1965-66	—	—			—
1966-67	P	P	—		—
1967-68	P	P	—		—
1968-69	P,S	P	T		—
1969-70	P,S	P,S	P		—
1970-71	P	P	P,T		(P)
1971-72	—	—	—		P
1972-73	—	—	—	—	P
1973-74	—	—	—	—	—
1974-75	—	—	—	—	—
1975-76	—	—	—	—	—
1976-77	—	—	—	—	—
1977-78	—	—	—	—	—
1978-79	—	—	—	—	—
1979-80	—	—	—	T	—
1980-81	—	—	—	T	—
1981-82	—	—	—	T	—
1982-83	T	—	—	T	—
1983-84	T	—	—	T	—
1984-85	T	—	—	T	—
1985-86	—	—	—	—	—
1986-87	—	—	—	—	—
1987-88	—	—	—	—	—

Control Methods

P = poisoning

T = trapping

S = shooting

U = unspecified

— = no activity reported

() = "earlier" activity reported

1958-1988

comparing successful nests with those which were destroyed by predators during the preceding 6 year period - 1965/66 to 1970/71. IIDFG biologists concluded:

1. 14 of the 24 nest (58.3 percent) under observation were successful.
2. predation (all by wild pigs) was responsible for loss of only 4 of the 24 nests (16.7 percent).
3. the data, though sparse, indicate that the predator control program is effective insofar as the mongoose, rat and dog is concerned ... and demonstrably ineffective where feral pigs are concerned.

The resulting in-house evaluation and conclusions of predator control effectiveness by HDFG inexplicably did not address expansion of predator control activities "into other areas utilized by Nene for nesting" - one of the Project's principal goals. In fact, judging from the paucity of information in the annual reports which followed, broadscale activities were abandoned rather than expanded. The onset of a prolonged drought in the 1970's and the sharp drop in Nene population which followed in the early 1980's may have been responsible for diverting management attention from predator control to emergency feeding and localized habitat improvement during that period.

8. Reporting of Field Investigations (1954-1988)

As previously indicated, to be eligible for Federal-Aid the State of Hawaii (HDFG) was required to report annually to federal authorities (USFWS) progress made in conducting each phase of wildlife field investigation, those necessary for Nene populations being no exception. At least 39 progress reports were filed in compliance with the law during the 34-year 1954/55 to 1987/88 period on Hawaii; some 18 were completed for the 17 year 1970/71 to 1987/88 study period on Maui. A total of perhaps a dozen or so reports refer to projects peripheral to population studies such as habitat evaluation, management plans, or Pohakuloa propagation

1954-1988

facility, the balance referring to studies on Nene in the wild.

Federal-Aid progress reports are identified by Title, Project and Job number, and Period of Observations - almost always the now superseded federal fiscal year (1 July to 30 June). Titles and Objectives of each Project and Job are set forth in closely related sequential tasks and are usually repeated or paraphrased from year to year. The population studies are, of course, of central interest here.

As shown in Table 4, Objectives of population studies conducted on the island of Hawaii changed frequently, often without explanation. Objectives of field work performed on Maui (Table 5) changed less often and bore a more consistent relationship to each other. Perhaps the difference is due to the greater diversity and broader scope of questions addressed in the more complex of the two environments, e.g. movement and distribution of Nene among the four sanctuaries and the "summer flyway". In any event, the net effect of multiple unexplained changes in Objectives tends to confound systematic analysis of information collected on the island of Hawaii more than the data collected on Maui.

As indicated in Table 4, Objectives of Nene field observations on the island of Hawaii show a rather consistent progression of emphasis over time ranging from broad general goals - such as "life history", population "number", and "movement" or "distribution" to more specialized objectives such as population "trend", integration of captive with wild-reared stock, and "survival". The aim of obtaining information on population "number" was replaced after the onset of prolonged drought in 1979/80 by the term "trend".

Other changes in direction of field investigations on Hawaii are apparent. The vague aim of assisting "non-federal projects" was an exclusive

Table 4

Objectives of Nene Field Observations, Island of Hawaii, 1954/55-1987/88

1 July - 30 June	Wild/Captive-Raised Nene				Limiting Factors: Control, Reduce, Eliminate	Recording, Compiling, Statistical Sampling	Data Analysis	Habitat: Survey, Preserve, Maintain, Develop	Assist Non- Fed. Projects
	Life History	Population Number, Trend	Movement, Distribution, Integration	Survival, Production, Recruit- ment					
1954-55				---- none stated ----					
1955-56				---- none stated ----					
1956-57				---- none stated ----					
1957-58	X	FN							
1958-59	X	FN							
1959-60	X	FN	D						
1960-61									
1961-62		FN	M, D						X
1962-63		FN	M, D						X
1963-64		FN	M, D						X
1964-65									
1965-66		FN	M, D	S					
1966-67		FN	M, D						X
1967-68		FN	M, D						X
1968-69		FN	M, D						X
1969-70		FN	M, D						X
1970-71		FN	M, D	S	R, C, SS	X			
1971-72		FN	M, D, I	S, P	R, C, SS	X			
1972-73		FN	M, D, I	S, P	R, C				
1973-74		FN	M, D, I	S, P	R, C, SS	X			
1974-75		PN, T	M, D, I	S	R, C				
1975-76		PN, T		S, P, R					
1976-77		PN, T		S, P, R					
1977-78		PN, T		S, P, R					
1978-79		PN, T		S, P, R					
1979-80		PN, T		S, P, R					
1980-81		T			C, R, E			S, P, M, D	
1981-82		T			C, R, E			S, P, M, D	
1982-83		T			C, R, E			S, P, M, D	
1983-84		T			C, R, E			S, P, M, D	
1984-85		T			C, R, E			S, P, M, D	
1985-86		T			C, R, E			S, P, M, D	
1986-87		T			C, R, E			S, P, M, D	
1987-88		T			C, R, E			S, P, M, D	

Table 5

Objectives of Nene Field Observations Haleakala Crater (National Park), Maui, 1967/68-1987/88

1 July - 30 June	Wild/Captive-Raised Nene		Evaluate			
	Population Number, Trend	Movement, Distribution	Survival	Nesting/ Brood Success	Predator Control	Impact of Nene on Habitat
1967-68	PN	M, D				
1968-69	PN	M, D				
1969-70						
1970-71	PN	M, D		NS	X	X
1971-72	PN	M, D		NS	X	
1972-73	PN	M, D		NS	X	X
1973-74	PN	M, D		NS, BS		
1974-75	PN	M, D		NS, BS		
1975-76	T		X			
1976-77	T		X			
1977-78	T		X			
1978-79	T		X			
1979-80	T		X			
1980-81	T		X			
1981-82	T		X			
1982-83	T	D	X			
1983-84	T	D	X			
1984-85	T	D	X			
1985-86	T	D	X			
1986-87	T	D	X			
1987-88	T	D	X			

1954-1988

responsibility during 7 years of the 9-year 1961/62 to 1969/70 period. This Objective was replaced by an emphasis on the recording, compiling and statistical sampling of information during the 5-year 1970/71 to 1974/75 time span. Likewise, the 8-year 1980/81 to 1987/88 period (shown later to coincide with a period of prolonged drought) features an almost complete shift of work emphasis from the control, reduction and elimination of factors believed to limit the growth of Nene populations to the survey, preservation, maintenance and development of suitable habitats.

Though some of the specific goals of field work on Maui (Table 5) are different, objectives show a similar pattern of change over time. For example, multiple objectives involving recording of data on population numbers, movement and distribution in the 8-year 1967/68 to 1974/75 period, shifted to obtaining information on population trend, survival, and distribution in the 13-year time span of 1975/76 to 1987/88. Objectives emphasizing observations of nesting and brood success, predator control, and impact of Nene on their habitat, were carried out wholly within the 5-year 1970/71 to 1974/75 time-span.

9. Field Procedures:

Each of the 57 Federal-Aid reports filed during the 1957/58 to 1987/88 period, with rare exceptions, contained brief statements of procedures used to carry out project objectives. Procedures for field work on Hawaii were omitted for unstated reasons in 1960/61 and 1964/65, while field methodologies on Maui were indicated in 1986/87 but never implemented. The various procedures used to carry out objectives during the 31-year study on Hawaii and 18-year period on Maui are shown in Tables 6 and 7.

As displayed in Table 6 for Hawaii, procedures utilized for the initial 9-year period (1957/58-1965/66) are limited to a mix of usually not more than three of the following six items:

1. relocate, count, and monitor Nene in all known habitats;
2. conduct follow-ups searches in localities indicated by citizen reports;
3. explore and search for Nene in promising unsurveyed habitats;
4. monitor reproduction in established breeding areas;
5. census and assess summer flyway and Puu Oo Ranch populations; and
6. band wild stock as feasible.

The following 4-year period (1967/68-1969/70) featured omission of report follow-ups (Procedure 2) and added a 7th - the evaluation of predation (so that predator control might be eliminated in unneeded areas).

For the next 5-year period (1970/71-1974/75) only the following 3 of the original 7 procedures remained in effect: 1. relocate, count, and monitor; 3. exploratory search; and 5. census and assess flyway and Puu Oo populations. Procedure 8. statistical analysis of data gathered - was added in 1970/71.

The following 5-year period (1975/76-1979/80) was marked by a phase-out of procedures: 3. exploratory search, and 5. census and assess flyway and Puu Oo populations; plus the addition of: 9. biotelemetry (1 year only) and 10. the development of a comprehensive census method.

Of the 10 procedures identified during the initial 23-year time-span (1957/58-1979/80), only two: 1. relocate, count, and monitor; and 4. monitor reproduction - were carried forward to merge with two new ones: 11. monitor predator traps, and 12. improve habitat - for implementation during the final 8-year period (1980/81-1987/88).

Procedures for Nene field observations on Maui for the entire 18-year period (1970/71-1987/88) compare favorably in number with those on

Table 7

Summary of Field Observation Procedures Island of Maui, 1970/71-1987/88

	1	2	3	4	5	6	7	8
	Monthly Surveys	Weekly Surveys*	Report Followups	Analyze Mortality, Survival	Calculate Wild/Release Ratios	Calculate Survival	Estimate Population Size/Trend	Map Distribution
1970-71	X	X	X					
1971-72	X	X	X					
1972-73	X	X	X					
1973-74	(X)	X	X					
1974-75	(X)	(X)	X					
1975-76	X	(X)		X	X	X	X	X
1976-77	X	(X)		X	X			X
1977-78	X	(X)		X	X			X
1978-79	X	(X)		X	X			X
1979-80	X	(X)		X	X			X
1980-81	X	(X)		X	X			X
1981-82	X	(X)		X	X			X
1982-83	X	(X)		X	X	X		X
1983-84	X	(X)		X	X	X	X	X
1984-85	(X)	(X)		X	X	X	X	
1985-86								
1986-87**	(X)	(X)		X	X	X	X	
1987-88	(X)	(X)		X	X	X	X	

* During release and nesting periods

** Procedures mentioned but not implemented

(X) Periodic surveys only "attempted" or assumed

1954-1988

Hawaii for the same period, but are more sophisticated and uniformly executed. Three methods: 1. monthly surveys, 2. weekly surveys during release and nesting periods, and 3. cooperators report followups - were used on Maui during the initial 5-year reporting period (1970/71-1974/75). For the next 13-years on Maui (1975/76-1987/88), procedure 3. - follow-up searches - was abandoned; while activity directed toward analysis of data collected on 4. mortality, 5. banded-unbanded ratios, 6. survival, 7. population size/trend, and 8. map distribution of sightings, was indicated.

Procedures stated for studies on Maui in recent years lack consistency either in statement or implementation, perhaps indicating a change in investigators. For example, procedures were unstated in 1985/86, while in 1986/87 methods were indicated but not executed. Procedures in 1987/88 were identical to those stated in 1986/87 but not fully implemented.

Federal-Aid reports also included a few cases where exploratory or incipient methodology was initiated and then suddenly dropped. For example, in 1977/78 on Hawaii a "Competition Index" and "Herbivore Index" was compiled for Keauhou 2 Sanctuary where Procedures called for population counts of food competitors (turkeys), and habitat destroyers (sheep, goats) in certain localities. A prolonged drought which began in 1978/79 was blamed for the crash of the Keauhou 2 Nene population which followed. No further information on either Index was gathered in 1978/79 or in the years that followed, the investigators apparently feeling that a prolonged drought which began that year overshadowed competition or habitat destruction as the most immediate adverse factor.

10. Management Techniques:

In describing field methodology, some Federal-Aid reports substitute the heading "Techniques" for that of "Procedures", thus indicating the close relationship between these two terms. Consider-

ing the general lack of information on the techniques used and how they were employed makes it clear that inclusion of "Techniques" in the mandatory reporting format would have been very helpful to those attempting to analyze results.

While the lack of specific information, especially hours worked, forestalls comparative analysis of data recorded, some insight of operational efficiency may be gained by reading successive accounts. Details reported under titles of Sexing and Banding; Brailing, Pinioning, and Removal of Flight Feathers; Biotlemetry and Censusing are evaluated in Appendix C.

11. Recommendations:

As can be seen in Table 8, recommendations made in Federal-Aid reports as a result of field work on the island of Hawaii varied greatly over the 34-year period (1954/55-1987/88). No suggestions were made the first two years. Recommendations to produce 50 Nene 1956/57 and to coordinate their efficient release with the ecological survey are unique and were never repeated thereafter. Suggestions made in 1957/58 are ambiguous and vague and were not repeated.

Recommendations during the 12-year period (1958/59-1969/70), emphasizing a wide diversity of tasks, are dominated by the mere listing "to continue" the job. Suggestions to obtain a statistician to work up field data collected during the preceding span of 16 to 19 years occurred during a 3-year period beginning in 1970/71.

Recommendations reached peak expression in both variety and number from 1973/74 to 1979/80. Suggestions literally "exploded" during this 7-year span and cover an entire spectrum of objectives. Recommendations during this period averaged 7 per year and varied greatly from one year to the next.

Table 8

Recommendations, Federal-Aid Progress Reports, Island of Hawaii, 1954/55-1986/87

YEAR	RECOMMENDATIONS
1954-55	no recommendations made
1955-56	no recommendations made
1956-57	rear 50 nene per year ... coordinate efficient release w/ ecological survey
1957-58	continue but reduce scope of job ... integrate future work with overall program
1958-59	continue job
1959-60	continue job
1960-61	continue job ... more time required for follow-up of released birds
1961-62	continue work to help augment non-federal aid program...
1962-63	continue job so as to assist ecological study ... intensify predator control
1963-64	continue job ... increase efforts to locate other breeding areas ... intensify predator control
1964-65	continue job ... increase efforts to find nene summering
1965-66	continue job ... increase efforts to find undiscovered habitats ... expand predator control
1966-67	continue study ... increase predator control efforts
1967-68	continue predator control ... hold State-Federal workshop ... prepare publication schedule
1968-69	continue study ... predator control efforts
1969-70	continue study ... predator control efforts
1970-71	obtain statistician to work up data ... employ biotelemetry
1971-72	obtain statistician to work up data ... increase breeding grounds search ... apply biotelemetry
1972-73	obtain statistician to work up data ... increase breeding grounds search ... apply aerial surveys
1973-74	continue summer flyway counts ... study biotelemetry ... fertilize Kipuka Ainahou ... increase breeding grounds, brood survival surveys ... computerize, correlate, analyze all data ... update breeding charts and tables for statistical analysis ... conduct comprehensive surveys ... intensity brood survival surveys
1974-75	increase search of old and new breeding grounds ... implement Devick recommendations
1975-76	further refine, utilize census techniques ... continue spot checks of marginal habitats ... continue summer flyway counts ... make no more massive releases ... increase effort to determine survival, reproduction rates ... continue to gather, evaluate, analyze data, instrument Nene, assess survival of young and seek alternate source of transmitters for biotelemetry studies
1976-77	conduct census and gather additional data on vegetation, predation, competition, and breeding ... analyze population data ... propagate, release more birds
1977-78	test modified census technique ... implement vegetation surveys ... analyze and interpret data ... modify census technique further if needed ... gather survival data ... including that of broods ... compile and analyze population trend data
1978-79	continue census technique ... implement vegetation surveys ... analyze and interpret data ... further modify census technique if needed ... gather survival data ... including that of broods ... compile and analyze population trend data
1979-80	critically evaluate past 5-years of census data ... re-evaluate census methods ... establish population monitoring procedures ... gather survival data ... compile and analyze population trend data ... initiate habitat improvement practices ... maintain predator control ... increase breeding flock at Pohakuloa from 5 to 10 pairs
1980-81	no recommendations made
1981/82- 1987/88	continue job

Table 9

Recommendations, Federal-Aid Progress Reports, Island of Maui, 1966/67-1986/87

YEAR	RECOMMENDATIONS
1966-67	make another release of English-reared birds
1967-68	no recommendations made
1968-69	no recommendations made
1969-70	no recommendations made
1970-71	continue project
1971-72	continue project
1972-73	continue project
1973-74	continue project
1974-75	continue project ... consider another release of Hawaii-reared birds
1975-76	continue job
1976-77	continue job
1977-78	continue job ... conduct more surveys in lands of Haleakala, Ulupalakua, Kaupo Ranches
1978-79	continue job ... conduct occasional surveys of lower elevation ranches
1979-80	continue job with modified census technique ... continue section surveys ... survey lower ranches occasionally
1980-81	continue job ... expand to include banding of goslings ... use radio telemetry to determine movement, mortality factors
1981-82	continue job ... use telemetry to determine movement, mortality factors ... stop release of captive-reared stock ... determine population stabilization level
1982-83	continue job ... use telemetry to determine movement, mortality factors ... stop release of captive-reared stock to determine whether population is self-sustaining, consider new release sites, especially Ukumehame on West Maui Mtn.
1983-84	continue job ... use telemetry to determine movement, mortality factors ... stop release of captive-reared stock to determine whether population is self-sustaining, seriously consider Ukumehame on West Maui as release site
1984-85	continue job ... use telemetry to locate, follow family groups ... stop release of captive-reared stock to determine whether population is self-sustaining ... plot past and future sightings on a map in future reports
1985-86	continue job ... use telemetry to locate and follow family groups ... stop release of captive-reared stock to determine whether population is self-sustaining
1986-87	project inactive ... no recommendations made
1987-88	continue project ... initiate banding of wild-reared progeny ... employ radio telemetry to monitor family groups

1954-1988

Recommendations ended abruptly in 1980/81. During the most recent 7-year period (1981/82 - 1987/88), the only recommendation noted was a terse "continue job".

Table 9 shows recommendations recorded in Federal-Aid Progress Reports resulting from field work on Maui over the 22-year period (1966/67-1987/88). The single recommendation to "make another release of English-reared birds" - was made during the first year (1966/67), but no suggestions were made for the following 3-year period (1967/68-1969/70). The 9-year period (1970/71-1978/79) was characterized by the repeated suggestion to "continue" - with only 3 years during this period recording further suggestions to "consider another release of Hawaii-reared birds" (1974/75), or to conduct additional surveys in the lower elevation ranches of Halcaakala, Ulupalakua, and Kaupo (1977/78 - 1978/79).

The 1979/80 to 1985/86 period was characterized by multiple recommendations in addition to the suggestion to "continue job". The most common recommendations during this 7-year span were to "use telemetry to determine movement, mortality factors ... stop release of captive-reared stock ... determine population stabilization level" or similar suggestions. Other occasional recommendations during this period were to use a "modified census technique ... continue section surveys ... survey lower ranches occasionally ... include banding of goslings ... determine population stabilization level ... consider new release sites, especially Ukumehame on West Maui Mtn. ... determine whether population is self sustaining ... plot past and future sightings on a map in future reports ... use telemetry to locate and follow family groups."

Unfortunately, the format for Federal-Aid reports does not include a statement indicating what follow-up action, if any, was taken on recommendations made. Most suggestions could not realistically be implemented without

1973-1982

the assistance of additional field personnel, but this never seems to have been mentioned. In effect, then, the stated recommendations apparently served largely to remind supervisory echelons of how much work needed to be accomplished, and where emphasis would be placed if the time could be spared from other duties. Report content in most cases provided evidence that the previous year's recommendations were seldom heeded or at least bore little fruit in the form of additional information.

12. Data Analysis by William S. Devick (1973-1982)

As previously mentioned, HDFG (Fisheries Branch) biologist W. S. Devick began statistical analysis of Nene field data as early as report-year 1973/74. Six examples of his undated reports supplied by HDFG suggest completion dates from 1975 to 1981. A two-sentence abstract of a paper delivered in 1982 at the Fourth Conference in Natural Sciences, Hawaii Volcanoes National Park, indicated that Devick continued to compile and analyze Nene field data and furnish census suggestions over at least a 10-year span, from 1973 to 1982.

Devick's initial report (12 pp. + 7 tables, 4 figures) entitled "Status of the Nene Population on the Island of Hawaii to 1975" was appended to the 1974/75 report for Federal-Aid Project W-18-R-1. Sources of information and analytical procedures used were described as follows:

Data from field notes and a file maintained by Nelson Santos, who also collected the bulk of the data, were tabulated manually or by computer with the aid of Fred Yost, a computer systems specialist with the State Department of Health. A data storage-retrieval system was established for all observations on banded birds, and all such data collected from 1960-1973 were stored on magnetic tape. These data were tabulated through a series of programs utilizing a software package known as CROSSTABS. Principal results of the tabulations and subsequent analyses are presented below ... Summary:

1973-1982

1. Band retention was excellent in the field. Band loss was significant only in birds that had been released 5 years previously. Loss was greatest from ganders. Few if any birds lost all bands.
2. Movements of banded geese between the principal sanctuary areas were minimal. The limited movements observed were significantly greater for ganders than for geese.
3. Survival of banded birds released in the sanctuaries was very high. Greatest loss occurred during the first year after release. More than 25% of birds survived for 5 years after release. Survival of geese and ganders was virtually identical.
4. Population size showed an upward trend, with the 1975 population estimated to exceed 700 birds. The estimated increase in the population of unbanded birds was greater than the combined estimated mortality of banded and unbanded adult nene.
5. The data suggested that the reproductive potential of the unbanded group of birds exceeded that of the banded group. However, both groups were breeding significantly in the field.
6. The introduction of Pohakuloa-bred birds to new areas appears to have provided bases for new wild populations. Indications are that the population trend would continue upwards in areas where birds are present, even in the absence of new releases. Presumably, new releases could profitably be made in suitable habitats where the birds presently are not found, based upon the limited observed movements in this report.

Sometime from April to September 1975, Devick and Santos collaborated in writing a Job Progress Report entitled, 'Final Report and Nene Management Plan for Hawaii'. Although it was stated that the intent of their work was to organize all previously-collected information needed for a management plan, the actual result was a scaled-down report on the contemporary status of Nene in terms of sub-populations, survivability, and distribution. The co-authors expressed the belief that more specific information on these aspects should be obtained before a viable management plan could be written. The task of writing a Nene Management Plan was

thus deferred. However, certain recommendations were made, as follows:

1. Work in the 3 sanctuaries must be continued at the present level. Limited portions of these areas must be systematically and intensively surveyed. Concurrent with these base-line studies, data for areas outside the sanctuaries must be gathered. This would include nene habitat on Mauna Loa between the Keauhou, Kahuku and Keauhou 2 sanctuaries. Suitable areas adjacent to the Kipuka Ainahou Nene Sanctuary must also be surveyed routinely.
2. Survival and mortality rates for the sanctuaries must be determined through more intensive surveys. The use of transmitters on adult nene with young should be utilized where feasible to monitor survival of goslings in the various sanctuaries. Additional data on mortality rates for adults should also be compiled.
3. Efforts to locate the summering grounds of the many unbanded nene seen in the Keauhou sanctuary only during the breeding season must be intensified. The use of transmitters would be ideal. This habitat, when discovered, must be preserved for use by nene.
4. Another nene release site in South Kona is needed to accelerate recovery of the nene population. Data indicate that it will take many years before this remote but suitable habitat will be occupied by nene. A release of 250-300 nene produced at Pohakuloa should accomplish this objective.
5. Although the effectiveness of predator control measures has not been demonstrated, these activities should be continued. Shooting of feral pigs, goats and sheep is desirable to prevent predation on young or flightless nene, and also to prevent physical destruction of the habitat. Poisoned baits should be used to control predation by feral dogs and cats, mongooses and rats, and prevent mortality of young nene in particular.
6. A standard census technique for measuring the nene population must be developed. Subsequently, comprehensive censuses of the 4 nene sanctuaries should be made every 5 years to determine population trends.

7. The importance of competition, food supply, climate, habitat requirements and other aspects of the ecology of the nene must be defined. Those effects which can be altered by management activities must be determined and management practices developed.
8. Since the nene data analysed to date are preliminary in nature, the publication of findings for Project W-15-1 through 5 should be postponed until more definitive data are available.

Devick's second report (13 pp. + 3 figures) entitled "Status of the Nene Population on the Island of Maui to 1976" was appended to the 1975/76 report for Federal-Aid Project W-18-R-1. Sources of data and analytical procedures were described as follows:

Analyses of data collected during field observations of the Maui nene population between 1962 and 1976 are presented in this report with particular reference to survival and, insofar as is reasonable, population trend. Data applicable to comparative evaluation of reproductive potential, breeding success, age versus release group survival, or movement patterns were not available. For present purposes any examination of movements of the birds on Maui would probably be irrelevant because of the apparently restricted range of the birds and the corresponding relatively limited area covered by the observers. The basic assumptions and methods discussed in a previous report, which is attached for clarity, were accepted for these analyses. Two findings in the attached report - (1) that there was no differentiation between the survival curves for geese and ganders, and (2) that band loss was insignificant in birds released 5 years previously were similarly assumed to hold for the birds on Maui.

Most of the data in Devick's second report were collected and organized by Joe Medeiros, Maui District Wildlife Biologist, and Ed Andrade, Wildlife Technician ... Summary:

1. Survival of nene released on Maui was not distinguishable statistically from survival on Hawaii. No significant difference in survival of birds originating from England, Connecticut or Hawaii was found.
2. Population size for nene on Maui was estimated to be 167±31 birds during 1975 with a maximum range of 119 to 284.

The number of identifiable banded birds known to be alive was 88.

3. The total population of nene on Maui and Hawaii combined for early 1976 should approximate 1,000 birds.

Referring to his 1975 status reports on the Nene, Devick also produced an undated 9-page outline and a 2-page work schedule entitled, "Organization of Field Data Collection Concerning Nene on Hawaii". The stated purpose of this paper was "to establish a statistically reliable Index of Relative Population Size within the sanctuaries". The outline addressed procedures, personnel requirements and other considerations. In addition, the outline proposed that accessory information on factors "likely to influence nene population trend in the sanctuaries" be collected and correlated. This ambitious expansion of research effort was not only to be directed toward recording detailed information on nene breeding habits and survival of wild stock, but on a broad array of related environmental subjects as well. Development of indices for vegetation (food), predation, herbivores and potential competitors were proposed, as well as establishment of meteorological stations in each sanctuary. The need to census Nene sanctuaries just prior to or early in the breeding season, search for Nene throughout their entire potential range, and conduct basic ecological research was also mentioned. It was estimated that it would be necessary to employ "at least one person for several years to arrive at reasonable conclusions in a study of this scope". A detailed annual 36-week schedule was appended as a specific guideline of information needed.

Devick also wrote an undated 4-page paper entitled, "Comments on Nene Census Procedures" in reference to unsuccessful attempts in 1975 and 1976 to collect statistically valid Nene census data. In addition to discussing the practicalities of censusing Nene both in sanctuaries and over their entire potential range, Devick proposed statistical methods for monitoring survival and population trends. His report concluded with the recommendations:

1973-1982

1. Systematic collection of nene population data on Hawaii still has not been accomplished. The proposed method for monitoring trend should become effective as soon as possible, since it should require little alteration in existing field activity. Notably the proposed method will allow duplication of the sampling procedure by any competent two-man crew. At present all such observing is dependent upon the inclinations of a few highly experienced individuals.
2. A census of all nene sanctuaries just prior to or during the breeding season should be tried using the transect technique.
3. A spring census using the transect technique is unlikely to be productive and therefore should not be attempted.
4. Further consideration should be given to the banding of wild-bred fledglings.
5. Exploration of territory outside of the nene sanctuaries or of areas normally unvisited within the sanctuaries would be a useful first step towards censusing the entire nene range.

Devick updated his pre-1975 analysis of Nene populations on Hawaii and Maui with separate reports covering each island for the 5-year period 1975 to 1980. As background to understanding the new 1975-1980 report, Devick indicated that (1) the new report focused on data obtained during the 1975-1980 period, though it necessarily incorporated all data collected since 1965 for evaluation of survival and movements, (2) many procedures and rationales were equivalent between the first and last reports, (3) no additional examination of band retention was required, (4) greater attention to the warnings and recommendations in the prior report would have avoided the inadequacies of the more recently collected data and could have provided insight into the causes of the downward trend in the nene population, (5) all work was done much more efficiently with the aid of a desktop computer rather than through the cumbersome State computer system.

Devick summarized the results of his 1975-1980 analysis of the Hawaii island Nene population as follows:

1. A severe and nearly continuous decline in the nene population size from roughly 650 birds in 1975 (not including those released during the year) to less than 300 birds in 1980 was found. In the absence of further releases of domestically propagated birds there is a high probability of a further decline, until the nene again becomes a rarity, if not extinct, on Hawaii.
2. Expected trends were projected, based on known survival and reproductive potential, and demonstrated that the nene should have been increasing in abundance, unless limiting environmental factors or unrecognized breeding problems were of paramount importance. No data were available to examine these possibilities, but the population decline did in fact follow the trend expected if virtually no successful breeding had occurred.
3. Even a small mortality in excess of expectations was shown to have profound effect on population trend, if reproductive success was minimal. Some emphasis on predator control was therefore deemed advisable.
4. A deterioration in field effort led to serious deficiencies in the available data covering the 1977-80 period. If the consistency and frequency of field data collection are not improved, future definitions of survival and population trend will be impossible. Other priority data related to nesting success, fledgling survival, recruitment to the breeding population, and movement patterns must be obtained, if there is to be any hope of developing a genuine restoration program.
5. An effective transect procedure, derived from field trials, is described, but its immediate application is not required as long as the deficiencies in data collection, described above, are corrected.
6. Further analysis confirmed the prior finding that ganders moved significantly further than geese.

Using procedures described in the 1975 and 1981 Hawaii Island Nene reports, and 1976 Maui Nene report, Devick analyzed population data from Maui for the same 5-year 1975-80 period. For the 1975-80 Maui Nene population analysis, Devick stated that, "Comments on expected reproductive potential compared to actual

population trends incorporated in the 1981 Hawaii report are applicable to the Maui situation, as are the emphases on the need for field studies that will properly identify the limiting factors on the growth and future survival of the wild nene population.”

Devick summarized the results of his 1975-80 analysis of the Maui Nene population as follows:

1. Survival of released banded nene on Maui was found to be essentially identical to the survival of banded nene on Hawaii.
2. The estimated size of the nene population on Maui increased to a peak of 275+/- 54 birds in 1977, then declined rapidly to 125+/-20 in 1980. The marked downward trend paralleled events on Hawaii.
3. Although the collected data pertaining to population size were excellent, application of the transect sampling procedure described in the Hawaii report is strongly recommended for the Haleakala Crater region.
4. Evaluation of the causes of the nene population decline was impossible from the data at hand. Future emphasis on the collection of data related to reproductive success and fledgling survival is imperative.

Devick's most recent contribution to an understanding of Nene population dynamics is found in a 2-sentence abstract of paper delivered at the Fourth Conference in Natural Science at Hawaii Volcanoes National Park, June 2-4, 1982, as follows:

The size of the Nene populations on both Hawaii and Maui declined markedly between 1975 and 1980, following the curtailment of the artificial propagation program. The available data yielded no explanation for the causes of the downward trend but suggested that the artificially propagated and released nene might not be nesting as readily as wild-bred birds.

Regrettably, insofar as is known, none of the results of Devick's decade-long interest in Nene population dynamics received the benefit of peer criticism, suggestions for improvement, and eventual publication in a professional journal.

Careful study of assumptions, definitions, methodology and equations does not, unfortunately, create a high level of confidence in many of the conclusions drawn - though the guideline furnished for census techniques was uniformly excellent. Devick himself occasionally expressed awareness of the limitations placed on his analysis by the inferior quality of the data gathered, admitting on one such occasion that “the statistical foundation for this conclusion is extremely shaky”.

13. Supplemental Management Papers (1960-1988)

As previously indicated, P. H. Baldwin (National Park Service), Sir Peter Scott (The Wildfowl Trust, Slimbridge, England), J. D. Smith (Territory of Hawaii), and W. H. Elder (Professor of Wildlife Management, University of Missouri) staked out the scientific parameters of the contemporary Nene restoration program in the 1940's and 1950's. With financial support from the U. S. Fish and Wildlife Service, the Territory gradually assumed a more responsible role in field investigations in the mid-1950's. In fact, for a period of some 14 years (from 1957 when Dr. Elder returned to the University of Missouri until 1972 when the National Park Service initiated the re-introduction of Nene to unoccupied habitats under its jurisdiction), the State of Hawaii was in sole conceptual and practical control of the restoration effort.

In the 1960's anonymous HDFG authors wrote two papers on Nene restoration. The first, Progress report on the Re-establishment of Nene on the Island of Maui (1963) was a detailed 5-page historical account of the transfer of stock propagated in England (Wildlife Trust) and Connecticut (S. Dillon Ripley) to Haleakala Crater, Maui, in 1962 and 1963. The second paper, entitled Nene Restoration Project Report(1969) was a 9-page revised report containing information on the early history of Nene restoration

1960-1988

including the field investigations, propagation and release of captive-raised stock on Maui.

The State of Hawaii Department of Land and Natural Resources sponsored a detailed comprehensive summary of Nene restoration activities from inception in 1949 to January 1972. These accounts were published in the May and June 1974 issues of 'Elepaio', journal of the Hawaii Audubon Society. Neither this or preceding reports drew any conclusions from technical investigations or discussed progress in terms of population restoration.

T. A. Burr, student at the University of Hawaii, Manoa Campus, authored Notes on the Ecology and Management of the Hawaiian Goose in 1972 to satisfy undergraduate course requirements. The paper discussed Nene distributional patterns, habitat requirements, predation, captive-breeding, and other related topics but did not analyze results of field investigations or make any management suggestions (95).

Hawaii State Department of Land and Natural Resources issued a report entitled Nene Restoration Project, 1 July 1972 to 30 June 1975. Published in the 'Elepaio' (1976), the account reviewed the history of the Nene restoration program for the 1972-1975 period, focusing principally on production at the Pohakuloa Propagation Facility and distribution of the captive-reared stock. Progress made toward restoring wild Nene populations was not discussed.

In 1973, HDFG staff member R. L. Walker presented a paper in Honolulu to the American Association of Zoo Veterinarians entitled How to Save an Endangered Species - The Hawaiian Goose (Nene). Walker's address emphasized the role of captive-breeding and release techniques in bolstering the wild population; however, doubt was expressed as to the outcome of the State's on-going restoration program (97).

A few years later and based principally on familiarity with the Nene restoration program in Hawaii Volcanoes National Park since 1977, P. Banko (1980) addressed the overall status of the wild population by saying that their extinction in the wild had been forestalled by Hawaii State and National Park Service releases of captive-raised stock (18).

In a collaborative effort joining the experience of The Wildfowl Trust with that of expertise at the University of Hawaii at Manoa, Kear and Berger (1980) authored a monograph on the Nene restoration effort recounting the history of cooperation between the State of Hawaii and The Wildfowl Trust. Broad-based research opinion on the Nene's various behavioral traits, selection pressures, genetic characteristics, rearing and release techniques, and survival in the wild were expressed in the 6th and final chapter. However, Conant (1981) with more recent knowledge of the Nene's severe population drop during the prolonged drought of the late 1970's and early 1980's stated, "It appears that the nene is far from 'saved from extinction', as has been suggested (Kear 1975)" (36).

In 1981 N. Santos and M. Ueoka summarized the results of Hawaii State Division of Fish and Game studies carried out from 1975 to 1980 on the islands of Hawaii and Maui. Entitled, "Analysis and Preparation for Publication of Results of Nene Investigations", objectives of this projected final Federal-Aid report were to "estimate the population ... monitor trends ... estimate reproductive and recruitment success ... (and) survival ... of wild and released, captive-bred nene ... (and) to prepare a report on the findings and make recommendations for the management of nene in Hawaii". However, the report summarized rather than analyzed the results of field observations and thus contained no definite conclusions. The seven recommendations made for managing Nene were similar in detail and scope to countless other suggestions made in the standard Federal-Aid report series.

In 1972, the National Park Service introduced captive breeding pairs of Nene to Hawaii Volcanoes National Park, Hawaii, and Haleakala National Park, Maui (P. Banko and Manual 1982 report). The principal goal in Hawaii Volcanoes National Park was to re-establish populations in historic, but then empty low and mid-elevation habitats by permitting the expected progeny of captive breeding pairs to fly free. The prime objective in Haleakala National Park was to augment the population which the Hawaii State Division of Fish and Game had established inside the Crater by allowing the anticipated progeny expected from penned pairs either to supplement the population in the Crater or establish new breeding sub-populations. Details of these twin efforts were documented in a comprehensive 153-page management report by P. Banko and D. Manuwal (1982).

P. Banko and Manuwal (1982) presented results of field work carried out from 1977 to 1981 in National Parks on Hawaii and Maui. Investigations of Nene centered on answering two basic questions: 1) What factors contributed to the historical decline of Nene populations? and 2) what factors are now preventing the species from recovering? Answers were presented in the form of management recommendations - 6 applicable to wild populations, 9 directed toward captive propagation and release, while 8 referred to further research needs.

P. Banko (1982) and Stone, et al (1982) also summarized studies of Nene productivity in and near Hawaii Volcanoes National Park from 1977 to 1981. Banko (1982) stated that:

The number of birds known from all 3 study areas (Keauhou Sanctuary, Kilauea Crater, Hilina Pali) dropped from 112 in 1978 to 34 in 1981 as a result of the virtual extinction of the Keauhou population ... proportions of paired birds in all 3 study areas decreased from 91 percent in 1978 to 76 percent in 1981 ... populations around Kilauea Crater and on the lowland slopes of Kilauea (Hilina Pali) may have increased slightly in size ...

These authors evaluated various causes of the decline by comparative analysis of paired vs. unpaired individuals, breeding vs. non-breeding pairs, hatching success vs. clutch failure, and the other technical factors which subsequently resulted in only 4 fledglings produced from 67 nests in 4 years of nesting (343, 992, 993).

Devick (1982), from his statistical analysis of HDFG field data during the same period, concluded that:

The size of the populations on both Hawaii and Maui declined markedly between 1975 and 1980, following the curtailment of the artificial propagation program. The available data yielded no explanation for the causes of the downward trend, but suggested that the artificially propagated and released nene might not be nesting as readily as wild birds (19).

State and federal biologists and administrators exchanged information at a Nene Workshop held in conjunction with the Fourth Conference in Natural Sciences held June 2-4, 1982, in Hawaii Volcanoes National Park. On 18 June 1982, R. L. Walker listed the 25 attendees, cited expert opinion, and summarized results of the Workshop.

In 1982 E. Kosaka reported progress of the USFWS-appointed Recovery Team in outlining a program for restoration of this species, stating:

(the) ... draft Nene Recovery Plan had gone through more than four revisions ... (and was) currently being revised to incorporate new information regarding decline of the population in the wild and the significance of predation in contributing to that decline. New data brought forth at this session will also be incorporated ... (20)

On 14 February 1983 Nene Recovery Team members E. Kosaka (Leader), E. Kridler, J. Medeiros, D. Reeser, and D. H. Woodside, completed preparation of a Nene Recovery Plan for the U. S. Fish and Wildlife Service. Preceded by a disclaimer, the stated purpose of the Plan was to:

establish a population of 2,000 nene on Hawaii and 250 on Maui, well distributed in

1960-1988

secure habitat and maintained exclusively by natural reproduction so that the species can be removed from the endangered list.

To accomplish this goal, rather than set forth a list of basic management guidelines based on the results of the decades-long field experience Recovery Team members set forth a comprehensive 51 line-item checklist (Step-Down Outline) of untested needs.

Some months later in August 1983, Stone, et al (1983) published a list of 7 management and 9 research projects needed before establishment of self-perpetuating Nene flocks in the wild could be expected, summarizing the contemporary status of this species as follows:

... Today Nene are found largely at high elevations (4000 to 7000 ft.) in limited areas on the island of Hawaii and on Maui (as a high altitude introduced population). Recent efforts by the DLNR (Devick 1981 a, b) have demonstrated that population declines in the wild are likely if stocking of captively propagated birds in current habitat is not continual (22).

In a brief popular article, Horrigan (1983) commented that the "effort to save the Nene from extinction is frequently cited as a model of conservation in action ... Today, thanks to the efforts of many aviculturists in Hawaii and elsewhere, the Nene seems to have been saved from extinction ... " (21).

The State of Hawaii Department of Land and Natural Resources (DLNR) prepared a Hawaii Wildlife Plan in January 1984 drawing attention to the fact that management of Nene are governed by stipulations enumerated in section D(4) of the Plan entitled Resident Waterfowl, which apply as follows:

- D4.a. Recovery plans for resident endangered waterfowl should be used as a guideline to the extent program constraints and resources allow.
- D4.b. At least two permanent sanctuaries now in private ownership in key habitat area should be established for the nene on the island of Hawai'i; one on Hualalai at Keauhou 2 or Ka-'u-pulehu and one on Mauna Loa at Kahuku or Ke-au-hou.

D4.c. Predator control, particularly during breeding and flightless periods, should have the highest management priority on permanent native waterfowl sanctuaries.

D4.d. (applied only to Koloa)

D4.e. A more effective protocol to prevent the accidental or deliberate introduction of new predators to the State, and especially to the Island of Kaua'i, should be established within the State structure.

D4.f. (applied only to Koloa)

D4.g. Cooperative agreements with private landowners, the National Park Service and other agencies, should be strengthened to aid restoration efforts including predator control.

Paton and Scott (1985) termed the Nene an "abundant native resident" (37), stating that this species was observed on the open grassland flanks of Mauna Loa and occasionally seen swimming in small cattle ponds on the slopes of Mauna Kea and Mauna Loa (64, 65). None of the stated observations were specifically documented.

Scott, et al (1986) reviewed the fossil distribution, historical decline and recent population status of Nene; correlated numbers of Nene observed on forest bird surveys with general habitat type; commented on the potential effectiveness of releasing captive-reared stock; and made management recommendations. Scott, et al (1986) also furnished specific information on effective detection distance; depicted an extinction model; outlined habitat and area in assumed original range; cited summary statistics in study areas on Hawaii; computed population density [mean (SE)] by elevation, habitat and study area; exhibited distribution and abundance in windward Hawaii study areas, Kona study area, and East Maui study area; and provided regression models for habitat response (22a).

Michael (1987), in a paper reviewed by P. Banko and C. Stone, studied the food response of up to 4 pairs of Nene confined to fenced enclosures in western Washington State during the 1984 to 1987 breeding seasons. Observations suggested that, in addition to a "much more precise"

response to photoperiod than males, "the female responds to some other environmental cue, such as diet quality, and produces eggs when some dietary threshold is reached". Michael (1987) concluded, "Rigorous study would probably pinpoint the answer and may demonstrate a key element in nesting and brood success useful to restoration and rehabilitation programs".

Scott and Carpenter (1987), in a brief general paper addressing release of captive-reared or translocated endangered birds, state: "claims of success for the Hawaiian Goose (*Nesochen sandvicensis*; Ripley 1986) are premature (Stone, et al 1983, Scott, et al 1986b)".

Lastly, in 1988, P.C. Banko completed a 6-year (1979-1984) study entitled Breeding biology and Conservation of the Nene, Hawaiian Goose (*Nesochen sandvicensis*), a PhD dissertation (Univ. Wash.) aimed at determining factors limiting growth of wild populations. Effects of food availability on the productivity and breeding behavior of wild and captive Nene, and biology of Nene and Canada geese (*Branta canadensis*) were compared to assess the influences of insularity, tropical latitude, and terrestrial habitat. Reproduction of wild Nene was found to be limited because: 1) many pairs apparently bred infrequently, 2) clutch size was relatively small, 3) eggs failed to hatch in over half the nests, and 4) few goslings survived to fledge each year.

The low incidence of nesting was discovered to apparently reflect the inability of many, especially small, females to accumulate sufficient body reserves for egg laying and incubation due to poor foraging conditions. Limited food resources were also found to reduce clutch size and nest attentiveness of wild nene. The high rate of nest failure was linked mainly to predation on eggs and incubating females by the introduced mongoose. Vulnerability to predation was judged high partly because females required substantial time away from the nest in order to feed, slept

much of the time while on the nest, and were sometimes unattended by their mates. Gosling mortality was discovered to be high because of poor foraging conditions near many nests, making it necessary for just-hatched goslings to perform long arduous treks over rugged volcanic terrain to distant rearing areas having more favorable food conditions.

The breeding biology of Nene and Canada geese was found to be dissimilar principally because of differences in the seasonal availability of food. Unlike the intense, predictable pulse of plant food accessible to Canada geese each year, the seasonal pattern of food available to Nene was determined to be less distinct and more variable because of Hawai'i's tropical maritime climate. As a result, Nene were found to nest during much of the year, breeding was only loosely synchronized, and only a few pairs were seen to re-nest if clutches or broods failed. Furthermore, Nene were calculated to have a lower metabolic rate than Canada geese, as indicated by their longer incubation period, egg laying interval, and gosling growth period. In addition to slow growth of goslings, the Nene's large egg was found to represent yet another adaptation to variable availability of food for the young.

Finally, control of alien predators, herbivores, plants, and habitat rehabilitation were deemed necessary for Nene restoration. Special efforts directed toward increasing native food plants were found to be desirable if not absolutely essential for the maintenance of self-perpetuating wild flocks.

Part III. **ANALYSIS OF HDFG FIELD OBSERVATIONS (1954/55-1987/88)**

1. Comparative Analysis of Population Data

The foregoing section (Part II. Hawaii State Restoration Program 1949-1988) addressed the

background and early operation of the Nene propagation facility at Pohakuloa; management of Nene Sanctuaries beginning with that of Keauhou in 1958; overall purpose, reporting format and observations recorded in Federal-Aid reports; and the program guidance provided by what might be termed Supplemental Management Papers - a body of reports issued sporadically over the years by State, Federal and institutional biologists.

As background to understanding the significance of the thousands of unanalyzed field observations contained in the 30-plus years of existing Federal-Aid reports, it is necessary to identify factors which had an obvious influence on the comparative values of the data reported. Such weather variables as drought, cold temperatures, and severe wind and rainstorms not only reportedly affected Nene breeding success and gosling survival, but the quality and comparability of the data collected. Lack of statistical design, manpower shortages, and other operational deficiencies were also found to influence comparative values of field data. Readers interested in the various factors influencing comparability of population data are referred to Appendix D, where detailed information on weather, reporting deficiencies and operational inconsistencies is presented and their influence documented.

As detailed in Appendix D, a host of variables acted alone or in concert to limit year-to-year comparison of observational data. However, when the various influences for each area and period of study are identified and tabulated, chronological sequences of influential factors form patterns helpful to comparative analysis.

As shown in Table 10, various types of influences tended to confound year-to-year comparability of population figures for several years in succession. For example, in Keauhou weather extremes influenced data comparability over one 3-year period, three 2-year spans, and two 1-year periods; while operational deficiencies were

reported for only two 1-year periods followed by a 10-year span. In only two years did both weather and operational factors coincide to affect data comparability. Because weather and operational variables tended to exert broad rather than limited influences geographically, the pattern shown for Keauhou tends to apply to other study areas as well.

A similar clumping of weather and operational and/or reporting inconsistencies also resulted in non-comparable data being recorded from Paliku, Maui, though specific factors and periodicity are noticeably different than those that were influential on the island of Hawaii.

The total years of survey and comparable data reported from each study area are summarized below in Table 11. As shown, comparable data were recorded from the four study areas on the island of Hawaii roughly less than a third of the time while information reported from Paliku, Maui, was judged comparable about 40 percent of the time.

In practical terms, conclusions relating to data comparability are actually only minimum estimates. For instance, no attempt has been made in the foregoing analysis to consider all possible factors known to reduce comparability of the information recorded, e.g. banding materials with different life expectancies.

Subtle year-to-year shifts in work emphasis, even those governed by stated objectives, also tended to place priorities of certain chores over others. Beginning with the severe drought year of 1978/79, for example, field work on the island of Hawaii was directed toward providing Nene at release sites with food and water rather than trying to monitor any widely-scattered survivors. Not only did the resultant shift of work effort apparently preclude population surveys for the duration of a prolonged drought - duration unknown due to lack of rainfall records - but altered

**Table 10 Weather and Operational/Reporting Inconsistencies
Influencing Comparability of Population data
Islands of Hawaii and Maui, 1957/58-1987/88**

Legend

- | | |
|---|--------------------------------------|
| 1 = drought = poor production | 5 = wind/rain/hail = poor visibility |
| 2 = drought = distributional change | 6 = fog/rain = poor visibility |
| 2 ^a = cold = poor production | 7 = fog/rain = distributional change |
| 3 = rain = good production | 8 = minor inconsistencies |
| 4 = wind/rain/hail = poor production | 9 = major inconsistencies |

* initial breeding survey

** first release of captive-raised stock

() = inferred

Year	Keauhou	Keauhou 2	Kahuku	Kipuka Ainahou Puu Oo	Paliku
1956-57	*				
1957-58	8			8	
1958-59				9	
1959-60	1			9	
1960-61	1	(1)**		9	
1961-62	1	(1)			**
1962-63					
1963-64				9	
1964-65					
1965-66				9	
1966-67			**		
1967-68				6	
1968-69	2a	(2a)	(2a)	6	4
1969-70	3	3	3	6	9
1970-71	8	8	8	6	9,4
1971-72				6,7	9
1972-73	1	1	(1)	8 (1)*	
1973-74	3	(3)	(3)	8 (3)	8
1974-75				8	
1975-76				8,8	
1976-77	1	1	1	1,2	
1977-78	1	1	1	8,1,2	8
1978-79	9	9		9	5
1979-80	9	9	9	9	8,4
1980-81	9,1	9,1	9,1	9 (1)	8
1981-82	9	9	9	9	8,4
1982-83	9,1	9,1	9,1	9 (1)	9,1
1983-84	9	9	9	9	8
1984-85	9	9	9	9	9
1985-86	9	9	9	9	9
1986-87	9	9	9	9	9
1987-88	9	9	9	9	9

Total Years of Population Surveys

Keauhou	31
Keauhou-2	28
Kahuku	22
Kipuka Ainahou-Puu Oo	31
Paliku	27

Table 11

Years Comparable Population Data Were Reported Islands of Hawaii and Maui, 1957/58 - 1987/88

Area	Total Survey Years	Years of Comparable Data	Percentage of Years Comparable Data Were Reported
Keauhou	31	10	32
Keauhou-2	28	9	32
Kahuku	22	6	27
K. Ainahou-Puu Oo	31	9	29
Paliku	27	11	41
Totals	139	45	

the whole scope of information reported during the most recent 10-year period.

In any event, it seems clear that comparable data were reported for each area long enough to justify a detailed investigation of the propagation program. The following comparative analysis is therefore directed toward understanding what, if any, long-term influence the release of captive-raised stock had on restoration of wild populations.

2. Production and Release of Captive-Reared Stock (1949-1988)

The initial 11-year 1949 to 1959 build-up of the breeding flock at Pohakuloa (see Part II.2.) and successive years following first release of captive-reared stock in 1960 were marked by meticulous record keeping. In 1972 HDFG issued "A Report of the Nene Restoration Program" summarizing information on the production of stock from the 1953/54 through 1971/72 breeding seasons. Subjects included fertility and number of eggs laid in relation to the ages of laying geese, hatching success as related to method of incubation, weights of 52 adult Nene during 1969, dates of first eggs, egg shell and gosling egg weights of 32 first clutches in 1968/69 and 1969/70; and finally, the numbers of captive-raised stock reared since 1949 and released to the wild from 1959/60 through 1971/72. Some of these data were supplemented by explanatory details added later (Lee 1978).

Walker (1982) brought the Pohakuloa production record up to date and described four operational phases of growth: 1) development of production techniques, 2) mass production and release to the wild, 3) gearing down production and release efforts to test the sustainability of wild populations, and 4) gearing up production to halt a demonstrated decline of wild populations in the late 1970's and early 1980's. Future options projected for captive rearing by Walker (1982) were: 1) continuing present levels of

production at the existing State facility, 2) increasing production at a new, larger State facility, 3) farming out production to other public agencies (zoos, federal government), 4) establishing individual rearing sites on State sanctuaries and/or within the National Parks, or 5) contracting with private entities (zoos, game bird farmers, ranchers) to rear birds for the State. In conclusion, Walker (1982) stated: "Whatever the option chosen, for the foreseeable future, captive rearing will be an integral part of the overall State Nene Restoration Program. The ultimate goal is to eliminate the necessity for captive propagation". Giffin (1989) subsequently documented close-down of the Pohakuloa propagation center and transfer of the Nene breeding flock to a new facility at Olinda, Maui, on August 30, 1989.

The number of Nene reared annually at Pohakuloa and those released on Hawaii and Maui from 1949/50 through 1987/88 are shown in Table 12. As indicated, a total of 1,948 Nene were reared, while only 1,783 (91.5 percent) were liberated. Most of the difference between numbers reared and those liberated is due to: 1) accumulation of breeding stock before releases commenced in 1960, 2) accumulation again after releases were halted for 2 years in 1982/83, and 3) Nene supplied to cooperative breeding projects in Connecticut (S. Dillon Ripley), and England (Peter Scott, The Wildfowl Trust) early in the history of captive propagation.

Some 1,499 (84.1 percent) of the total 1,783 Pohakuloa-reared Nene released were liberated on Hawaii, while 284 (15.9 percent) were set free on Maui. Pohakuloa-reared Nene transferred to Hawaii Volcanoes National Park (Hawaii) and Haleakala National Park (Maui) are included in the respective numbers shown for each island.

Of 1,783 Pohakuloa-reared Nene liberated, some 1,421 (79 percent) were distributed fairly equally among the four HDFG study areas on the island of Hawaii, as follows: 350 at Keauhou, 348 at Keauhou-2, 404 at Kahuku, and 319 at Kipuka

Table 12

Origin and Release Site of Captive-Reared Nene liberated on Hawaii and Maui.

(Updated from Walker, 1982)

Legend

¹ all reared at Pohakuloa

² Shipman Estate

³ hatched at Pohakuloa; reared by HAVO foster parents

⁴ reared in England (Wildfowl Trust)

⁵ reared in Connecticut (D. Ripley)

⁶ only 40 reared at Pohakuloa

Year	Reared at Pohakuloa	Year	Reared at Pohakuloa	Year	Reared at Pohakuloa	Year	Reared at Pohakuloa
1949-50	2	1959-60	17	1969-70	114	1979-80	13
1950-51	3	1960-61	32	1970-71	131	1980-81	9
1951-52	2	1961-62	45	1971-72	104	1981-82	19
1952-53	1	1962-63	54	1972-73	109	1982-83	18
1953-54	4	1963-64	38	1973-74	134	1983-84	28
1954-55	4	1964-65	41	1974-75	141	1984-85	36
1955-56	8	1965-66	69	1975-76	160	1985-86	38
1956-57	12	1966-67	84	1976-77	47	1986-87	18
1957-58	3	1967-68	123	1977-78	46	1987-88	31
1958-59	15	1968-69	156	1978-79	39	Total	1948

Year Released	Released on Hawaii ¹							Released on Maui				Grand Total Released	
	Keauhou	Keauhou-2	Kahuku	Kipuka Ainahou	Keau ²	HAVO ³	Total	Paliku			Hosmer Grove ¹		Total
								H ¹	E ⁴	C ⁵			
1960	20						20						20
1961	11	20					31						31
1962		35					35	5	30				70
1963		42					42	5	19	5			71
1964								8	20				28
1965	30	19					49	8	24	2			83
1966								25					25
1967			75				75						75
1968			85				85	20				20	105
1969		33	122				155	22	50			72	227
1970	106						106		55			55	161
1971	94						94						94

Year Released	Released on Hawaii ¹							Released on Maui				Grand Total Released	
	Keauhou	Keauhou-2	Kahuku	Kipuka Ainahou	Keaau ²	HAVO ³	Total	Paliku			Hosmer Grove ¹		Total
								H ¹	E ⁴	C ⁵			
1972	2	35					37	44				44	81
1973	13			61			74	50			5	55	129
1974				123			123				4	4	127
1975				135			135				2	2	137
1976		164					164	34			4	38	202
1977								47				47	47
1978			47 ^b				47 ^b				1	1	48
1979			35				35						35
1980			12				12						12
1981													
1982													
1983	19					8	27						27
1984	5				4	28	37						37
1985						12	12						12
1986	17		25		2	17	61						61
1987	8		2			8	18						18
1988	25		1			6	32						
Total	350	348	404	319	6	79	1506	268	198	7	16	489	1995

Ainahou. Of the remaining 362 (plus 7 reared elsewhere) 284 were liberated in Haleakala National Park (268 at Paliku, and 16 at Hosmer Grove), 79 in Hawaii Volcanoes National Park, and 6 at Keaau. Some 158 were retained at Pohakuloa for breeding purposes. The releases at Keaau (H. Shipman Estate), HAVO (Hawaii Volcanoes National Park), Paliku and Hosmer Grove in HALE (Haleakala National Park) were made in cooperation with the respective resident representatives in charge.

Numbers and 9-year chronology of a cooperative experiment involving periodic liberation of 198 Nene reared by the Wildfowl Trust, Slimbridge, England, and 7 raised by Dr. Dillon Ripley, Connecticut (USA) at Paliku, Maui, from 1961/62 to 1969/70 are also shown in Table 12.

Since a total of 1,995 captive-reared Nene were set free, the 1,783 Pohakuloa-raised stock released constituted 89 percent of the total stock liberated - the remaining 205 (10 percent) being made up essentially by contributions from the Wildfowl Trust, Slimbridge, England. In addition, S. Dillon Ripley contributed 7 Nene from his personal aviary.

All captive-reared stock, regardless of source, were sexed and banded prior to release. However, HDFG reported only total numbers liberated without reference to sex. In the absence of any information to the contrary, the foregoing and following accounts therefore assume that geese and ganders were produced and released in approximately equal numbers.

The following series of tables and analyses correlates sightings of Nene in all 5 release areas with release and rearing backgrounds (captive-reared, wild-reared or unknown) during the respective years of study on each area. Diagnostic footnotes are used to denote those years in which weather or operational factors were known to have influenced the total number of Nene observed.

In the detailed analyses it is assumed that leg-banded Nene observed in the wild represent captive-reared individuals, while unbanded Nene were reared in the wild. In truth, a small but probably insignificant number of captive-reared Nene may have lost all leg bands and thus may have been mistakenly identified as wild-reared.

It is also assumed that Nene listed for successive years, of whatever background, may or may not represent the same individuals. Band loss and varying reporting methodologies regrettably place identification of individual nene, with few exceptions, beyond practical determination.

3. Behavior of Captive-Reared Stock Released on Maui

As previously described, captive-reared Nene were liberated in selected habitats on the islands of Hawaii and Maui by setting them free with food and water in a chicken-wire pen of about an acre (0.4 hectare) as recommended by Elder (1958c), the well known "gentle-release" method. (Various disabilities caused by pinioning and brailing prior to release on Hawaii are detailed in Appendix C and will not be repeated here.) The gentle-release method permitted the released birds to re-establish their equilibrium after the stress of transportation and, over a period of weeks or months, adapt to a new natural environment.

Except as observations of banded captive-reared Nene might apply to such central questions as survival, dispersal, reproduction, etc., the subject of post-release behavior was never targeted for specific study by HDFG biologists. Consequently, information on how liberated captive-reared stock adapted to a free life are limited to a few notes made from 1962/63 to 1983/84 on Maui.

Notes on behavior of captive-reared stock released on Maui were gleaned from Federal-Aid reports, organized according to what seemed

like appropriate titles and arranged chronologically by subject. Since the intermittent and casual nature of the selected notes make it impractical to track the behavior of successive release-year classes, it was necessary to organize note chronology by subject rather than by release-group. Nevertheless, the fragmentary information available makes it possible to at least partly understand the difficulties these birds faced in making a not always successful transition from a flightless captive-reared existence to a free-flying life in a natural environment - natural except for the complete absence of wild kin. The information cited is wholly or essentially in report language.

Transport of Captive-Reared Stock

1970-71: A shipment of 55 birds was received on October 1, 1970. The birds were trucked to Kaupo Gap, the crates loaded onto pack mules, and transported to the release site at Paliku. One bird died en-route.

1972-73: Two releases, about nine months apart, were made during the report period. The first shipment of 44 nene arrived from Hawaii island on August 29, 1972 and had to be retained in a holding pen at the National Park headquarters because of unfavourable helicopter flying conditions. On September 5, 1972, eight days later, they were recreated and flown via helicopter to the Paliku release pen site in Haleakala Crater.

The second release consisted of 50 nene received from Hawaii on June 5, 1973. These birds were flown via helicopter to the release site on the same day.

Behavior in Release Pen

1962-63: ... adaptation marked by establishment of "peck orders", long flights to distant parts of Haleakala Crater and return, and pairing between England-raised and Pohakuloa stock ...

1963-64: ... a flock of 29 (19 from England and 5 each from Dillon Ripley and Pohakuloa) were put into the release pen at Paliku. The new birds adapted readily to their new environment and were seen to feed heavily on natural foods ... 1 killed by a predator before it was able to attain flight ...

Transition to Free Flight

1962-63: ... the flock of 30 nene from England and 5 from Hawaii released in July were making short flights from the pen by September ...

1963-64: All but 2 birds had left the release pen by the end of October ...

1966-67: In general, Nene from the 1966 release all Pohakuloa birds, were quite wary once they grew their flight feathers and were able to leave the holding pen. It was often quite difficult to record their band color combinations as they flushed when approached more readily than English or Connecticut reared birds.

1970-71: At the end of November, 19 had developed primary replacements so as to successfully leave the release pen. On December 31 all but four birds had left the pen. Most of the birds remained in the area or nearby during the remaining months of the report period.

1972-73: The usual procedure of pulling the flight feathers of one wing, while keeping the birds in a predator-proof pen until new ones grew in, was followed. No problems were experienced.

The second release consisted of 50 nene received from Hawaii on June 5, 1973. Here again, no problems were associated with the standard gentle release practices.

1981-82: The last gentle release of 48 nene in the Paliku area was made in 1977. Twenty-three (48%) of the 4 nene were sighted this year as compared to 27 (56%) in 1980-1981, and 35 (73%) in 1979-1980. As mentioned in previous reports disappearance is initially high following release, but becomes less abrupt once the birds are established.

Persistent Attraction of Release Site

1963-64: A maximum of 10 released last year was seen at the release pen when flightless birds were still confined. This number dwindled until only a pair remained in the vicinity.

1968-69: Twenty juvenile nene from the Pohakuloa Propagation Project were released on September 3. Though only about 18 birds were seen in the area during the two months previous to the release, a gradual buildup of previously released birds began, and by the end of September a total of 39 birds had returned to the area. By the end of October, four additional birds from prior releases returned to the area.

In June, 22 adult birds from Pohakuloa were released at Paliku. Only 27 nene from prior releases were noted in the area during the month ... In July and August, most of the nene began to move out from the immediate vicinity of the release site, but remained within the general Paliku area (A one mile radius of the release pen).

Release-Class Interactions

1968-69: Whereas, intermingling of birds from the various releases was noted, the older birds actually shied farther away from the new ones with each passing week. A bird released in 1962 ventured into the pen and was viciously attacked by the younger birds. A nene released in 1965 was not as fortunate as it was almost pecked to death in the pen and finally died of what the State veterinarian termed "a deficiency." In previous years, the young juveniles used for releases never attacked intruding birds from prior releases, but would actually band together and seemed to be afraid of the older birds ...

1972-73: Two of the three young produced in 1970-71 and the first brood to reach adult status on Maui were seen paired with 1969 and 1970-released nene of English origin.

Molting Behavior

1968-69: In April, nene were difficult to locate as they were beginning to molt. By mid-May, most of the birds had completed their molt.

1970-71: At least one visit into the release area was made by project personnel (each month) to record the number of birds seen. The low counts of 25 Nene were recorded in March and April 1971, during the molting season when birds are characteristically secretive.

1978-79: The data supports the fact that nene were most conspicuous during the latter part of the nesting season and immediately following the molting period. The low counts coincide with the spring molt of the nene at which time the birds are extremely secretive due to their temporary inability to fly. In certain sections of the survey area, the only evidence of the presence of nene was the scattering of "dropped" feathers.

1981-82: ... low counts have been consistently recorded for April, May and June and can be explained in terms of the molting period in which birds become flightless and secretive.

Seasonal Movements

1980-81: A high count of 52 nene was recorded during the month of August as compared to 93 counted in November of last year. The high counts over the past five years have not been recorded during one particular month with any consistency. The data indicated that nene became conspicuous from the months of June to November.

1981-82: A monthly high count of 43 nene was obtained in March as compared to a high of 52 last year during the month of August. Based on this and previous data, high counts have not remained consistent to any particular month. High counts probably result from the enumerator's success in searching for and locating a major flock. Because of the unpredictable movements of the nene flock to various sections of the crater, the monthly census results from fixed transects would provide information that indicate an extremely low or extinct population.

1982-83: A high count of 53 nene was obtained in February as compared to a high of 43 nene recorded in March of last year. A monthly comparison could not be made due to the limited number of survey trips. However, as mentioned in the previous report, high counts probably result from the enumerator's success in searching for and locating a major flock.

1983-84: The monthly high count of 45 nene recorded this year occurred in the month of February as did the high count of 53 reported in last year's Annual Job Progress Report. Since most nesting attempts are completed or terminated by February, those birds that have failed at reproduction reappear again in areas where surveys are conducted.

Inter-island Movement

1966-67: An analysis of the observation of the nene released in 1965 is of interest. During the last quarter of the report period, 18 or 72% of the 24 English birds were accounted for. During the same period, only two of the eight Pohakuloa birds or 25% were seen. Also, of the 25 Pohakuloa birds released in 1966, only seven or 27% were accounted for during the last quarter.

The relatively low numbers of Pohakuloa birds seen suggests that perhaps these birds might be returning to Hawaii which is clearly visible from the release area on Maui. Witness the "Blue Goose" which has

returned to Hawaii after being released on Maui.

Further insight on the Maui-to-Hawaii movement is gained by reviewing the case of the "Blue Goose" and her mate, the "Maui Gander". What little is known of their earlier histories is pieced together from various Federal-Aid reports, as follows:

1964-65: The blue banded goose and 7 other nene were sent to Maui for release in July. The blue banded goose returned to Pohakuloa in January with a gander, presumably from the Maui release. This pair was caught and released at Keauhou. In February, this pair had established a nest at Three Trees Kipuka in the Hawaii Volcanoes National Park. Two of the three eggs laid by the goose were hatched in March; both goslings inherited the hairy-down characteristic of the goose. This family remained in this kipuka until the goslings and adults attained flight after their annual molt.

1965-66: The "Blue Goose", her mate, the "Maui Gander", and their two young (both females) returned to Pohakuloa in August and were captured. The "Blue Goose" was culled since she had the undesirable hairy-down character and had made a nuisance of herself by repeatedly returning to the pens at Pohakuloa and greatly disturbing the nene breeders. Three other nene that had the hairy down characteristic proved themselves unsuitable for release. They were unable to adapt to the wild state and had to be returned to the pens, each of them in an emaciated condition. The Maui Gander, and his two young (both of which inherited the "hairy down" character of the goose) which were color-banded at Pohakuloa, were released at Puu Oo near a flock of wild nene in late August 1965. [for description and implications of "hairy down" see Kear and Berger pp. 52, 116-118 (1980)]

On October 12, 1965, the Maui Gander, one of his young and a goose released at Keauhou Sanctuary in March 1965, returned to the nene pens at Pohakuloa and were captured. The goose (#239) was of breeding age, having been released the second year after hatching. She appeared to be mated with the Maui Gander and apparently tolerated the presence of the young goose, since the pair were not actively nesting at the time of their capture. This captive trio was re-released in the Keauhou release pen

on October 14, 1965, the third and final release ...

... on June 28, 1966, the Maui Gander, his mate, and a young gander that is presumed to be their young, returned to Pohakuloa. This pair was not seen since their re-release at Keauhou on October 14, 1965. They left at dusk on the 28th and flew in a southeasterly direction towards Kipuka Aina Hou and Keauhou.

Gradually, over time, other captive-reared Nene besides the "blue-banded goose" and the "Maui gander" were observed on the island of Hawaii wearing color band combinations indicating that they too were originally released on Maui. All such records were carefully segregated, and after a period of some 7 years were reviewed, double-checked for misinterpretation (including that due to band loss), and analyzed as follows:

1973-74: In eight of the eleven possible movements of nene from Maui to Hawaii, the birds in question were last seen on Maui during the fourth quarter of the year. The reports of Maui-released nene being seen on Hawaii were analyzed as to dates when the birds were observed on both islands, the band color combinations and the possibility of bands falling off.

In the breakdown of the reported movements, it is significant that six of eleven involved nene from the 1962 and 1963 releases—a total of 64 released birds. It is also significant that in 1962 and 1963, widespread movements of nene on the island of Maui were recorded more often than in subsequent years. It thus appears that in the first two years some birds formed a nucleus at Paliku but that it was not strong enough to discourage nene from wandering into new areas of Maui but also Hawaii, which at its nearest point is only thirty miles away. Thus, it is very probable that the above movements did in fact occur. In later years as the nucleus of birds at Paliku enlarged with additional releases, less inter-island movement occurred.

To increase chronological perspective of these records, the elapsed times (in years) between release and last sighting on Maui, and between the last sighting on Maui and first sighting on Hawaii, were calculated for each Nene. These data, combined with the original tabular data in

the 1973/74 Federal-Aid Progress Report, are shown below in Table 13.

In Table 13, some 8 (73 percent) of the 11 Nene last seen on Maui were observed in the "4th. quarter", presumably that of the report period, i.e. April to June. This anomaly may be due to seasonal behavioral differences or, perhaps as likely, biased sample size.

Eight of the 11 released on Maui also shared another similarity - they were all first seen on Hawaii in 1973. Other years of first sightings on Hawaii were 1969, 1970 and 1974. There appears to be no rational explanation except perhaps duplication or loss of band color combinations, why so many Maui-released individuals - most of which has not been sighted at all for 9 or 10 years - should suddenly be first seen on the island of Hawaii in 1973. The fact that 6 of the 65 captive-reared Nene (9.2 percent) released on Maui in 1962 and 1963 were seen later on Hawaii while none of the 226 liberated on Maui from 1969 to 1973 were apparently ever observed on Hawaii appears to be significant. Aberrant behavior of the initial release groups indicates that unlike those liberated later on Maui and all those set free on Hawaii they had greater difficulty adapting to a free life in an environment devoid of resident wild stock.

When data on elapsed times are compared, there seems to be a significant decrease in the average post-movement elapsed time between the last Maui sighting of the 1962 and 1963 release groups and their first sighting on Hawaii (average 8.8 years), and the average post-movement elapsed span of only 4.0 years between Maui-last and Hawaii-first sightings of the 1964 to 1968 release groups. There seems to be no obvious explanation for this difference.

The average post-release time of 1 year for the 1962 and 1963 year-classes vs. the 2.8 post-release average time for the 1964-1968 release groups indicates that movement to Hawaii was

made much sooner by the earlier liberated classes than those which were released later.

The 1966-1967 Federal Aid Progress Report suggested that individuals which eventually made the Maui-to-Hawaii flight may have been represented in greater proportion by Pohakuloa rather than English-reared stock. But with more than six times as many Pohakuloa-reared Nene in the 1964-1968 release groups (61 vs. 10), the average elapsed post-movement time between last Maui and first Hawaii sightings did not increase as one might expect, but actually fell by 50 percent! Therefore, lacking information on where Maui-released Nene sighted on the island of Hawaii were originally captive-reared, the speculation that Pohakuloa-raised stock comprised proportionally more of the one-way migrants than those reared elsewhere may be incorrect.

4. Movement of Captive-Reared Stock Released on Hawaii

Several factors tend to complicate comparison of post-release movement records between captive-reared stock liberated on Hawaii and those released on Maui. For example, while liberated stock on both islands tended to remain in the vicinity of release pens long after they were capable of distant flight, the vastly greater expanse of potential habitat outside normal search parameters near release sites on Hawaii provided a much greater challenge to successful location of distant groups than on Maui. Proportionately much less manpower for search effort per release site was also available on Hawaii. Comparative analysis of the many records available in Federal-Aid reports from Hawaii nevertheless permit interpretation of post-release movement patterns of liberated stock. Comparable search of State computer files based on data recorded in field notebooks would no doubt turn up records not mentioned in Federal-Aid reports.

Records assembled in Table 14 show that of 1,792 captive-reared Nene released during the

Table 13

Movement of Maui-Released Nene to Island of Hawaii, 1962-1974 (adapted from HDFG 1973-1974 report)

Year	Number Released* H ¹ - E ² - C ³	Qtr. and Year Last Seen on Maui	Post-Release Elapsed Time (Years)	Year First seen on Hawaii	Post-Movement Elapsed Time (Years)
1962	5-30-0	4th 1963	1	1973	10
		1st 1963	1	1973	10
1963	5-19-5	2nd 1964	2	1973	9
		4th 1963	0	1973	10
		4th 1964	1	1969	5
		4th 1964	1	1973	9
Total:	10-49-5	Average = 1.0		Average = 8.8	
1964	8-20-0	4th 1964	0	1973	9
1965	8-24-2	2nd 1972	7	1973	1
1966	25-00-0	4th 1966	0	1970	4
		4th 1971	5	1974	3
1968	20-00-0	4th 1970	2	1973	3
Total:	61-44-2	Average = 2.8		Average = 4.0	
1969	22-50-0			None seen on Hawaii	
1970	00-55-0			None seen on Hawaii	
1972	44-00-0			None seen on Hawaii	
1973	55-00-0			None seen on Hawaii	
Total	121-105-0				
Grand Total	192-198-7				

Origin of Captive-Reared Stock

- ¹ Pohakuloa, Hawaii
- ² Slimbridge, England
- ³ Connecticut, USA

1964/65 to 1979/80 period, at least 130 sightings - including several duplicate sightings of individual Nene - occurred in study areas other than where liberated. It is not possible to determine exactly how many individual Nene are represented by the 130+ sightings because it is not clear whether all duplications are shown.

Also, 5 records include sightings of unreported numbers. Analysis of data in State field notes and computer bank might not only provide more insight into incidence of duplicate sightings, but contribute toward a better understanding of movement patterns of liberated stock.

As might be expected, some 120+ (92+ percent) of those sighted had been released on the island of Hawaii, while only 10 (8 percent) represented individuals liberated on Maui. Only 1 captive-reared Nene liberated on Hawaii is known to have turned up later on Maui - an individual of unrecorded sex released in 1960 (Keauhou Sanctuary) seen in Kaupo Gap south of the release site on 19 December 1971 with an English-reared bird liberated at Paliku in 1969 (pers. comm. M.L.H. Ueoka, 26 May 1988).

The number of captive-reared Nene subsequently observed in localities other than where released, naturally tend to vary according to the total number liberated and degree to which each potential habitat was eventually surveyed. While numbers released are known with relative certainty, records of subsequent survey efforts seem not to have been systematically reported. Thus, while records of movement to different study areas should not be given equal weight, it is known that significant amounts of survey effort per release site were expended throughout the 1964/65 to 1979/80 period. For example, two or three-man teams made regular surveys of release-site areas within the four sanctuaries during the 4-year 1976/77 to 1979/80 period. In any event, however qualified the data, it would appear that tendencies of liberated stock to move from release-site areas to adjacent rather than

distant habitats (Table 14) represents a real rather than perceived behavior pattern.

A quick scan of Table 14 reveals that the chronological distribution of Nene sighted in areas other than where released over the 16-year period is very patchy. While Keauhou-released stock were detected in areas other than where released 11 of the 16 years (69 percent - a proportion greater than any other release site), 23 (48 percent) of the sightings occurred in only 2 years (12.5 percent) of the total 16-year recording period.

Stock released at Keauhou-2 and sighted elsewhere show a bimodal pattern of chronological distribution with about two-thirds of the total 25-27 + 2 unreported number observed on other areas in the 4-year 1968/69 to 1971/72 period, with the approximate remaining one-third seen in the 4-year 1976/77 to 1979/80 span. None of the latter group was assigned to specific release-year classes due to lack of reporting detail.

In contrast with stock released at Keauhou or Keauhou-2 as previously cited, those liberated at Kahuku and sighted elsewhere display yet another pattern of sightings - some 26 (93 percent) of which were observed in the 5-year 1967/68 to 1971/72 period. The remaining 2 sightings (7 percent) were both tallied in 1979/80.

On the other hand, all (100 percent) of the 21 plus 2 unreported numbers of Nene resighted in areas other than the Kipuka Ainahou release site where they were liberated were observed during the 6-year 1974/75 to 1979/80 period. The resulting chronology clearly reflects the large numbers released at Kipuka Ainahou (319) in the preceding 3-year 1973 to 1975 span.

The 10 Maui-released Nene which were resighted later on Hawaii may be divided chronologically into two distinct groups, some 6 turning up in 1964/65 and 1965/66, and 4 not

Table 14

Movement of Liberated Captive-Reared Stock, Islands of Hawaii and Maui, 1964/65-1979/80

Release Site	Number Released	Number Post-Release Observations	Observations in Areas other than where released							
			Keauhou	Keauhou-2	Kahuku	K. Ainahou	Puu Oo	Pohakuloa	Other Hawaii	Paliku, Maui
Keauhou	276	48	-	1	1	17	25	3	0	1
Keauhou-2	348	25-27 + 2U	7	-	12	1	0	0	5-7 + 2U	0
Kahuku	376	25	8	2	-	0	4	1	13	0
K. Ainahou	319	21 + 3U	16	2	0	-	3U	3	0	0
Paliku	473	10			3		1	6	0	1
Totals	1792	130-132 + 5 U	31	5	16	18	30+3U	13	18-20 + 2U	1

U = Unreported number sighted

being seen until much later - the 1971/72 to 1973/74 year period. (Maui-reported data cited earlier in Table 13 showed that 9 of the 11 known to have made the journey were first sighted on Hawaii in 1973 and 1974. It is not known whether the Hawaii-reported or Maui-reported chronology is correct).

Examination of the data provided in Table 14 shows, as might be expected, that observations of stock sighted in areas other than where released, tend to decline with increase in distance. Thus, movement of Nene liberated at Keauhou, Keauhou-2, Kahuku, and Kipuka Ainahou show strong affinities, with some exceptions, to adjacent areas. For example, by far the greatest number of Nene released at Keauhou and sighted elsewhere apparently moved north-easterly to Kipuka Ainahou, Puu Oo, and Pohakuloa. Comparatively few moved south-westerly to Kahuku. Stock liberated at Keauhou-2, however, seemed to range more distantly, going south to Kahuku, west to lower elevations, and even around to Keauhou on the east side of Mauna Loa. Those released at Kahuku seemed to disperse more widely than those freed at other release sites showing strong affinities to lower elevation habitats on the east side of Mauna Loa, including Keauhou. Stock liberated at Kipuka Ainahou exhibited the least tendency for distant movement, most being seen at nearby Keauhou, Puu Oo and Pohakuloa. As might be expected, Nene liberated at Paliku tended to turn up most often at Pohakuloa where they were reared, and at Kahuku on the south-western slope of Mauna Loa.

Keauhou with only 15.4 percent of the total captive-reared stock liberated, and 36.9 percent later resighted elsewhere, had a significantly higher release-to-resighting ratio (1:2.4) than any other sanctuary. Keauhou-2, Kahuku, and Kipuka Ainahou with remarkably similar release-to-resighting ratios of 1:0.9, 1:0.9 and 1:0.9 followed. As might be expected, Maui was last with a 1:0.3 release-to-resighting ratio. The

much higher release-to-resighting ratio of Keauhou (1:2.4) no doubt reflects the proximity of Puu Oo and Kipuka Ainahou and the once traditional post-breeding movement of the Keauhou population to the Puu Oo - Kipuka Ainahou area where opportunities for resighting during the frequent surveys were much greater.

5. Release and Rearing Backgrounds of Wild-Breeding Nene

As previously noted, HDFG banded all captive-reared Nene with color-coded combinations of plastic leg bands before their liberation in wild habitats. While several operational deficiencies inhibit the comparative usefulness of information gathered on subsequent re-sighting of banded birds, band retention and observational methodology were consistent enough to offer a basis for a few preliminary conclusions.

Fortunately, for many years HDFG biologists made a concerted effort to locate and record the unique band combinations found on all captive-reared stock observed breeding in the wild. When band combinations of breeding Nene are compared to the numbers and chronology of captive-reared stock released in each area, one not only learns something about the relative numbers of captive-reared Nene which eventually achieved breeding status in the wild, but gains valuable insight into perhaps the key restoration question - to what degree has liberation of captive-reared stock enhanced long-term survival prospects of the species in the wild?

Keauhou Sanctuary

Table 15 exhibits records pertaining to release and rearing backgrounds of 203 breeding pairs of Nene (both wild and captive-reared) observed in Keauhou Sanctuary from 1956/57 to 1987/88. As indicated by diagnostic footnotes, environmental or operational factors stated or inferred to have influenced the number of breeding pairs observed each year at Keauhou occurred in repetitive series. Added to these factors are the lack of breeding pair data shown for the 4-year

Further examination of Table 15 shows a lapse of several years between release of captive-reared stock and corresponding increase in number of pairs breeding in the wild. Liberation of 20 captive-reared Nene in 1959/60 and 11 in 1960/61, for example, did not produce any increase in breeding pairs until 1963/64 when 4 captive-reared breeders were found. Only 1 captive-reared pair was observed the next year—1964/65 while no captive-reared breeders were identified the following year - 1965/66. Thus, of a total of 31 captive-reared Nene released during the 2-year period, 1959/60 to 1960/61, only 6 breeding mates of captive-reared origin were observed during the subsequent 6-year period. Again, 3 consecutive years of severe drought beginning in 1959/60 were apparently responsible for the poor survival rates of liberated stock.

By comparison, a near-identical total of 30 captive-reared Nene was liberated in 1964/65 - believed to be a year of average rainfall. The first three years of the following 5-year period was also characterized by average rainfall conditions. A severe cold spell during the egg-laying and incubation period was believed responsible for poor reproductive success in 1968/69 - the fourth year after release; while the fifth year was characterized by abundant rainfall thought to favor breeding success in 1969/70. Comparative analysis reveals that 15 breeding pairs involving released stock were recorded during the 5-year period following freeing of 30 in 1964/65. While exact comparisons between released captive-reared Nene breeding attempts during the two comparable periods may not be possible, the sighting of almost four times as many breeding Nene during the latter period of average weather as during the drought-prone span is believed significant.

Beginning in 1969/70 some 215 captive-reared Nene were released in Keauhou Sanctuary as follows: 1969/70 (106), 1970/71 (94), 1971/72 (2), and 1972/73 (13). As might be expected from liberation of so many captive-reared birds,

numbers of breeding pairs increased markedly in 1972/73, doubled again the next year, and stayed high for 5 more years despite drought and operational deficiencies which occurred during the 9 year 1970/71 to 1978/79 period.

Weather and operational variables make it impractical to attempt population analyses during the most recent 9-year period (1979/80 to 1987/88). Unbolstered by releases of captive-reared stock, the Keauhou breeding population evidently disappeared during this period, apparently due to a shortage of food during at least four severe drought years (1976/77-1977/78, 1980/81, and 1982/83), and natural attrition or dispersion.

The virtual disappearance of the predominant component of wild-reared breeding Nene following release of 215 captive-reared individuals beginning in 1970/71 deserves special comment. Of a total of 66 mated wild-reared pairs found during the entire 32-year 1956/57 to 1987/88 period, 92.4 percent were seen during the initial 14-year 1956/57 to 1969/70 span, while only 7.6 percent turned up during the later 18-year 1970/71 to 1987/88 period. It would seem that the massive releases of captive-reared stock had a depressive influence on the population of wild birds, perhaps by competing for insufficient food supplies in this strongly territorial bird. The last breeding stock of clearly pure wild ancestry apparently became extinct in Keauhou shortly after 1969/70.

Keauhou-2 Sanctuary

Table 16 exhibits year-of-release and rearing backgrounds of some 348 captive-reared Nene liberated and 28 breeding pairs subsequently reported in Keauhou-2 Sanctuary during the 28-year period 1960/61 to 1987/88. Interestingly, although 16 percent more captive-reared Nene were released in Keauhou-2 than in Keauhou (348 vs 300), 86 percent fewer breeding pairs were subsequently observed (203 vs 28).

The contribution of wild-reared mates to the overall breeding effort was also minimal in Keauhou-2. Only 1 breeding pair of wild-reared origin was tallied during the entire 28-year effort, and that in 1964/65 before any mate of captive-reared origin was noted. Only 8 of the remaining 27 breeding pairs observed had a wild-reared mate.

While the dominant background of breeding pairs observed over the entire 28-year effort was clearly captive-reared (25 of the 28 pairs sighted had at least 1 mate of captive-reared origin), a number of substantial releases resulted in comparatively few subsequent sightings of breeding pairs. For example, some 116 captive-reared Nene released during the 5-year 1960/61 to 1964/65 period would have been of breeding age by 1967/68, yet these combined releases resulted over the potential 6-year (1962/63 to 1967/68) breeding period in the sighting of only 5 captive-reared mates. The extreme drought noted in 1961/62, directly affecting some 55 (47 percent) of the 116 liberated, was apparently at least partially responsible for this very poor showing. Although breeding birds resulting from the later releases of 33 captive-reared Nene in 1968/69, and 35 in 1971/72 cannot be separated with certainty from those which formed pair-bonds from the 116 liberated earlier, it would appear that the much higher number (20) observed during the 5-year 1971/72 to 1975/76 breeding period was at least partially the result of the favorable rainfall conditions in 1969/70 and 1973/74, even though 1972/73 was a year of severe drought.

The release of 164 captive-reared Nene in Keauhou-2 in 1975/76 on the other hand, was followed by drought conditions in 4 of the following 7 years. As might be expected from the negative influence of drought on Nene reproduction indicated thus far, a total of only 6 pairs with at least 1 captive-reared mate were observed, and these only for the first 3 years after release. No

pairs were reported for the most recent 9-year period.

Kahuku Sanctuary

Table 17 shows that 401 of the 404 captive-reared Nene liberated at Kahuku had potentially attained breeding age by the end of the study period and that only 26 breeding pairs with at least 1 captive-reared mate were subsequently observed - an even poorer showing than that at Keauhou-2 where release of 348 captive-reared birds resulted in the sighting of some 28 pairs with at least one captive-reared mate. Only 4 mates of wild-reared origin were reported from Kahuku compared with 10 wild-reared mates sighted in Keauhou-2.

Relatively greater numbers of breeding pairs were observed at Kahuku during years of average rainfall than during periods of dry weather as at Keauhou and Keauhou-2. The 11-year 1966/67 to 1976/77 period was characterized by 3 years with negative and 2 years with positive implications for breeding, yet the release of some 282 captive-reared Nene in 3 groups from 1966/67 to 1968/69 resulted in the observation of 27 captive-reared breeding birds. The 12-year 1976/77 to 1987/88 period, on the other hand, featured 3 drought years with 6 years of operational deficiencies, all of which no doubt contributed to the lackluster results reported; nevertheless, the release of 94 captive-reared Nene in the 3-year 1977/78 to 1979/80 period resulted in a minimum of only 2 and a maximum of only 8 breeding birds of captive-reared origin subsequently observed. It seems most likely that the minimum of only 2 captive-reared breeding birds reported in 1979/80 originated from the group of 47 released in 1977/78, and that the 6 captive-reared breeding birds reported in the two most recent years probably formed from the flock of 25 liberated in 1985/86.

Kipuka Ainahou Sanctuary

In contrast to numbers of liberated birds shown previously for other release sites, Table 18 indi-

Table 19

Release and Rearing Backgrounds of Breeding Pairs Paliku, Haleakala National Park, Maui, 1961/62-1987/88

Year	Total Released	Observed in the Field										Breeding Pairs Seen
		W M&F	R M&F	U M&F	RM WF	WM RF	UM WF	UM RF	WM UF	RM UF		
1961-62	35											
1962-63	29											
1963-64	28											
1964-65	34											
1965-66	25											
1966-67												
1967-68	20		6									6
1968-69 ²	72		11						4			15
1969-70 ⁴	55											
1970-71 ^{2,4}												
1971-72 ⁴	44											
1972-73	50		4								1	5
1973-74			10						2		1	13
1974-75			3	2	1	1						7
1975-76	34		1	3		1					1	6
1976-77	47		3						1			4
1977-78				4	1				1			6
1978-79 ³			1	6					2		1	10
1979-80 ²			3		5		1	3				12
1980-81		2	7	4	4	4						21
1981-82 ²		1	2	2	2	1						8
1982-83 ¹			3		2	5						10
1983-84		2	2	1	6	3						14
1984-85		3	2		2	3						10
1985-86		2	1	1		3						7
1986-87 ⁴												
1987-88		4	2		1							7
Totals	473	14	61	23	24	21	1	13	0	4	161	

Legend

¹drought-production deficiency

²wind/rain/hail-production deficiency

³wind/rain/hail-operational deficiency

⁴gross operational deficiency

R-Released W-Wild M-Male F-Female U-Unknown Status ()-Inferred

liberated (see preceding section Part III.4). It will be recalled that not only did released stock from the earliest liberations turn up with greater frequency at widespread locations on Maui, but some 11 of their number were identified later on Hawaii suggesting, perhaps, that they failed to settle down in unfamiliar terrain because of an absence of territorial opposition from resident stock.

As indicated by footnotes, weather factors may have influenced reproduction negatively during the second multiseasonal loss of breeding potential (1969/70 to 1971/72), but the complete lack of breeding pairs during this period was, according to the applicable Federal-Aid reports, clearly due to a consecutive 3-year failure to run field surveys.

Examination of the breeding pair data collected during the 17-year 1971/72 to 1987/88 period, reveals several new trends: 1) the first appearance of wild-reared breeding mates in 1974/75 and their general increase in the early 1980's, 2) a decline since 1980/81 in the number of pairs having exclusively captive-reared mates, 3) the advent of exclusively wild-reared mated pairs in 1980/81, and 4) the preponderance of exclusively wild-reared pairs in the breeding population.

Geographical origin of pairs formed by mates originating from three different propagation centers (Slimbridge, England; Connecticut, USA; Pohakuloa, Hawaii) is shown in Table 20. Information on geographical origin of breeding pairs was found missing or incomplete in Federal-Aid reports filed after 1979/80 when the wild-reared component of the breeding population began to rise.

The 21 pairs which bred during the 2-year 1967/68 to 1968/69 period included only 31 mates known to be of captive-reared origin. Some 19 mates formed from English-bred goslings, 10 from Hawaii-reared offspring, and 2

from Connecticut-raised stock. Five pairs solely of English origin were recorded in 1968/69, while only 1 exclusively Hawaii-reared pair was observed that same year.

The 63 pairs which bred during the 9-year 1972/73 to 1979/80 period included some 72 mates known to be of captive-reared origin. As one might suppose, numbers of breeding mates sighted from Hawaii (45) and Connecticut (1) are roughly proportional to numbers liberated. The 26 captive-reared mates of English-bred origin sighted were not, however, representative of the substantial numbers released. Such poor representation was apparently due to the widespread scattering which characterized the initial releases composed mostly of English-reared stock.

Although no exclusively wild-reared pairs formed during the 13-year 1967/68 to 1979/80 period, 2 wild-reared mates were observed in 1974/75, 2 in 1975/76, 1 in 1977/78, and 5 in 1979/80 - the last year for which complete information is available. Clearly, the wild-reared component of the breeding population was on the rise when the recording of rearing background was inexplicably and abruptly terminated.

Release areas and rearing backgrounds of 1,894 captive-reared individuals liberated, and observations of 918 breeding mates subsequently resighted in five release-areas during the overall 32-year study period, is summarized in Table 21.

Observations of breeding mates vary greatly area-by-area when compared with total numbers of captive-reared individuals released, e.g. Keauhou 406 observations vs. 350 liberated; Keauhou-2 56 vs. 348; Kahuku 52 vs. 473; Kipuka Ainahou (Puu 6677) 82 vs. 319; and Paliku 322 vs. 473. It should be pointed out that observations of breeding mates include a certain amount of redundancy since no effort was made in HDFG reports to identify individual breeding mates on a year-to-year basis.

Table 20

Geographical Origin of Breeding Pairs Paliku, Haleakala National Park, Island of Maui, 1961-1986

Year	Number Released			Observed in the Field															Breeding Pairs Seen
	H	E	C	HM	HM	HM	HM	EM	EM	EM	EM	EM	WM	UM	UM	UM	UM		
				HF	EF	WF	UF	HF	EF	CF	WF	UF	HF	HF	EF	WF	UF		
1961-62	5	30																	
1962-63	5	19	5																
1963-64	8	20																	
1964-65	8	24	2																
1965-66	25																		
1966-67																			
1967-68	20						3					2					1	6	
1968-69	22	50		1				3	5	2				2	2			15	
1969-70		55																	
1970-71																			
1971-72	44																		
1972-73	50			2			1		1	1								5	
1973-74				6	1				3				1		1	1		13	
1974-75				1	1	1			1				1				2	7	
1975-76	34			1									1	1			1	2	6
1976-77	47			2	1											1		4	
1977-78											1					1		4	6
1978-79							1	1						1	1		6	10	
1979-80				1		5		1	1					2	1	1		12	
Totals	268	205	7	14	3	6	5	5	11	3	1	4	2	6	7	2	15	84	

Legend

R-Released W-Wild M-Male F-Female U-Unknown Status
H-Hawaii E-England C-Connecticut, USA

Table 21

Release and Rearing Backgrounds of Wild Breeding Nene Islands of Hawaii and Maui, 1956/57 to 1987/88

Release Area	Study Period	Total Released	Breeding Pairs Observed in Release Area									Total
			W&F	R M&F	U M&F	RM WF	WM RF	UM WF	UM RF	WM UF	RM UF	
Keauhou	1956/57-1987/88	350	66	67	16	23	11	2	0	4	14	203
Keauhou-2	1960/61-1987/88	348	1	17	1	4	3	0	0	1	1	28
Kahuku	1966/67-1987/88	404	1	15	5	1	1	0	0	0	3	26
K. Ainahou	1972/73-1987/88	319	14	14	2	8	1	0	1	0	1	41
Paliku	1961/62-1987/88	473	14	61	23	24	21	1	13	0	4	161
Totals		1894	96	174	47	60	37	3	14	5	23	459

R=Released=Captive-Reared

W= Wild M= Male F= Female U= Unknown Background

Table 22

Release and Rearing Backgrounds of Wild-Breeding Nene Islands of Hawaii and Maui, 1956/57-1987/88

Release Area	Study Period	Total R'lsd	Breeding Nene Observed									Totals
			Captive-Reared			Wild-Reared			Unknown Background			
			M	F	Sub-Total	M	F	Sub-Total	M	F	Sub-Total	
Keauhou	1956/57-1987/88	350	104	78	182	81	91	172	18	34	52	406
Keauhou-2	1960/61-1987/88	348	22	20	42	5	5	10	1	3	4	56
Kahuku	1966/67-1987/88	404	19	16	35	2	2	4	5	8	13	52
K.Ainahou	1972/73-1987/88	319	23	16	39	15	22	37	3	3	6	82
Paliku	1961/62-1987/88	473	89	95	184	35	39	74	37	27	64	322
Grand Totals		1894	257	225	482	138	159	297	64	75	139	918

Among Nene having any one of three different rearing backgrounds (captive-wild-unknown), some 482 observations (53 percent) were those of captive-reared origin, 297 resightings (32 percent) were of Nene with a wild-reared background, and 139 (15 percent) were of individuals of unidentified backgrounds.

A total of 174 sightings, the largest number, were of captive-reared ganders observed mated to captive-reared geese distributed among the various release areas as follows: Keauhou 67, Paliku 61, Keauhou-2 17, Kahuku 15, and Kipuka Ainahou 14. As expected, the areas exhibiting the largest proportion of sightings of captive-reared mates are ranked roughly the same as those in which the largest numbers of captive-reared stock were released.

A total of 96 sightings of wild-reared ganders found mated to wild-reared geese were distributed by area as follows: Keauhou 66, Paliku 14, Kipuka Ainahou 14, Keauhou-2 1, and Kahuku 1. The great preponderance of pairs in Keauhou having exclusively wild-reared backgrounds was due to the presence of wild birds for a number of years prior to liberation of captive-reared stock, as previously noted.

Further breakdown of breeding mates by sex, as in Table 22, reveals that, in all areas except Paliku, total sightings of captive-reared ganders outnumbered records of captive-reared geese 168 to 130. The reverse was true, though less proportionately, at Paliku where sightings of captive-reared geese outnumbered those of captive-reared ganders 95 to 89.

The gander to goose ratio was quite different for wild-reared breeding mates. Sightings of wild-reared breeding mates at Keauhou, Keauhou-2, and Kahuku totaled only 88 for those of ganders compared with 98 for those of geese. Total sightings of wild-reared breeding mates at Kipuka Ainahou and Paliku show an even greater gander

to goose discrepancy, 50 ganders to 61 geese seen.

Assuming sexes were released in the various areas in equal numbers, the difference in ratios between those seen at Paliku, and perhaps Kipuka Ainahou, may be significant. Sightings of both captive-reared and wild-reared geese outnumbered those of captive and wild-reared ganders at Paliku, suggesting that geese in Haleakala Crater tend to survive longer than those on the island of Hawaii. This possibility is supported by the evidence that an incipient self-supporting population of wild breeding Nene appears to be slowly becoming established at Paliku. The fact that Kipuka Ainahou, with its supplementary feeding and watering program, provides the highest ratio of captive and wild-reared geese to captive and wild-reared ganders, 38 to 38, also weighs in favor of significance.

The inference that captive-reared geese tend to be more strongly represented in stable or slowly increasing breeding populations than in less favored localities suggests that, in impoverished habitats, limited food supplies may weigh more heavily against reproduction or survival of geese than of ganders.

6. Fidelity of Captive-Reared Breeding Pairs to Area of Release

Federal-Aid reports contain area and year-of-release data for all breeding Nene observed on the five principal areas of liberation. Information on these subjects was recorded on Keauhou, Keauhou-2, Kahuku and Kipuka Ainahou for the 5-year 1973/74 to 1977/78 period. To these records may be added similar data from Kipuka Ainahou for an additional 4-year 1981/82 to 1984/85 period. Comparable data was also collected intermittently from Paliku, Maui, during the 11-year 1962 to 1977 time span.

Examination of Table 23 reveals the release localities of 269 wild-breeding Nene - some 262 (97 percent) of which were subsequently

resighted in the same area where they had been liberated several years previously. This points up the strong tendency by both sexes to breed in the area of release rather than exercise independent choice based on other factors.

Study of the exceptions, however, draws attention to some of the other influences at work. The breeding of a 1960 Keauhou-released individual at Paliku in 1969, a 1962 Paliku male at Keauhou in 1973/74, and a 1965 Keauhou male at Kahuku in 1974/75, all involve Nene in early release groups. Two of the foregoing were in flocks liberated in their respective release areas for the first time, pointing again to the widespread dispersal tendencies characteristic of early releases.

In Table 23 three of the remaining four examples seen breeding in areas other than where released occurred in the same year, 1975/76, and in the same area, Keauhou. The first case involved a mate of unknown sex which originated from a group of 35 released at Keauhou-2 in 1972; the 2nd. and 3rd. examples include a gander and an unrelated mate which originated from a flock of 122 released at Kipuka Ainahou in 1974. The last example was perhaps a repeat of the first record cited when a mate of unknown sex from the Kipuka Ainahou 1974 release of 122 was observed breeding at Keauhou in 1976/77.

Lastly, it is perhaps significant that 5 of the 7 cases involved defections to Keauhou from 3 other release areas. This would seem to establish the Keauhou-Hawaii Volcanoes National Park area as the most attractive Nene habitat remaining on the island of Hawaii during the period studied.

7. Breeding Observations, 1957/58 to 1987/88

Breeding Pairs and Gosling Survival

For many years HDFG biologists directed their principal field effort toward locating nesting Nene and determining their relative breeding success. On the island of Hawaii, annual breed-

ing ground surveys were fairly evenly apportioned among the four sanctuaries, with few exceptions, from inception of liberated stock on each area through 1978/79. Beginning in 1976/77 however, a prolonged 7-year drought apparently resulted in widespread dispersal and depopulation of both captive and wild-reared stock in all four release areas. Three years later in 1979/80, conditions had deteriorated to the point where establishment and maintenance of supplementary feeding and watering stations near release sites essentially replaced breeding ground surveys as the dominant field activity. As a result, information on nesting Nene on Hawaii is minimal or missing for the 4-year 1979/80 to 1982/83 period. Lack of observational and weather data from 1983/84 to 1987/88 suggests that maintenance of food and water stations continued to absorb virtually all of the available field effort for the most recent 5-year period as well.

On the island of Maui where biologists were able to deploy search effort more efficiently because of the limited breeding range, information on paired breeders and survival of goslings was more consistently recorded than for most areas on Hawaii. Except for the 3-year 1969/70 to 1971/72 period, and again in 1986/87 and 1987/88 when the resident biologist was assigned other duties, pertinent year-to-year survey records are relatively comparable.

To facilitate comparative analyses, all report data have been tabulated for each release area on Hawaii and Maui. Numbers and success of breeding pairs found during the study period in each area are shown in Tables 23-27. While the presence of color-coded bands on the legs of all released captive-reared and some wild-raised individuals made it possible to eliminate duplicate same-season records at the outset, there is no doubt that information on many of the same pairs was included in data reported in successive years.

Table 23

Release Year-Class and Area-Origin of Wild-Breeding Captive-Reared Stock Islands of Hawaii and Maui, 1973/74-1984/85

1. Release Area:	Keauhou													Keauhou 2			Kipuka Ainahou			Paliku, Maui		
	Year:	1960	1961	1965	1970	1971			1972		1973		Totals		1972			1974			1962	
No. Released:	20	11	30	106	94			2		13		276		35			122			35		
Observed in Keauhou	M		F		M		F		U		M		F		U		M		F		U	
1973-74	3		2		16		14				2		3		21		19				1	
1974-75	1		1		12		7						1		13		9					
1975-76	2		2		11		7		1				1		13		10		1		1	
1976-77									12										12		1	
1977-78					5		5															
Totals	6		5		44		33		13		2		5		52		43		13		1	

2. Release Area:	Keauhou 2															
	Year:	1961	1962	1963	1965	1969			1972			Totals				
No. Released:	20	35	42	19	33			35			348					
Observed in Keauhou 2	M		F		M		F		U		M		F		U	
1973-74	1		2						3		3		5		4	
1974-75									1		1		1		1	
1975-76									1						1	
1976-77																
1977-78									1		1		1		1	
Totals	1		2						5		5		1		7	

Legend
M=Male
F=Female
U=Unknown

Table 23 (cont'd)

3. Release Area:	Kahuku								Keauhou	
	1967		1968		1969		Totals		1965	
No. Released:	75		85		122		282		30	
Observed in Kahuku	M	F	M	F	M	F	M	F	M	F
1973-74	1		1	1	3	2	5	3		
1974-75		1		1				2	1	
1975-76										
1976-77										
1977-78										
Totals	1	1	1	2	3	2	5	5	1	

4. Release Area:	Kipuka Ainahou							
	1973		1974		1975		Totals	
No. Released:	61		122		135		319	
Observed in K. Ainahou	M	F	M	F	M	F	M	F
1973-74								
1974-75								
1975-76			1		1		2	
1976-77					1		1	
1977-78		1			1		1	1
1981-82	1		1	1	2	2	4	3
1982-83	1		1		1	2	3	2
1983-84	1	1			1	1	2	2
1984-85	1				2	3	3	3
Totals	4	2	3	1	9	8	16	11

Legend
M=Male
F=Female
U=Unknown

Table 23 (cont'd)

5. Release Area:		Paliku, Haleakala National Park, Maui																									
Year:	1962	1963		1964		1965		1966		1968		1969*		1970		1972		1973		1976		1977		Totals			
No. Released:	35	29		28		34		25		20		72		55		44		50		34		47		473			
Observed in Paliku	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
1968-69	1				1	9	8	1	5		1														11	15	
1969-70	No surveys conducted.																										
1970-71	No surveys conducted.																										
1971-72	Survey incomplete.																										
1972-73							1	1	1		1	1	1			2	1								5	4	
1973-74						2	1			2		2	3	1	2	4	5									11	11
1974-75														1	2	2		1	2							4	4
1975-76														1		1	2									2	2
1976-77															2	4	2		1							4	5
1977-78														1	1											1	1
1978-79										1				1	2					1	1					2	4
1979-80										1		1		1	2						2	5	2		8	6	
Totals	1				1	12	10	2	5	3	4	5	4	6	11	13	10	1	3	1	3	5	2	49	53		

*not shown is a 1969 Paliku-release and 1960 Keauhou-release mated pair observed near Paliku December 19, 1971 (sexes unreported) (M.L.H. Ueoka pers. comm.)

Table 23a

Number and Success of Breeding Pairs Keauhou Sanctuary, Island of Hawaii, 1957/58-1987/88

1 July to 30 June	No. Pairs Seen (no nests found)		No. of Goslings Seen (Age in Weeks)					No. Pairs Seen (nests found)		No. of Goslings Seen (Age in Weeks)					Total G Seen	Total G Fl'gd	Parental Origin of Fl'gd G
	w/G	wo/G	0-5	6-7	8-12	12+	UA	w/G	wo/G	0-5	6-7	8-12	12+	UA			
1957-58								1	1	2					2		
1958-59		1							9								
1959-60	3								3						5		
1960-61	2		3						2						3		
1961-62									1								
1962-63									1								
1963-64	3		2		2				5						4		
1964-65	1							1					2		5	2	2 RM+RF
1965-66	3														8		
1966-67	7	1	8	2	1			1	3			3			14		
1967-68	11		17	1	2			4	2	12					32		
1968-69									4								
1969-70	2		2	3					3						5		
1970-71									3								
1971-72									2								
1972-73								1	11					1	1		
1973-74	5		1				11	3	14(7)	1	2		2		17	13	13 RM+RF
1974-75	4		3	1			1	2	9(3)				3		8	4	3 RM+RF 1 RM+UF
1975-76	2				4			1	9(7)					1	5		
1976-77	2		2					1	13(1)						2		
1977-78	2	1	4						6		1				5		
1978-79									9								
1979-80																	
1980-81																	
1981-82																	
1982-83																	
1983-84									1								
1984-85	1														1		
1985-86	2														5		
1986-87																	
1987-88																	
Totals	50	3	42	7	9	12	22	15	112(18)	15	3	3	7	2	122	19	18 RM+RF 1 RM+UF

Legend

Wks. Old
0-5=downy young
6-7=half grown

8-12=3/4 grown; able to fly
12+=fledged; strong flyer
w/G=with Goslings

wo/G=without Goslings
fl'gd=fledged
() = 1st. seen w/G, last seen wo/G

M=Male, F=Female, R=Released,
UA=Unreported Age

Table 24

Number and Success of Breeding Pairs

Keauhou 2 Sanctuary, Island of Hawaii, 1964/65-1978/79

1 July to 30 June	No. Pairs Seen (no nests found)		No. of Goslings Seen (Age in Weeks)					No. Pairs Seen (nests found)		No. of Goslings Seen (Age in Weeks)					Total G Seen	Total G Fl'gd	Parental Origin of R'gd G
	w/G	wo/G	0-5	6-7	8-12	12+	UA	w/G	wo/G	0-5	6-7	8-12	12+	UA			
1964-65	1														3		
1965-66	1														1		
1966-67	2			2			1								3	1	1 UM+UF
1967-68	1											2			2		2 RM+RF
1968-69	1						1		1						1	1	1 UM+UF
1969-70	1		1						1						1		
1970-71	1				2										2		
1971-72									3								
1972-73									2								
1973-74	5				4		2								6	2	1 RM+RF 1 RM+WF
1974-75	1		1												1		
1975-76	1				2										2		
1976-77																	
1977-78									1								
1978-79	1	1	3						2						3		
Totals	16	1	5	2	8	6	4		10						25	6	3 RM+RF 1 RM+WF 2 UM+UF

Legend

Wks.Old

0-5=downy young

6-7=half grown

8-12=3/4 grown; able to fly

12+=fledged; strong flyer

w/G=with Goslings

wo/G=without Goslings

Fl'gd=Fledged

M=Male, F=Female, R=Released, W=Wild, UA=Unreported Age

Table 25
Number and Success of Breeding Pairs
Kahuku Sanctuary, Island of Hawaii, 1968/69-1987/88

1 July to 30 June	No. Pairs Seen (no nests found)		No. of Goslings Seen (Age in Weeks)					No. Pairs Seen (nests found)		No. of Goslings Seen (Age in Weeks)					Total G Seen	Total G Fl'gd	Parental Origin of Fl'gd G
	w/G	wo/G	0-5	6-7	8-12	12+	UA	w/G	wo/G	0-5	6-7	8-12	12+	UA			
1968-69	1					4									4	4	4 UM+UF
1969-70								1									
1970-71	1							2							2		
1971-72								1									
1972-73	4							1							7	5	5 UM+UF
1973-74	4							2							7	1	1 UM+UF
1974-75	2		1		1			1							2		
1975-76								1									
1976-77								1									
1977-78																	
1978-79																	
1979-80	1					4									4	4	4 RM+RF
1980-81																	
1981-82																	
1982-83																	
1983-84																	
1984-85																	1 RM+RF
1985-86															2	2	1 UM+UF
1986-87	1					2									4	1	1 RM+RF
1987-88								2				1		3			
Totals	14		1		1	10	16	2	10			1		3	32	17	6 RM+RF 11 UM+UF

Legend

Wks Old

0-5=downy yong
6-7=half grown
8-12=3/4 grown; able to fly
12+=fledged; strong flyer
M=Male, F=Female, R=Released,
UA=Unreported Age

w/G=with Goslings
wo/G=without Goslings
Fl'gd=Fledged

* 2 seen 10 Jan. and 5 seen in May 1973 (latter counted as Fledged)

** 1 seen 19 June (counted as Fledged)

Table 26

Number and Success of Breeding Pairs Kipuka Ainahou Sanctuary, Island of Hawaii, 1964/65-1987/88

1 July to 30 June	No. Pairs Seen (no nests found)		No. of Goslings Seen (Age in Weeks)				No. Pairs Seen (nests found)		No. of Goslings Seen (Age in Weeks)				Total G Seen	Total G Fl'gd	Parental Origin of Fl'gd G		
	w/G	wo/G	0-5	6-7	8-12	12+	UA	w/G	wo/G	0-5	6-7	8-12				12+	UA
1964-65	1					4									4		
1965-66							1										
1966-67	1				3										3		
1967-68																	
1968-69																	
1969-70																	
1970-71																	
1971-72																	
1972-73	1		2					1							2		
1973-74							1	1						2	2		
1974-75																	
1975-76	1		1					2							1		
1976-77																	
1977-78																	
1978-79	1		5												5		
1979-80	1					2 ¹		2			3	2			7	4	4 RM+RF
1980-81								1									
1981-82	1					2		3	2	1	2				9	6	2 UM+UF 4 RM+RF
1982-83								3	2	2		3	3		8	3	3 RM+RF
1983-84								3		1			3		4	3	2 WM+WF 1 RM+RF
1984-85								4	3	4	1		1		6	1	1 RM+RF
1985-86								1						2	2		
1986-87									2								
1987-88								1*	4**					3	3		
Totals	7		8		3	8		18	19	8	3	6	13	7	56	17	15 RM+RF 2 WM+WF 2 UM+UF

Legend

Wks. Old
 0-5=downy young
 6-7=half grown
 8-12=3/4 grown; able to fly
 12+=fledged; strong flyer
 w/G=with Goslings

wo/G=without Goslings
 Fl'gd=Fledged
¹2 seen 6 May 1980 (counted as Fledged)
²1 taken 17 April, 3 seen 22 April 1980
 (counted as Fledged)

M=Male, F=Female, R=Released, W=Wild, UA=Unreported Age
 *largest of 3 goslings taken to Pohakuloa
 **includes 1 3-egg incubated clutch taken to Pohakuloa for future breeding stock; no followup observations of hatched 2-egg and 3-egg nests (1 egg broken in remaining 1-egg nest).

Table 27

Number and Success of Breeding Pairs Paliku, Haleakala National Park, Island of Maui, 1967/68-1987/88

1 July to 30 June	No. Pairs Seen (no nests found)		No. of Goslings Seen (Age in Weeks)					No. Pairs Seen (nests found)		No. of Goslings Seen (Age in Weeks)					Total G Seen	Total G Fl'gd	Parental Origin of Fl'gd G
	w/G	wo/G	0-5	6-7	8-12	12+	UA	w/G	wo/G	0-5	6-7	8-12	12+	UA			
1967-68									6								
1968-69									15								
1969-70 ¹																	
1970-71 ¹																	
1971-72 ¹	1											3			3		1 RM+RF
1972-73	1								1	3					5		2 RM+RF
1973-74	4				3			1	8*				2		9		2 RM+RF
1974-75	5											13			13		1 UM+RF
																	3 RM+RF
																	1 WM+RF
																	1 RM+WF
																	1 WM+RF
1975-76	2		4						2	4					7	3	
1976-77		1							2	2*	4				4		
1977-78	1				1				1	4			2		3	2	1 UM+RF
1978-79	3			1	6				2	5(1)				3	10		
1979-80	3									6(3)					7	7	3 RM+RF
1980-81	1							2	1	13*(7)				1	3		
1981-82									1	7				2	2		
1982-83	3	1							1	3(2)			1		4	4	1 RM+RF
																	1 WM+RF
1983-84	4							3	3	6(1)	1U		4		11+1U	8	2 RM+WF
																	2 WM+RF
1984-85	4							2	2	4			1U	2	7+2U	2+2U	2 RM+RF
																	1 RM+WF
1985-86	1							2	2	3(1)				4	6		
1986-87 ²																	1 RM+WF
1987-88									1	4**		9			9		4 WM+WF
Totals	33	2	4	1	10	42+1U	10	18	95(15)	4	1U	9	11+1U	12	103+3U	53+2U	14 RM+RF

Legend

Weeks Old
 0-5=downy young
 6-7=half grown
 8-12=3/4 grown; able to fly
 12+=fledged; strong flyer

M= Male, F= Female, W= Wild,
 R= Released, UA= Unreported age,
 U=Unreported numbers or rearing back-
 ground
 w/G=with Goslings
 wo/G=without Goslings
 Fl'gd=Fledged

()=other pairs losing all goslings
 * = includes 1 reneesting pair
 **= no followup observations of 5-4-3-3 eggs
¹"no special effort made to find nests"
²no. survey conducted

Distribution of 458 observations of breeding pairs plus survival and parental backgrounds of 338 goslings are detailed in Table 28. In no area did the average pair replace themselves with 2 surviving goslings - a discouraging result of the long restoration effort.

Number and Fate of Eggs and Nests

The number and history of eggs in a given nest is often difficult to determine. For example, eggs sometimes simply disappear with no clue as to what happened. In nests discovered after robbery or destruction of eggs, numbers and fates may be impossible to reconstruct. Even in normal nests one may not be able to learn the exact number of goslings which emerged from the scattered bits of shell which remain. Too, biologists sometimes simply overlook reporting the necessary details. For these and other reasons the following findings should be regarded as tentative.

The fates of some 338 nests and 837 incubated eggs are indicated by year and study area in Tables 29-33 and summarized in Tables 34 and 35 which follow. Of the 338 nests found, 192 (57 percent) were successful, 43 (13 percent) were abandoned, and 23 (7 percent) were destroyed. Biologists failed to report the fate of 81 (24 percent) of the total nests found. Of 815 eggs whose fate was reported only 428 (53 percent) hatched, 145 (18 percent) were believed to be fertile but failed to hatch, 81 (10 percent) were judged infertile, 68 (8 percent) were destroyed by predators, and 93 (11 percent) failed to hatch for other reasons.

8. Captive vs. Wild-Reared Population Replacement Rate

The essential statistic in calculating the rate at which wild-reared progeny may be replacing liberated captive-reared stock in the wild is the ratio of percentages of each group observed on repetitive field surveys. Numbers of banded, unbanded and unclassified (unidentified as to band status) Nene observed on apparently declining monthly surveys in Haleakala Crater,

have been included in Federal-Aid reports for 12 of the past 13 years. The foregoing data (Part B.), combined with numbers of banded Nene released most years at Paliku and Hosmer Grove (Part A.), are shown below in Table 36 for comparative purposes. Table 36 thus loosely relates the ratio of captive-to wild-reared stock observed monthly, to the annual release of varying numbers of captive-reared Nene (totaling 489) over the entire 17-year 1961/62 to 1987/88 period. It should be noted that some 403 Nene had already been liberated over a 14-year period before tabulation of banded:unbanded ratios were initiated in 1975/76.

Examination of the principal data in Table 36 (Part B.) shows that monthly surveys were not consistently carried out during the 13-year period. For example, only 3 surveys were conducted during the month of September, and only 5 in the months of May and June - 23 and 38 percent of the respective times available. At the other extreme, 10 surveys were carried out each month in January and February, 77 percent of the time. No surveys were conducted in reporting year 1986/87. Despite the patchy survey record, it seems clear that many more individuals were observed during the nesting and brood-rearing months of December, January and February than during April and May when, as previously noted, Nene tend to scatter and become secretive when undergoing flightless moult.

Scrutiny of the bottom line, Percent Banded, shows that (except in 1976/77) percentages of banded Nene observed tended to decline quite consistently, and percentages of unbanded Nene to rise rather evenly, from the initiation of surveys in 1975/76 to the last year of record in 1987/88. But not until 26 years after Nene were first released on Maui in 1961/62, and 7 years after releases were essentially halted, did unbanded (wild-reared) Nene substantially outnumber liberated captive-reared individuals in the wild population.

Table 28

Observations of Breeding Pairs and Gosling Survival Hawaii and Maui Release Areas, 1957/58-1987/88

	<u>Keauhou</u>	<u>Keauhou-2</u>	<u>Kahuku</u>	<u>K.Ainahou</u>	<u>Paliku</u>	<u>Totals</u>
Breeding pairs	198	27	26	44	163	458
Breeding pairs w/goslings	65	16	16	25	51	173
Pairs w/goslings from known nests	15		2	28	18	63
Pairs w/goslings from unfound nests	50	16	14	7	33	120
Breeding pairs w/o goslings	133	11	10	19	112	285
Pairs w/o goslings from known nests	130	10	10	19	110	279
Pairs w/o goslings from unfound nests	3	1			2	6
Goslings observed	122	25	32	56	103	338
Number of goslings age-classified	98	21	13	49	81	262
0-5 weeks of age	57	5	1	16	8	87
6-7 weeks of age	10	2		3	1	16
8-12 weeks of age	12	8	1	9	19	49
12+ weeks of age (fledged)	19	6	11	21	53	110
Fledgings w/parents of known backgrounds	19	4	6	15	28	72
No. with captive-reared parents	19	3	6	13	14	55
No. with wild parents				2	4	6
No. with mixed parentage		1			10	11

Table 29

Fate of Nests and Eggs, Keauhou Sanctuary, 1957/58-1987/88

1 July-30 June	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Eggs Inc'btd	Eggs Hatch'd	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Egg Failures
1957-58	2		2			U2N					
1958-59	9	1	3	3	2	28**+U1N	12	5+U1N	10		1
1959-60	3					U3N		U3N			
1960-61	2		1			4	3				1
1961-62	1					U1N		U1N			
1962-63	1					U1N		U1N			
1963-64	5		1	1	2	16**	2	7	3		4
1964-65	1		1			3	2				1
1965-66											
1966-67	4		(3)	3		13	5		8		
1967-68	6		5			20	15		4	1	
1968-69	4		1			16	3		11	1	1
1969-70	3		2			12	6			6	
1970-71	3		1	1		7+U1N	1		6		
1971-72	2		1			7	2		5		
1972-73	12		7		2	28+U1N	13	5	2	5	3
1973-74	24	1	16			51+U6N	33		11	4	3
1974-75	14		12			42+U1N	25		13	4	
1975-76	17		12		1	32+U7N	18	U1N	5	3	6
1976-77	14		7		3	20+U7N	17	U3N	1	2	
1977-78	7		5			16+U1N	14	1			1
1978-79	10		1	1	5	30+U1N	1	18	1		10
1979-80											
1980-81											
1981-82											
1982-83											
1983-84	1				1	3		3			
1984-85											
1985-86											
1986-87											
1987-88											
Totals	145	2	81	9	16	28**+U1N 16** 304+U32N	172+U14H 2DH U5H/X	39+U10N	80	26	31

Legend

Suc'sfl=successful=nests hatching 1 or more eggs

Ab'nd=abandoned

Inc'btd=incubated

Destr'yd=destroyed

*includes 1 egg taken for hatching at Pohakuloa

**includes 3 eggs taken for hatching at Pohakuloa

D=died, X=destroyed, H=hatched

N=nest(s)

U=unreported no. of eggs

()=goslings in 2 nests died after hatching

Table 30

Fate of Nests and Eggs, Keauhou 2 Sanctuary, 1964/65-1978/79

1 July-30 June	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Eggs Inc'btd	Eggs Hatch'd	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Egg Failures
1964-65											
1965-66											
1966-67											
1967-68											
1968-69	1		1			U1N					
1969-70	1		1			4	3		1		
1970-71											
1971-72	3		3			9	9				
1972-73	2		2			6	6				
1973-74											
1974-75											
1975-76											
1976-77											
1977-78	1					U1N					
1978-79	2		2			6	6				
Totals	10	0	9	0	0	25 + U2N	24	0	1	0	0

Legend

Suc'sfl=successful=nests hatching 1 or more eggs

Ab'nd=abandoned

Destr'yd=destroyed

Inc'btd=incubated

U=unreported no. of eggs

N=nest(s)

Table 31

Fate of Nests and Eggs, Kahuku Sanctuary, 1968/69-1987/88

1 July-30 June	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Eggs Inc'btd	Eggs Hatch'd	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Egg Failures
1968-69											
1969-70	1		1			4	4				
1970-71	2					2+U1N		2+U1N			
1971-72	1		1			3	3				
1972-73	1		1			3	3				
1973-74	2					2+U1N	U1H		1		1
1974-75	1		1			U1N	U1H				
1975-76	1		1			3	3				
1976-77	1					3		3			
1977-78											
1978-79											
1979-80											
1980-81											
1981-82											
1982-83											
1983-84											
1984-85											
1985-86											
1986-87											
1987-88	2		2			5	5				
Totals	12	0	7	0	0	25+U3N	18+U2N	5+U1N	1	0	1

Legend

Suc'sfl=successful=nests hatching 1 or more eggs

Ab'nd=abandoned

Destr'yd=destroyed

Inc'btd=incubated

U=unreported no. of eggs

N=nest(s)

Table 32

Fate of Nests and Eggs, Kipuka Ainahou Sanctuary, 1964/65-1987/88

1 July-30 June	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Eggs Inc'btd	Eggs Hatch'd	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Egg Failures
1964-65											
1965-66	1					2					2
1966-67											
1967-68											
1968-69											
1969-70											
1970-71											
1971-72											
1972-73	1		1			3	3				
1973-74	2		1			6	2				
1974-75											
1975-76	2					8		4	3		
1976-77											
1977-78											
1978-79											
1979-80	2		2			8	5				3
1980-81	1		1			4	4				
1981-82	5		3			14 + U1N	3 + U1H		4		
1982-83	5		4			13	11				
1983-84	3		3			10	5				3
1984-85	7		5			21	8		5		5
1985-86	1		1			3	2				1
1986-87	2		2			6	3		2		1
1987-88	5		3			13 ¹	8			1	1
Totals	37	0	26	0	0	111 ¹ + U1N	54 + U1H	4	14	1	16

Legend

Suc'sfl=successful=nests hatching 1 or more eggs
 Ab'nd=abandoned
 Destr'yd=destroyed
 Inc'btd=incubated

U=unreported no. of eggs
 N=nest(s)
¹includes a 3-egg incubated clutch taken to Pohakuloa for future breeding stock

Table 33

Fate of Nests and Eggs, Paliku, Haleakala National Park, Maui, 1967/68-1987/88

1 July -30 June	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Eggs Inc'btd	Eggs Hatch'd	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Egg Failures
1967-68	6		4	1		17	6	4	1	6	
1968-69	15		2	12		52	5		31	13	3
1969-70 ¹											
1970-71 ¹											
1971-72 ¹											
1972-73	4		2			12	3		2	5	2
1973-74	9	1	3		1	19	10	U1N	3	2	4 + U1N
1974-75	2			2		6			1	4	1
1975-76	4		3	1		13	5		2	6	
1976-77	4	1	4			14	9		3	2	
1977-78	5		4	4		4	3+U3H			1	U1N
1978-79	8	1	5	4		21	10			8	3 + U1N
1979-80	9		2	3		21	4			5	12
1980-81	21	1	9	1	5	40	15	13	4	2	6 + U6N
1981-82	8		5	1	1	20	10	2	2		6
1982-83	6		5	1		15	14	1			
1983-84	10		8	2		32	26				6
1984-85	6		5	1		18	16				2
1985-86	6		6	1		22	22				
1986-87 ²											
1987-88	5		1*			2	2				
Totals	128	4	68	34	7	328	160+U3H	20+U1N	49	54	45 + U9N

Legend

¹no search for nests was conducted

²no survey was conducted

*fate of remaining 4 nests unknown

Suc'sfl=successful=nests hatching 1 or more eggs

Ab'nd=abandoned

Destr'yd=destroyed

Inc'btd=incubated

U=unreported no. of eggs

N=nests

Table 34**Fate of Nests, Hawaii and Maui****1957/58-1987/88**

Area Years	Nests Found	Renests	Suc'sfl Nests	Ab'nd Nests	Destr'yd Nests	Nests with Unreported Fates
<u>Keauhou</u>						
1957/58-	145	2	81	9	16	41
1987/88	(99)	(1)	(55)	(6)	(11)	(28)
<u>Keauhou 2</u>						
1964/65-	10		9			1
1978/79	(100)		(90)			(10)
<u>Kahuku</u>						
1968/69-	12		7			5
1987/88	(100)		(58)			(42)
<u>K. Ainahou</u>						
1964/65-	37		26			11
1987/88	(100)		(70)			(30)
<u>Paliku</u>						
1967/68-	128	4	68	34	7	23
1987-88	(97)	(3)	(52)	(26)	(5)	(17)
Totals	332	6	191	43	23	81
Ave. Percent	(98)	(2)	(57)	(13)	(7)	(24)

Legend

Suc'sfl=successful=nests hatching 1 or more eggs

Ab'nd=abandoned

Destr'yd=destroyed

()=percent

Table 35

Fate of Eggs, Hawaii and Maui 1957/58-1987/88

Area Year	Eggs Inc'btd	Eggs Hatched	Eggs Destr'yd	Fertile Failures	Infertile Eggs	Other Failures
Keauhou 1957/58- 1987/88	348	172 (49)	39 (11)	80 (23)	26 (7)	31 (9)
Keauhou 2 1964/65- 1978/79	25	24 (96)		1 (4)		
Kahuku 1968/69- 1987/88	25	18 (72)	5 (20)	1 (4)		1 (4)
K. Ainahou 1964/65- 1987/88	111* [89+22]	54 (61)	4 (4)	14 (16)	1 (1)	16 (18)
Paliku 1967/68- 1987/88	328	160 (49)	20 (6)	49 (15)	54 (16)	45 (14)
Totals	837*	428	68	145	81	93
Ave. Percent	[815+22]	(53)	(8)	(18)	(10)	(11)

Legend

Inc'btd=incubated

Destr'yd=destroyed

()=percent

* includes 22 eggs (20 percent) having unreported fates

Table 36

(A) Banded Nene Released Yearly, (B) Banded/Unbanded Nene Sighted Monthly
Haleakala Crater, Maui, 1962-1987

(A) No. of Nene Released Per Year¹

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
35	29	28	34	25		20	72	55		44	55	4	2	38	47	1

(B) No. of Banded/Unbanded Nene Sighted 1 July-30 June

Year Sighted:	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Sub-Totals	Totals
Month Sighted:	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988		
July	14/7	28/8	28/14	27/16		22/13	3/3	10/8				N		132/69	201
Aug.	5/4	17/12	34/35	3/3	16/12	23/19	6/1					O		104/86	190
Sept.	14/11	29/35		21/15										64/61	125
Oct.	11/5	14/20		10/6	24/18	9/11						S		68/60	128
Nov.	12/3	2/8	21/6	3/3	37/21	15/9	8/6				2/13	U		100/69	169
Dec.	9/1	4/18			17/5	15/9		18/15	18/14	12/21		R	14/29	107/112	219
Jan.	19/10	19/24	28/5	53/23	*	12/8	18/15	20/15	8/8	12/24	7/19	V		196/151	347
Feb.	4/0	14/18	59/14	12/3	*	13/6	19/14	28/25	24/21	14/24	35/42	E		222/167	389
Mar.	8/1		14/5	11/4		10/5	28/15		10/14			Y		81/44	125
Apr.	2/3	8/3	8/0	6/0	4/1					8/12		S		26/19	55
May			19/5	6/0	4/5	11/6	3/2							43/18	61
June		9/2	16/7					27/14	11/8	11/18				74/49	123
S-Totals	98/45	144/148	227/91	152/73	102/62	130/86	85/56	103/77	71/65	57/99	44/74		14/29	1227/905	2132
Totals	143	292	318	225	164	216	141	180	136	156	118		43		2132
Percent Banded	69	49	71	68	62	60	60	57	52	37**	37		33	Average=58	

¹includes Nene released at Paliku and Hosmer Grove

*no surveys conducted due to severe storms

**percent of Nene observed unbanded substantially greater than those banded - the first time since restoration on Maui began 26 years previously, in 1961/2

9. Survival of Captive-Reared Stock Released in the Wild

A total of 473 captive-reared Nene in 12 groups were released at Paliku, Haleakala National Park, Maui, during the 16-year 1962-1977 period. Subsequently, beginning in 1966/67, HDFG biologists recorded the presence and year-of-release (if identifiable) of each captive-reared Nene observed in the wild. The resulting distribution of some 1,326 sightings over the 22-year period which followed appears below in (Life) Table 37. Properly interpreted, these data furnish the best insight available on life expectancy of liberated captive-reared stock. Unfortunately, comparable data for comparative analyses were not collected from release areas on the island of Hawaii.

In Table 37 numbers of released captive-reared Nene observed in successive years beginning in 1966/67 are shown in vertical columns under the respective year released. Casual examination of these data shows that although a total of 12 releases were made, sightings of only the first 9 releases (1962 to 1972) can be considered reasonably complete due to the long life expectancy of this species.

More detailed study of the data reveals that many fewer Nene in the first 3 release groups were subsequently observed than in later releases. This is due partly to the years which passed prior to initiation of record-keeping; partly to exclusion of sightings of Nene with lost bands (making year-of-release impossible to determine in some cases - see footnote 2); and no doubt partly as a result of disorientation and dispersal previously noted to have characterized the early release groups on Maui. Also, when compared with other release groups, numbers of Nene subsequently observed in the 1968 release class appear to be unusually high during an uncharacteristically long survival period. Higher than usual numbers of Nene seen in the 1968 release

class may have resulted from faulty interpretation of records due to lost bands.

To prepare the data for comparative analyses, the ratio of Nene subsequently sighted to those originally released was calculated for each year represented. The resulting percentages were then arranged in successive elapsed year order, as shown in Table 38. In defense of line D it is felt that since the beginning and last years data are those most likely to reflect unknown operational and reporting variables (receiving as they do the least benefit of average smoothing), omission of averages found in columns of elapsed years 0 and 16 from averages in bottom line D is justified. Basically, however, as close comparison will show, averages in lines A through D describe essentially the same survival curve.

Data in Table 38 support a conclusion that captive-reared Nene released at Paliku, Maui, from 1962 to ca. 1977 have thus far attained a maximum age of 16 years in the wild. Certainly of no less importance is the fact that at Paliku - one of the more promising release areas - fewer than half of each release group, on average, survived to reach breeding age (2nd elapsed year = 3rd year of life).

It should be pointed out, however, that the numbers of Nene observed in each release group becomes less and less representative with the passage of time due to the increasing tendency of aging bands to drop off, thereby permitting fewer and fewer Nene each year to be identified as to year of release. Thus the effective survival curve may be somewhat flatter than that shown.

10. Observed Mortality, Disablement and Emancipation

As might be expected with any wildlife restoration program involving release of captive-reared stock, subsequent observations turned up a significant number of dead and disabled individuals. To the degree that such examples were reported in Federal-Aid progress reports,

Table 37 (Life Table)

Released Captive-Reared Nene Observed Successive Years in the Wild
 Paliku, Haleakala National Park, Maui, 1967/68 - 1987/88
 (collated from HDFG data in Federal-Aid reports)

Year Released= No. Released=	1962	1963	1964	1965	1966	1968	1969 ²	1970	1972	1973	1976	1977	Totals
	35	29	28	34	25	20	72	55	44	50	34	47	473
<u>Year Observed</u>	<u>Numbers Observed</u>												
1966-67	1	2	1	23	25								52
1967-68	2	2	2	22	11								39 ²
1968-69 ¹	2	2	3	24	9								40
1969-70 ¹	3	2	2	24	8	20							59
1970-71 ¹	3	4	2	24	9	16	59						117
1971-72	3	2	1	20	6	11	44						87
1972-73	4	2	0	10	6	11	38	15					86
1973-74	3	2	1	13	6	11	30	15	23	23			127
1974-75	1	1	0	13	4	3	23	5	22	31			103
1975-76	1		0	2	0	1	9	5	11	15			44
1976-77			0	0	1	4	3	5	17	18	6		54
1977-78			0	0	1	4	5	5	14	9	20	28	86
1978-79			1	1	2	1	1	5	3	5	15	33	67
1979-80			1	2	1	3	2	5	6	7	16	35	78
1980-81					1	5	3	3	4	12	11	27	66
1981-82					0	2	3	3	3	4	10	23	48
1982-83					1	3	1	4	4	5	12	20	50
1983-84						3	1	2	6	4	11	22	49
1984-85							2	2	2	3	9	16	34
1985-86								1	4	3	6	13	27
1986-87	no survey conducted												
1987-88										1	4	8	13
Totals	23	19	14	178	91	100	222	75	119	140	120	225	1326

¹data furnished by M. Ueoka (per. comm.)

²does not include 6 Nene whose year of release is unknown due to lost bands

Table 38

Percentages of Captive-Reared Nene Per Release-Year Observed in Successive Years

Elapsed Year:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year/No. Released	<u>Percentages of Released Captive-Reared Nene Observed</u>																
1962-35					3	6	6	9	9	9	11	9	3	3			
1963-29				7	7	7	7	14	7	7	7	3					
1964-28			4	7	11	7	7	4	0	4	0	0	0	0	4	4	
1965-34		68	65	71	71	71	59	29	38	38	6	0	0	3	6		
1966-25	100	44	36	32	36	24	24	24	16	0	4	4	8	4	4		4
1968-20		100	80	55	55	55	15	5	20	20	5	15	25	10	15	15	10
1969-72		82	61	53	42	32	13	4	7	1	3	4	4	1	1		
1970-55			27	27	9	9	9	9	9	9	5	5	7	4	4	2	
1972-44		52	50	25	39	32	7	14	9	7	9	14	5	9			
1973-50	46	62	30	36	18	10	14	24	8	10	8	6	6	0	2		
1976-34	18	59	44	47	32	29	35	32	26	18	0	12					
1977-47	60	70	74	57	49	43	47	34	28	0	17						
A ¹ =	56	67	47	38	31	27	20	17	15	10	6	7	6	4	5	7	7
B ² =	56	67	52	45	39	34	25	19	18	11	6	8	8	4	5	9	7
C ³ =	41	62	48	44	37	31	26	21	18	10	7	6	5	4	3	2	4
D ⁴ =		62	48	44	37	31	26	21	18	10	7	6	5	4	3	2	

A¹=unaltered averages

B²=A minus percentages of first 3 release groups

C³=B minus inflated percentages of 1968 release group

D⁴=C minus atypical percentages of elapsed years 0 and 16

they have been listed together with what is known of condition or causative factors by release area and year in Table 39 below.

As a cursory examination of Table 39 reveals, dead, disabled, and emaciated Nene were reported most often in release areas apparently surveyed most frequently, extensively, and over the longest periods of time. For example, release areas ranked in descending order according to number and percentage of such cases reported are as follows: Paliku 40 (42 percent), Keauhou 34 (35 percent), Keauhou-2 8 (8 percent), Kahuku 7 (7 percent), and Kupuka Ainahou 7 (7 percent). Further analysis shows that of the 96 cases of dead, disabled, or emaciated Nene reported, 83 (86 percent) were released captive-reared stock, 1 (1 percent) was wild-reared, while 12 (13 percent) had unreported rearing backgrounds. Eighty-four (88 percent) of the 96 reported cases involved individuals which were found dead, 7 (7 percent) were emaciated, and 5 (5 percent) were disabled.

Cause of death, disablement, or emaciation was unknown in 41 (43 percent) of the 96 cases. A wide range of known or suspected factors were reported causing death, disablement, or emaciation in the remaining 55 (57 percent) of the cases. Of the 19 deaths associated with predation, dogs were thought to be responsible for 13 and mongoose for 6. Seven Nene apparently died as a result of colliding with vehicles (Saddle Road and Haleakala Highway). Some 7 cases of emaciation were widely distributed, as follows: Keauhou (2), Keauhou-2 (1), Kahuku (2), and Paliku (2).

Nene found dead, disabled, or emaciated due to unknown causes appear to have been reported more or less randomly in time with one possible exception. In Keauhou Sanctuary, 4 Nene were found dead of unknown causes in 1978/79 after 2 years of prolonged severe drought.

11. Island-wide Population Size

Hawaii

Following an unnamed citizen's report in late July 1955, biologists discovered what was believed to be the only remaining remnant of the once abundant Nene population - a loose aggregation of not more than 24 birds which moved freely about in the Mauna Loa - Mauna Kea Saddle area some 30 miles west of Hilo. Here, HDFG observers at strategic locations on the Saddle Road tallied, hopefully without omission or duplication, the number of Nene in the small low-flying flocks which passed more or less regularly from feeding grounds on the 1852 and 1881 lava flows of Mauna Loa south of the Road to a traditional night roosting area on Puu Oo Ranch north of the Road.

Systematic censusing of the flyway on an annual basis began in 1961/62 and was conducted without interruption for the next 24 years. Ground counts of wild vs. captive-reared individuals were initiated in 1964/65. Censusing continued thereafter most years until 1985/86 when reporting of both flyway and ground count data ceased, presumably because of changes in traditional flight patterns following release of stock in nearby K. Ainahou from 1972/73 to 1974/75 and a sharp drop in numbers following prolonged drought in the late 1970's and early 1980's.

Flyway and ground-count numbers of Nene recorded during years of census taking, together with numbers of released captive-reared stock and factors affecting the counts, are exhibited in Table 40. Total numbers shown in Table 40 should not be taken to represent the size of the total island-wide population, but rather as a rough index, composed as it was of loosely formed post-breeding flocks.

Analytical and interpretive values of the data in Table 41 are not only diluted by the constant flux in the size and behavior of the summering

Table 39

Dead, Disabled or Emaciated Adult Nene Observed In or Near HDFG Study Areas Hawaii and Maui, 1954/5-1986/7

Keauhou, 1954/55-1986/87

Year	No. and Background			Found or Reported	Unknown or probable cause and action taken	
	Wild	Released	Un'rptd			
1965-66	1			dead	x	
		1		dead	x	
			1	emaciated	x	escaped capture
		1		emaciated	x	diagnosed acute; treated; sacrificed
1966-67		1		dead		bacterial enteritis diagnosed
		2		dead	x	
1967-68		1		dead	x	
1968-69			1	dead	x	
1970-71		1*		dead	x	
1971-72		1		dead		dog(s) suspected
1972-73		2*		dead	x	
		1		dead	x	
			1	dead	x	
1973-74		1		dead	x	
		1		disabled	x	injured right wing
1974-75		2		dead	x	
1978-79		1		dead	x	
		1		dead	x	
		1		dead		unidentified predator
		1		dead	x	
1979-80		9		dead		dog(s) suspected
1984-85		1		dead	x	
Sub-total	1	30	3	31 dead	19	
				2 emaciated		
*died in release pen				1 disabled		

Keauhou 2, 1962/63-1986/87

1962-63			2	dead		dog(s) suspected
1963-64		1		emaciated		deformed primaries; unreported fate
1964-65		1		dead		collision with tree
1969-70		2		dead	x	
1978-79		2		dead		illegally shot
Sub-total		6	2	7 dead	1	
				1 emaciated		

Table 39 (Cont'd)

Kahuku, 1968/69-1986/87

Year	No. and Background		Un'rptd	Found or	
	Wild	Released		Reported	Unknown or probable cause and action taken
1968-69		2		dead	mongoose suspected
			2	emaciated	vitamin deficiency; treated; died
1969-70		1		dead	egg "miscarriage" suspected
		1		dead	x
1978-79			1	dead	illegally shot
Sub-total		4	3	5 dead	1
				2 emaciated	

Kipuka Ainahou, 1964/65-1986/87

1973-74		1		dead	collision with release pen
		1		disabled	weak legs; captured; sacrificed
1974-75		1	4	dead	1 verified, 4 reported hit by cars
Sub-total		3	4	6 dead	
				1 disabled	

Paliku, 1961/62-1986/87

1962-63		4*		dead	mongoose suspected
		1*		dead	x
		1		emaciated	x
		1		emaciated	x
		1		dead	x
1968-69		1*		dead	"deficiency" diagnosed
1970-71		1		dead	x
		1		dead	x
		4		dead	violent storm
1971-72		1		dead	x
		1		dead	x
		1		dead	x
		2		dead	x
		1		disabled	x sent to Honolulu; unreported fate
1972-73		1*		dead	x
1973-74		1		dead	x
1974-75		3		dead	x
1975-76		3		dead	x
1976-77		1*		dead	x
		1		dead	x
		1		dead	x

*died in release pen

Table 39 (Cont'd)

Paliku, 1961/62-1986/87 (Cont'd)

Year	No. and Background			Found or reported	Unknown or probable cause and action taken
	Wild	Released	Un'rptd		
1977-78		1		dead	x
1979-80		1		dead	entanglement, starvation
1982-83		1		dead	collision with car (NPS Hdqs. area)
1983-84		1		dead	dog(s) suspected
		1		disabled	tar removed, released Haleakala NP
		1		disabled	infection treated, released HNP
1984-85		1		dead	x
1985-86		1		dead	collision with car (Haleakala Hi'way)
Subtotal		40		35 dead 3 disabled 2 emaciated	20
Grand Total		83	12	84 dead 7 emaciated 5 disabled	41

Table 40

Nene Observed in Summer Flyway Area Kipuka Ainahou - Puu Oo, Island of Hawaii 1955/56-1987/88

Report Year	Captive-Reared Stock Released		Maximum Ground Count			Total Counted	Count Factors*
	Island-wide Total	Kipuka Ainahou	Maximum Flyway Count	Wild Reared	Captive Reared		
1955-56			24			24	
1956-57							7
1957-58			22			22	6
1958-59							7
1959-60	20						7
1960-61	31						1,7
1961-62	35		37			37	
1962-63	42		30			30	
1963-64			9			9	7
1964-65	49		48	32	4	48	
1965-66			76			76	
1966-67	75		45	49	5	54	
1967-68	85		46	41	1	46	4
1968-69	155		45	44	1	45	4
1969-70	106		87	70	10	114	4(3)
1970-71	94		15	29	2	31	4(6)
1971-72	37		106	(85)	17	113	4,5
1972-73	74	61	11	6		11	(8)
1973-74	123	123	72		5	72	7(8)(3)
1974-75	135	135				58	7(8)
1975-76	164		50		(6)	50	7(8)
1976-77				2		8	1,2
1977-78	47			(17)		77	1,2,7
1978-79	35			9	19	39	7
1979-80	12			39	60	(99)	7
1980-81				(15)	(15)	30	(2)7
1981-82				14	15	29	7
1982-83	27			6	9	15	(2)7
1983-84	37			14	10	24	7
1984-85	12			9	4	13	7
1985-86	61						7
1986-87	18						7
1987-88	32						7
Total.	1,506						

() - calculated or inferred

*Weather and Operation Factors Reported To Have Affected Year-to-Year Comparability of Nene Count Data

1-drought-change in distribution
2-drought-reproduction deficiency
3-rainfall-reproduction success
4-fog/rain-census handicap

5-fog/rain-change in behaviour
6-minor operational deficiency
7-major operational deficiency
8-released stock-change in behaviour

population, but by the concurrent annual release of highly variable numbers of captive-reared stock totaling more than 1,400 Nene during the 29-year 1959/60-1987/88 period considered. Release of more than 200 captive-reared stock in Kipuka Ainahou near the census viewpoints along the Saddle Road during the 3-year 1972/73 to 1974/75 period was observed to be particularly disruptive of traditional flight patterns. Finally, census inconsistencies caused by the weather and operational deficiencies debase comparative values of the data still further.

Nevertheless, the data in Table 40 exhibits several noteworthy characteristics. For example, while the counts obviously cannot be literally interpreted as a reflection of island-wide population size, it seems clear from the numbers counted and lack of similar flocking elsewhere, that the Kipuka Ainahou - Puu Oo Flyway counts made a significant contribution to what may now be recognized as the last remaining traditional flocking behavior of island-wide population segments. Another characteristic worth noting in Table 40 is the relative frequency with which wild-reared stock outnumber those of captive-reared origin in ground counts. Although it is clear that the data are not comparable in all cases, the fact that wild-reared birds outnumbered captive-reared stock in 10 of 15 examples, seems significant. This is particularly true considering the hundreds of captive-reared Nene which had been released.

Further examination of the data in Table 40 reveals that the average number of Nene counted increased for a period of some 17 years from inception of census in 1955/56 through 1971/72, presumably as a result of the constant liberation of captive-reared stock in the wild. However, this is the period in which wild-reared individuals outnumbered captive-reared stock by the widest margins. After 1971/72 when Flyway flocks declined apparently (due to the shift in behavior caused by release of stock at Kipuka Ainahou and later, prolonged drought), propor-

tions of captive-reared stock in flocks observed on the ground rose.

While data are not available which enable reliable estimation of the total island-wide population, some insight regarding the size of the total breeding population may be calculated by adding together the number of pairs found annually with nests or young in each release area. When results are compared with the adjusted potential cumulative population of breeding stock available, as in Table 41, increasingly large discrepancies are readily apparent, pointing up the apparently heavy mortality rates of the released stock.

For example, a maximum of 10 breeding pairs were tallied in Keauhou alone in 1958/59. However, despite annual releases (adjusted for delay of breeding potential) of a total of 598 captive-reared stock in all 4 release areas, doubling (21 pairs) of the observed breeding population was not achieved until 14 years later, in 1972/73. While the total observed breeding population doubled again (42 pairs) the following year (1973/74), the observed breeding population continued to decline irregularly to pre-release levels over the following 14 years despite periodic releases of significant numbers of captive-reared stock.

Maui

Observations of released (banded) captive-reared Nene and their (unbanded) progeny were recorded in the area of Paliku, Maui, with greater seasonal and year to year consistency over a longer period of time than in any of the 4 release areas on the island of Hawaii. The resulting bank of recorded information permits reliable projection of total population size provided the proper computations are applied. The following account of the technique utilized is extracted from the 1980/81 Federal-Aid report, while the resulting 10-year population projections are taken from the most recent 1987/88 report, as follows:

The high count of 52 nene was classified as 23 banded, 19 unbanded and 10 in flight.

Table 41

Potential and Actual Breeding Population

Island of Hawaii, 1956/57-1987/88

Year	Potential Breeding Mates			No. of Wild or Captive-Reared Breeding Pairs Observed				Total
	Total Released	Cumulative Total	Adjusted* Total	Keauhou	Keauhou-2	Kahuku	K.Ainahou	
1956-57 ⁵				5				5
1957-58 ⁴				2				2
1958-59 ⁴				10				10
1959-60 ¹	20	20		6				6
1960-61 ¹	31	51		4				4
1961-62 ¹	35	86		1				1
1962-63	42	128	20	1				1
1963-64		128	51	8				8
1964-65	49	177	86	2	1			3
1965-66		177	128	3	1			4
1966-67	75	252	128	12	2			14
1967-68	85	337	177	17	1			18
1968-69 ²	155	492	177	4	1	1		6
1969-70 ³	106	598	252	5	3	1		9
1970-71 ⁴	94	692	337	3	1	3		7
1971-72	37	729	492	2	3	1		6
1972-73 ¹	74	803	598	12	2	5	2	21
1973-74 ³	123	926	692	29	5	6	2	42
1974-75	135	1061	729	18	1	3		22
1975-76	164	1225	803	19	1	1	3	24
1976-77 ¹		1225	926	16		1		17
1977-78 ¹	47	1272	1252	10	1			11
1978-79 ⁵	35	1307	1276	10	5		1	16
1979-80 ⁵	12	1319	1284			1	3	4
1980-81 ^{1,5}		1319	1277				1	1
1981-82 ⁵		1319	1277				6	6
1982-83 ^{1,5}	27	1346	1297				5	5
1983-84 ⁽⁵⁾	37	1383	1297	1			3	4
1984-85	12	1395	1320	1			7	8
1985-86	61	1456	1371	2			1	3
1986-87	18	1474	1319			1	2	3
1987-88	32	1506	1400			2	5	7
Total	1506			203	28	26	41	298

*assuming breeding potential to start the 3rd year following release and continuing uninterrupted for 15 years

¹drought-production deficiency

²cold-production deficiency

³rain-production efficiency

⁴minor operational deficiency

⁵major operational deficiency

()- inferred

The calculated banded to unbanded ratios were 55 percent banded and 45 percent unbanded. The mean banded to unbanded ratios based on the results of the monthly count computed to 61 percent and 39 percent respectively. A total of 79 (different) nene could be accounted for during this report period. By applying the mean banded to unbanded ratio and the total number of banded birds to the Lincoln index, a population estimate of 130 nene was obtained. Comparatively, population estimates for the previous 2 years were 106 in 1978/79 and 118 in 1979/80. The population estimates indicated a rising trend over the 3 years ...

Yearly populations of Nene in the Eastern Section of Haleakala Crater Covering 9 Years

Year	Population estimates
1978-79	106
1979-80	118
1980-81	130
1981-82	108
1982-83	112
1983-84	119
1984-85	128
1985-86	129
1986-87	—
1987-88	104

12. Nene Seen Outside Sanctuary Boundaries (1960-1988)

While Nene observed outside boundary study areas have already received scattered and incidental mention, it is useful to review these records in chronological context with others reported in the literature, as follows:

Island of Hawaii

Keauhou-2 Area:

Distant movement from Keauhou-2 was first noted in 1961/62 when a single escaped Nene from the May/June 1961 release was seen repeatedly many miles away in Waimea (98).

Subsequent field checks of 42 released in 1963/64 were said to have attained "good dispersal", with a few - one a very emaciated goose with crooked primaries - being seen miles distant on Huehue and Horseshoe One Ranches (171). A pair from the group of 19 released in April 1965, was found frequenting a 2-mile stretch of the Holualoa Road some 14 miles from the release site during the entire month of June. This individual became very tame, being captured by boys. Later it was confiscated and returned to Pohakuloa (228).

In 1968/69, HDFG reported that a Nene released at Keauhou-2 in 1962 was observed by Parker Ranch employees some 18 miles distant in the Waikii area (1293). An unreported number of some 33 released on 22 April 1969 were seen later around the summit of Hualalai and at water-holes in Huehue Ranch, 5 to 7 miles away (172).

Dispersal of captive-reared Nene released at Keauhou-2 continued long after the initial liberations. HDFG Federal-Aid reports cite 4 to 6 banded Nene, suspected of having been released at Keauhou-2, seen by the caretaker at Puu Waawaa Ranch during the 1969/70 period (211). A group of 4 adult banded Nene and 2 two-to-three month old unbanded goslings with parents from the April 1969 release group in Keauhou-2 were also observed (2 February 1971) on Puu Waawaa Ranch (212). Two banded Nene were seen on the jeep road above the upper end of Kaloko Mauka Road near Kona, where they allowed approach to within 5 feet on 29 January 1978 (229).

Some released Nene appeared to frequent distant habitats far from the release site years later. For example, an unbanded gander and a 1976 Keauhou-2 released goose were sighted repeatedly on Puu Waawaa Ranch during the 1983/84 period (213). Of some 11 Nene sighted in Puu Waawaa Ranch in 1984/85 some 6 were unbanded, combinations on 3 indicated lost

bands, while rings on 2 showed that they had been liberated in Keauhou-2 in 1976 (214).

Kahuku Area:

Prior to liberation of captive-reared stock in Kahuku in 1966/67 there seems to be only one prior observation of Nene in adjacent lowland areas - a single unbanded bird - "probably" a year-old female, observed to remain on Kapapala Ranch most of November 1961 (63). Post-release history of Nene liberated in Kahuku Sanctuary revealed, like those released in Keauhou-2, a minority with a marked desire to move to adjacent lowland areas, many atypical of their natural habitat. In reporting period 1967/68, a pair from the May 1967 release was seen for several days along the Belt Road at Naalehu and Kioloakaa (356), and an individual liberated that same year was observed for several weeks in Pahala Plantation sugar cane fields (374). The following year, in 1968/69, a gander from each of the 1968 and 1969 release flocks was captured at unreported locations and returned to Kahuku for re-release; two others were captured by a school bus driver and student (one each) possibly in Pahala; while 3 from the 1968 and 1969 release flocks were seen in a Hawaiian Ranch pasture below the town of Pahala (357, 375).

Keauhou Area:

Except for the proclivity of captive-reared stock liberated in Keauhou Sanctuary to move to the Kipuka Ainahou - Puu Oo area during the summer months, there seemed to be only 1 distant movement. In 1968/69, an individual originally released at Keauhou was captured at Punaluu Black Sand Beach with a throw-net and returned to Keauhou for re-release (373). A few years earlier, in 1967/68, a farmer familiar with Nene reported a pair in a 100-acre papaya farm at Kalapana, but HDFG assumed that these birds were from H. Shipman's flock at Aina Hou (then an in-holding in Hawaii Volcanoes National Park) since the flock was free to roam at will (1030). In another example of straying, though

not involving Nene known to be released in Keauhou, a goose from Hawaii Volcanoes National Park was observed at the self-feeder in the Kahuku Sanctuary in 1985-1986 paired with an unbanded gander. This pair was later seen by National Park personnel in Kapapala Ranch (393, 866).

Nene, presumably those released in Keauhou Sanctuary (or their progeny), are frequently reported in Hawaii Audubon Society Christmas Bird Counts in and near Hawaii Volcanoes National Park. In or adjacent to the Park at mid-elevations various compilers tallied 2 Nene seen on Keauhou Ranch and Volcano Golf Course in 1972, and 4 on Keauhou Ranch in 1973 (416, 417). The same year, van Riper III (1973) commented that Nene were found "frequently" on the eastern slope of Mauna Loa, but he did not specify dates or locations (76).

H.E. Smith (1974) observed 8 Nene swimming, presumably on a stock watering pond, in Keauhou Ranch at 5,380 ft. el. on 17 June 1974 (418) - one of the few observations of Nene actually in the water. Katahira (1978, 1979, 1985) reported 1 or 2 Nene seen during the Christmas Counts of 1978 and 1980 in Keauhou Ranch, and (once) on the crater rim of Kilauea (419-422). Taylor (1982), compiler of the 1981 Christmas Count, recorded Nene seen at the following locations: 3 on the hike through Kipuka Puuulu, along the Golf Course, and past adjacent areas; 2 on Kilauea crater rim near Thurston Lava Tube; and 2 along Transect 30 in Keauhou Ranch (423-425). Katahira (1985, 1986) and Williams, et al (1987), accounting for Christmas Counts conducted from 1982 to 1986, logged a total of 33 Nene seen in the same mix of areas as those reported by Taylor (1982), (426-432, 1917, 1018).

In a recent observation at a lower elevation in the Park, Taylor and Hoffman (1989) reported that a flurry of tour aircraft activity caused part of a flock of 18 Nene to discontinue social activity

and depart Kipuka Kahalii near Mauna Ulu on 5 December 1988 (1028).

At higher elevations in Hawaii Volcanoes National Park, along the Mauna Loa Trail ranging from 6,600 to over 8,200 ft. el. adjacent to Keauhou Sanctuary, observers on Christmas Count surveys - and during the course of hiking at other seasons - frequently reported seeing Nene. U.S. Fish and Wildlife Service files contain records of 2 Nene seen flying at 8,000 ft. el. along the Mauna Loa Trail on 5 June 1972 (984), and 2 flushed at about 7,900 ft. el. along the Trail on 15 August that same year (985). Gagne (1973) included in the 30 December 1972 Christmas Count 4 Nene seen along the Mauna Loa Trail from 6,600 to 8,000 ft. el. (986), while McKinnon (1974) reported seeing 2 a quarter of a mile north from the end of the Strip Road about 20 September 1974 (987).

S. Conant censused birds in Hawaii Volcanoes National Park and adjacent areas from 1972 to 1975, reporting 3 Nene observed per 40 ha. with 46 percent occurrence frequency in monthly censuses of subalpine scrub (transect 9), and none (0) seen in eight censuses in the tree line ecosystem during the same period (988, 989). At lower elevations during the same period Conant found less than 1 Nene per 40 ha. with only 8 percent occurrence frequency in monthly censuses of lower mountain parkland (transect 5), and the same results in monthly censuses of upper mountain parkland (transect 7) (1015, 1016). During the same general 1973/74 period, Mull (1975) tallied 2 Nene censused on the rim of Kilauea Crater during the 1974 Christmas Count (1014), and HDFG commented on the fate of a Nene given to the Park Service for release in the lower elevations (1013).

Katahira (1978, 1979) reported 4 Nene counted along Mauna Loa trail from 6,600 to 8,200 ft. el. during the 1977 Christmas Count and 1 along the same stretch of trail during the 1978 Count (990, 991). For the 1982 and 1983 Christmas Counts,

Katahira (1985) tallied 2 Nene counted each year along the same section of trail (994, 995), while Williams et al (1987) again tallied 2 Nene in the same general area during the 1985 Count (996).

Nearby, in KULANI quadrangle, HDFG reported that during the 1965/66 report period a pig hunter brought in a red plastic band removed from the carcass of a dead Nene found in the Upper Waiakea Forest Reserve (851). The band identified the carcass as a captive-reared individual originally released at Keauhou in April 1961, and last seen at the edge of Kipuka Kekekaniho (due west of the cabin), mated to an unbanded gander (no date) (851).

S. Conant also conducted bird censuses during the 1972-1975 period in KULANI quadrangle, seeing less than 1 Nene per 40 ha. with 31 percent occurrence frequency on monthly counts in upper Keauhou Ranch (transect 92), but seeing none on similar monthly counts in Kilauea Forest Reserve (transect 91) (852, 853). After communicating with F.L. Carpenter and R.E. MacMillen, Conant stated that they had observed a flock of about 15 banded Nene several times weekly during July and August 1974 usually feeding in pastures near Keawewai Camp (which Conant herself observed in addition to occasional sightings of single pairs feeding in pastures or near cattle watering holes above ca. 1400 m. (4,600 ft.) on Keauhou Ranch) (854).

Added to the above observations, Katahira (1978) logged 6 Nene censused on the 1977 Christmas Count in the Kulani Project (transect 28 mauka) (855), while 9 years later Williams et al (1987) tallied 2 during the Count in "Kulani" during the Christmas Count of 1986 (856). Pyle (1988d) stated that 2 Nene were seen at the Kulani Correctional Facility on 23 November 1987 (857).

It is not surprising that most Nene sightings outside Keauhou Sanctuary since 1959 have been made in Hawaii Volcanoes National Park

immediately adjacent to their principal breeding ground in Keauhou Ranch. Dunmire (1961) stated that this species was occasionally seen along the Mauna Loa trail between 6,600 and 7,000 ft. el. (938), the identical remark (939) made later by van Riper III (1973). Some 17 HDFG and NPS records of Nene seen in the Park adjacent to Keauhou Sanctuary from 1964/65 to 1978 bear testimony to the importance of Park habitat during this period (940-956). After 1978 however, during the drastic Nene population decline which occurred in Keauhou Sanctuary in the 1980's, observations of Nene in adjacent Park areas dropped off steeply.

Some 25 miles to the northeast of Hawaii Volcanoes National Park at H. Shipman's seaside Keaau Ranch, HDFG gave the Shipman Estate 2 pairs of Nene originally intended for release into Keauhou Sanctuary that year (1983/84) for the establishment of a breeding colony at Keaau (1270). A young gander, presumably produced at Pohakuloa, was also released on the Shipman Estate in Keaau in 1985/86 (1271).

At a higher elevation some 20 miles to the west of Keaau in the Waiakea-Uka area of Hilo, HDFG reported that in 1986/87 an unbanded Nene was captured and turned over to Dr. Renata Gassman-Duvall at Pohakuloa for examination. It was an older 5+ year bird with a slipped tendon that caused its right foot to turn outward. It was an old injury and there was no remedy for its ailment so it was re-released along the Saddle Road in company with other Nene (1268).

Kipuka Ainahou Area:

Still farther west and higher in elevation, in the Saddle area, Nene were observed in Kipuka Ainahou for a number of years before captive-reared stock were released in 1972/73. The first evidence of breeding discovered by HDFG biologists was a brood of 4 by wild parents observed in 1964/65 (1110). The following year in 1965/66, an unsuccessful nest by a wild pair was located (1111). Three 3/4 grown goslings

were reported in Kipuka Ainahou by an archery hunter in March 1967 (1112). Four Nene were observed at Puu Omaokoili in 1968/69, but no further sightings or reports of Nene in the area were recorded in Kipuka Ainahou until after captive-reared Nene were released there in 1972/73 (1113-1116). More recently, Nene have been observed flying in the Saddle Road area near Puuhuluhulu - 11 on 21 June and 9 on 26 June 1986 (Pyle 1986) (1117, 1118). For the subsequent history of Nene observed in Kipuka Ainahou and the Puu Oo flyway (1229-1265), readers are referred to the appropriate sections of the text in NENE RESTORATION PROGRAM (1949-1988).

HDFG's Pohakuloa Propagation Facility located in the southeast corner of AHUAMOA quadrangle, was the scene of much Nene traffic during the 1960-1987/88 period. Readers wishing to review the history of captive-reared Nene produced there from 1949/50 to 1987/88 are referred to the text in NENE RESTORATION PROGRAM (1949-1988). Supplementary observations of ailing Nene taken to Pohakuloa for treatment and free-flying birds returning of their own volition - often duplicating records cited elsewhere - are beyond the scope of the present work. However, readers wishing to review such records are referred to serial numbers 1294-1321 in the Appendix.

Some miles to the west in the Waikii area, HDFG in 1962/63 recorded an unbanded individual a considerable distance from any areas known to be frequented by Nene (1292). Not too far away, near Kemole cabin, 4 Nene were observed in September 1981 during HDFG's feral sheep and goat eradication work, but this seems to be the farthest north Nene have been recorded along the west slope of Mauna Kea (1327).

Island of Maui (1960-1988)

While the behavior and movement of captive-reared Nene on Maui was addressed previously,

it is useful to review such records in chronological context with others reported since 1959.

Some 35 Nene - 30 raised in England and 5 reared at Pohakuloa - were released in Haleakala Crater, Maui, in July 1962. Although most of these captive-reared individuals appeared to adapt to the Crater initially, widespread wandering soon became apparent. On 28 January 1963, a male not seen at Paliku since 1 October 1962 was captured about 15 airline-miles distant by a rancher at Kokomo (1350). Feeding and watering the 1962 group was discontinued on 1 April 1963, after which 2 Nene were seen at Kaupo Gap about 4 miles away from the release pen at Paliku, on 26 June 1963 (1389). Various reports of 1962-released Nene seen in the general area extending from Haiku to Pukalani and Makawao continued to come in during the balance of 1963 (1351).

Although some 397 Nene were released at Paliku during the 10-year 1961/62 to 1972/73 period, widespread wandering on Maui seems not to have been reported. Whether this apparent gap in the records represents a lack of distant movement or a recording failure is not known. Anonymous authors (1974, 1975) did, however, report that in 1973 and 1974 a total of 6 goslings were hatched by two breeding pairs confined to pens in the National Park Headquarters area high on the slopes of Haleakala (1359-1361).

Sometime later, Joyce (1974) reported that Nene sometimes wandered down about 4 miles from Paliku through Kaupo Gap to the Seven Pools area in Kipahulu Valley where they stayed most of the summer, and where at least 2 pairs unsuccessfully attempted to nest (1390). Joyce's note was corroborated in part by Hansen (1975) who reported that Nene were seen on a hike from Paliku to Kaupo Village and Seven Sacred Pools on 24 August 1971 (1347).

In September 1975, a hiker's report of 9 Nene along the southern slopes of Haleakala in the

Kahikinui area, was verified (1382). Ralph (1977) reported that 3 clutches of 5 eggs laid by the captive NPS flock failed to hatch during the 1976/77 breeding season - the dry weather being blamed (1362). On 12 July 1977 a farmer at Kihei caught a 1976-released Nene and turned it over to HDFG who re-released it in the Paliku area (1354). A few months later, a second Nene was caught in an unspecified area and returned by HDFG to the Crater (1336).

In 1977/78, a September 1976-released Nene was sighted on Kaupo Ranch, people living in the area reporting that this particular individual had been observed in the area for nearly a year, and on several occasions was seen in the company of another bird (1391). HDFG reported that since early fall of 1977, reports of Nene near the Kahua hunter's cabin and the "Baseball Park" area became quite regular at approximately the same time each year. Thorough search of these areas produced no evidence of attempted nesting or expansion of range but rather that on most occasions these Nene did not remain in the area for more than a week (1383). During the same 1977/78 period, 3 Nene were seen in flight below Kahikinui forest in the Waiopai area, Haleakala Ranch; 2 were observed near the Kahua hunter's shelter during several survey trips into the Kahua and Kahikihui areas, and other Nene were heard but never located below the Kahua hunters' shelter (1384-1386). In November 1978, while manning the Kula hunter check station, a pair of Nene was sighted on several occasions flying over the Kula Game Management Area. Several follow-up investigations indicated that these birds were not permanently established but rather that the sightings represented frequent movement outside the Crater area prior to the start of breeding season (1374). The following year, 1978/79, HDFG investigations of similar flights outside Haleakala Crater led to the same conclusion (1349, 1387). However, on 25 June 1980, a pair of 1977 Hawaii released birds was seen attending 2 fledged young in the "Ball Park" area, but a

week later these birds were not seen there (1378). It is not known for certain whether the term "Hawaii released" means that the parents were raised on Hawaii for release on Maui or whether they were both raised and released on Hawaii. Without explanation the possible significance of the statement is lost.

HDFG reports summarized for the 1975-1980 period contain the same, if not identical, information as just indicated (1352, 1355, 1377, 1392). Since apparently identical records cannot be checked for duplication they are not repeated here.

P. Banko (1982) found that only 36 percent of the clutches by pairs in confined pens in the Hdqs. area, Haleakala National Park, hatched at least 1 gosling whereas a success rate of 49 percent was achieved in large open-topped pens in natural surroundings in Hawaii Volcanoes National Park; a comparison of fledging success found only 76 goslings fledged from 72 clutches in both Parks - 19 from Haleakala and 57 from HAVO (1363).

The U.S. Fish and Wildlife Service (1983) summarized the production record of captive Nene maintained by the National Park Service at Haleakala, calculating that 16 had been raised and released at nearby Hosmer Grove in the 10 year period 1973-1982 (1364).

HDFG biologists reported that Nene continued to be seen and heard in the Kahikinui Game Management Area during October and November 1982, but did not attach any significance to these records beyond those already expressed (1388).

Pyle (1987c) stated that numerous Nene were observed at Paliku cabin in the spring of 1987, some 24 (including 8 goslings) being counted on 6 May, the largest count made (1369). Pyle (1988f) also noted that 2 unbanded adults with 2 full-grown young were reported on the

Halemau'u trail, Haleakala Crater rim on 6 May 1988 (1370).

Islands of Lanai, Molokai, Oahu, Kauai and Niihau 1960-1988

Nene do not seem to have been recorded on Lanai, Molokai or Niihau during the past 29 years; however, Kaiakapu (1987) reported that a small flock and a nest were confiscated on Oahu on 14 January 1987 (1413). He further indicated that the flock of 2 adult pairs and 4 juveniles, including a nest with 3 eggs, were "found held" and were taken to the Honolulu Zoo for temporary holding and examination. The owner of the flock reported that he captured the original pair at a stock (watering) pond in Makaha Valley. No leg bands or neck collars were found on any of the Nene indicating a wild stock whose parents may have derived from a captive stock years ago, according to Kaiakapu (1987).

Due to their new environment and the possibility of nest abandonment, the eggs were artificially incubated along with 2 additional eggs which were laid in the holding pen the following day. After a period of 31 days (average incubation time), none of the eggs hatched. Zoo personnel continued to incubate and monitor (the eggs) daily for 5 more days but, despite all efforts, the work was unsuccessful. It was later agreed to allow the Nene to remain at the Zoo as their new permanent home. This will provide an opportunity to introduce the Waianae flock to the Zoo's captive flock and possibly increase the genetic traits of future offspring (Kaiakapu 1987).

Records of Nene on the island of Kauai from 1960 to 1988 include Sears (1975) account that 6 were censused in the 15 December 1974 Christmas Bird Count in the lagoons along the north fork of the Wailua River at Paradise Pacifica (1418); however, this count was disputed by Zeillemaker (1975) who stated that "no geese (Nene or Canada) should be included on

the 1974 Lihue Christmas Bird Count at Paradise Pacifica (1419).

Pyle (1987a) reported that 5 banded Nene from a captive flock at Kipu Kai turned up 11 km. distant at Ahukuni Landing on 3 November 1986, and that after a newspaper story solicited observations from the public, sightings of free-flying Nene - the first "wild" Nene reported from Kauai - were sighted in 5 other localities in southeast Kauai (1428). Next, Ten Bruggencate (1986) reported on 14 December 1986 that "about 5 ... of roughly 15 ... were seen recently ... in the Lihue area and around Mahaulepu on the south side ... flock originated from a freed captive flock at Kipu Kai ranch of the late Jack Waterhouse ... first acquired from Herbert Shipman on Hawaii ... " (1420). Then, Williams et al (1987) logged 17 seen at Kipu Kai on the 20 December 1986 Christmas Bird Count (1429). Lastly, Pyle (1988b) stated that 1 free-flying Nene, presumably from the banded releases previously reported, was seen at Smith's Tropical Gardens in Kapa'a, and another on a pond near the Lihue Airport, both on 30 December 1986 (1426, 1440).

In 1987, HDFG (T. Telfer pers. comm.) logged an unconfirmed helicopter pilot report of Nene seen at Nualolo Aina on the Na Pali Coast on 13 January (1422). Later, T. Telfer and T. Pratt visited Kipu Kai Ranch on 24 September and counted 4 adults in old pens, 4 adults on the "East Beach", and 4 adults in the Kipu Bridge Pasture (HDFG 1 July 1987-30 June 1988 report) (1443-1445). T. Pratt determined that the Kipu Kai Nene came from "Carlsmith stock at Puuwaawaa Ranch, which in turn came from the Shipman flock at Ainahou Ranch at Kilauea, Hawaii", and that these individuals "were apparently of lowland origin" (1442). HDFG (1 July 1987-30 June 1988 report) also contained much valuable information on reproductive success, movement and population status of this incipient semi-wild flock on Kauai (see Appendix 1414, 1446).

Reports of Nene movement to other parts of Kauai were logged later in 1987 (HDFG 1 July 1987-30 June 1988 report), as follows: an adult seen at Barking Sands, Pacific Missile Range Facility, on 30 September (1427); 4 adults observed at the Kauai Community College (Puhi) on 2 Oct. (1447); 4 banded adults spotted at Mahaulepu on 4 October (1430); 4 adults reported at Ulu Ko Subdivision, Lihue, on 5 October (1448); species noted regularly in Aweoweonui, Mahaulepu, on 14 October (1449); 1 adult seen near rock cliffs at Polihale Beach on 22 October (1423); and 4 adults again seen in Ulu Ko Subdivision, Lihue, on 23 October (1450). Nine were counted in the Lihue area for the first time in the Christmas Bird Count of 1987 (Pyle 1988g) (1441).

Records of continued breeding success and movement of the Nene flock on Kauai continued to accumulate in 1988. Telfer (1988) reported that, with the assistance of Mrs. Karen Caires of Kipu Kai Ranch, 3 nesting pairs were monitored with 2 pairs producing 2 goslings each (1 drowning later), and a third pair hatching 6 goslings during the January to March period (1431). Pyle (1988e) reported that 2 nests produced 11 goslings at Kipu Kai in early February (1434), and that the sighting of 2 more juveniles during the March to May period raised to 10 the total number fledged in 1988 (Pyle 1988b) (1433). Meanwhile, T. Telfer, K. Caires and R. Rice reported sightings on Kipu Kai Ranch as follows: 2 adults and 2 goslings on East Beach, and 2 adults and 6 goslings near the Manager's Residence on 8 February (1451, 1452); 1 dead gosling found in water tank, 2 adults and 6 goslings near the Manager's Residence, plus 2 adults and 2 goslings 3/4 mile west of Kipu Kai on 17 March (1453-1455); and 3 noted frequenting Residence No. 2 on 25 March (1456).

Movement of Nene to more distant locations was noted by HDFG (1 July 1987-30 June 1988 report) in May, as follows: a pair seen near Pooku Stables, Princeville, on the 5th (1424); 2 seen in

Ulu Ko Subdivision, Lihue, on the 12th (1457); 5 seen in flight over Mahaulepu, and 7 to 8 flying at Menehune Fishpond, Nawiliwili on the 26th (1435, 1458); 5 observed in Aweoweonui Valley, Mahaulepu, on the 27th; and 7 seen mauka Kilohana Crater on the 28th (1425).

Later in 1988, HDFG (1 July 1987-30 June 1988 report) logged a few more occurrences, as follows: 2 captured and banded at Niumalu (Lihue) and released at Kipu Kai Ranch 26 July (1459); 8 seen at Vidinha Stadium baseball field, Lihue, on 28 July (1460); 8 seen regularly at the Grove Farm rockcrusher scale, Mahaulepu, on 5 August (1437); flights of 3 and 7 seen regularly in Mahaulepu noted 9 September (1438); Nene "roosting" in dense bushes on bluffs between Mahaulepu and Kipu Kai for the month prior to 1 October (1439); and a pair seen repeatedly on "Bird Island", Westin Hotel Lagoon, Nawiliwili, on 16 November (1461).

13. Summary Conclusions: HDFG Field Data (1954/55-1987/88)

Weather Factors

Variable periods of extremely dry weather, abnormally cold temperatures and/or severe wind, rain and/or hail storms were observed to adversely affect Nene populations in all release areas. Cold temperatures prevailing at altitudes ranging from 1585 m. (5,200 ft.) at Keauhou-2 to 1980 m. (6,500 ft.) at Kahuku (the upper breeding range of Nene) increased the negative influence of exposure on reproductive success. Areas listed in decreasing order of average breeding season rainfall (3-19 years of record) - Paliku, Kahuku, Keauhou and Keauhou-2 - appear to be ranked approximately in order of increasing adverse influence of drought on breeding success and survival of liberated captive-reared stock. Overall, adverse weather factors appeared to influence populations negatively about 28 percent of the time. Abortion of field surveys due to fog and rain at Kipuka Ainahou-Puu Oo, and severe wind, rain, and hail storms at Paliku resulted in noncomparability of data for some years.

Operational and Reporting Deficiencies

Failure to conduct established surveys and report year-to-year findings in a systematic manner seriously degraded the comparative value of the data collected. Underlying causes such as manpower shortage, sick leave, adverse weather, resignation, landowner lockout, work reassignment, promotion, study design failure, etc. were tabulated and judged as a major or minor influence for each area and period of study. In a total of 139 report years, major inconsistencies were found 37 percent, and minor deviations 12 percent of the time. Overall, when weather factors were included, comparable data was judged to have been reported only about a third (32 percent) of the time during study periods ranging from 16 to 32 years.

Production and Release of Captive-Reared Stock (1949-1988)

The total 39-year production of 1,948 Nene reared at the Pohakuloa Propagation Facility and subsequent release of 1,790 (92 percent) in 4 State Nene Sanctuaries, 2 National Parks, and a private ranch over the 1949/50 to 1987/88 period is shown. The 9-year chronology of a cooperative experiment involving liberation of 198 Nene reared by the Wildfowl Trust, Slimbridge, England and 7 raised by S. Dillon Ripley, Connecticut (USA) at Paliku, Haleakala National Park from 1961/62 to 1969/70, is also shown.

Behavior of Captive-Reared Nene Released on Maui

Of some 489 captive-reared Nene released on the island of Maui over the 17-year 1961/62 to 1977/78 period, 473 were liberated at Paliku, Haleakala National Park. Of the 473 liberated at Paliku, 268 were raised at Pohakuloa, 198 were reared by the Wildfowl Trust, Slimbridge, England, and 7 were raised by S. Dillon Ripley, Connecticut (USA). All were released by setting

them free with food and water in a chicken-wire pen of about an acre (0.4 hectare) in size - the "gentle-release" method. This procedure permitted the released birds to re-establish their equilibrium after the stress of transportation, and, over a period of weeks or months, adapt to a new natural environment.

While the subject of adaptation behavior was not specifically targeted for study by HDFG biologists, their recorded notes were extracted from pertinent Federal Aid reports and arranged chronologically by topic for future reference, as follows: transport of captive-reared stock, behavior in release pen, transition to free flight, site fidelity to release areas, release-class interactions, molting behavior, seasonal movements, inter-island movement, and the case of the "Blue Goose" and her mate, the "Maui Gander".

Movement of Maui-released Nene to the island of Hawaii during the 13-year 1962 to 1974 period is examined in detail. Some 6 of the 65 captive-reared Nene (9.2 percent) liberated in 1962 and 1963 were seen later on the island of Hawaii; while none of the 226 released from 1969 to 1973 were apparently ever observed on Hawaii, perhaps indicating a degree of social unrest or maladjustment among the early pioneers on Maui. There also appears to be a significant decrease in the average elapsed time between the last Maui sighting of the 1962 and 1963 release groups and their first sighting on Hawaii (8.8 years average) and the average lapsed time interval of only 4.0 years between Maui-last and Hawaii-first sightings of the 1964 to 1968 release groups. Support was found lacking for the theory expressed in Federal Aid reports that Pohakuloa-reared Nene comprised a proportionately greater share of the one-way Maui to Hawaii migrants.

Movement of Captive-Reared Nene Released on Hawaii

Captive-reared Nene released on the island of Hawaii developed significantly different move-

ment patterns than their counterparts on Maui. In general, liberated Nene showed high site fidelity by remaining in the general area where released. Of some 1,792 liberated, only about 130 were sighted in areas other than where released and then, usually, were observed in adjacent release-areas. Only one was ever sighted later on Maui.

Keauhou, with only 15.4 percent of the total captive-reared stock liberated, had 36.9 percent of the total numbers resighted elsewhere, resulting in a higher release-to-resighted-elsewhere ratio (1:2.4) than any other release site. The greater tendency of stock released at Keauhou to be resighted elsewhere was due to the once traditional post-breeding movement from Keauhou to the regularly monitored summer flyway area across the Saddle Road to the Puu Oo Ranch. Keauhou 2, Kahuku and Kipuka Ainahou all possess identical release-to-resighting-elsewhere ratios of 1:0.9, 1:0.9 and 1:0.9. As might be expected, Paliku, Maui, is last with a very low 1:0.2 release-to-resighting-elsewhere ratio.

Release and Rearing Backgrounds of Wild-Breeding Nene

Despite the non-comparability of data some years, comparison of background and breeding success of mated pairs (including during periods of severe drought and/or non-release of captive-reared stock) yields insight on the potential contribution made to population growth by liberated stock, as follows:

1. Periodic liberation over the years of 1,894 captive-reared Nene - 350 at Keauhou, 348 at Keauhou 2, 404 at Kahuku, 319 at Kipuka Ainahou and 473 at Paliku - was initially followed (after a 2-year period for maturation) by temporary increase and then gradual or abrupt decline in numbers of breeding pairs observed in each area.

2. Although similar numbers of captive-reared stock were released in each area, sub-

sequent sightings of breeding birds varied widely, from 406 in Keauhou (where wild pairs were originally present) and 322 in Paliku (where there were no wild pairs when releases were initiated), down sharply to 82 in Kipuka Ainahou, 56 in Keauhou 2 and 52 in Kahuku. While some of the difference between numbers of breeding birds sighted in Keauhou and Paliku, and those seen in other areas, may be due to differences in the number and/or effectiveness of surveys conducted, the spread of difference is so great that an increased rate of survival for stock liberated in Keauhou and Paliku may be involved, given the high degree of site-fidelity displayed by this species.

3. Of 367 observations of breeding pairs, whose rearing backgrounds could be determined, 174 (47 percent) had been raised in captivity, 96 (26 percent) had originated from wild-reared stock, and 97 (26 percent) were of mixed captive and wild-reared origin. Thus, among pairs where backgrounds of both sexes were identified, captive-reared mates contributed 60 and wild-raised individuals 40 percent of total reproductive effort. (Year-to-year sightings no doubt included some observations of the same individuals).

4. Of 97 observations of breeding pairs having mixed captive and wild-reared backgrounds, 60 (62 percent) were captive-reared ganders mated to wild-reared geese. Assuming ganders and geese were released in equal numbers and matured at the same age, significantly fewer geese than ganders apparently survived.

5. At Paliku, where there were fewer wild-reared individuals, the ratio of breeding geese to breeding ganders sighted was highest. Assuming both sexes were released in equal numbers and had the same visibility index, geese apparently tended to survive longer than ganders in Haleakala Crater than they did elsewhere.

6. The release of 1,894 potential breeding birds resulted in only 482 sightings of captive-reared breeding mates. The significance of these

comparatively few observations is increased by the fact that an unknown number of observations were year-to-year duplications.

7. Breeding mates of wild-reared origin made significant contributions to potential population growth only at Keauhou, Paliku and Kipuka Ainahou (Puu 6677). Numbers of wild-reared breeding pairs at Keauhou dropped drastically after 1969/70, increased noticeably at Paliku after 1979/80, and remained relatively stable at Kipuka Ainahou throughout the study period. The possibility that the small nucleus of wild-reared birds originally at Keauhou could not compete effectively against much larger numbers of younger artificially-fed liberated stock for a limited supply of natural foods cannot be ruled out. The last breeding stock of clearly wild-breeding ancestry apparently became extinct in Keauhou shortly after 1969/70.

8. Only two release areas were characterized by observations indicating greater percentages of exclusively captive-reared breeding pairs seen than percentages of total stock liberated. Keauhou produced 39 percent of the observations of captive-reared breeding pairs from only 18 percent of the total stock liberated, while Paliku exhibited 35 of the observations of captive-reared pairs from 25 percent of the birds released.

9. At Paliku, where there was initially no established wild population, captive-reared breeding mates formed in numbers roughly proportional to numbers of Connecticut- and Pohakuloa-reared stocks liberated. Proportional numbers of breeding pairs with English background were not observed, supporting the conclusion from movement studies that early releases composed largely of English-reared stock liberated in an otherwise Nene-free environment, essentially dispersed and disappeared.

10. Drought was confirmed as a major depressant of pair formation and/or breeding success. Non-release of captive-reared stock

also acted to highlight depopulation in all areas except possibly Paliku and/or Kipuka Ainahou.

11. The relative efficiency with which first generation wild-reared offspring might produce second generation breeding pairs (a prerequisite of population growth) cannot be projected because the background origin of wild-reared goslings is not identifiable after parental ties are broken. Nevertheless, judging from examples of depopulation which are shown to follow temporary increases in population growth, opportunities for first generation wild-reared goslings to produce second generation breeding pairs appears to be zero in all areas except possibly Paliku and/or Kipuka Ainahou.

Fidelity of Captive-Reared Breeding Pairs to Area of Release

Correlation of area-of-sighting with area-of-release records for 269 wild-breeding captive-reared individuals revealed that 262 (97 percent) had remained in the area where liberated. The high proportion of surviving captive-reared stock to breed in their release-area points up the high site-fidelity of this species. Five of the 7 exceptions involved individuals which defected to Keauhou from other release areas.

Breeding Observations (1957/58 to 1987/88)

Comparative analyses of HDFG observations on breeding success and gosling survival resulted in the following findings and conclusions:

1. Release-areas ranked in order of total nests (and renests) found are: Keauhou 147 (43 percent), Paliku 132 (40 percent), Kipuka Ainahou 37 (11 percent), Kahuku 12 (4 percent) and Keauhou-2 10 (3 percent).

Conclusion: While the above rankings no doubt reflect the relative proportion of search effort perhaps as much as actual nest production, all other factors being equal, biologists tend to

spend the majority of their search time in the most promising areas. It is therefore concluded that, in the absence of data on man-hours spent searching for nests in each area, actual nest production in Keauhou and Paliku, at least, out-ranked that in each of the remaining 3 areas.

2. Of 338 nests (and renests) found, 191 (57 percent) were successful (at least 1 egg hatched), 43 (13 percent) were abandoned and 23 (7 percent) were destroyed. Fates of 81 nests (24 percent) were unreported.

Conclusion: The non-reporting of the histories of 81 nests compromises any conclusions which might otherwise be drawn.

3. Of 815 eggs found in nests in the wild whose fates were reported, 428 (53 percent) hatched, 145 (18 percent) believed fertile failed to hatch, 81 (10 percent) were judged infertile, 68 (8 percent) were destroyed by predators and 93 (11 percent) failed to hatch for other reasons.

Conclusion: From data on total nests and renests found, nest success and number of eggs which hatched (Tables 31-35), some 428 eggs (from 338 nests and re-nests) hatched in 191 successful nests, an average of 2.2 eggs per successful nest. When unsuccessful nests are included in the computation, an average of only 1.3 eggs hatched per nest found.

4. Of 458 sightings of breeding pairs only 173 (38 percent) were accompanied by goslings.

Conclusion: Given the fact that most surveys were conducted after hatching of early nests, the comparatively few pairs sighted with goslings suggests that many pairs did not breed and/or were unfruitful in terms of gosling survival, or were from overlooked nests.

5. Of 173 sightings of goslings reported, in only 63 (36 percent) of the observations were the goslings accompanied by parents from known nests.

Conclusion: That only about a third of the gosling sightings included adults from known nests

suggest that most pairs nest outside time and/or area limits of search.

6. Of 262 age-classified goslings reported, 87 (33%) were 0-5 weeks old, 16 (6%) were 6-7 weeks of age, 49 (19%) were 8-12 weeks old, while 110 (42%) had fledged.

Conclusion: The practice of estimating ages of goslings using various time spans (such as 3-4 weeks) complicates analysis by creating overlapping periods of comparability. These factors, together with those related to mobility and visibility of family groups, confounds drawing of valid conclusions.

7. Of 110 fledged goslings reported, 72 (65%) were found to be accompanied by parents with known captive-or-wild-reared backgrounds.

Conclusion: The relatively large proportion of fledged goslings found unaccompanied by parents with known backgrounds (35%) suggests that separation of parents from increasingly independent fledglings appears to be the most likely possibility.

8. Of the 72 fledged goslings accompanied by breeding mates having known captive or wild-raised backgrounds, 55 (76%) were with parents of captive-raised origin, 6 (8%) were accompanied by wild-raised adults, and 11 (15%) were with pairs where either the gander was wild and the goose captive-reared or vice versa.

Conclusion: In cases where parental background of fledged goslings could be determined, 121 mates of captive-reared origin contributed 84%, and 23 mates of wild-reared background yielded 16% of the total production.

9. Of the 17 goslings seen with parents of wild (6) or mixed (11) captive-reared origin, 14 were observed at Paliku, Maui; 2 were sighted at Kipuka Ainahou, and 1 was seen at Keauhou-2, Hawaii.

Conclusion: In contrast to the almost complete absence of wild-reared breeding pairs reported from island of Hawaii Sanctuaries in recent years, slowly increasing numbers at Paliku indi-

cate that a self-sustaining wild population may becoming established.

Captive vs. Wild-Reared Population Replacement Rate

Systematic collection of banded:unbanded ratio data began at Paliku, Maui, in 1975/76, the year after the first wild-reared mates of breeding captive-reared stock were identified and 13 years after the first release of captive-reared birds. Releases were essentially halted the next year. In the following 13 years (with one exception) proportions of banded individuals tended to decline while proportions of unbanded wild-reared birds were rising. But not until 1984/85, 26 years after Nene were first released, did numbers of unbanded individuals increase to the point of outnumbering sightings of captive-reared stock - 63 to 37 percent. The encouraging recent rise in the proportion of unbanded birds sighted is tempered by knowledge that the apparent increase may be as much the result of the natural mortality of older captive-reared stock as increase in the numbers of younger wild-reared breeders.

Survival of Captive-Reared Nene Released in the Wild

Subsequent observations of 473 captive-reared Nene released at Paliku, Maui, in 12 groups during the 16-year 1962-1977 period were examined for clues to life expectancy. Data adjusted for operational deficiencies, disorientation, dispersal associated with initial releases and other factors, displayed a relatively smooth regressive curve ranging from 62 percent of released stock observed 1 year after release, to 2 percent seen 15 years after liberation. While the data supports a conclusion that captive-reared Nene released at Paliku, Maui from 1962 to ca. 1977 attained a maximum age of 16 years in the wild, it also seems clear that fewer than half of each release group, on average, survived to reach breeding age (2nd elapsed year = 3rd

year of life). However, the actual survival curve may have a perceptibly longer toe than that calculated due to the increasing tendency of aging bands to drop off, thereby permitting significantly fewer and fewer Nene to be identified as to age-class each year.

Observed Mortality, Disablement, and Emaciation

Some 96 dead, disabled, or emaciated Nene were discovered by HDFG biologists from 1954/55 to 1986/87. Release areas ranked in order according to number of examples reported are as follows: Paliku 40, Keauhou 34, Keauhou-2 8, Kahuku 7, and Kipuka Ainahou 7. Numbers found apparently represent proportional amount of field survey effort expended more than harsh environmental conditions.

Of the 96 examples found, 83 were of captive-reared stock, 1 was a wild-reared individual, while 12 had unreported backgrounds. It may be assumed that most, if not all, of the latter were of wild-reared origin since colored bands would probably have been reported if present. Of the 96 cases, 84 were found dead, 7 were emaciated, and 5 were disabled due to injury.

A wide range of known or suspected factors were reported causing death, emaciation or disablement in 55 of the cases where diagnosis was attempted. Of 19 deaths, feral dogs were thought responsible for 13 and mongoose for 6. Seven Nene apparently died as a result of being struck by vehicles. Seven cases of emaciation were distributed as follows: Keauhou 2, Keauhou-2 1, Kahuku 2, and Paliku 2.

Reports of dead, disabled, or emaciated Nene due to unknown causes appear to be more or less randomly distributed in time and geographical area except in Keauhou where 4 were found dead in 1978/79 after 2 years of prolonged drought.

Island-wide Population Size

On Hawaii, annual counts of individual Nene flying in loose post-breeding flocks over the Saddle Road 30 miles west of Hilo, furnish a rough index to size of populations which existed from 1955/56 to 1984/85. While comparability of data varies, it is clear that despite successive yearly releases of captive-reared stock, wild-raised Nene counted on the ground at Puu Oo (the Flyway destination area) consistently exceeded numbers of liberated stock seen. After 1971/72 Nene released at nearby Kipuka Ainahou caused a reversal of the ratio. Large numbers of birds released there failed to have a significant long-term positive effect either on the size of the island-wide population, as measured by the flyway index, or on sightings of breeding birds in the various release areas.

On the island of Maui, application of the Lincoln index to monthly counts of banded and unbanded individuals permitted reliable projection of total population size. Population size from 1978/79 to 1987/88 ranged from 104 to 130, averaging 117 for the 9 years given.

Nene Seen Outside Sanctuary Boundaries (1960-1988)

Review of HDFG records of Nene seen outside study areas on the island of Hawaii, together with such sightings reported in the literature, indicate that individuals seen at locations distant from liberation sites tend to be defectors from initial release groups, especially those liberated in less productive and/or more drought affected habitats such as Keauhou-2 or Kahuku.

Except for defections to the island of Hawaii by individuals from initial release groups, Nene liberated on Maui do not appear to stray as far from the area in which they were set free as those on Hawaii. This tendency is perhaps due more to a lack of suitable habitat than a trait of character. Principal areas beyond Haleakala Crater

visited more than once include the lower elevations of Kaupo Gap and Kipahulu Valley, Kahua hunters' cabin, "Baseball Park", and vicinity of the Kula hunter check station.

Nene seem not to have been recorded on Lanai, Molokai, or Niihau during the past 3 decades, however a flock of 2 adult pairs, 4 juveniles, and a nest with 3 eggs were "found held" on Oahu in 1987. The owner of the flock reported that he captured the original pair at a stock (watering) pond in the Makaha Valley. The family group was confiscated and integrated with the captive flock at the Honolulu Zoo.

In 1986, reports of Nene seen in various locations on Kauai were traced to a flock of up to 17 free-flying birds located on Kipu Kai Ranch on the southeastern coast. This group reportedly originated from Carlsmith's flock at Puuwaawaa Ranch, Kona, Hawaii, which in turn sprang from Shipman's stock at Ainahou Ranch, Kilauea, Hawaii. Successful reproduction and continued widespread movement of this flock on Kauai was reported in 1987 and 1988.

Part IV. COOPERATIVE NATIONAL PARK SERVICE PROGRAM

1. Hawaii Volcanoes National Park

The National Park Service initiated a Nene restoration program based on captive breeding in Hawaii Volcanoes National Park in 1972. Within a few years a total of 8 breeding pairs had been established in large open-topped enclosures at 8 carefully selected low and mid-elevation (15-1220 m) habitats throughout the Park. The purpose of this program was to produce free-flying offspring which would establish a self-sustaining wild population over the former ancestral range of this species in and near the Park. Details surrounding the initial 10 years of

this plan were reported by P.C. Banko and D.A. Manual (1982).

H.M. Hoshide, A.J. Price and L. Katahira kindly provided us with drafts of their recent reports "Nene Management in Hawaii Volcanoes National Park from 1974-1989" (4 Dec. 1989 draft) and "A Progress Report on Nene (*Branta sandvicensis*) in Hawaii Volcanoes National Park from 1974 to 1989" (Aug. 1990 draft). The following account is based on the information furnished.

Although production of fledglings in the initial Park program was low, results were otherwise promising. To increase the number of free-flying fledglings produced annually, a cooperative inter-agency understanding was reached with officials of the Hawaii State Division of Forestry and Wildlife in 1984. Under terms of this agreement a quota of 3-6 weeks old goslings from the State's propagation facility at Pohakuloa were to be placed with penned adults in the Park for foster rearing. Fledglings produced under the terms of this agreement were also to be allowed to fly free, thus supplementing numbers reared by the original Park program.

Each year since 1975 all fledglings reared have been sexed and marked with identifying leg bands prior to free-flight capabilities. Free-flying fledglings produced at the various release pens during the 15-year 1975 to 1989 period are shown in Table 42 which follows. For pen locations and elevations see Table 42a.

In addition to the free-flying fledglings listed in Table 42, 7 individuals were liberated at Lae Apuki (100 ft. el.) in 1986. Radio tracked movements of this flock indicate that they left the area shortly after release and took up residence in papaya fields at Opihikau (650 ft. el.) over 10 miles away. Since then, one was fatally injured by a car and another was captured and re-released at Ainahou. Only two of the original

Table 42

Free-Flying Fledglings Released from Open-Topped Pens Hawaii Volcanoes National Park, 1975-1989

Year	No., Origin of Fledglings Released		Location of Pens													
			Ainahou		Kilauea		Kaone		Kukalaula		Kalapana		Hilina Pali			
			M	F	M	F	M	F	M	F	M	F	M	F		
1975	4		1	3												
1976	10		1	2		1	3	1	2							
1977	15		4	9			1	1								
1978	6						2	2		2						
1979	5		1					1	2	1						
1980	8								2	1				5		
1981	7	1	1	1		1	1	1	2		1					
1982	6		1	5												
1983	0															
1984	19	19	18	20												
1985	10	12	8	10	2	2										
1986	0	22	11	4							4	3				
1987	4	8	5	7												
1988	8	5	7	6												
1989	2	6	4	4												
Totals	104	73	62	71	2	4	7	6	8	4	5	3	5	0		

Table 42a

Locations and Elevations of Nene Release Pens Hawaii Volcanoes National Park 1975-1989

<u>Pen No.</u>	<u>Name and Location</u>	<u>Elevation</u> (± 10 ft)
1	Ainahou, 1.3 mi. ssw of Ainahou House	2,550
2	Ainahou, 0.4 mi. n of Ainahou House	3,100
3	Ainahou, 0.3 mi. n of Ainahou House	3,090
4	Kilauea, 0.5 mi. wnw of Keauhou Ranch House	4,000
5	Puu Kaone, 1.9 mi. w of Halepe Shelter	700
6	Kukalaula, 1.1 mi. sse of Pepeiau Shelter	950
7	Ainahou, 1.6 mi. s of Ainahou House	2,440
8	Ainahou, 2.0 mi. e of Kipuka Nene Picnic Area	2,700
9	Kipuka Ahiu, 2.1 mi. wsw of Hilina Pali	1,980
10	Laeapuki, 2.5 mi. wsw of Wahaula Visitor Ctr.	100
no number	Ainahou (4 adjacent covered pens) 0.8 mi. s of Ainahou House	2,750

group of seven were since sighted regularly at Opihikau.

Field observations over the years indicated that a reliable census of the Park population could be obtained by careful tabulation during the pre-breeding season when almost every individual tended to appear within a social group in more-or-less traditional flocking areas. For example, counts conducted within known flocking areas in 1988 revealed that a total of 163 wild Nene (121 banded, 42 unbanded) were residents of Hawaii Volcanoes National Park. Since flocking areas have been known to vary from year to year, the possibility exists that some Nene may have been missed by census takers. Nevertheless, the majority of the 1988 Park population was observed to be distributed among three major flocking area, as follows:

Ainahou/Kipuka Nene: This resident flock was found to be made up of 87 individuals. Eighty-seven percent were Park released birds, 1 percent were released by the State, and 12 percent were unbanded. Only 7 percent of this flock was observed at other flocking areas.

This flock was seen to visit several different areas within the Ainahou/Kipuka district. The pattern of usage appeared to vary from year to year. The observed trend was for the flock to graze at Kipuka Kahali'i until noon then disperse into smaller groups at the horse pasture, release pen, and Kipuka Nene Campground for the remainder of the day. The availability of food appeared to be a factor in determining flocking patterns to some extent ... It was not uncommon to see 30 birds within close proximity at Kipuka Kahali'i on a single outing during flocking season.

Kilauea: The golf course was the most popular area for the Kilauea flock. Members of this group were observed flying in from the direction of the Kilauea Crater area at approximately 7:30 a.m., spend the day grazing and relaxing at the golf course, then return to the crater area around 5:30 p.m. This flock was comprised of 43 birds. Fifty-eight percent were Park released birds; 5 percent were State released; and 37 percent were banded. Thirty three percent of this flock were also sighted at either Halfway House or Ainahou. Members of this flock

experienced the greatest amount of inter-flock encounters of all three groups.

Halfway House: This group was originally a mix of birds released by the Park at Kukalaula and birds released by the State at Kipuka Ainahou and Kahuku sanctuaries. The Park-released birds were observed nesting at Kukalaula and grazing at Halfway House. Most of these birds have disappeared over the years. There were approximately 30 birds in this flock. Thirty-nine percent were Park releases; 12 percent were State released; and 49 percent were unbanded. This flock contained the largest percentage of unbanded birds, reflecting a relatively high level of reproduction and recruitment. Thirty-three percent of this flock was sighted in other flocking areas. In 1989, no birds were sighted at Halfway House until mid-September.

Twelve banded and 4 unbanded individuals of unknown origin were also found to divide their time in 1989 between Keauhou Sanctuary, 3-Trees Kipuka, and Kipuka Mauniau. While there was no known link between this upper elevation group and flocks which inhabit middle and low elevation habitats in the Park, these 16 individuals were counted as Park residents.

The total number of fledglings known to be recruited into the wild Park population over the past 15 years was 48 birds. The actual number, however, may be considerably higher due to the fact that only fledglings associated with family groups during the flocking season were included in the count. A significant number of unbanded birds of unknown age and origin, being very difficult to differentiate, were not incorporated into the above recruitment total. Some recruitment was the result of free-flying pairs which returned to nest within "home" pens in which one or the other was reared.

Recruitment of fledglings according to flocking area where they were sighted was as follows: In the Ainahou/Kipuka Nene area, 19 fledglings were recruited into the wild population, 6 as a result of nesting by wild birds within release pens. In the Kilauea area, 12 wild fledglings (all resulting from nests in the Kilauea Crater/South-

west Rift area) were recruited. Two pairs consistently nesting near the Keanakakoi area produced more than 50 percent of these fledglings. In the Halfway House area, a total of 9 fledglings were recruited.

There was no confirmed record of recruitment of fledglings in the more distant, apparently disconnected, upper elevation Keauhou Sanctuary/3 Trees Kipuka/Kipuka Maunaiu area located mostly out of the Park.

In analyzing breeding success, Hoshide, Price and Katahira state that one nesting attempt was tabulated for each observed nest, gravid goose, goose with a brood patch, or pair accompanied by young-of-the-year. The resulting total of 129 nesting attempts recorded over the 15-year period in the Park (excluding 7 nesting attempts by pairs in Keauhou Sanctuary/3 Trees Kipuka/Kipuka Maunaiu area) were found to be distributed as follows: 53 (41 percent) in the Ainahou/Kipuka Nene area, 36 (28 percent) in the Kilauea area, 20 (16 percent) in the Halfway House/Kau Desert area, 14 (11 percent) at Kukalaula, and 6 (5 percent) at Kaone.

A reproductive failure was tabulated if the breeding pair was sighted without goslings during the following flocking season. Hatching failures observed included abandoned nests, infertile eggs, egg predators, dead embryos, and eggs broken in the nest. Rearing failures included any mortality that occurred after hatching. One hundred eight (78 percent) of the 129 known nesting attempts in the Park over the 15-year period resulted in failure. Fourteen percent of the total eggs located were taken by mongoose.

One hundred forty-four goslings were known to have hatched successfully in wild nests, 96 (67 percent) dying or disappearing before fledging. The majority of gosling mortality was found to occur within the first two weeks of hatching. Carcasses were usually too decomposed for necropsy; however, inadequate nutrition and

predation were suspected of being influential factors.

Hoshide, Price and Katahira described conditions which contributed to nesting and rearing failures, as follows:

A condition unique to the upper elevation flock (Keauhou Sanctuary/3 Trees Kipuka/Kipuka Maunaiu) on Mauna Loa is the high incidence of large dead embryos. Embryos (are found) fully developed with no obvious clues as to the cause of death. One hypothesis is that a slight temperature drop in the egg may cause the embryo to die. On Mauna Loa where temperatures below freezing are encountered, any break in incubation is critical. Egg temperatures may drop significantly if the female is disturbed by a predator (dog, cat or pig). Wild dogs have been sighted near nesting sites and were considered a possible cause for nest desertion. However, the fact that all embryos were found at a similar stage of development remains a peculiarity. It is possible that large embryos are more susceptible to subtle changes in temperature.

The "desert" nesting flocks which include Kilauea and Halfway House birds appear to follow a trend. Nest sites are chosen in sparsely vegetated, open areas which contain a smaller population of mongoose. Upon leaving the nest, the families begin a long arduous trek to an area where food is plentiful. In the case of the Kilauea flock, this new grazing area is located 3-4 miles away in Kapapala Ranch or the new golf course. Goslings have limited food storage capabilities and must reach this new food supply within a few days. Heavily used road systems sometimes deter and delay nene attempting to reach these foraging areas. Radio telemetry movement data has shown families moving parallel to the highway for several days. This utilizes their limited energy and makes them vulnerable to predation.

Periodic eruptions of lava in the summit area of Kilauea Volcano frequently cause extensive wildfires. In recent years modification of Nene habitat and changes in nesting activity due to lava-ignited wildfires in the Park have not gone unnoticed by those charged with Nene restoration, as follows:

In general, the wild Nene population appears to respond very favorably to recent

burns (which have) ... provided an attractive though very temporary food source and created habitat favorable for Nene nesting ...

The clean burn in the Ainahou/Kipuka Nene area temporarily removed most of the alien grass cover and resulted in large open patches of non-vegetated areas with a few remaining native shrubs. Within a couple of weeks, the alien grasses began sprouting new shoots which were very attractive to nene. Observations have shown that recovering patches of kikuyu grass within the burn perimeter were especially appealing. Kikuyu grass is presently an important diet constituent of all low and mid-elevation flocks. The remaining native shrubs provided adequate cover to protect the nest from the elements. The result was very favorable nesting habitat.

Prior to wildfires between 1980 and 1986 there were a total of only 17 known wild nesting attempts within the Ainahou/Kipuka Nene area. The breeding season which followed the 1987 Ainahou/Kipuka Nene fire resulted in 13 known attempts alone. Twelve of the 13 known attempts were located within the burn area. Nesting data collected after the Ainahou/Kipuka Nene burn of September 1987 showed that individual pairs would nest within 200 meters of each other and possibly closer under the right conditions. Observations of nesting attempts after wildfires at Puu Kaone and Hilina Pali have also shown increased activity on a smaller scale.

However, the benefits were very short-lived. After 12-18 months, the rapidly growing alien grasses also stimulated by the new burn reverted to the same conditions which existed prior to the burn. The number of nesting attempts within the Ainahou/Kipuka Nene burn area dropped significantly during the 1988-1989 breeding season (1 year after burn). Intensive search efforts turned up only 3 nests within the burn perimeter. Six gravid females were sighted in the vicinity throughout the breeding season, however it is doubtful that their nesting attempts were located within the burn.

The increased nesting activity did not result in a (proportionably) greater number of successful fledglings. During the '87-'88 breeding season, 13 attempts in the Ainahou/Kupuka Nene burn area resulted in only 3 successful fledglings ...

Recognizing the favorable results obtained by USFWS in the use of diphacinone for mongoose control Hoshide, Price and Katahir point out the advantages of using this chemical in combination with prescribed burning of selected nesting sites and/or cutting and fertilizing kikuyu grass plots to simultaneously stimulate food production and control mongooses in nesting areas. Study of the effects of feral cat and pig predation and/or disturbance on nesting Nene is a suggested research need.

Hoshide, Price and Katahira state that it is premature to conclude that the present wild population of 163 Nene in the Park (including the 16 individuals in the upper elevation Keauhou Sanctuary/3 Trees Kipuka/Kipuka Maunau area is self sustaining. Three alternatives dealing with captive propagation are identified and discussed.

Hoshide, Price and Katahira stress the need to continue monitoring the population over the next 3-5 years to provide an accurate assessment of the long-term population trend. Information on all aspects of Nene activity - nesting, movements, habitat usage, recruitment, molting and predation - is needed. Funding to support a seasonal biologist, thereby eliminating the need to recruit and train new volunteers every year, is viewed as a more efficient way to meet this goal. They point out that research must continue to investigate the underlying problems and provide management recommendations.

2. Haleakala National Park, Maui

Encouraged by 10 years of progress in the cooperative effort with the State to establish a self-perpetuating population of Nene in Haleakala Crater, the National Park Service initiated a supplementary project in 1972/73, placing 2 captive-reared pairs in separate holding pens at their Headquarters high on the outside rim of the Crater. A 1971 Pohakuloa-raised pair laid 4 infertile eggs their first year in that location but an older 1968 Pohaluloa-raised pair

produced 5 fledglings. One fledgling left the pen voluntarily, but the other 4 were transferred to a separate release pen nearby from which they eventually flew.

Results of reproduction by penned Nene at NPS Headquarters, kindly supplied by Cathleen Natividad Hodges (Resources Management) are shown below in Table 43. As indicated, from 1 to 3 pairs were confined for breeding during the 16-year 1972/73 to 1987/88 period. Except for 1983/84 and from 1985/86 to 1987/88, all pairs produced at least 1 clutch of eggs per year. A total of 40 clutches thus resulted from 44 breeding opportunities. Clutch size varied between 1 (n=2) and 5(n=16). There were 8 examples of renesting.

A total of 162 eggs were produced in 32 first nests and 8 re-nests for an average of 4.1 eggs per clutch. Geese that re-nested produced similar clutch sizes in their first and second attempts (mean clutch size = 4.1 and 4.0 respectively). Second clutches were the same size as first clutches (n=2), smaller than first clutches by 1-3 eggs (n=3), and larger than first clutches by 1-2 eggs (n=3).

Of 134 eggs which did not hatch, 74 (55 percent) were classed as infertile, 20 (15 percent) died as embryos, while 40 (30 percent) failed due to

unreported or miscellaneous causes. Only 7 goslings died as a result of rearing failures.

Of 40 clutches produced, only 13 (33 percent) were successful in hatching at least 1 egg. Of the 13 successful attempts, 11 (85 percent) fledged a total of 21 young for an average of 1.9 goslings fledged per successful nest. Three of the 8 re-nesting attempts resulted in the production of only 4 fledglings (19 percent of the total produced).

In 1978/79, 6 years after production of the initial fledglings from captive-reared penned pairs, wild Nene (presumably the mature offspring of penned pairs) were observed nesting in the NPS Headquarters area. Results of reproduction from these wild nesting pairs are shown in Table 44.

During the 13-year period from 1977/78 to 1989/90, unmarked wild pairs made 21 breeding attempts near NPS Headquarters. There were 16 first nests, 4 re-nests, and apparently 2 nests (8 eggs) in unreported areas. These 22 breeding efforts resulted in production of 12 broods of 1-4 goslings each for a total of 31 goslings fledged.

Wild-reared goslings were not marked or banded, therefore their survival and breeding histories remain unknown.

Table 43

Reproduction of Pinned Nene, Headquarters Area Haleakala National Park, Maui, 1972/73-1987/88

Breeding Season	Pen No.	Eggs Laid	Egg Failures					Rearing Failures			Goslings Fledged
			A	I	P	D	U	D	V	U	
1972/73	1	4		4							0
	2	5									5
1973/74	1	4		1							3
	2	4		4							0
1974/75		(5)		(2)					(2)		(1)
	1	5		2		3					0
		(5)		(4)							(1)
	2	4		2			1				1
1975/76		(5)		(4)			(1)				(0)
	2	5		1		1					2
		(4)		(3)		(1)					(0)
1976/77	3	4		1		1					2
	1	5		3		2					0
		(4)		(4)							(0)
1977/78	2	5		2		3					0
	3	5		3		2					0
	1	4		4							0
	2	5		4							1
1978/79	3	4		3					1		0
		(4)		(1)						(1)	(2)
	1	3		3							0
	2	4		4							0
1979/80	3	4		2		2					0
		(1)			(1)						(0)
	2	4	4								0
	4*	2			2						0
1980/81		(4)	(2)	(2)							(0)
	5**	4		2					1		1
	2	5		3		2					0
	4	5		3							2
	5	5		3		2					0

Table 43 (cont'd)

Breeding Season	Pen No.	Eggs Laid	Egg Failures					Rearing Failures			Goslings Fledged
			A	I	P	D	U	D	V	U	
1981/82	2	3					3				0
	4	2					2				0
	5	5					4	1			0
1982/83	2	3					3				0
	4	3					3				0
	5	5					5				0
1983/84	2	0									0
	4	5					5				0
	5	4					4				0
1984/85	View	1					1				0
1985/86	View	0									0
1986/87	View	0									0
1987/88	View ¹	0									0
Totals		162	6	74	3	20	31	5	1	1	21

*pair formerly occupied Pen No. 3

**pair formerly occupied Pen No. 1

¹View pen removed in June 1988 when female died; male released into the wild

A=abandoned

I=infertile

P=predation (mongoose)

D=died

U=unreported fate

V=vanished

()= results of renesting

Table 44

Reproduction of Wild Progeny of Penned Nene Headquarters Area, Halcakala National Park, Maui 1977/78-1986/87

Breeding Season	Nesting Area	Eggs Laid	Egg Failures		Rearing Failures		Goslings Fledged
			A	U	D	U	
1977/78	Brick Qtrs.	4		2			2
1978/79	Puu Nianiau	2					2
1979/80	Old Pen #1	2		2			0
1980/81	Gas Shed	3	2	1			0
	Across HQ	3			1		2
1981/82	Gas Shed	3		1	1		1
	Gas Shed	(5)		(1)	(1)		(3)
1982/83	Gas Shed	2		1	1		0
	Behind HQ	3		3			0
1983/84	Gas Shed	4		4			0
	Behind HQ I	4				2	2
	Behind HQ II	(1)		(1)			(0)
1984/85	Gas Shed	3					3
1985/86	Gas Shed	4		4			0
1986/87	Unreported	8					8
1987/88	Gas Shed	3		2			1
	Near View	4		4			0
	Near View	(4)				(3)	(1)
1988/89	Near View	4					4
1989/90	Near View	5		3		2	0
	Near View	(5)		(2)		(1)	(2)
Totals		76	2	31	4	8	31

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APPENDIX A

1. Observations, reports, and specimen records are organized by island group, island, district, and/or quadrangle map. Order of listing, names and locations of district, and quadrangle boundaries are explained and illustrated in CPSU/UH Avian History Report 4: Introduction to Part I, Population Histories—Species Accounts.
2. Acronyms composed of the first three letters of the author's (or senior author's) last name, the initial letter of the first name, and the last two digits of the year of publication represent sources found in the bibliography under References Cited. For example, BRYWO1 = Bryan, W. A., and Alvin Seale. 1901. Notes on the birds of Kauai. Bishop Museum Occ. Papers. 1(3): 129-137. In cases where it is necessary to distinguish between two or more articles published by an author in any given year, letters are added to the acronym in alphabetical sequence, e.g., BRYWO1a = Bryan, W. A. 1901. A key to the birds of the Hawaiian group. Bishop Museum Press. 76 pp.
Parenthetical numbers such as (5) represent references listed under Unpublished Sources in the bibliography.
3. Place-names are cited in original form.
4. Parenthetical information is qualified; when parentheses are used under heading of Date, the information represents date of interview or publication rather than date of observation.

Nesochen sandvicensis

Southeastern Hawaiian Islands

	Relative Abundance / Locality	Date	Source
1	<p>...Fossil remains of <u>Branta</u> have now been found on Hawaii, Molokai, Oahu, and Kauai. Originally, all of the main islands were probably home to <u>Branta sandvicensis</u> or closely related taxa. Because some of the fossil material differs from the few skeletons of <u>B. sandvicensis</u> available for comparison, final determination of the status of the various fossil populations awaits our more detailed study. Nevertheless, the specimens from Hawaii, Molokai, and Kauai are very similar to the extant form, whereas those from Oahu appear to be different and for the time being, can only be referred to as <u>Branta</u> sp. (but see the following species).</p> <p>Fossils of <u>Branta</u> from Molokai, Kauai, and Oahu are all from the lowlands near the present shore line, showing that the genus is not naturally restricted in the Hawaiian Islands to the high altitudes and harsh environments it generally inhabits at present. We also have remains from middens on Oahu and Molokai, indicating that <u>Branta</u> became extinct on those islands after Polynesian settlement. It probably was able to survive into the historic period on Hawaii, and possibly Maui (Baldwin, 1945), because these are the only islands in the chain with subalpine zones that provide suitable (although perhaps marginal) habitat for the Nene, but not for Polynesians...</p>	1982	OLSS82
2	Pickering: seen / in the mountains...especially numerous about 7000 ft. above the sea	(Dec. 1840)	CASJ58
3	not uncommon in ornithological collections (in Europe) and have been frequently noticed by voyagers...curious that we have not been able to find it named by ornithologists...what is most remarkable is the story related to us by natives, and which we have every reason to believe is a fact, that this Goose, which has the powers of flight which would enable it to move to as great distances as any others of the genus, is limited to the single island of Hawaii; rarely visiting any other islands of the group, although several are in sight. It bears confinement well, is hardy, and soon becomes domesticated...	(1840)	PEAT48
4	repeatedly noticed by the naturalists of the Expedition, and is apparently peculiar to Hawai'i, one of the Sandwich Islands...	(1840)	CASJ58
5	...indigenous and peculiar to our islands, and even here much restricted in its habitat, being only found on the mountain plains / of Hawaii, except occasionally, when blown off, it has reached Haleakala on Maui, and very rarely Kauai	(1867)	PEAW67
6	found in the highlands / Hawaii and Maui	(1868)	BRIW68

Southeastern Hawaiian Islands

- | | | | |
|----|--|-------------|---------|
| 7 | common in flocks of 3-7 in the highlands...living almost constantly on the high lava fields at an elevation of 5000-7000 feet / Hawaii and Maui | (1869) | DOLS69 |
| 8 | present in the highlands / (Hawaii and Maui) | (1879) | DOLS79 |
| 9 | widely distributed on Hawaii and in some localities is a fairly common bird, and is said to have formerly frequented Haleakala, Maui, although neither in my many visits to the summit, nor when camping in the bottom of the great crater did I myself get sight of one...its scarcity on Maui at the present time (if indeed it still exists there at all) is remarkable...other islands are quite unsuited to its natural habitats and it is not found on these...In the winter months large numbers of these upland geese resort to the lowlands and remain there for such time as the vegetation is fresh and green, and they are said to breed during this season...becoming less common than in former years and unless stringently protected at all seasons will probably become extinct...a source of much regret, for apart from the scientific interest...its appearance is striking and beautiful...and it is highly characteristic of some localities, themselves remarkable... | (1892-1896) | PERR03 |
| 10 | found / only on (Hawaii, Maui) above an altitude of 4000 feet | (1898) | PALT98 |
| 11 | it would be an easy matter to introduce the Nene from Hawaii into other islands...especially Maui...(where) no doubt the bird would thrive, if properly protected | (1902) | HENH02 |
| 12 | widespread below 9000 ft. el. / Maui and Hawaii | 1924 | GROG24 |
| 13 | primitive range...consisted of the dry, rugged lava slopes of the western and southwestern sides of Maui and Hawaii from 1000 to 8000 ft. el. Once they were reported to have been on Kauai and Niihau...In the early spring and summer months the birds lived at 5000 to 8000 ft. el. Usually during August, flocks move down to semi-desert flats ca. 1000 ft. el. | (1942) | ELLC42 |
| 14 | probably migrated between Hawaii and Maui, and sometimes was reported to straggle to other islands | (1944) | MUNG44 |
| 15 | Schwartzes (C.W. and E.R.) did not encounter any Nene in the wild during their two years of intensive field work in the Islands | (1946-47) | ELDW58a |
| 16 | distribution of Hawaiian Geese worldwide: 11 (captive) H.C. Shipman, Keaau; 1 (captive) Mrs. Wall, Kealakekua; 9 (captive) Board of Agriculture and Forestry, Pohakuloa; 30 (estimated) wild, island of Hawaii; 3 (captive) Severn Wildfowl Trust, England; 3 (captive) island of Molokai... | 1951 | SMIJ52 |
| 17 | HDFG: officially classed as endangered | (1969) | (2) |
| 18 | Extinction of the remnant population...was forestalled by releases of captive raised birds...1,319 on Hawaii since 1960, and 474 on Maui since 1962 by Hawaii State DLNR...plus 50 in HAVO since 1975 and 17 in HALE since 1973 by the National Park Service | (1977-1980) | BANP80 |

Southeastern Hawaiian Islands

- 19 The size of the populations on both Hawaii and Maui declined markedly between 1975 and 1980, following the curtailment of the artificial propagation program. The available data yielded no explanation for the causes of the downward trend but suggested that the artificially propagated and released nene might not be nesting as readily as wild-bred birds. (abstract) 1975-1980 DEVW82
- 20 draft Nene Recovery Plan has gone through more than four revisions...currently being revised to incorporate new information regarding decline of the population in the wild and the significance of predation in contributing to that decline. New data brought forth at this special session will also be incorporated... (1982) KOSE82
- 21 effort to save the Nene from extinction is frequently cited as a model of conservation in action...Today, thanks to the efforts of many aviculturists in Hawaii and elsewhere, the Nene seems to have been saved from imminent extinction... (1983) HORD83
- 22 Today Nene are found largely at high elevations (4000 to 7000 ft.) in limited areas on the island of Hawaii and on Maui (as a high altitude reintroduced population). Recent efforts by DLNR (Devick 1981) have demonstrated that population declines in the wild are likely if stocking of captive propagated birds in current habitat is not continual. (1983) STOC83
- 22a Hawaiian Goose densities are highest in dry subalpine ohia scrub and savanna on the island of Hawaii (Fig. 68). Occasional birds representing flyovers also occur in mesic and woodland habitat. A few pairs breed in the edges of mesic to wet forest kipukas surrounded by barren lava flows (N. Santos, R. Bachman, pers. comm.), but most nests are placed in areas of sparse vegetation (Elder and Woodside 1958). Hawaiian Geese have lower populations and densities on Maui than on Hawaii (Table 13), and occupy a narrower range of habitats. The regression models for habitat response (Table 14) indicate that Hawaiian Geese are most commonly associated with dry high elevation areas. Strong positive terms (e.g., t-statistics for the regression coefficients) for native herbs and native grasses in the three windward Hawaii models (Kau, Hamakua, Kipukas) reflect the diet of browse and seeds, suggesting that habitat response is partly determined by availability of suitable forage. (1986) SCOJ86

Island of Hawai'i

ISLANDWIDE INFERENCE

23	the great decline in numbers had occurred	by 1900	BALP45
24	now found chiefly if not wholly / on Hawaii	(1902)	HENHO2
25	becoming scarcer and scarcer every year	(1903)	HENHO3
26	restricted to the higher elevation...no longer migrates or leaves its mountain habitat / of Mauna Loa and Mauna Kea	(1934)	PALT34
27	population now reduced to about 50 birds...may once have totaled 25,000 or more...reduction began between 1778 and 1850; reduction in numbers, and perhaps range, noticed shortly after 1850, progressed rapidly between 1850 and 1900, and tapered off slowly from 1900 to 1930...since 1930...appears to have remained constant / present range encircles Mauna Loa...between roughly 5,000 and 7,500 ft. el. and extends to or near the seashore in parts of Kau, North Kona, and south Kohala...present center of population is in Puuwaawaa	(1945)	BALP45
28	...inhabits barren lowlands / from sea-level to 3,000 ft., and from 3,000 to 9,000 ft. el. on Mauna Loa and Hualalai...(concluding from extensive food habits studies) that "greater availability of food in the interior uplands may have favored the retreat of the remnant population to the uplands rather than to the lowlands"...	(1947)	BALP47
29	only 17...known in the wild	1950	ELDW58
30	sight reports...have dropped off to only 1 or 2 a year...despite active publicity	(1951)	SMIJ52
31	on the basis of a continued restriction of its range since 1949 and a drop in sight report frequency, the population today...can hardly exceed 30 birds	1951	SMIJ52
32	...population today is even less than it was in 1944 and 1947 when Baldwin and the Schwartzes (C.W. and E.R.) made their field studies	(1952)	SMIJ52
33	within the last 3 years Nene have failed to return to certain locations that until recently were apparently highly preferred parts of their habitat...	(1952)	SMIJ52
34	interviews of local residents islandwide turned up over 200 places Nene had been seen during the historical period / principal concentration seemed to be between Kilauea and Puu Oo...and in upland Kona...seemed to have disappeared from Puuwaawaa area...where formerly numerous, except for a possible remnant on Hualalai	(1956-1957)	ANON57
35	seen less than half a dozen times in the 5 years since Paul Baldwin's (1945) study	(1958)	ELDW58a

Island of Hawai'i

ISLANDWIDE INFERENCE (Cont.)

- | | | | |
|----|--|--------|--------|
| 36 | ...appears that the nene is far from "saved from extinction", as has been suggested... | (1981) | CONS81 |
| 37 | ...abundant native resident... | (1985) | PATP85 |

UNDESIGNATED LOCALITY

- | | | | |
|----|--|---------------|--------|
| 38 | told by natives of "vast flocks in the interior" | 1823 | ELLW17 |
| 39 | Along the trail from Hilo to Kilauea, some 5 or 6 to 9 miles from the volcano, passed by "several pools of water which are often the resort of wild geese which frequent this part of the country and live on purple berries..." | 28 June 1825 | BLOA25 |
| 40 | ...observed them on the volcanic mountains of Hawaii...generally in pairs at the season of our visit..rarely 4 or 5 were seen together feeding on the berries of a very abundant species of Vaccinium growing on the old beds of lava; on these they become very fat, and were delicious eating; grass appeared, however, to be their ordinary food. We never saw them near water, which is scarce in these regions...but they are said to breed near shallow ponds, some few occurring between the mountains... | November 1840 | PEAT48 |
| 41 | Pickering: seen / in the mountains...especially numerous about 7000 feet above the sea | (Dec. 1840) | CASJ58 |
| 42 | shot two...number...has been much underrated...admits of the annual slaughter of several hundred without diminution / elevated plain between the three mountains (Hualalai, Mauna Loa, Mauna Kea)...at least 4000 feet above the sea | 29 July 1864 | BRIW68 |
| 43 | C. Wall: reported as abundant / between Hualalai and Mauna Loa | 1859-1875 | POPW32 |
| 44 | J.D. Johnson, C. Kaa: obtained living young Nene / between Hualalai and Mauna Loa | (1890's) | BALP45 |
| 45 | Palmer and Munro failed to find it / between Hualalai and Mauna Loa | 1891 | BALP45 |
| 46 | Dole: builds its nest / on old lava fields 5000-7000 feet elevation | (1893) | WILS93 |
| 47 | to be found in June and July showing a preference for the clinker beds of the old lava flows / at some 5000 feet elevation | (1887) | WILS93 |
| 48 | Elder: Bearer: heard / John Baker trail (Puu Oo to Volcano) | 1899 | (1) |
| 49 | Elder: Ruttle (1956 / 1957): displayed photo of sister Irene Dixon and Sam Parker Jr. with 2 nene shot in summer of 1904 | 1904 | (1) |

Island of Hawai'i

UNDESIGNATED LOCALITY (Cont.)

50	Elder: A. Lindsey: (son of Wm. Lindsey) kept flock of nene and used surplus for the table; 24 pairs remained at the time of his death in 1907 / Parker Ranch	(early 1900's)	(1)
51	far in the night, heard a flock of Hawaiian geese far overhead...saw and heard them again the next day / on a ride from Humuula to Kona	(1912)	SHES12
52	(saw) a flock on the old Shipman trail / between Volcano House and Humuula	(1912)	SHES12
53	leads a life of seclusion high up on the mountainside, seldom if ever descending to the sea level	(1915)	BRYW15
54	Elder: Bryan: saw 8 in flight / Puu Oo trail	17 Jan. 1929	(1)
55	Bryan: observed a few / driest part, plateau between Hualalai and Mauna Kea	1932	BALP45
56	Elder: M. Greenwell: saw / between their upper ranch house at Puu Lehua and Ahuauri Heiau	ca. 1932	(1)
57	Donaghho: Bryan reported 2 along the Puu Oo-Volcano trail	June-Aug. 1937	(4)
58	Donaghho: Payne reported total of 19 between Mauna Kea and Hualalai	June-Aug. 1937	(4)
59	Payne via Donaghho: 19 seen between Mauna Kea and Hualalai	(prior 1937)	BALP45
60	NPS: none seen / on visits to nene localities	Mar. 1942	(5)
61	still a few birds...some semi-wild that have been raised by ranchers...(species) likely...saved...by this action	(1944)	MUNG44
62	although no longer legally hunted, there is evidence that some are shot occasionally	(1946-1947)	SCHC49
63	HDFG: ...a single unbanded nene, probably a year old female, was observed, remaining there for most of the month / Kapapala Ranch	November, 1961	(25)
64	observed / on the open grassland flanks of Mauna Loa	(1985)	PATP85
65	occasionally seen swimming in small cattle (watering) ponds / on the slopes of Mauna Kea and Mauna Loa	(1985)	PATP85

MULTI-DISTRICT

66	nest / barren flats near the sea...in Puna, Kona, Kau and Kohala	(1894-1902)	HENHO2
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Island of Hawai'i

MULTI-DISTRICT (Cont.)

67	found for the greater part of the year / from about 5,000 feet upwards...range...quite extensive...from the district of Kona to the northeast flanks of Mauna Kea...the region it affects is open and in general as barren as can well be imagined, consisting for the most part of lava flows, naked except for very scanty growth of ferns, ohelos, puakeawe, and a few other lowly shrubs	(1894-1902)	HENHC2
68	P. Baldwin: did not find any droppings or see any...obviously rare here / between Pohakuloa through Kanahaha and even to Puu Lehua...all this country appears an excellent potential nene breeding and feeding area	20 Nov. 1942	(7)
69	have now abandoned...concentrations nowhere to be found / all of Puna and parts of Kau	(1944)	BALP45
70	A. Wall: seen / all over the country between Mauna Loa and Mauna Kea	1890's	BALP45
71	A. Wall: found everywhere / between Mauna Loa and Hualalai and along the west slope of Mauna Loa to the south end of the mountain	1890's	BALP45
72	Woodside: no nene sign at waterholes along way / mauka of Puu Oo trail from west end of Stainback Highway toward Puu Oo Ranch reaching Ainahou Kipuka at 11 a.m....walked across and up Ainahou reaching Saddle Road at 1 p.m.	27 Nov. 1956	(16)
73	Woodside: no nene seen or heard in 5 hour hike from camp to Stainback Highway / broke camp...walked down a ways then north across edges of log kipuka, strawberry kipuka, pahoehoe above Kewewai and on down to where I could see the boys school (near Kulani Prison)...a scrub forest of ohia and aalii on pahoehoe...camped near Stainback Highway	27 Nov. 1956	(16)
74	Elder: Veriato (interviewed 25 Sept. 1956): saw none...during entire year / camped from Hilo to Kona...surveying...2 1/2 months at Ainahou	(1956)	(1)
75	6 pairs reared 10 young in the wild on Mauna Loa / all at Keauhou and Puu Oo (shown in Source (6) Table 1)	1957	ELDW58a (6)
76	frequently found / eastern slope of Mauna Loa	(1973)	VANC73

Island of Hawai'i

MULTI-DISTRICT (Cont.)

- | | | | | |
|----|---|---|-----------------------------------|--------|
| 77 | <p>None were seen on the survey but their droppings were present in the east end of Area 1, in the SW portion of the Impact Area, and in Area 9. Nene leg bones were among the skeletal material found in an early Hawaiian sleeping cave in Area 7. Extensive survey with the assistance of State biologists Nelson Santos and Miles Nakahara, failed to turn up any other recent evidence of Nene at PTA. However, the condition of typical food species (i.e. ohelo, kukae-nene, etc.) was very poor during the survey. Santos (pers. comm.) suggested that Nene would probably not use habitat within PTA regularly unless there was adequate food to sustain them over extended periods. Although our survey was extensive, the atypical rainfall conditions make it unwise to conclude that PTA is not important Nene habitat...</p> <p>Four State Nene sanctuaries have been established within suitable habitats around Mauna Loa. Two of these (Kipuka Ainahou and Keauhou 2) are very close to PTA on east and west boundaries..One record of nesting near the east PTA boundary is noteworthy. Two nests were found during the 1974-75 season on a small puu just east of the Area 8 boundary (Grid 37,38-78,79). This puu, sparsely vegetated with mamane and naio, is isolated by a wide expanse of barren pahoe-hoe lava. An adult pair with two young were observed on the puu. State biologists indicate (Job Progress Report W-15-4, Job I-D-3) that "other hills and kipukas along the eastern edge of the Impact Area also have suitable habitat".</p> | U.S. Army
Pohakuloa
Training Area | late Nov.
1976 to
Jan. 1977 | SHAR77 |
| 78 | <p>HDFG: Extensive surveys were made into nene habitat that is part of the Pohakuloa Training Area, and also areas adjacent to it. The field staff accompanied Department of Defense personnel who were collecting data for an environmental study of the training area. Two helicopters were made available for these surveys, making it possible to search the more remote areas for signs of nene. The entire portion of this slope of Mauna Loa thought to provide adequate nene habitat was thoroughly searched on foot. No droppings, feathers, or any other signs of nene were discovered by the members of the search crew. Apparently nene fly over this area but there was no evidence discovered to show that they utilized this habitat.</p> | U.S. Army
Pohakuloa
Training Area | 1 July 1976-
30 June 1977 | (46) |
| 79 | <p>135 observed by members of forest bird inventory team.</p> | windward
coast of
Hawaii | 1977 | (84) |

Island of Hawai'i

MULTI-DISTRICT (Cont.)

- | | | | | |
|----|---|--------------------|------|------|
| 80 | 90 observed during eight-minute counts and 43 observed otherwise by members of forest bird inventory team...many observations of birds flying between foraging and roosting areas...species observed on 7 of 21 transects surveyed and during .86 percent of the eight-minute count periods...observations made throughout the study area with most at elevations above 5,000 ft. | windward
Hawaii | 1977 | (84) |
|----|---|--------------------|------|------|

UNDESIGNATED LOCALITY

- | | | | | |
|----|--|--|--------|--------|
| 81 | nest found by Palmer Wood of Kchala / in lava flat | | (1902) | HENH02 |
|----|--|--|--------|--------|

MULTIQUADRANGLE

- | | | | | |
|----|--|--|----------|-----|
| 82 | Elder: Lima (born 1872) via Vredenberg interviewed 28 Sept. 1956): once in thousands...Hawaiians collected eggs but tabooed the bird / nene lived from Waimea to the sea...in pili grass | | ca. 1890 | (1) |
|----|--|--|----------|-----|

Kohala District

HAWI

- | | | | | |
|----|--|--|--------------|--------|
| 83 | von Holt: Kaiamakini used to herd nene flocks / at Kahua | | ca. 1880 | BALP45 |
| 84 | Elder: Ruttle: captive flock kept / Kahua Ranch | | (1890's) | (1) |
| 85 | Elder: E. Thompson: saw nene several times / one-half mile below Kahua Ranch, Kohala | | 1921 | (1) |
| 86 | Elder: Stillman (Ruttle's cousin): cowboys brought in eggs...originated from flying flock fed in 1890's / to the ranch (house) at Puu Hue, North Kona, thought to have been found makai (toward the sea) | | (early days) | (1) |
| 87 | Elder: Wiley: saw 1 on the ground / near Reservoir No. 12, 1 1/2 miles north on airport road | | 20 Oct. 1956 | (1) |

KAWAIHAE

- | | | | | |
|----|--|--|---------------|--------|
| 88 | Captain John Meares of the <u>Iphigenia</u> noted that 12 geese were received aboard / at Kawaihae | | 1789 | LOCF37 |
| 89 | von Holt: disturbed a pair / Kapoie (Waikapole) Gulch in Makiloa, north Kohala, at 800 feet | | 1938 | BALP45 |
| 90 | Elder: Brown: 3-4 pairs seen / Kona side of jeep trail between Kawaihae and Waimea | | Jan-Feb. 1943 | (1) |

**Island of Hawai'i
Kona District**

ANAEHOOMALU

118	Elder: E. W. Low: hunted yearly / Keawaiki	(ca. 1907)	(1)
119	Elder: J. Paulo (age 62 in 1956): saw 6 come to spend the night / Kalahui Pond below Puako, F. Brown Ranch	ca. 1917	(1)
120	Elder: W. Akau: 12 seen flying / back of Weliweli	ca. 1937	(1)
121	Elder: J. Paulo (age 62 in 1956): kept 2 pairs in captivity; no eggs laid / Keaviki (Keawaiki)	1925-1935	(1)
122	Elder: E. Paulo: seen / on Pueo pond, F. Brown Ranch	1930's	(1)
123	Elder: Brown: 3 wild pairs nested successfully / Pueo Pond, Brown's Ranch	before 1941	(1)
124	Elder: E. Paulo: 10 pairs in captivity / F. Brown Ranch	released before 1940	(1)
125	Elder: S. Akau: 14 in captivity (from State Game Farm at Mokapu, Oahu) / F. Brown Ranch, Keawaiki	before 1940 when all were released	(1)
126	Elder: S. Akau: 7 from Puu Waawaa occasionally visited / Keawaiki	before 1940 when captive flock present	(1)
127	Elder: Kaono: released ca. 24 in captive flock / F. Brown Ranch	1942	(1)
128	Brown and von Holt: have occasionally come across them / near shore ponds just north of Keawaiki Bay	during the past few years (1940-1944)	BALP45
129	Elder: J. Paulo (age 62 in 1956): saw 8-10 roosting in pens at night / Weliweli Ranch	1940's	(1)
130	Elder: Kaono: saw 2 / Pueo Pond, F. Brown Ranch, .5 mile mauka Weliweli Ranch	1955	(1)
131	Elder: Kaono: saw 2 flying / Anaehoomalu	25 Nov. 1956	(1)
132	Elder: Mrs. von Holt: occasionally a wild pair come on moonlight nights to visit their captive trio (from State Game Farm at Mokapu, Oahu) / at ranch Weliweli of Anaehoomalu	(unspecified date prior to 1956 interview)	(1)

Island of Hawai'i
Kona District

ANAEHOOMALU (Cont.)

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| 133 | Elder: J. Paulo (age 62 in 1956): 2-3 pairs visited fish ponds and left at 5:30 a.m. / Anaehoomaluu | (unspecified date prior to 1956 interview) | (1) |
| 134 | Elder: E. Paulo via Brown: caught nene at night with jack-light (Ruttle questioned this) / Anaehoomalu, Parker Ranch | (unspecified date prior to 1956 interview) | (1) |
| 135 | Elder: E. Paulo via Wishard: 2 nests / Weliweli | (unspecified date prior to 1956 interview) | (1) |
| 136 | Elder: Goto: saw 2 / von Holt's place, Weliweli | (unspecified date prior to 1956 interview) | (1) |
| 137 | Elder: Goto: saw 2 / Parker Ranch fish pond | (unspecified date prior to 1956 interview) | (1) |

PUU HINAI

- | | | | |
|-----|---|--|--------|
| 138 | von Holt: noticed / near the seashore near Puako | until 1915 | BALP45 |
| 139 | native-relayed report by von Holt: nene used for food (in old days) / Kalahuipuaa, south Kohala | (1945) | BALP45 |
| 140 | native-relayed report by von Holt: (in old times) nene came / to Puako | (1945) | BALP45 |
| 141 | Elder: Kobayashi: saw 2 / Puako | (unspecified date prior to 1956 interview) | (1) |
| 142 | Elder: Andrews: saw 8 geese flying single file / over beach at Puako...headed toward Kailua | 30 Sept. 1956 | (1) |
| 143 | Elder: Munro (age 90 in 1956): saw 4 on flat below where they shot 6 on 14 Dec. as mentioned in his book / McGuire's (Huehue) Ranch | 10-11 Dec. 1891 | (1) |
| 144 | Elder: Munro's original notes show that they shot and skinned birds in breeding condition and saw many others—one nest with 4 eggs at McGuires / Huehue Ranch | 12 Dec. 1891 | (1) |

Island of Hawaii
Kona District

KIHOLO (Cont.)

- | | | | |
|-----|---|-------------------|-----------|
| 145 | hunted...found nest with 4 eggs, caught 2 very young chicks and shot a young bird nearly full grown...at the higher elevation / on the rough lava flow of 1801 (Hualalai), down nearly to sea-level, and up on the Huehue Ranch to about 2200 ft. el. | 12 Dec. 1891 | Dec. 1891 |
| 146 | specimens collected by Palmer and Munro / on the lava flow of 1801 near sea level in North Kona | Dec. 1891 | BALP45 |
| 147 | Elder: Munro (age 90 in 1956): half-grown and some smaller ones were brought from higher elevations; they imprinted and followed him around camp / Huehue Ranch | (1891) | (1) |
| 148 | Palmer and Munro collected specimens / on Hualalai at the Huehue Ranch in North Kona around 2,000 feet | 1891 | BALP45 |
| 149 | a pair bred / near Kiholo | (1893) | WIL.S99 |
| 150 | Elder: Ruttle (interviewed 26 Sept. 1956): father Eben Low often shot as many as 12 or 14 / hunted west from Kiholo to Luahinewai | 1898-1900 | (1) |
| 151 | Elder: Ruttle (interviewed 26 Sept. 1956): often seen flying in wedges / when riding as a girl from Puu Waawaa to Kiholo | 1894-1903 | (1) |
| 152 | Elder: E. W. Low: hunted yearly / Luahinewai | until 1907 | (1) |
| 153 | Elder: E. W. Low: hunted yearly / Kiholo | (until 1907) | (1) |
| 154 | D. Paris: found nene / at the Kaupulehu Lava Flow along the Wainea road | ca. 1910 | BALP45 |
| 155 | Elder: Simeona (age 60 in 1956): 2-15 came to feed on Elamo berries in summer / just north of Kaupulehu lava flow at 1,000 ft. el. | 1925-1926 | (1) |
| 156 | found the nest / on the old Kaupulehu lava flow, north side of Hualalai, at an elevation of about 3,000 ft. | several years ago | POPW32 |
| 157 | L. Hint: observed 19 / at Luahinewai (Puuwaawaa shoreline) | 1937 | BALP45 |
| 158 | Elder: F. Henriques: saw 2 / Kaupulehu lava flow between Puu Waawaa and Huehue Ranch | 1937 | (1) |
| 159 | Elder: Stanley: saw 4 flying / toward Mauna Loa from Kona road at 1801 lava flow | ca. 1937 | (1) |
| 160 | Elder: Perez (Game Warden): saw 2 flying / across highway where 1800 (1801) (lava) flow crosses above Huehue | 1939 | (1) |

**Island of Hawai'i
Kona District**

PUU ANAHULU (Cont.)

174	(R.) Hind Sr: reported very abundant / Puuwaawaa Ranch	ca. 1900	DESR41
175	Elder: Wm. Paris, Sr.: a captive pair led young to Waihou and returned each year with more birds until flock numbered 40 / Puu Waawaa Ranch	early 1900's	(1)
176	P. Baldwin: F. Greenwell (interviewed 24 Sept. 1943): seen frequently / Puu Anahulu Homesteads	1906	(7)
177	F. Greenwell: seen...Low told (Wm.) Paris (Sr.) that they bred / in the adjacent lands of Puu Anahulu both above and below the Belt Road in the homesteads area	years around 1906	BALP45
178	small flock / flew into Mr. Robert Hind's (Sr.) home station (Puuwaawaa Ranch)	1923	GREH24
179	Elder: Mrs. M. Holmes: young captured and reared...up to 84 pairs at one time...nested around her house for years...some imprinted on her... / Puu Anahulu	up to 1925-1927	(1)
180	Elder: Podmore: saw / Keau, near Puu Waawaa	ca. 1927	(1)
181	(R.) Hind, (Sr.): reported only important flock...left / Puuwaawaa Ranch	ca. 1927	DESR41
182	(R.) Hind, (Sr.): only about 50 remain / Puu Waawaa Ranch	(1928)	DELJ28
183	Elder: Kawaha (age 72 in 1956): saw 7 at tanks / Puu Waawaa Ranch (Hind then had 14 fliers)	1923-1929	(1)
184	Horner: saw occasional pairs / in the vicinity of the 1859 lava flow above and below the road (Belt Road, in the Homesteads area)	from 1915 to 1930...when last was seen	BALP45
185	Elder: W. Paris (Sr.): found nest...4 or 5 eggs / near Puu Paha, 2 miles SE of Puu Waawaa Range Hdgs.	fall of 1936	(1)
186	Elder: Munro (age 90 in 1956): last saw half-tame nene / Puu Waawaa	1936	(1)
187	Elder: Perez (Game Warden): confiscated 2 captive nene and sent them to Game Farm at Mokapu, Oahu / Puu Anahulu near Kapalau	ca. 1936	(1)
188	3 seen / Puu Waawaa	(1935-1937)	MUNG46
189	Elder: E. Paulo: seen / below Puu Anahulu	1930's and earlier	(1)
190	Elder: Horner: pair frequently flew makai (toward the sea) in a.m. and mauka (up the mountain) in p.m. / below Kona Road north of 1855 (1859) lava flow	1930-1940	(1)

**Island of Hawai'i
Kona District**

PUU ANAHULU (Cont.)

191	T. Lindsey: nesting / above Halekula	Nov. 1941	BALP45
192	L. Hind: flock of 33 seen / near the hill Puu Waawaa	1941	BALP45
193	saw 5 adults / at 3700 feet near Poohohoo	11 Apr. 1942	BALP45
194	T. Lindsey: noted several / Halekula	Mar. 1942	BALP45
195	L. Hind: saw 26 / near the hill Puu Waawaa	Mar. 1942	BALP45
196	Elder: Cambra: formerly hunted frequently / third kipuka above road...halfway between 1859 lava flow and Kuainiho	1936-1943	(1)
197	L. Hind: largest flock...found...was 13 / Puuwaawaa Ranch	1943	BALP45
198	W. Banko: R. Hind, Jr. (interviewed 24 Sept. 1969): population declined / Puu Waawaa Ranch, North Kona	in late 1930's and early 1940's	(9)
199	W. Banko: R. Hind, Jr. (interviewed 24 Sept. 1969): last 2 killed by WWII pilots on leave at Ranch / Puuwaawaa Ranch	1943	(9)
200	L. Hind: nest especially / in Waiho and Halekula, in paddocks between Puu Waawaa and Hualalai, fro about 2,300 to 4,000 feet	(prior 1944)	BALP45
201	L. Hind: continuous presence...recalled / Puu Waawaa Ranch	1900-1944	BALP45
202	found continuously...nested there and young were seen frequently / Puu Waawaa Ranch	1944	SMIJ52
203	although certainly not common (prior to 1944) (Puu Waawaa) ranch hands usually saw a few geese before 1949; however in the last 3 years these same persons have seen no geese...(nene) now vanished...	(1952)	SMIJ52
204	Elder: S. Kahola (interviewed 28 Sept. 1956): saw 2 on ground / at Puu Anahulu, by trail to Kiholo	(unspecified date prior to 1956 interview)	(1)
205	Elder: S. Kahola: got eggs from same site 6 or 7 years / 3/4 mile above Puu Waawaa ranchhouse	unspecified date prior to 1956 interview)	(1)

**Island of Hawai'i
Kona District**

PUU ANAHULU (Cont.)

206	Elder: Wm. Paris, Sr.: frequently saw nene / open kipukas of Kuainiho near pigeon caves	unspecified date prior to 1956 interview)	(1)
207	Elder: Wm. Paris, Sr.: saw 1 nest with 2 eggs / crater hill 1 1/2 miles above Puu Waawaa	unspecified date prior to 1956 interview)	(1)
208	Elder: Lona (age 86 in 1956): seen many times, nests and eggs; caught young for pets / Puu Anahulu	(in early days)	(1)
209	Elder: E. W. Low: saw singles and pairs / in flats below (Puu Anahulu)	(in early days)	(1)
210	Elder: F. Greenwell: ate nene twice when Eben Low shot 12-15 / 2,500 ft. el. below Puu Waawaa	in early days	(1)
211	HDFG: banded nene were seen by caretaker during the year...4-6 in the pastures or at the feeders near the residences...caretaker did not obtain color band combinations as requested...but it is suspected that these nene were Keauhou 2 release birds...efforts were continued to secure caretaker's cooperation... / Puu Waawaa Ranch	1 July 1969-30 June 1970	(33)
212	HDFG: ...a group of 6, composed of 4 adult banded birds and 2, 2-3 months old unbanded goslings, were observed...color bands were recorded only from the pair with 2 young...both parents were from the April 1969 release at Puu Keanui in the Keauhou 2 Sanctuary / Puu Waawaa Ranch	2 Feb. 1971	(83)
213	HDFG: ...While participating in the alala survey, one pair of nene was sighted on the slopes of Hualalai, within the Puu Waawaa Ranch. This pair was sighted on subsequent occasions and consisted of an unbanded gander and a 1976 Hualalai released goose... / Puu Waawaa Ranch	1 July 1983-30 June 1984	(60)
214	HDFG: 11 nene were sighted in the nearby Puu Waawaa Ranch while conducting forest bird or alala surveys...6 were unbanded and 5 were banded...3 combinations represented lost bands and the remaining 2 combinations were from the 1976 Hualalai (Keauhou-2) release...	1 July 1984-30 June 1985	(89)
215	4 flying / Puuanahulu	7 Dec. 1986	PYLR87b
216	1 or 2 seen repeatedly / Puuanahulu	Oct. 1987	PYLR88d
217	3-5 pairs reported / Puuanahulu	19 Nov. 1987	PYLR88d

**Island of Hawai'i
Kona District**

PUU ANAHULU (Cont.)

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|-----|---|--------------|---------|
| 218 | a very small surviving original flock...on the northern flanks of Hualalai...has over the years been supplemented by captive birds released by the State on the south side of the mountain and, more recently, by ranchers on the north side...3-5 pairs...recently...reported...frequenting the grassy road verges of a sub-division / Puu Anahulu | 19 Nov. 1987 | PYLR88a |
| 219 | group seen regularly...included 6 adults with 9 juveniles (April 1) and 15 mixed adults and juveniles (May 14) / around Puu Lani Ranch, Puuanahulu | spring 1988 | PYLR88f |
| 220 | ...groups of Nene...regularly frequenting...Puu Lani Ranch at Puu Anahulu...included 6 adults with 9 juveniles on 1 April and 15 mixed adults and immatures on 14 May | spring 1988 | PYLR88c |

MAKALAWENA

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|-----|---|-----------------|--------|
| 221 | native relayed report by von Holt: nene formerly came / to Makalawena on the shore line in North Kona | (in early days) | BALP45 |
|-----|---|-----------------|--------|

KAILUA

- | | | | |
|-----|--|------------------------------|--------------|
| 222 | Elder: Gouveia: saw 6 or 7 several times / Hualalai Forest Preserve above Greenwell Ranch at 6500 ft. at Kaupulehu Flow | 1927-1936 | (1) |
| 223 | Ranger Marteen: dozen lived...flock...slowly increasing / about the sheep station on Hualalai | May 1940 | DONW40 |
| 224 | Elder: Kaeo (age 65 in 1956): in 30 years work on F. Greenwell Ranch saw from 2-6 many times (but no nests nor young nor flightless birds) / at Honokohau, 1,250 ft. el., F. Greenwell Ranch | 1916-1945 | (1) |
| 225 | Elder: Funihoale: saw 5 on ground / 2 miles mauka (toward the mountain) of highway on south edge of Kaupulehu (lava) flow | 2 Sept. 1956 | (1) |
| 226 | Elder: Kaeo (age 65 in 1956): seen / Puu Laalaa | (years ago) | (1) |
| 227 | Elder: Marks: saw pair and 18 young (?) / above Huehue Range | (years ago) | (1) |
| 228 | HDFG: pair released at Keauhou 2 in April 1965 frequented a 2-mile stretch of the Holualoa Road 14 miles from the release site during the entire month of June...became very tame...captured by juveniles...confiscated by Warden Crisafi...taken to Pohakuloa...re-released near a flock of wild nene at Puu Oo in late July...unfortunately has been seen since... | 1 July 1965-
30 June 1966 | (28)
(29) |
| 229 | two banded birds found...allowed approach to within 5 feet before flying / along the jeep road above the upper end of Kaloko Mauka Road, near Kona | 29 January
1978 | PYLR78 |

**Island of Hawai'i
Kona District**

HUALALAI

230	saw some / in this desert valley (Hualalai-Mauna Loa saddle)	1792	MENA20
231	shot two / near temple of Kaili (Ahuaumi Heiau)	Nov. 1840	WILC45
232	Elder: Beamer: heard geese / 5 miles above Puu Waawaa	1910	(1)
233	A. Wall: caught goslings / on the north slope (Hualalai)	ca. 1913	BALP45
234	Elder: J. Henriques: saw 1 big pair / 1/2 mile from the temple Ahuaumi Heiau	1924	(1)
235	Elder: J. Greenwell: saw flocks since boyhood, mostly in summer / Kealakekua Ranch	1920's and 1930's	(1)
236	Donaghho: Payne: flock of six reported where a number live (Payne's total nene observations reported as 19 by local paper) / Great Central Plain, between Mauna Loa and Hualalai	(June-Aug. 1937)	(4)
237	reported present / near the east slope of Hualalai	24 July 1937	DONW51a
238	Elder: Murray: saw 5 or 6 / 3 miles south of Puuwaawaa	1938	(1)
239	W. Banko: R. Hind, Jr.: a few / at Kileo...in open grassy areas	1930's	(9)
240	F. Greenwell: small flocks...nesting not observed / southeast flank of Hualalai just above the plateau	through the years up to 1940	BALP45
241	P. Baldwin: F. Greenwell (interviewed 21 Nov. 1942): small flocks seen / in Keauhou 2 on the SE flank of Hualalai north of the Judd Trail...below 6,000 ft.	up to 1940	(7)
242	P. Baldwin: F. Greenwell: last saw (10-12) nene flying south / Ahuaumi to Pulehua Ranch	last seen 1940	(7)
243	Elder: J. Greenwell: last saw (10-12) nene flying south / Ahuaumi to Pulehua Ranch	1940	(1)
244	Elder: J. Greenwell: found nene nest and eggs in pukiaawe / Ahuaumi (Heiau)	ca. 1940	(1)
245	Baybrook: one seen / near Ahuaumi Heiau	1941	BALP45
246	T. Lindsey: adult with young / at Poohohoo	Feb. 1942	BALP45
247	P. Baldwin: Nick and Baybrook (interviewed 20 Nov. 1942): seen in this area / vicinity Ahuaumi Heiau, Hualalai-Mauna Loa plateau	recently (1942)	(7)

**Island of Hawai'i
Kona District**

HUALALAI (Cont.)

248	P. Baldwin: F. Greenwell (interviewed 21 Nov. 1942): always been scarce in his experience / between Hualalai and Mauna Loa	(up to 1942)	(7)
249	P. Baldwin: F. Greenwell (interviewed 21 Nov. 1942): never seen / below 5000 feet on south flank of Hualalai	(up to 1942)	(7)
250	Elder: Yamayoshi: saw a pair / Puuwaawaa side of Hualalai at 6500 ft. el.	1 Aug. 1945	(1)
251	Johnson and Kaa: obtained young / between Hualalai and Mauna Loa	1945	BALP45
252	F. Greenwell: found...comparatively scarce...since the turn of the century / between Mauna Loa and Hualalai...lower limit...on the south side of Hualalai around 5000 ft.	(1945)	BALP45
253	Elder: Kaa via Wassman: often saw nene / on Hualalai (near Puu Laalaa) not lower than 6500 ft. el.	until 1950	(1)
254	Elder: N. Greenwell: saw 1 pair / 2 1/2 miles Kona side of the Ahuaumi Heiau	ca. 1950	(1)
255	Elder: Pung (Game Warden): had seen nene but once, 3 birds (Bryan says it was a pair) / Puu Hale in Keauhou 2, F. Greenwell's place, 2 1/2 miles southeast of forest cabin	23 May 1951	(1)
256	Elder: M. Greenwell: found nest with 2 eggs after flushing female / Ahuaumi (Heiau)	1932-1952	(1)
257	Elder: Hocoba: saw groups of 4,6,3 / trail below Ahuaumi Heiau	1947-1952	(1)
258	HDFG: brood reported / southeast flank of Hualalai, 5,000-6,000 ft. el.	1953	(21)
259	Elder: Pung: flushed 1 that circled when he shot a pheasant / along trail to forest cabin, Puu Hale at 6,000 ft. el.	1955	(1)
260	Elder: N. Greenwell: saw 2 small young...first ones seen in 10 years / at Ahuaumi Heiau	Feb. 1956	(1)
261	Pung: saw one / on the south slope of Mount Hualalai at 6,000 ft.	27 Nov. 1956	ELDW58
262	Elder: Simeona (age 60 in 1956): saw pairs flying mauka (up the mountain) / Judd trail 2 miles below Ahuaumi Heiau	(unspecified date prior to 1956 interview)	(1)
263	Elder: Kaeo (age 65 in 1956): seer. / Kahuahoiiekanapa, 1 mile north northeast of Ahuaumi	(unspecified date prior to 1956 interview)	(1)

**Island of Hawai'i
Kona District**

HUALALAI (Cont.)

264	Elder: Kaeo: seen / Puu Hale	(unspecified date prior to 1956 interview)	(1)
265	Elder: Kaeo: seen / Waikulukulu (cave with drip) / 1/2 mile northeast of Ahuaumi Heiau	(unspecified date prior to 1956 interview)	(1)
266	Elder: Kaeo: seen / Puu Ikaaka	(unspecified date prior to 1956 interview)	(1)
267	Elder: Marks: seen / above pigeon cave, Huehue Range	(unspecified date prior to 1956 interview)	(1)
268	Elder: F. Greenwell: found nests with 2 to 3 eggs but never saw young / rough country; saddle between Hualalai and Mauna Loa	(unspecified date prior to 1956 interview)	(1)
269	found numerous scattered droppings...(indicating another) family or two as yet unseen, or the breeding season resort of the unemployed birds / two miles to the southeast near Ahuaumi's temple (Heiau)	months later (1957)	ELDW58
270	HDFG: plentiful recent droppings found...determined that several...used this area in May and June for feeding and roosting / southeast flank of Mt. Hualalai at elevations 5,000 to 6,000 ft.	July (1958)	(10)
271	Woodside: no sign of nene...old sign of a few droppings at (Ahuaumi Heiau)...1 month and older droppings at 3 hills (Pohakuloa area) / near gate on drive from Puu Lehua, Ahuaumi Heiau and the race track (3 green hills)	3 Aug. 1958	(14)
272	HDFG: plentiful recent droppings found in July...it was determined that several nene had used this area during May and June for both feeding and roosting...but use was discontinued in late July or early August / southeast flank of Hualalai, 5,000-6,000 ft. el.	1 July 1957-30 June 1958	(21)
273	HDFG: nene again visited (this area)...but use was very limited as evidenced by droppings found / southeast flank of Hualalai	summer 1958	(22)
274	HDFG: field trips to Ahuaumi failed to result in sightings...but evidence in the form of droppings and feathers were found near the Judd trail / southeast slope of Hualalai	(summer 1959)	(23)

**Island of Hawai'i
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HUALALAI (Cont.)

- 275 HDFG: Droppings indicated that a few nene were in the area / Hualalai-Mauna Loa saddle (Keauhou-2 area) (summer 1960) (24)

For history of Nene restoration in Keauhou-2 Sanctuary 1960 / 61 to 1987/88 see Hawaii State Restoration Program, Part II

KEALAKEKUA

- 276 Elder: C. Thompson (age 78 in 1956): one landed on their barn / 3 miles above Kealakekua 1880's (1)
- 277 Elder: Cambra: seen many times...15 once / Sherwood Greenwell Ranch above Kealakekua 1936-1943 (1)
- 278 Elder: Davis: saw 1 flying...2:30 p.m. / towards Hualalai from Keauhou Bay 2 Sept. 1955 (1)
- 279 Elder: Seigfried: flock of 12 or more large birds flying in formation / 2 miles south of Kailua, near coast Sept. 1956 (1)
- 280 Elder: Gregory Henriques (interviewed 2 Oct. 1956): saw only twice 17 years ago / (Sherwood Greenwell Ranch above Kealakekua) (1956) (1)
- 281 Elder: Mrs. R. Wall (interviewed 2 Jan. 1957): raised captives for years; father had a pet nene for several years that flew up and down the mountain and followed his horse / Kealakekua (many years ago) (1)

PUU LEHUA

- 282 Elder: R. Wall: frequently saw nene / between Monohaa and Hualalai 1920's and early 1930's (1)
- 283 P. Baldwin: Baybrook (interviewed 20 Nov. 1942): nested several years / vicinity of Pohakuloa, 5,058 ft. el. (ca. 3 miles north of Pulehua Ranch Hdqs.) (1929-1930) (7)
- 284 Baybrook: saw nesting / at Pohakuloa in Keauhou 2 (1929-1931) but not subsequently BALP45
- 285 Baybrook: three were seen / on the plateau at Puu Keanui 1941 BALP45

**Island of Hawai'i
Kona District**

PUU LEHUA (Cont.)

286	P. Baldwin: Baybrook (interviewed 20 Nov. 1942): 3 seen / vicinity of Puu Keanui, north of Puu Lehua	1941	(7)
287	P. Baldwin: Baybrook (interviewed 21 Nov. 1942): no records / Puu Lehua ranch...in the mamane forest at lower elevations (than ca. 5000 ft.)	(1923-1942)	(7)
288	Elder: Matsuoka (Greenwell cowboy): saw 3-4 / kipuka above Kanahaha	1944-1946	(1)
289	Elder: Matusoka: saw 3 flying over / Kanahaha, old sheep station	1944-1946	(1)
290	Elder: J. Henriques: saw smallish nene / 2 or 3 miles makai (seaward) of Ahuaumi at Kanahaha	Oct. or Nov. 1952	(1)
291	Elder: M. Greenwell: seen flying 3 times in the a.m. from SW to NE / over the (Pulehua) ranch house	1932-1952	(1)
292	Elder: Silva: pair seen / Kipuna tanks (Keakauoopuna) near Puu Lehua	June 1955	(1)
293	Elder: R. Wall: saw 3 or 4 fly over high at noon / Monohaa at 4000 ft. el. mauka (toward the mountain) from Kainaliu	Aug. 1955	(1)
294	Elder: Kaeo (age 65 in 1956): seen / Kanahaha	(years ago)	(1)
295	Elder: N. Greenwell: pair at Nenenui Gate near Pohakuloa	(years ago)	(1)
296	Woodside: Norman Greenwell reported that a cowboy saw 2 nene on pahoe-hoe / just south of water tank above windmill at Keikiaeae (2 miles SE Pulehua Ranch Hdqs) about 2 months ago	3 Aug. 1958	(14)
297	Woodside w/ Burke and Takata: checked for droppings...found none / mauka kipuka just past Nenenui gate	19 Nov. 1958	(14)
298	Woodside: no droppings found / about 1 and 2 miles beyond Nenenui gate	19 Nov. 1958	(14)
299	Woodside: no droppings found / Ahuaumi Heiau	19 Nov. 1958	(14)
300	Woodside: found 2 fairly recent droppings / on small knoll at lower end of race track	19 Nov. 1958	(14)
301	Woodside: no recent droppings but lots several months or more old / hike around 3 green hills	19 Nov. 1958	(14)
302	Woodside: checked for droppings, found none / Kahana (Kanahaha) area	11 Jan. 1959	(14)
303	Woodside: checked for droppings...found none / Nenenui Gate area	11 Jan. 1959	(14)
304	Woodside: no droppings / Ahuaumi Heiau	11 Jan. 1959	(14)

**Island of Hawai'i
Kona District**

PUU LEHUA (Cont.)

- | | | | |
|-----|---|--------------|------|
| 305 | Woodside: only old droppings...found a few nene bones in a shelter cave, near Heiau / area west and north of Ahuaumi Heiau to lava checked for nene sign | 11 Jan. 1959 | (14) |
| 306 | Woodside: checked for droppings..found none / Halelaau to 1859 flow | 11 Jan. 1959 | (14) |
| 307 | Woodside: only old droppings found...no birds have been here since last two visits / looked for sign from end of sand above Ahuaumi Heiau to race track—3 green hills | 12 Jan. 1959 | (14) |
| 308 | Woodside: no recent sign found / on hike along contour from race track—3 green hills area around Hinau back to race track and return to jeep | 12 Jan. 1959 | (14) |

HONAUNAU

- | | | | |
|-----|---|---------------|--------|
| 309 | Upon our first arrival at Karacacooah Bay, the natives brought off several geese, which were quite tame; they were not unlike the Chinese geese; they called them Na-na / Kealakekua | 23? Dec. 1778 | ELLW83 |
| 310 | ...bought one or two geese that were tame...small and not very unlike a wild goose...from Mr. Portlock's account who carried six dozen to sea with him we expected to procure a tolerable supply...surrounded by an amazing number of canoes... / hove to, off Kealakekua Bay | 3 Mar. 1792 | BELE29 |
| 311 | Elder: Hayes: saw 1 flying south at 5:00 PM / Keokea Road junction, south Kona | 25 Oct. 1950 | (1) |

KAUNENE

- | | | | |
|-----|--|-----------------|--------|
| 312 | Elder: Johnston: shot nene for Wm. Paris, (Sr.) / mauka (toward the mountain) of the forest line, McCandless Ranch | 1915-1917 | (1) |
| 313 | Elder: E. Thompson: shot 2 from a flock which circled and landed again / Kaunene | 1921 | (1) |
| 314 | Wingate: young were seen / Puukinikini | 1926 | BALP45 |
| 315 | Elder: E. Thompson: saw 5-15 near pools and the Calendula patch / Kaunene | 1920's | (1) |
| 316 | Elder: F. Henriques: saw 2 / above McCandless Ranch | 1935 | (1) |
| 317 | D. Paris: encountered pairs / 2 miles east of Keanapaakai | as late as 1936 | BALP45 |
| 318 | D. Paris: encountered pairs / at 7,250 and 7,000 feet, 2 miles east of Komakawai waterholes | as late as 1936 | BALP45 |
| 319 | W. Thompson: found 3 / on the lava above Komakawai water holes | early in 1944 | BALP45 |

**Island of Hawai'i
Kona District**

KAUNENE (Cont.)

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|-----|--|-----------|-----|
| 320 | Elder: Isenberg (interviewed 2 Oct. 1956): saw 3 or 4 birds / at pond in jeep trail, McCandless Ranch | Feb. 1956 | (1) |
| 321 | Elder: Isenberg: saw 6 flying makai (seaward) / from Keanapaakai (4 miles south of Greenwell boundary) | (1956) | (1) |

PUU POHAKULOA

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|-----|--|--|--------|
| 322 | Crosby: observed a pair / just above the Polewai water holes (Polewai Waterhole is at 6,400 ft. el.; a second, labeled "waterhole", is located 3/4 mile east at 6,960 ft. el. on USGS map) | May 1937 | BALP45 |
| 323 | von Holt: saw several flocks of 5-8 / from the Alika Lava Flow north to Hooper Camp from 6,750 to 8,000 ft. el. | 1940 | BALP45 |
| 324 | Elder: Chee: seen / near old Kaohe Ranch | sometime from
1927 to 1948 | (1) |
| 325 | Elder: Chee: saw 6 / flying south towards Keanapaakai from old Kaohe Ranch at 6,300 ft. el. | 1948 | (1) |
| 326 | Elder: Simeona (age 60 in 1956): saw pairs on the ground / 7,000 ft. el., above Puu Pohakuloa just above forest line | (unspecified
date prior to
1956 interview) | (1) |

PAPA

- | | | | |
|-----|--|--------------|-----|
| 327 | Elder: Breithaupt: saw up to 12 several times / in the ohelo on pumice flat, makai (seaward) of Puu Ohohia | early 1930's | (1) |
|-----|--|--------------|-----|

Ka'u District

UNDESIGNATED LOCALITY

- | | | | |
|-----|---|-----------------------|--------|
| 328 | Pritchard via Horner: reported nene scattered / along the Ainapo trail, Kau, below timberline | 1899 | BALP45 |
| 329 | nest found by Kauhane / on the lava below Kahuku, Kau | (1902) | HENH02 |
| 330 | Donaghho: two reported by Hosaka / Kahuku-Ainapo trail | last spring
(1936) | (4) |
| 331 | Hosaka: saw 3 / on the Kahuku-Ainapo trail | 27 July 1936 | MUNG46 |

**Island of Hawai'i
Ka'u District**

UNDESIGNATED LOCALITY (Cont.)

332	D. Paris: encountered pairs / Kahuku	as late as 1936	BALP45
333	Donaghho: nene used to visit / water tank along the Ainapo-Mauna Loa trail	(prior to 1937)	(4)
334	Donaghho: saw 8 / Mauna Loa slope	21 July 1937	(4)
335	Hosaka via Donaghho: sighted / on the slopes of Mauna Loa above the Kau Forest Reserve	1937	BALP45
336	Martinson: has not seen any in frequent visits / Kahuku lowlands in Kau	(1931-1944)	BALP45
337	2 gosling-1 adult family seen by reliable observer / near the eastern boundary of the National Park	1950	SMIJ52
338	3 reported in May, and in June a flock of 7 was seen briefly / near the eastern boundary of the National Park	1951	SMIJ52
339	HDFG: last reported sighting / upper Kahuku Ranch	1952	(10)
340	NPS: total of 9 observed / in an area just north of the Park	30 Oct. 1958	(5)

MULTIQUADRANGLE

341	Konanui: nene plentiful / above the inshore cliffs around 1500-2000 ft...(as far to the east as Panau)...but not on the flats which line the shore...across...the Puna lowlands to Kau	ca. 1894	BALP45
342	Elder: Beck via Meinecke: formerly bred commonly / from Puu Nahaha near Great Crack, Pahala, west to S. Kona District	(years ago)	(1)

**Island of Hawai'i
Ka'u District**

MULTIQUADRANGLE (Cont.)

- 343 The number of birds known from all three study areas (Keauhou Sanctuary, Kilauea Crater, Hilina Pali) dropped from 112 in 1978 to 34 in 1981 as a result of the virtual extinction of the Keauhou population...proportion of paired birds in all 3 study areas decreased from 91% in 1978 to 76% in 1981..This decreasing ratio of paired to unpaired geese may be related to the decline of the total population...Populations around Kilauea Crater and on the lowland slopes of Kilauea (Hilina Pali area) may have increased slightly in size...only 47% of the pairs encountered in the field attempted to nest in 1978 while 69% bred in 1981...59% of all available captive pairs and free-flying volunteers attempted to nest in HAVO pens from 1975 to 1981...Most wild pairs (75%) which bred did so in only 1 of the years while 21% bred in 2 years and only 4% bred in 3 years...no pairs bred in all 4 years...of the 67 breeding attempts observed in the wild during 1978-1981 only 2 resulted in fledglings...most females that were gravid were known to have laid eggs and initiated incubation, but only 37% were successful in hatching eggs...The success rate of clutches laid in captivity was 79%...The most important factor responsible for clutch failure in the wild (including Nene on Maui) was predation by mongoose on eggs (62%) and incubating females (10%)...abandonment, storms, embryo mortality, accidental egg breakage by the female and other factors accounted for the remaining 28% of the clutch failures...In NPS breeding pens only 12% of all clutch failure in pens were embryo mortality (55%) and infertility (32%)...only 12% of all clutch failures were attributable to egg predation...mean clutch size for wild pairs on Hawaii was 3.1...NPS pens clutches averaged 4.0...4.3 at the Pohakuloa facility...fertility of eggs in the wild (83%) was as high or higher than of eggs laid in captivity...hatchability of wild eggs (85%) was the same or exceeded that of captive-laid eggs...gosling mortality approached 100% in the wild, was 34% in NPS pens, only 9% at Pohakuloa and 15% at Slimbridge...From 67 breeding attempts on Hawaii only 4 fledglings were produced in 4 years...frequency of renesting in the wild appears to be less than in captivity...On each island (Hawaii, Maui) there were 3 renest attempts, comprising 9% of the total number of active nests located.
- 1977-1981 BANP82

POHUE BAY

- 344 Elder: Nakamura via Woodside: 1 seen at 12 noon / one-half mile north of Manuka State Park on 1907 (lava) flow, south Kona 9 Sept. 1955 (1)

KA LAE

- 345 Elder: Meinecke: female with several young; 2 captured and reared / 611 ft. el. on road from Waiohinu to Kaalualu 1896-1898 (1)

**Island of Hawai'i
Ka'u District**

KAHUKU

- | | | | |
|-----|---|------------------------------|--------|
| 346 | Elder: Yates (age 70 in 1956): recalled that nene were hunted / 2 miles mauka (up the mountain) (from Waiakimu (Waiohinu), Kau (plotted near Puu Lepo) | ca. 1900 | (1) |
| 347 | Elder: Kawaha (age 72 in 1956): saw ca. 7 / 2 1/2 miles below Kahuku Ranch (buildings) | 9 Jan. 1907 | (1) |
| 348 | Elder: Kahakua: flushed ca. 12 when quail hunting / near Kahuku Ranch | summer 1913 | (1) |
| 349 | Elder: Richards saw 15 / a half-mile above Kahuku Ranch | ca. 1915 | (1) |
| 350 | Elder: McCumber: saw female and 2 half-grown young in pili grass / between Kahuku Ranch (buildings) and the beach, 2 1/2 miles from 1907 lava flow | ca. 1924 | (1) |
| 351 | Elder: Breithaupt: fence rider (Kau ranches) for 20 years: saw old female and 2 young (all 3 captured) / in Kipuka Kekake, Kau side of 1907 (lava) flow | March 1929 | (1) |
| 352 | Martinson: secured some goslings / below Kipuka Kapulehu, Kahuku lowlands in Kau | 1931 or 1932 | BALP45 |
| 353 | Elder: Meinecke: ...young captured by a Hawaiian, Bob Beck (Pecky Bob) / 4 miles west and below road to Kahuku Ranch | before 1950 | (1) |
| 354 | HDFG: Banded pair...captured at a farm where the goose had begun to build a nest under a homesteaders house / Kiolokaa, Kau | 1 July 1969-
30 June 1970 | (33) |

NAALEHU

- | | | | |
|-----|--|------------------------------|------|
| 355 | Elder: Schattauer: saw 1 / edge of Maniania Pali | 6 June 1957 | (1) |
| 356 | HDFG: pair from May 1967 release at Kahuku seen for several days / at Naalehu and Kiolokaa, along the Hawaii Belt Road | 1 July 1967-
30 June 1968 | (31) |
| 357 | HDFG: 1 gander from 1968, 1969 release flocks captured and returned to Kahuku Sanctuary for re-release...2 others from 1968 release were confiscated (1 captured by school bus driver, the other by a student)...one with permanent injuries to the flight feathers was retained at Pohakuloa, the other released after regrowth of new primaries... | 1 July 1968-
30 June 1969 | (32) |

**Island of Hawai'i
Ka'u District**

PUU O KEOKEO

358	Elder: Kawaha (age 72 in 1956): ate nene from bag of 12 brought by pig hunters and shot with rifle / Kipuka Nene above Kahuku Ranch	1902	(1)
359	Elder: Meinecke: many friends hunted and shot nene / Kipuka Nene, Kahuku Ranch	up to 1908	(1)
360	noted a pair / riding northward...(from) campground at elevation approximately 6,000 ft.near a good spring in a meadow to the southwest of the aa flow called Pohaku (Ke A) Pohina, and near the forest reservation boundary...reached by the Kahuku-Kapapala trail...we quickly left the timber, passing one fine specimen of silver sword...we followed the eastern margin of a rough aa lava flow	9 Oct. 1919	JAGT19
361	Jaggar: saw 2 / in grassy Kipuka O Nene in Kahuku	(1919)	BALP45
362	flock of 17 seen / 6500 ft. el. Kipuka Nene, Kau district	1948	SMIJ52
363	Elder: Glover: saw 17 on ground / Kipuka Nene, Kahuku Ranch	Aug. 1949	(1)
364	3 observed / 6500 ft., Kipuka Nene, Kau district	Jan. 1949	SMIJ52
365	none seen / 6500 ft., Kipuka Nene, Kau district	(1949-1951)	SMIJ52
366	Elder: Freitas: saw 7 walking / Kipuka Nene (Kahuku Ranch)	Mar. 1952	(1)
367	Elder: Molcilio: saw 3 flying / towards Kipuka Nene from Mauna Loa near Keapohina, Kahuku Ranch	Jan. or Feb. 1953	(1)
368	Elder: Freitas: saw 3 flying down the mountain (Mauna Loa) / Kahuku Ranch	Feb. 1954	(1)
369	Elder: Freitas: saw 1 flying up Mauna Loa / Kahuku Ranch	early Apr. 1954	(1)
370	Elder: Hosaka: never saw Nene at Kipuka Nene but heard from many old timers that they were often seen there / Kipuka Nene	(in years past)	(1)
371	Elder: Breithaupt (fence rider for Kau ranches for 20 years): 1-17 seen many times / Kipuka Nene, 1000 ft. above forest line and below Kahuku Ranch fenceline	June 1956 and earlier	(1)
372	Elder: Wagner: saw 4 or 5 / Kahuku Ranch, where last (lava) flow crosses the jeep road at 5,000 ft. el.	summer (1956)	(1)

For history of Nene restoration project in Kahuku Sanctuary 1966/67 to 1987/88 see Hawaii State Restoration Program, Part II.

**Island of Hawai'i
Ka'u District**

PUNALUU

- 373 HDFG: nene originally released at Keauhou Sanctuary captured with a throw-net and returned to Keauhou for re-release / Punaluu Black Sand Beach 1 July 1968-30 June 1969 (32)

PAHALA

- 374 HDFG: 1 nene from May 1967 release at Kahuku seen for several weeks / Pahala Plantation sugar cane fields 1 July 1967-30 June 1968 (31)
- 375 HDFG: 3 nene from flocks released in 1968 / 1969 at Kahuku Sanctuary were seen in a Hawaiian Ranch pasture below town of Pahala...2 captured with a throw-net and returned to Kahuku for re-release...third individual was too wary and elusive...the latter hatched at Pohakuloa from a stray egg recovered from the Keauhou-2 Sanctuary...one might speculate that the wild blood of this nene was evident in its more wary nature...the 2 nene captured were from the Pohakuloa project flock 1 July 1968-30 June 1969 (32)

KEAIWA RESERVOIR

- 376 Elder: Wingate: saw 2 or 3 repeatedly / at Anipeahi where Ainapo Trail crosses the stone wall 1925 (1)
- 377 Elder: NPS Rangers caught 1 of 2 flightless nene / Punaluu Kakawai on trail from Anipeahi to Kahuku spring 1926 (1)
- 378 Elder: Silva: 4 seen / 1 1/2 mile beyond Kahuku forestry cabin 1937-1938 (1)
- 379 Elder: Iaukea: saw 2 / above Forestry cabin, Kahuku Ranch summer 1930's (1)
- 380 Elder: Breithaupt: seen (confirmed by CCC crew) / Holewai Waterhole, Ainapo trail 1932-1936 (1)
- 381 Martinson: saw 2 / at Punaluu Kahawai at 7,250 feet Nov. 1942 BALP45
- 382 W. Banko: T. Sumner: seen / near Punaluu Kahawai, Hawaii State forestry cabin, 6167 ft. el. 1949 (9)
- 383 W. Banko: T. Sumner: some seen / Kipuka Aiaka Alala, Kahuku, about 7,300 ft. el., above jeep trail ca. 1950 (9)
- 384 W. Banko: T. Sumner: seen / Anipeahi, Kapapala, vicinity of waterhole about 7,600 ft. el. near Kau boundary (1949-1951) (9)
- 385 Elder: Wm. Paris, Sr.: saw nene / above forest line, Kapapala Ranch (1956) (1)
- 386 Elder: McKenzie: saw nene / 2 miles NE of mauka cabin, Kipuka Nene (1956) (1)

**Island of Hawai'i
Ka'u District**

WOOD VALLEY

- | | | | |
|-----|---|------------------------------|------|
| 387 | Elder: Wm. Paris, Sr.: father hunted nene / Ainapo | (1930's) | (1) |
| 388 | W. Banko: T. Sumner: never seen...only a legend that they once used to land here for rest / Puu Kuanene, Kapapala, 2,825 ft. el. | (1949-1951) | (9) |
| 389 | Elder: E.B. Medeiros and Fontes: saw 2 / Stone Wall, Kapapala Ranch | June-July 1954 | (1) |
| 390 | Elder: old Hawaiian hunter via Horner: killed packhorse load of flightless nene / Ainapo area of Kapapala Ranch | (in years past) | (1) |
| 391 | Elder: E.B. Medeiros and Fontes: saw 1 / Kapapala Ranch | June-July ca.
1956 | (1) |
| 392 | HDFG: ...a single unbanded Nene, probably a year-old female...observed...remaining there most of the month / Kapapala Ranch | Nov. 1961 | (25) |
| 393 | One goose from the Hawaii Volcanoes National Park was observed at the self-feeder in the Kahuku nene sanctuary; it was paired with an unbanded gander. This pair was last seen by National Park personnel / in Kapapala Ranch | 1 July 1985-
30 June 1986 | (93) |

MAUNA LOA

- | | | | |
|-----|--|-----------------------|-----|
| 394 | Elder: E.B. Medeiros and Fontes: saw 5 / flats above stone wall at Kapapala Ranch | June-July ca.
1954 | (1) |
| 395 | Elder: Bryan: flushed 7 / Halewai water tank at Anipeahi, 7,700 ft. el. along Ainapo Trail | (in years past) | (1) |
| 396 | Elder: J. Armitage: saw 15 on ground / 1 mile above Halewai tank, Ainapo Trail | 1956-1957 | (1) |

KIPUKA PAKEKAKE (outside Hawaii Volcanoes National Park)

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|-----|--|-----------------|-----|
| 397 | NPS: 12 seen / elevation 4,500 ft. about 5 miles southwest of the Mauna Loa Strip (Road)...Kapapala Ranch flying toward the Park | (May 1949) | (5) |
| 398 | W. Banko: T. Sumner: large groups seen / Pahuamimi, Kapapala, on two small hills near large water hole about 7,000 ft. el. | ca. 1949 | (9) |
| 399 | Elder: B. Sumner: twice saw ca. 9 calling from the top of knoll / near Halewai cabin | (in years past) | (1) |

**Island of Hawai'i
Ka'u District**

KIPUKA PAKEKAKE (outside Hawaii Volcanoes National Park)

- 400 Woodside: many droppings—old to fresh on pahoehoe around tube “cave-ins” / left jeep at upper end of roads on (Park) boundary (with Kapapala Forest Reserve) in Kipuka Maunaiu...hiked up boundary fence and on past to “seeps” on aa to 6,500 (ft. el.) 8 Oct. 1959 (14)

KILAUEA CRATER (outside Hawaii Volcanoes National Park)

- 401 Elder: Waipa (age 77 in 1956): saw them often, families up to 5 / Keauho(u), between ranch house and mauka house of Shipman's father, Keawewai ca. 1895 (1)
- 402 Elder: Meinecke: saw 3 / old, (Capt. U.S. Army) Bates Camp (4998 ft. el. waterhole near Park bndry, Keauhou Ranch) Aug. 1909 (1)
- 403 Elder: Meinecke: undetermined number seen / old (Capt. U.S. Army) Bates Camp (4998 ft. el. waterhole near Park bndry, Keauhou Ranch) July-Aug. 1916 (1)
- 404 Elder: Meinecke: 2 seen / old, (Capt. U.S. Army) Bates Camp (4998 ft. el. waterhole near Park bndry, Keauhou Ranch) 27 July 1922 (1)
- 405 Elder: Meinecke: 2 seen / old, (Capt. U.S. Army) Bates Camp (4998 ft. el. waterhole near Park bndry, Keauhou Ranch) 30 July 1922;
22,23,26 July
1924 (1)
- 406 Elder: Miranda: saw 5 on ground / Ohaikea, Kapapala Ranch 1924 (1)
- 407 Elder: Meinecke: undetermined number seen / old, (Capt. U.S. Army) Bates Camp (4998 ft. el. waterhole near Park bndry, Keauhou Ranch) 11 Aug. 1925 (1)
- 408 Elder: F. Waltjen: saw 3 several times / open kipuka 1 mile toward Kulani from (?Bates) camp, old Mauna Loa trail 1927 (1)
- 409 Elder: F. Waltjen: saw nene come every night (1600 hours) from direction of Kulani to roost near their camp / where stone wall meets Mauna Loa trail June, Aug.
1930 (1)
- 410 Elder: Kimi (age 65 in 1956): frequently saw a small flock / Ohaikea ca. 1930 (1)
- 411 Elder: McKenzie: saw pair with nest, later saw 2 young with 1 infertile egg and 1 dead embryo / Bates Camp winter of 1940-
1941 (1)
- 412 Elder: McKenzie: saw 4 young with parents / Bates Trail, near Bates camp 1950 (1)

**Island of Hawai'i
Ka'u District**

KILAUEA CRATER (outside Hawaii Volcanoes National Park) (Cont.)

413	Elder: McKenzie: saw 2 young with parents / Bates Trail	1950	(1)
414	Elder: T. Lindsey: saw 24 fly over / Keauhou Ranch house	(in years past)	(1)
415	Elder: T. Lindsey (interviewed 12 Sept. 1956): 2 adults and 2 flightless young seen / below Bates Camp on the Keauhou side of Kipuka Kekekaniho (Kipuka Kulalio)	(1956)	(1)
416	2 censused / Keauhou Ranch and Volcano Golf Course	30 Dec. 1972	GAGW73
417	4 censused / Keauhou Ranch	30 Dec. 1972	MULW74
418	8 observed swimming / Keauhou Ranch , 5350 ft. el.	17 June (1974)	SMIH74
419	2 censused, Christmas Count / Keauhou Ranch	2 Jan. 1978	KATL78
420	2 censused, Christmas Count / Kilauea Crater Rim	30 Dec. 1978	KATL79
421	5 censused, Christmas Count / Keauhou Ranch	30 Dec. 1978	KATL79
422	1 seen, Christmas Count / Keauhou Ranch	27 Dec. 1980	KATL85
423	3 censused, Christmas Count / Kipuka Puaulu, Golf Course, adj. areas	27 Dec. 1981	TAYA82
424	2 censused, Christmas Count / Kilauea Crater Rim, Thurston Lava Tube	27 Dec. 1981	TAYA82
425	2 censused, Christmas Count / Keauhou Ranch, Transect 30	27 Dec. 1981	TAYA82
426	4 seen, Christmas Count / Kipuka Puaulu, Golf Course, adj. areas	26 Dec. 1982	KATL85
427	4 seen, Christmas Count / Kilauea Crater Rim, Thurston Lava Tube	26 Dec. 1982	KATL85
428	4 seen, Christmas Count / Kipuka Puaulu, Golf Course, adj. areas	2 Jan. 1984	KATL85
429	4 seen, Christmas Count / Kilauea Crater Rim, Thurston Lava Tube	2 Jan. 1984	KATL85
430	7 seen, Christmas Count / Kilauea Crater Rim, Thurston Lava Tube	29 Dec. 1984	KATL85
431	2 seen, Christmas Count / Keauhou Ranch	29 Dec. 1984	KATL85
432	2 seen, Christmas Count / Kipuka Puaulu, Golf Course, adj. areas	4 Jan. 1986	KATL86

**Island of Hawai'i
Ka'u District**

VOLCANO (outside Hawaii Volcanoes National Park)

433	Elder: Verbiske: frequently seen flying mauka / ca. milepost 25 along the Hilo to National Park highway	1940's-1955	(1)
434	Elder: McKenzie: saw 8 flying (1130 hours) / towards Bates Camp	19 Oct. 1956	(1)
435	Elder: Verbiske: saw ca. 12 flying makai (towards the sea) in late p.m. / milepost 26 along road to Park from Hilo	Sept.-Oct. 1956	(1)
436	Elder: McKenzie: saw 6 (2 young fuzzy heads able to fly) / at McCake Ranch, end of Wright Road	7 Dec. 1956	(1)
437	HDFG: Several scattered reports of wild nene flying...investigated, but none were verified / Volcano area	1959-1960	(23)
438	Elder: McKenzie: 9 seen / Wright Road, 1 1/2 miles above Volcano Road	25 Feb. 1957	(1)
439	HDFG: several scattered reports of nine flying...but none were verified / Volcano area	1 July 1959- 30 June 1960	(23)

PUU O UO

440	Elder: J. Greenwell: seen once (group of 6) in 20 years / at forest line, 7000 ft. el., Puu Oo (Puu o Uo)	1932-1952	(1)
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KOOKOLAU

441	Woodside: Yamamoto (surveyor): saw a pair on 2 separate occasions / 1 mile past the end of the Hilo-Kona Road and a little mauka (toward the mountain)	about 7 weeks prior to 5 Aug. 1955	(14)
442	Woodside: no sign of nene found / on hike past the end of the Hilo-Kona Road to 1859 lava flow and return	5 Aug. 1955	(14)

KULANI

443	Elder: Silver (? Silva) a pig hunter: saw 2 / between 1881 and 1852 (lava) flows near Kipuka Aina Hou	1955	(1)
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**Island of Hawai'i
Ka'u District**

PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park]

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| 444 | Woodside: Elder: found many fresh droppings, small nene contour feathers and a few bits of down at the seep / ...from end of truck trail walked over along stone wall to boundary flow and down the trail to Bates Camp. Lost trail in Kekekahniho. Elder continued on down the kipuka...I was attracted to a green area on the north aa flow above me...went up to it (finding droppings, contour feathers, down)...I call this area the seep as there is lots of green grass, verbena, gosmore and a few poka plants on the thin soil of the aa. | 9 Nov. 1956 | (14) |
| 445 | Woodside: found more droppings and sign in another similar seep / located north across the channel of the flow | 9 Nov. 1956 | (14) |
| 446 | Woodside: heard and saw nene on edge of small (about 4 acres) forested kipuka just north of second seep | 9 Nov. 1956 | (14) |
| 447 | Woodside: lots of fresh droppings and a pair with a nest under a fallen koa with a large pukeawe growing up through it...nest with 2 eggs, lots of down...about 25 feet from the edge of the aa and extremely well hidden...goose very tame...did not hiss or defend nest even when I approached within 10 feet...only a low monosyllabic moan when she left the nest to go up on the lava...gander flew off 50 feet when I got to within 25 feet of him...at nest about 40 minutes, only the last 15 of which was the goose off the nest...returned to jeep...found Elder waiting | in 4-acre forested kipuka
9 Nov. 1956 | (14) |
| 448 | the first nest ever to be seen in the wild by a biologist...3 old nests in progressive stages of deterioration also found | in a tiny kipuka...6,500 ft. el...upper lands of Keauhou Ranch on the eastern slope of Mauna Loa
9 Nov. 1956 | ELDW58 |
| 449 | 'trio' adults seen | Keauhou Ranch breeding ground
9 Nov. 1956 | ELDW58 |
| 450 | Woodside: Elder: set up blind at nest and left Elder in it...goose on nest, gander watching quietly from aa above nest...noon | (4-acre forested kipuka)
13 Nov. 1956 | (14) |
| 451 | Woodside: saw pair | fourth long kipuka (from 4-acre kipuka down the flow to the next kipuka and thence northeast)
13 Nov. 1956 | (14) |

Island of Hawai'i
Ka'u District

PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)				
452	'trio' adults seen	Keauhou Ranch breeding ground	13 Nov. 1956	ELDWS8
453	Woodside: returned to Elder at 3 p.m....goose still on nest, gander nearby...went away and returned 4:30 p.m....goose still on, gander nearby	(4-acre kipuka)	13 Nov. 1956	(14)
454	'trio' adults seen	Keauhou Ranch breeding ground	16 Nov. 1956	ELDWS8
455	Woodside: gander on the grassy part...goose on the nest	the seep (4-acre kipuka)	19 Nov. 1956	(14)
456	'trio' adults seen	Keauhou Ranch breeding ground	19,20,22,23 Nov. 1956	ELDWS8
457	Woodside: pair on lava at lower near-edge of "nest kipuka"...nest hatched yesterday...no young seen...took pictures of nest and unhatched egg (Elder was up yesterday and saw 1 chick)...went back to where pair was but could not find them, circling kipuka twice and going back to seep	(4-acre "nest" kipuka)	23 Nov. 1956	(14)
458	Woodside: saw a pair with binoculars...no young	on the lower seep	23 Nov. 1956	(14)
459	Woodside: 1 male and 2 ?female nene on ridge...no young...appears that the one young has been lost	nearest nest kipuka	23 Nov. 1956	(14)
460	Woodside: mapped location of nest found and revisited	nest kipuka, 1 1/4 miles NW of cabin	9,23 Nov. 1956	(14)
461	Woodside: mapped location of 3 adults seen	nest kipuka, 1 mile NW of cabin	23 Nov. 1956	(14)
462	Woodside: mapped location where 2 adults were seen	1/2 mile N of cabin	23 Nov. 1956	(14)
463	Woodside: Elder took me up to end of truck trail and left me to walk to Saddle Road. Cut across to nest kipuka...no nene on seep or in kipuka...seems like nest was used last year or before as there are old shell fragments under this year's down...left gear in kipuka...walked up edge of Kekekaniho to the plane wreck	nest kipuka and seep	25 Nov. 1956	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

464	Woodside: no sign of nene	in two kipukas on return hike from plane wreck back down to nest kipuka	25 Nov. 1956	(14)
465	Woodside: 1 pair came to seep at 5:10 p.m....goose started to feed immediately...gander watched me for 35 minutes before starting to feed on grass or gosmore...both left area at 5:50 p.m....made camp in nest kipuka	nest kipuka and seep	25 Nov. 1956	(14)
466	Woodside: no nene seen or heard till 7:30 a.m. (when)...sounded as if nene were near the nest site...looked for them till 8:30 but did not find them (for observations on trip from Keauhou Sanctuary to Saddle Road see MULTIQUADRANGLE)	nest kipuka	26 Nov. 1956	(14)
467	'trio' adults seen	Keauhou Ranch breeding ground	3,13 Dec. 1956	ELDW58
468	Woodside: lots of fresh droppings...located an old nest (last year's) near this season's nest...heard and flushed young nene in the grass and pukeawe on the north side	nest kipuka	5 Jan. 1957	(14)
469	Woodside: 2 old (1-2 year-old) nests located, flushed an adult pair which flew downslope about 1/2 mile, leaving 2 or possibly 3 young about 5 weeks old behind	nest kipuka	5 Jan. 1957	(14)
470	Woodside: mapped location where brood of 2 was seen	1 1/4 mile NW of cabin	5 Jan. 1957	(14)
471	Woodside: found a pair with 3 young about 4 weeks old	edge of aa, main kipuka	5 Jan. 1957	(14)
472	Woodside: mapped location where pair with 3 young seen	1/4 mile N of cabin	5 Jan. 1957	(14)
473	pair with 3 young seen	Keauhou Ranch breeding ground	5 Jan. 1957	ELDW58
474	pair with 2 young seen (color banded)	Keauhou Ranch breeding ground	5 Jan. 1957	ELDW58
475	Woodside: found a pair with 4 young	at seep	6 Jan. 1957	(14)
476	Woodside: mapped location where pair with 4 young seen	1 mile NW of cabin	6 Jan. 1957	(14)

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PUU ULAULA		[Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)		
477	Woodside: 3 adults flew to seep, took pictures, no sign of brood	nest kipuka	6 Jan. 1957	(14)
478	Woodside: mapped location where 3 adults seen	1 1/4 mile NW of cabin	6 Jan. 1957	(14)
479	Woodside: located parents with brood of 4	on aa about 400 yards below seep and 20 yards in from edge	6 Jan. 1957	(14)
480	Woodside: mapped location where parents with brood of 4 seen	7/8 mile NW of cabin, below nest kipuka	6 Jan. 1957	(14)
481	pair with 4 young seen	Keauhou Ranch breeding ground	6 Jan. 1957	ELDW58
482	'trio' adults seen	Keauhou Ranch breeding ground	6 Jan. 1957	ELDW58
483	Woodside: found a pair with 2 young about 8 weeks old; banded young yellow	NE of nest kipuka	24 Jan. 1957	(14)
484	Woodside: mapped location where 2 young were banded yellow	1 1/2 miles NW of cabin	24 Jan. 1957	(14)
485	pair with 2 young seen (color banded)	Keauhou Ranch breeding ground	24 Jan. 1957	ELDW58
486	Woodside: 1 pair with 3 young; flightless female and 3 young banded red	about 1 mile below nest kipuka	27 Jan. 1957	(14)
487	Woodside: mapped location where female and 3 young were banded red	1 mile NWN of cabin	27 Jan. 1957	(14)
488	pair with 3 young seen	Keauhou Ranch breeding ground	27 Jan. 1957	ELDW58
489	Woodside: flushed 3 adults	strawberry kipuka	31 Jan. 1957	(14)
490	Woodside: mapped location where 3 adults were flushed	2 miles NW of cabin	31 Jan. 1957	(14)
491	Woodside: Ah Fat found family with red-banded young all together...female still flying...took pictures	in the nest south lava river from strawberry kipuka	31 Jan. 1957	(14)
492	Woodside: mapped location of family with red-banded young	1 1/2 miles NW of cabin	31 Jan. 1957	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

493	pair with 3 young seen	Keauhou Ranch breeding ground	31 Jan. 1957	ELDW58
494	'trio' adults seen	Keauhou Ranch breeding ground	31 Jan. 1957	ELDW58
495	Woodside: found family with red-banded young all together, female can still fly	between strawberry kipuka and grassy "Flat" on lava ca. 200 yds north of "Flat"	6 Feb. 1957	(14)
496	Woodside: mapped location where family with red-banded young were found together	2/3 mile N of cabin	6 Feb. 1957	(14)
497	pair with 3 young seen	Keauhou Ranch breeding ground	6 Feb. 1957	ELDW58
498	Woodside: found 1 red-banded young	kipuka next to nest kipuka	21 Feb. 1957	(14)
499	Woodside: mapped location where (red-banded young was found)...young able to fly ca. 100 ft. downslope before crashing	1 1/2 miles NWN of cabin	21 Feb. 1957	(14)
500	pair with 3 young seen	Keauhou Ranch breeding ground	21 Feb. 1957	ELDW58
501	Woodside: 3 adults and 2 red-banded young found...unbanded adult an still fly...1 red-banded young seen 21 Feb. apparently never rejoined family	between seep and strawberry kipuka	27 Feb. 1957	(14)
502	Woodside: mapped location where family with 2 red-banded young and unattached adult seen	1 1/2 miles NW of cabin	27 Feb. 1957	(14)
503	pair with 3 young seen	Keauhou Ranch breeding ground	27 Feb. 1957	ELDW58
504	Woodside: flushed 1 red-banded young	on the "Flat" seep below seep down from strawberry kipuka	12 Mar. 1957	(14)
505	Woodside: 4 nene flew over, low and noisy	cabin	13 Mar. 1957	(14)
506	Woodside: found "2 day" old droppings in grassy places...did not notice them there yesterday...3 or 4 roosted here	just below strawberry kipuka	13 Mar. 1957	(14)

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PUU ULAULA		[Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)		
507	Woodside: heard flying but could not see in fog and rain...sounded like 1 only	between roosting area above where brood was banded yellow and cabin	14 Mar. 1957	(14)
508	Woodside: very old droppings found	string of small kipuka near Kipuika Kekake	14 Mar. 1957	(14)
509	pair with 3 young seen	Keauhou Ranch breeding ground	14 Mar. 1957	ELDW58
510	Woodside: waited on lava for nene—none seen or heard	near strawberry kipuka	15 Mar. 1957	(14)
511	Woodside: 2 or 3 have been roosting in caves...but sign indicates little feeding	seep near nest area (kipuka)	17 Apr. 1957	(14)
512	Woodside: saw 3 or 4 nene (flew away) silent...1 sleeping on the Pahoehoe ridge but disappeared as I looked away	north of the nest kipuka	17 Apr. 1957	(14)
513	Woodside: recent droppings indicate feeding but few are fresh	nest kipuka	17 Apr. 1957	(14)
514	Woodside: came on 3 adults, no broods, noisy while flying...lots of fresh sign along line of Luas	in koa log kipuka above strawberry kipuka and luas (pit craters)	17 Apr. 1957	(14)
515	Woodside: fresh sign all the way	to "Flat" below nest kipuka	17 Apr. 1957	(14)
516	Woodside: saw nene with binoculars...little fresh sign around "Flat"...heard alarm note in nest kipuka...saw 3 nene...2 adults and 1 unbanded young	on seep by nest kipuka...near "Flat", main seep	17 Apr. 1957	(14)
517	pair with 1 young seen	Keauhou Ranch breeding ground	17 Apr. 1957	(14)
518	'trio' adults seen	Keauhou Ranch breeding ground	17 Apr. 1957	ELDW58
519	Woodside: found fresh droppings	at seep, nest kipuka	28 Apr. 1957	ELDW58
520	Woodside: possible nene note heard at 3 p.m.	nest kipuka	28 Apr. 1957	(14)
521	Woodside: pair with 1 young (all unbanded) seen	in channel near seep, nest kipuka	28 Apr. 1957	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

522	HDFG: four or five broods observed...moulted primaries and secondaries found...indicating...(other adults were) less successful or left early	Keauhou Ranch breeding ground	(1956-1957 nesting season)	(20a)
523	pair with 4 young seen	Keauhou Ranch breeding ground	28 Apr. 1957	ELDW58
524	pair with 1 young seen	Keauhou Ranch breeding ground	28 Apr. 1957	ELDW58
525	pair with 3 young seen	Keauhou Ranch breeding ground	13 May 1957	ELDW58
526	pair with 2 young seen (color banded)	Keauhou Ranch breeding ground	13 May 1957	ELDW58
527	pair with 2 young seen	Keauhou Ranch breeding ground	13 May 1957	ELDW58
528	'trio' adults seen	Keauhou Ranch breeding ground	21 May 1957	ELDW58
529	pair with 2 young seen	Keauhou Ranch breeding ground	21 May 1957	ELDW58
530	pair seen	Keauhou Ranch breeding ground	21 May 1957	ELDW58
531	observed flocks of 2-6 (a total of) 31 times...at least 6 pairs used the area	in and within 2 1/2 miles of a tiny kiupka...at 6,500 ft...in the upper lands of Keauhou Ranch on the eastern slope of Mauna Loa	9 Nov. 1956- 21 May 1957	ELDW58c
532	pair found	at the little kiupka where nesting occurred the previous year	28 Aug. 1957	ELDW58
533	17 adults, 10 young (actually 12) (in 5 broods) discovered	in and with 2 1/2 miles of a tiny kipuka...on the eastern slope of Mauna Loa at an el. of 6,500 ft.	(1956-1957 breeding season)	ELDW58

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PUU ULAULA		[Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)		
534	conclude: at least 6 adult pairs...one unemployed bird...12 young...average production of 2 young per breeding pair	on Keauhou breeding ground on Mauna Loa	(1956-1957 breeding season)	ELDW58c
535	Woodside: no fresh droppings	nest kipuka	11 Sept. 1957	(14)
536	Woodside: no fresh droppings	kipuka above strawberry kipuka	11 Sept. 1957	(14)
537	Woodside: 1 unbanded pair seen	on lava at extreme mauka tip of strawberry kipuka	11 Sept. 1957	(14)
538	Woodside: only old droppings	on lava at extreme mauka tip of strawberry kipuka	11 Sept. 1957	(14)
539	Woodside: no real fresh sign...looks like only 1 pair in area (at mauka tip of strawberry kipuka)	searched lower end of strawberry kipuka, yellow brood kiupka and lower edge of "Flat" seep	11 Sept. 1957	(14)
540	Woodside: saw pair, not strong flier; no nest	nest kipuka	8 Nov. 1957	(14)
541	Woodside: 4 nene (1 red-banded) took off...may have been 5 in group	from aa kipuka, nest one N of nest, flew towards strawberry (kipuka)	8 Nov. 1957	(14)
542	Walker: found one fresh dropping...searched 1957 sighting points...heard single honk...then a 2-note call—at ease...sighted 2 nene on Volcano (Kilauea) side of nest kipuka on log...no bands seen	seep, nest kipuka	19 Dec. 1957	(14)
543	Walker: A. MacKenzie saw 1 pair with 3 young	1 mile below Keauhou Sanctuary	1 Jan. 1958	(14)
544	Walker: found old broken nene egg near dense pukeawe bush...no other egg sign or sign of a nest; fresh (1 wk.) droppings nearby	nest kipuka	6 Jan. 1958	(14)
545	Walker: heard, then saw 1 pair nene and 2 chicks about 1 week old	on boundary of nest kipuka	6 Jan. 1958	(14)
546	Walker: Nichols found nest remains (recent) in mauka half of kipuka; north of nest kipuka, 1 egg shell remains—pipped and hatched up on knoll under dense pukeawe...many down feathers (breast)...no fresh droppings or sign of adults...	nest kipuka	7 Jan. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)			
547	Walker: discovered nest site of 4:30 p.m. (1/6/58) sighted pair, many fresh droppings on trail	nest kipuka	7 Jan. 1958 (14)
548	Walker: found 1 whole nene egg...very fresh...not rotten...red material in yellow yoke near point where egg rested on ground	near SE end of nest kipuka	25 Jan. 1958 (14)
549	Walker: saw 2 unbanded nene during walk	from nest kipuka halfway across lava toward strawberry kipuka	25 Jan. 1958 (14)
550	Walker: saw same pair 1 mile further	on far edge of pahoehoe flow standing on aa	25 Jan. 1958 (14)
551	Walker: empty (negative search results)	lower end of strawberry kipuka	8 Feb. 1958 (14)
552	Walker: heard and saw goose and 2 chicks...female belligerent-sounding...saw male hiding in brush...flew off as I approached (heard male later in upper end of strawberry kipuka calling distress to mate)...female very mad—flew at me as I caught and banded 2 chicks about 6 weeks old (further notes on behavior here)	lower end of strawberry kipuka	9 Feb. 1958 (14)
553	HDFG: a pair was observed in Keauhou...where activity increased through October and November...but time available for field work was limited...however, 2 nests were located, both of which appeared to have hatched out young...1 brood of 2 goslings was located and banded...	Keauhou Sanctuary	1 July 1957-30 June 1958 (21)
554	NPS: 1 seen	bare aa lava flow at 7,000 ft. el, on Keauhou Ranch, just outside the Park	31 July 1958 (5)
555	Woodside: noted a few rather fresh droppings	on seep nearest nest kipuka	1 Aug. 1958 (14)
556	Woodside: found rather recent but dry sign, skeleton and feathers (no leg bones) on lava...guess not over 1 year by condition of feathers, bones very bleached	hiked through nest kipuka, on past next one and over to edge past strawberry (kipuka) and on past and down	1 Aug. 1958 (14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

557	Woodside: flushed 1 lone male?...nesting on edge of a kipuka...it flew to "kao log kipuka"?	continued on over and down (past strawberry kipuka and on past and down)	1 Aug. 1958	(14)
558	HDFG: at least 1 (banded individual), possibly more, returned repeatedly...	Keauhou nesting area	all through the summer, 1958	(22)
559	HDFG: activity increased	in nesting area	during October 1958	(22)
560	HDFG: at least 9 were known to be in the area, including 2 banded as goslings last year	in nesting area	by the 1st of November 1958	(22)
561	Woodside w/ Takata: heard nene alarm note but could not locate the bird	on the far edge of (Park) boundary lava flow	20 Nov. 1958	(14)
562	Woodside: saw a lone nene flying back toward the Park...landed close to boundary flow	about halfway across boundary lava flow to nest kipuka	20 Nov. 1958	(14)
563	Woodside: 1 yellow band gander	on nest kipuka seep	20 Nov. 1958	(14)
564	Woodside: found fresh "clockers"...no nest or birds	in pukeawe below nest site of 2 years ago, nest kipuka	20 Nov. 1958	(14)
565	HDFG: 3rd nest with 4 eggs under incubation found in clump of pukeawe...all 4 hatched	near nest kipuka on aa, 6,000 ft. el.	found 23 Nov. 1958 hatched 12-15 Dec.	(22)
566	HDFG: 4th nest with 3 fertile eggs found...goose was a 2-year old red-banded bird...nest under single pukeawe among scattered bushes on aa	1 mile below nest kipuka, 5,800 ft. el.	found 25 Nov. 1958 deserted 11 Dec. 1958	(22)
567	Woodside: pair seen flying...very little fresh droppings	nest kipuka	25 Sept. 1958	(14)
568	Woodside: no nene seen...a few rather recent droppings found	seep near nest kipuka	5 Oct. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

569	Woodside w/ Dumfire: week-old droppings found	along edge of boundary lava flow (after walking from end of truck trail over to boundary along stone wall and crossing to edge of Kekekaniho)	30 Oct. 1958	(14)
570	Woodside: few weeks old and older droppings	seep (near nest kipuka)	30 Oct. 1958	(14)
571	Woodside: no droppings or birds	nest kipuka	30 Oct. 1958	(14)
572	Woodside: flushed 1...no droppings	next kipuka over from nest kipuka	30 Oct. 1958	(14)
573	Woodside: heard nene moan...saw 4 (2 with aluminum bands...must be family of last year)	strawberry kipuka	30 Oct. 1958	(14)
574	Woodside: 4 seen flying	from strawberry (kipuka), out and around to upper seep	30 Oct. 1958	(14)
575	Woodside: heard nene...saw two on lava...Dumfire reported no bands on these but goose heavy compared to goose of aluminum bands' family	on other side of kipuka (reached after hiking from strawberry kipuka down ends of long kipukas and toward lower seep)	30 Oct. 1958	(14)
576	Woodside: 4 (aluminum band family)...1 (yellow band) came in and landed...2 more seen about 1/2 mile mauka going south...over to Park boundary flow...landed...doubt if the 2 which flew over at 5:45 were the ones Bill checked, but the single (yellow band) that came in was very likely the one seen at the nest kipuka over from the nest kipuka...total seen: 9 nene (2 aluminum bands, 1 yellow band; possibly 10 nene).	upper seep	30 Oct. 1958	(14)
577	Woodside: saw a pair, female very heavy...yellow banded male still on seep	on the closest side of the seep, nest kipuka	20 Nov. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

578	Woodside: saw lone nene and goose "frozen" on a possible unconcealed nest closest to the boundary flow...went back across lava toward truck (did not disturb (?nesting) pair)...total nene seen: 7 (3 pairs and 1 2-year old).	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaiho in a northerly direction from the corner of the "stonewall trail"	20 Nov. 1958	(14)
579	Woodside w/ Walker: visited nest #2-58...eggs well covered with down...pair on the aa close to the nest...one alarm note (low moan)...birds "froze"...did not disturb...could not see if female was banded...did not count eggs	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	23 Nov. 1958	(14)
580	Woodside: heard 1 alarm note (short honk)...searched but could not find it nor any fresh droppings	next kipuka (from nest close to boundary flow on way to nest kipuka)	23 Nov. 1958	(14)
581	Woodside: plentiful fresh droppings...saw pair on the lava about 100 yards from kipuka...they were moving away from kipuka...flew toward nest kipuka (after walk toward them)...Walker showed me last year's nest	nest kipuka	23 Nov. 1958	(14)
582	Woodside: Walker showed me the new nest of last year...no droppings	Park side of strawberry kipuka	23 Nov. 1958	(14)
583	Woodside: flushed 1 pair...collected droppings	last kipuka beyond strawberry kipuka	23 Nov. 1958	(14)
584	Woodside: no fresh droppings seen	on walk through strawberry kipuka	23 Nov. 1958	(14)
585	Woodside: flushed gander and goose...nest (#3-58) with 4 uncovered eggs with much down	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	23 Nov. 1958	(14)
586	Woodside: flushed 1 (no band seen) after hearing alarm note	from seep	23 Nov. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

587	Woodside: heard alarm note twice...no birds located...searched thoroughly	at kipuka near #2-58 nest	23 Nov. 1958	(14)
588	Woodside: goose on nest #2-58, gander flushed nearby...did not disturb goose...total nene seen: 4 pairs and 1 single	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	23 Nov. 1958	(14)
589	Woodside: goose was on nest #2-58...gander about 5 yards away...4 eggs...candled 1 by weak sunlight...seemed about 10 days incubated, maybe less...sharp rock protruding into nest	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	25 Nov. 1958	(14)
590	Woodside: no birds	seep	25 Nov. 1958	(14)
591	Woodside: saw the 1-year olds with aluminum bands	near tip of nest kipuka	25 Nov. 1958	(14)
592	Woodside: gander of nest #3-58 came out calling...goose on nest...did not flush the pair	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	25 Nov. 1958	(14)
593	Woodside: saw aluminum banded pair	at top of lower seep	25 Nov. 1958	(14)
594	Woodside: spotted 2 nene with binoculars	on lower seep (where I saw a pair with Dumfries on 30 Oct.)	25 Nov. 1958	(14)
595	Woodside: spotted a gander...searched for nest...saw goose fly from lava...found nest #4-58 with 3 eggs, much down	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	25 Nov. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

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|-----|--|--|--------------|------|
| 596 | Woodside: 2 aluminum banded birds circled and landed...gander of (nest 4-58 still there...did not flush him...also 1 red-banded 2-year old, 1 pair unbanded, aluminum banded 1-year olds—total 6 birds (plus uncopied notes on interaction between all birds from about 4:30 - 5:05 p.m. all at lower seep | about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2 | 25 Nov. 1958 | (14) |
| 597 | Woodside: checked nest #2-58...goose on...did not disturb | about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail" | 29 Nov. 1958 | (14) |
| 598 | Woodside: checked nest #3-58...goose on...gander on guard | about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow | 29 Nov. 1958 | |
| 599 | Woodside: no birds | lower seep and all kipukas on aa nearby (except nest #4-58) | 29 Nov. 1958 | (14) |
| 600 | Woodside: checked nest #4-58...pair gone but eggs well covered and warm | about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2 | 29 Nov. 1958 | (14) |
| 601 | Woodside: saw gander of nest #4-58 come out of brush; made unsuccessful search for goose... | about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2 | 29 Nov. 1958 | (14) |
| 602 | Woodside: saw 1 lone gander...after checking tips of all long kipukas and all small ones toward strawberry (kipuka) | in the small kipuka where the brood was banded yellow | 29 Nov. 1958 | (14) |

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

603	Woodside: heard nene...spotted gander...saw goose on nest #5-58...2 eggs...lots of down...did not disturb pair further	about 6000 ft. el. and approximately 100 yards mauka of strawberry kipuka about 15 yards from edge of "last kipuka"	29 Nov. 1958	(14)
604	HDFG: 5th nest with 2 eggs found under pukeawe bush on aa...being incubated when found...fertility undetermined...predator undetermined	100 yards below strawberry kipuka next to last kipuka, 6000 ft. el.	found 29 Nov. 1958 destroyed before 2 Dec.	(22)
605	Woodside: checked nest #2-58...goose was off and gander about 10 yards away...eggs all o.k. and well covered	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	2 Dec. 1958	(14)
606	Woodside: saw aluminum banded pair (both banded on right leg)...1 yellow banded young (in channel of the seep) which flew out and was joined by another bird which I heard but couldn't see	on the lava near seep in kipuka below nest #2-58	2 Dec. 1958	(14)
607	Woodside: checked nest #3-58...4 eggs were well covered, warm...pair was gone	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	2 Dec. 1958	(14)
608	Woodside: saw pair of nest #3-58...did not disturb them	among pukeawe and ohelos on lava about 150 yards below nest	2 Dec. 1958	(14)
609	Woodside: came upon another pair with no bands...goose not heavy...found nest #6-58...contained 4 eggs, warm, well covered with down	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	2 Dec. 1958	(14)
610	HDFG: 6th nest with 4 eggs found under pukeawe bush on aa...being incubated when found...	1/4 mile below nest kipuka, 5900 ft. wl.	found 2 Dec. 1958 all 4 hatched 24-27 Dec.	(22)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

611	Woodside: checked nest #4-58...goose on...gander on guard about 20 yards away...did not disturb	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	2 Dec. 1958	(14)
612	Woodside: 1 lone gander flew by in fog going in direction of lower seep	yellow brood kipuka	2 Dec. 1958	(14)
613	Woodside: checked nest #5-58...all (both eggs) hatched...flushed a red-banded 2 year old	about 6000 ft. el. and approximately 100 yards mauka of strawberry kipuka about 15 yards from edge of "last kipuka"	2 Dec. 1958	(14)
614	Woodside: heard nene below	where red-banded 2 year old flushed near nest #5-58	2 Dec. 1958	(14)
615	Woodside: saw possible aluminum-banded nene take off...it was with a pair of unbanded birds and a yellow-banded 2-year old...no chicks in spite of search	edge of last kipuka and lower part of strawberry kipuka	2 Dec. 1958	(14)
616	Woodside: found nene skeleton (red band on right foot) with several broken cervical vertebrae but otherwise intact...bird could fly...was dead about 3-4 months, I'd guess	on lava close to kipuka nest to strawberry kipuka	2 Dec. 1958	(14)
617	Woodside: flushed a lone nene...possible red band on left foot	near lone snag about 150 yards above nest #3-58	2 Dec. 1958	(14)
618	Woodside: goose on nest #2-58	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	2 Dec. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

619	Woodside: checked nest #2-58...eggs well covered...goose on nest...gander on guard...did not disturb	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	4 Dec. 1958	(14)
620	Woodside w/ Woodworth: checked nest #2-58...eggs well covered...pair on nearby lava...gander flushed, goose did not	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	4 Dec. 1958	(14)
621	Woodside: no birds	at seep	4 Dec. 1958	(14)
622	Woodside: checked nest #3-58...pair at nest...gander very defensive...made charge...hissed...goose on nest...did not disturb	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	4 Dec. 1958	(14)
623	Woodside: checked nest #6-58...gander on guard...goose on nest	about 6000 ft. el. approximately 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	4 Dec. 1958	(14)
624	Woodside: checked nest #4-58...pair away...all 3 eggs warm and covered...searched for pair	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	4 Dec. 1958	(14)
625	Woodside: flushed a gander	from the edge of the nest kipuka down	4 Dec. 1958	(14)
626	Woodside: no birds	at seep	4 Dec. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

627	Woodside: checked nest #2-58 at 2 p.m...goose on nest...gander on guard...did not disturb	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	6 Dec. 1958	(14)
628	Woodside: no birds	at seep	6 Dec. 1958	(14)
629	Woodside: 1 pair...did not disturb	lower edge of nest kipuka	6 Dec. 1958	(14)
630	Woodside: checked nest #3-58...pair away...eggs well covered...pair below (lower edge of nest kipuka) nest kipuka must be from the nest—off feeding	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	6 Dec. 1958	(14)
631	Woodside: checked nest #6-58...gander on guard...presume goose on nest...did not disturb	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	6 Dec. 1958	(14)
632	Woodside: saw a pair flying noisily over, headed for Keawewai	(near nest #4-58)	6 Dec. 1958	(14)
633	Woodside: checked nest #4-58...gander on guard...goose on nest, flying off and joined by gander (goose with red band on right foot—two year old)	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	6 Dec. 1958	(14)
634	Woodside: saw 4...1 had an aluminum band, another no band and could not see legs of remaining 2 birds	down the flow from lower seep on lava at upper tip of kipuka below nest #4-58	6 Dec. 1958	(14)
635	Woodside: no droppings or sign found	on hike on down and around the bottom of the kipuka to the park side and down to the extreme lower seep near Kipuka Kekake	6 Dec. 1958	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

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|-----|---|--|--------------|------|
| 653 | Woodside: checked nest #3-58...gander on guard...departed nest without inspecting nest | about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoe-hoe kipuka of about 4 acres surrounded by an ancient aa lava flow | 11 Dec. 1958 | (14) |
| 654 | Woodside: checked nest #6-58...gander on guard...departed site without inspecting nest | about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow | 11 Dec. 1958 | (14) |
| 655 | Woodside: checked nest #4-58...pair away...nest partially covered...egg cold...apparently deserted | about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2 | 11 Dec. 1958 | (14) |
| 656 | Woodside: checked nest #7-58...goose on nest...did not see gander | about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka | 11 Dec. 1958 | (14) |
| 657 | Woodside: checked nest #2-58 again (4:30 p.m.)...pair not back...eggs cold...waited till 5:00 p.m. but birds did not return...examined eggs...very cold...one egg had many small cracks on large end and two small punctures...appeared that the nest was deserted...took eggs and nest material...warmed eggs with warm water from radiator after return to jeep | about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail" | 11 Dec. 1958 | (14) |
| 658 | Woodside: checked nest #2-58...no change...no nene around | about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail" | 17 Dec. 1958 | (14) |

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PUU ULAULA		[Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)	
659	Woodside: all eggs at nest #3-58 have hatched...no sign of parents or brood at site or in nest kipuka	about 6000 ft. el. near "nest kipuka"—a roundish, isolated pahoehoe kipuka of about 4 acres surrounded by an ancient aa lava flow	17 Dec. 1958 (14)
660	Woodside: checked nest #6-58...goose on nest, did not see gander	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	17 Dec. 1958 (14)
661	Woodside: checked nest #6-58...goose on nest, gander not seen	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	17 Dec. 1958 (14)
662	Woodside: check nest #4-58...pair not around...eggs partially covered...cold...recovered the eggs	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	17 Dec. 1958 (14)
663	Woodside: checked nest #7-58...goose on the nest...gander flushed from dense pukeawe about 20 feet from nest	about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka	17 Dec. 1958 (14)
664	Woodside: pair seen under the upper koa tree...very tame and called, moaned and hissed...unsuccessful search for brood...did not flush the birds...this pair did not seem like the pair of nest #3-58...think it is nest #2-58 pair	nest kipuka	17 Dec. 1958 (14)
665	Woodside: at 5:35 p.m. on way from nest kipuka seep back to jeep saw a pair circle...seemed to land	at edge of lava...about 1/4 mile above nest #2-58	17 Dec. 1958 (14)
666	Woodside: no sign of birds except recent droppings	nest kipuka and seep	20 Dec. 1958 (14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

667	Woodside: checked nest #6-58...goose off nest feeding about 30 yards below, gander 100 yards below nest...both noisy when they saw me but quieted down when I left...looked back to see goose return to nest with gander nearby	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	20 Dec. 1958	(14)
668	Woodside: checked nest #4-58...pair gone...eggs partially covered...very cold...took the eggs and nest	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	20 Dec. 1958	(14)
669	Woodside: checked nest #5-58...undisturbed...took the remains	about 6000 ft. el. and approximately 100 yards mauka of strawberry kipuka about 15 yards from edge of "last kipuka"	20 Dec. 1958	(14)
670	Woodside: went up past nest #7-58...pair on edge of the lava nearest nest...flushed	about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka	20 Dec. 1958	(14)
671	Woodside: no birds seen along route	return to jeep through nest kipuka-seep, Kekekaniho	20 Dec. 1958	(14)
672	Woodside: no birds	nest kipuka and seep	23 Dec. 1958	(14)
673	Woodside: checked nest #6-58...gander on guard...did not disturb	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	23 Dec. 1958	(14)
674	Woodside: checked nest #7-58...pair away...eggs covered, warm	about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka	23 Dec. 1958	(14)
675	Woodside: many few day-old droppings	seep near nest kipuka	28 Dec. 1958	(14)

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PUU ULAULA		[Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)	
676	Woodside: no birds...several recent (dry) droppings	searched nest kipuka area	28 Dec. 1958 (14)
677	Woodside: checked nest #6-58...all eggs hatched...collected remains	about 6000 ft. el. approximately 1/3 mile below nest kipuka, on ancient aa flow	28 Dec. 1958 (14)
678	Woodside: only a very few recent (dry) droppings	lower seep	28 Dec. 1958 (14)
679	Woodside: checked site of nest #4-58...many recent (dry) droppings but no birds	about 1 mile below nest kipuka approximately 1/4 mile NW of lower seep and above mauka end of kipuka number 2	28 Dec. 1958 (14)
680	Woodside: checked nest #7-58...goose on nest...gander on ground...did not disturb	about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka	28 Dec. 1958 (14)
681	Woodside: on return trip found plentiful fresh droppings	on seep and lower seep	28 Dec. 1958 (14)
682	Woodside: found an old nest probably last year's, but possibly Oct. 1958, which apparently suffered predation before incubation began...there were 3 or 4 eggs...looks like mongoose as shells were under low pukeawe, etc...droppings on edge of Kekekaniho...	hike across boundary flow about 1 mile above nest #2- 58	9 Jan. 1959 (14)
683	Woodside: lots of old to fresh droppings...this is feeding area of the pair of nest #2-58	continued on down edge of flow above nest #2-58	9 Jan. 1959 (14)
684	Woodside: came upon a pair of nene in the ohia-aa area...not banded...female not heavy...collec: fecal samples	cutting across Kekekaniho above koa trees	9 Jan. 1959 (14)
685	Woodside: no fresh dropping found	nest kipuka	9 Jan. 1959 (14)
686	Woodside: saw a pair	on lava next to last kipuka below strawberry kipuka	9 Jan. 1959 (14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

687	Woodside: nest #7-58 hatched 3 of 4 eggs...4th egg still in nest	about 6000 ft. el. in strawberry kipuka about 10 yards in from northern edge about halfway up on the long axis of the kipuka	9 Jan. 1959	(14)
688	Woodside: pair flushed...no bands...no young...goose appeared heavy...small clocker droppings...may be the pair from nest #5-58 going to renest or maybe has a new nest someplace	down from nest #7-58	9 Jan. 1959	(14)
689	Woodside: searched for broods but found no sign	strawberry kipuka	9 Jan. 1959	(14)
690	Woodside: saw the pair of one year olds...did not flush them	lower seep	9 Jan. 1959	(14)
691	Woodside: lots of fresh sign...some old droppings	seep and nest kipuka	9 Jan. 1959	(14)
692	Woodside: saw 1 pair...no bands...goose slightly heavy...flushed, circled and landed on boundary flow...	boundary flow...about 100 yards above nest #2-58	9 Jan. 1959	(14)
693	Woodside: droppings mostly destroyed by rain...some fresh...no birds	on hike to boundary flow (from end of truck trail) and up the Park edge	17 Jan. 1959	(14)
694	Woodside: found fresh droppings	on hike over to Kekekaniho edge above cross fence	17 Jan. 1959	(14)
695	Woodside: flushed a pair...goose looked very heavy...searched area but found no nest	about 100 yards below (?last year's) nest of pair #2-58	17 Jan. 1959	(14)
696	Woodside: old-recent droppings only	small kipuka and "seep" about 1 1/2 mile above nest kipuka	17 Jan. 1959	(14)
697	Woodside: flushed 3	on edge of boundary flow near plane wreck	17 Jan. 1959	(14)
698	Woodside: saw a lone ?male nene...did not disturb	on the ground near (?last year's) nest of #2-58	17 Jan. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

699	Woodside: checked nest #2-58...no birds	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	17 Jan. 1959	(14)
700	Woodside: no really fresh droppings	on Kekekaniho side of boundary flow	20 Jan. 1959	(14)
701	Woodside: fresh droppings on seep	nest kipuka and seep	20 Jan. 1959	(14)
702	Woodside: heard nene...saw 3 adults with 4 young about 3 weeks old...all unbanded...seemed like goose with brood and an extra pair	lower end of nest kipuka seep	20 Jan. 1959	(14)
703	Woodside: flushed one aluminum-banded bird	lower seep	20 Jan. 1959	(14)
704	Woodside: checked for red-banded renesting...no sign of birds	next kipuka over from lower seep	20 Jan. 1959	(14)
705	Woodside: trio with the brood, a single red-banded but (alone) bird and another unbanded pair were at the seep...no hostility among these birds but they kept apart from each other	nest kipuka and seep	20 Jan. 1959	(14)
706	Woodside: flushed pair near nest #2-58	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	20 Jan. 1959	(14)
707	Woodside w/ Bachman: no fresh droppings	along boundary flow cross-fence	22 Jan. 1959	(14)
708	Woodside: lots of fresh droppings at seep	nest kipuka and seep	22 Jan. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

709	Woodside: droppings trail led to and out of kipuka...found pair with a brood of 4 young about 3 weeks old on lava...herded them into channel and caught the young...Bachman caught the goose by hand using a young one as lure...banded young with black-and-white bands and the goose with a green band on left leg...released all goose and young...adults flew to seep...young also...but parents did not go to them...heard nene above and saw an additional 3 adults on the seep...very confusing...also another pair came to seep from the strawberry kipuka area...went above seep and flushed a lone bird which flew toward the Park...total of 3 pairs of adults, a single red-banded bird and the brood (which hid in a "cave") were on the seep when we left...	nest kipuka and seep	22 Jan. 1959	(14)
710	Woodside w/ Bachman: came upon a pair...female very heavy and "froze"...searched for nest and found 1 egg in nest #2-58...obviously the same pair renesting...removed sharp rock from nest without disturbing egg...nest renumbered #8-58...pair did not flush or see us at nest	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	23 Jan. 1959	(14)
711	HDFG: 1 egg found in deserted Nest #2 redesignated as Nest #8...goose never returned...thought to be a renesting attempt by the goose which deserted Nest #2	on edge of Park side of Kekekaniho, 6200 ft. el.	23 Jan. 1959	(14)
712	Woodside: lots of droppings on seep	nest kipuka and seep	23 Jan. 1959	(14)
713	Woodside: no droppings	strawberry kipuka	23 Jan. 1959	(14)
714	Woodside: a few recent droppings	Nick's nest kipuka (near strawberry kipuka)	23 Jan. 1959	(14)
715	Woodside: no droppings	along last kipuka after leaving strawberry kipuka	23 Jan. 1959	(14)
716	Woodside: no droppings found	on way over pahoehoe to luas (pits, craters)	23 Jan. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

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| 717 Woodside: number of droppings increased...came upon a gander on guard on pahoehoe-aa...flushed, flying about 100 yards...flushed a goose off a nest (#9-58) containing 3 eggs and down...nest very poor...sharp rocks protrude and one egg is badly cracked...when the female flushed the male joined her in the air and they landed nearby...the aluminum-banded pair was there already... | on hike down line of luas | 23 Jan. 1959 | (14) |
| 718 HDFG: 9th nest with 3 eggs being incubated when found under pukeawe on aa...all eggs cracked during incubation by lava in nest...1 egg "fly blown". | on Keawewai boundary,
5800 ft. el. | found 23 Jan.
1959
deserted early
Feb. | (22) |

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

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| 719 | HDFG: Nest #8 thought to be a renesting of goose which deserted Nest #2. It is possible that this bird completed its 2nd clutch elsewhere...the only other possibility of renesting was in Nest #9. This nest was located less than a mile from Nest #5, and the time interval between predation of Nest #5 and the date when the last egg was probably laid in Nest #9 was approximately 50 days. If this was the case of renesting and Nest #8 is ignored, then there were at least 7 pairs of nene nesting in the area. A total of 11 goslings hatched out of the 3 successful nests. Nests 2 and 4 were broken up early and it is possible that the birds of these nests attempted renesting but were never relocated...Only 3 brood observations, all thought to be the same brood, were made despite repeated searches. A brood of 4 young was seen near Nest Kipuka on January 20. The young were accompanied by three adults and were 3-4 weeks old. On January 22, this brood was banded with black and white plastic bands. The goose of the parents of this brood was also captured and banded with a green band. This goose was captured before it started to molt...On January 28, 2 of the above young were seen along with the green banded goose and a red-banded 2-year old. Later, on February 5, the green banded goose and an unbanded gander were seen but the brood could not be located...During February, 3 nene were seen on a small hill in the Saddle area approximately 20 miles from the Keauhou nesting grounds. It was thought that these were probably non-breeding one year old birds...No flightless birds were located and only an occasional dropped primary was found in the area. By May, practically all of the birds left the breeding grounds. | Keauhou Sanctuary | 1958-1959
nesting season | (22) |
| 720 | Woodside: no droppings | hike back around lower part of last kipuka and above ends of long kipukas | 23 Jan. 1959 | (14) |
| 721 | Woodside: aluminum banded pair was present at 4:30 p.m. | on lower seep | 23 Jan. 1959 | (14) |
| 722 | Woodside: green pair present at 5:15 p.m...acted as if they had hid their brood...flushed and flew downslope...searched for but could not find brood | on seep | 23 Jan. 1959 | (14) |

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

723	Woodside: saw pair from nest #8-58 on return hike to end of truck trail	near highest koas	23 Jan. 1959	(14)
724	Woodside: saw green female and red banded male with 2 black and white banded young...did not disturb	at edge of seep (reached by exploring mauka of Kekekaniho trailhead for extension of jeep road...3.2 miles of ranch road from Park road to end of Kekekaniho)	28 Jan. 1959	(14)
725	Woodside: no birds...looked for (?location of) release pen area	lower seep	28 Jan. 1959	(14)
726	Woodside: saw one lone bird fly to lower seep	lower seep	28 Jan. 1959	(14)
727	Woodside: checked nest #8-58...1 egg...nest unchanged...took egg	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	2 Feb. 1959	(14)
728	Woodside: went up to the "last year's" nest of this pair...saw male on lava about 50 ft. from "last year's" nest...circled it...no sign of nest or female until I approached the male, then female came out of a small pukeawe-ohelo clump and both flew...looked unsuccessfully for nest...but they may have on here	(boundary flow about 1 mile above nest #2-58)	2 Feb. 1959	(14)
729	Woodside: no birds on seep	(nest kipuka) seep	2 Feb. 1959	(14)
730	Woodside: no birds	lower seep	2 Feb. 1959	(14)
731	Woodside w/ Lee: no fresh droppings	at lower seep (hiked over from end of Kekekaniho road)	5 Feb. 1959	(14)
732	Woodside: Ah Fat (Lee) heard then flushed 1 pair (green banded female, unbanded male)	from edge of a kipuka reached by hike from vicinity of nest #4-58 and up to the nest 3 kipukas	5 Feb. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

733	Woodside: no fresh droppings	strawberry kipuka	5 Feb. 1959	(14)
734	Woodside: hiked below last kipuka to nest #9-58...goose on nest (flushed)...gander in a depression nearby...1 egg badly cracked, dented—other two have small round cracks...pair circled and landed below on the lava	along line of luas	5 Feb. 1959	(14)
735	Woodside: some droppings found	continuing hike up the line of luas	5 Feb. 1959	(14)
736	Woodside: 1 unbanded pair...flushed and went toward seep	upper end of nest kipuka	5 Feb. 1959	(14)
737	Woodside: some droppings on seep	(nest kipuka) and seep	5 Feb. 1959	(14)
738	Woodside: Ah Fat flushed 1 aluminum-banded bird	lower seep	5 Feb. 1959	(14)
739	Woodside: no droppings found	on hike from end of truck trail over and up to corner of boundary and drift fence	6 Feb. 1959	(14)
740	Woodside: saw 2 nene...no bands...goose heavy but "dirty" about the vent...flushed them...they flew south and landed on the south side of Maunaloa trail...unsuccessful search for nest but found droppings scattered along edge of kipuka and heavily out on the vegetation and boundary flow	on lava at head of boundary kipuka reached by crossing over corner of fence and heading toward boundary flow	6 Feb. 1959	(14)
741	Woodside: checked area of "last year's nest 2-58"...no birds...few recent droppings	(boundary flow about 1 mile above nest #2-58)	6 Feb. 1959	(14)
742	Woodside: the 2 aluminum-banded birds and the "green pair" were on the highest part of the seep...no brood	(nest kipuka) and seep	6 Feb. 1959	(14)
743	Woodside: no droppings	nest kipuka	6 Feb. 1959	(14)
744	Woodside: no droppings found	on hike over and up to koa log kipuka	6 Feb. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

745	Woodside: no birds seen...nest #2-58	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	6 Feb. 1959	(14)
746	Woodside: checked nest #9-58...pair away...took 1 fly-blown egg...nest appears deserted...however underside of the eggs "seem warm" ...fly-blown egg contains a large feathered embryo with about a 3 / 16 inch pole in one end...no fresh droppings near nest...waited from 3:00 to 4:00 p.m. but there was no sign of birds...	explored Ranch roads from ranch-house to Keawewai (most are blocked by fallen trees)...hiked to nest #9-58 (from jeep parked at Keawewai) located along line of luas	17 Feb. 1959	(14)
747	Woodside: no birds	lower seep (reached after searching about the end of Kekekaniho jeep trail for likely cabin sites)	20 Feb. 1959	(14)
748	Woodside: no sign	nest kipuka	20 Feb. 1959	(14)
749	Woodside: flushed the aluminum-banded pair...joined in the air by a single bird...all circled and landed about 400 yards down flow	upper seep	20 Feb. 1959	(14)
750	Woodside: a pair came flying in from the direction of strawberry kipuka...the 3 above-mentioned birds took off, joined them, then all five circled and landed in the same area...the aluminum pair, the "green pair" and a yellow-banded bird..	on hike (from nest kipuka) toward nest #6-58	20 Feb. 1959	(14)
751	Woodside: no sign at nest #2-58	about 6,000 ft. el. in small kipuka nearest boundary (aa) lava flow on southern edge of Kekekaniho in a northerly direction from the corner of the "stonewall trail"	27 Feb. 1959	(14)
752	Woodside: some very fresh droppings at "last year's 2-58 nest"...but no birds	(boundary flow about 1 mile above nest #2-58)	27 Feb. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

753	Woodside: found few droppings	on hike from "last year's 2-58 nest" over and down to seep	27 Feb. 1959	(14)
754	Woodside: nest #9-58 deserted...took the 2 eggs	on hike from seep to nest #5-58 and down around last kipuka along line of luas	27 Feb. 1959	(14)
755	Woodside: some recent droppings	strawberry kipuka	27 Feb. 1959	(14)
756	Woodside: saw 4, aluminum pair and "green pair"...flushed and landed on lava ridge	on edge of 3rd long kipuka reached by hiking from strawberry kipuka to Nick's nest kipuka and on down toward lower seep	27 Feb. 1959	(14)
757	Woodside: no fresh droppings seen	on hike down through red brood kipuka to lower seep	27 Feb. 1959	(14)
758	Woodside: no fresh sign	left cabin after working on windows, etc. and went over to lower seep	11 Mar. 1959	(14)
759	Woodside: no fresh sign	went on over to nest kipukas and up along "red brood ridge" and over to nest kipuka	11 Mar. 1959	(14)
760	Woodside: some fresh sign at "seep"	(nest kipuka) and "seep"	11 Mar. 1959	(14)
761	Woodside: no fresh sign	spent last night at cabin...went up to boundary flow and crossed at stone wall...checked for nene along Park side of flow of boundary kipuka—corner of crossfence	17 Mar. 1959	(14)
762	Woodside: some fresh (1-day old) droppings along flow	cut over to Kekekaniho edge of flow and went down along flow to upper koa trees	17 Mar. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

763	Woodside: dry-old droppings	in caves at "seep"	17 Mar. 1959	(14)
764	Woodside: 1 noisy pair flew over cabin from	strawberry kipuka to the boundary flow where they seem to have landed	17 Mar. 1959	(14)
765	Woodside w/ Woodworth: no fresh sign	lower seep	9 Apr. 1959	(14)
766	Woodside: Dick saw fresh droppings indicating roosting in grassy spot	just below strawberry kipuka	9 Apr. 1959	(14)
767	Woodside: no real fresh sign	hiked from below strawberry kipuka above last kipuka and then back to nest kipuka and seep	9 Apr. 1959	(14)
768	Woodside: lots of fresh sign	small seep above nest kipuka	10 Apr. 1959	(14)
769	Woodside: fresh sign at seep	nest kipuka and seep	10 Apr. 1959	(14)
770	Woodside: pair of unbanded adults...flushed them...droppings indicate no roosting but much use by a pair	on lower seep	10 Apr. 1959	(14)
771	Woodside: some fresh droppings..no feathers	along feeding area above nest #2-58 (boundary flow area)	16 Apr. 1959	(14)
772	Woodside: fresh to old droppings in all likely places, especially in shelter of caves, etc...lots of small contour feathers	pahoehoe ridge above nest #2-58	16 Apr. 1959	(14)
773	Woodside: found a few very fresh droppings and thought I heard nene	hike over ohia kipuka to edge of nest kipuka flow	16 Apr. 1959	(14)
774	Woodside: very little nene sign in the area...no real fresh droppings anywhere except near Yap's tree a few "few-days old", left cabin at 12:00...went over to lower seep and on across top of long kipukas to strawberry kipuka	then over to Yap's tree and down the line of caved-in tube holes (luas) on Keawewai flow to below last kipuka...cut back below long kiupkas 5,4,3, then up between 1st and 2nd long kiupkas to seep and back to cabin...slept at cabin...	21 Apr. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

775	Woodside w/ Lee: no droppings in likely places	left cabin and went up to seep and nest kipuka and then on up main flow to upper end of Kekekaniho	22 Apr. 1959	(14)
776	Woodside: some rather recent droppings found on edge of kipuka above nest #2-58 in long otherwise fruitless search	hike around last trees above Kekekaniho and down the pahoehoe north of the boundary flow...continued on down to Bates trail and cabin checking the caves on the pahoehoe and edge of kipuka	22 Apr. 1959	(14)
777	Woodside: Ah Fat found 6 secondaries and old droppings	in a small cave on lava above nest #2-58	22 Apr. 1959	(14)
778	Woodside w/ Breese and Johnston: no recent sign	lower seep	26 Apr. 1959	(14)
779	Woodside: no sign	nest kipuka and seep	26 Apr. 1959	(14)
780	Woodside: fresh droppings only at upper seep	checked area from lower seep to strawberry kipuka back to nest kipuka and down to cabin	26 Apr. 1959	(14)
781	Woodside w/ Kimo: lots of roosting sign on seep...waited on seep from 4:30 to 6:30 p.m...no birds came	went up boundary flow to nest #2-58 and above to feeding area...cut over Kekekaniho to seep and nest kipuka and down to lower seep	17 June 1959	(14)
782	Woodside: no recent sign after short search	lower seep, nest kipuka and seep, nest #2-58 area	24 June 1959	(14)
783	HDFG: at least one...possibly more...returned to the nesting area...repeatedly all through the summer	lands of Keauhou	1 July 1958-30 June 1959	(22)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

784	HDFG: pattern...whereby practically all of the wild nene on Hawaii	nest in the Keauhou area and move north and west into the Saddle area and Mt. Hualalai during the summer was repeated this past year	1 July 1958-30 June 1959	(22)
785	HDFG: again used the pattern of nesting	in the Keauhou area at about 6,000 ft.	1 July 1958-30 June 1959	(22)
786	HDFG: practically all of the 40 to 50...nest...	in the upper Keauhou area on Mauna Loa	1 July 1958-30 June 1959	(22)
787	HDFG: activity increased during October...7 plus 2 banded as goslings the previous year returned by November	Keauhou	1 July 1958-30 June 1959	(22)
788	HDFG: 8 active nests found	Keauhou (plus 1 active nest in adjacent Hawaii National Park)	1 July 1958-30 June 1959	(22)
789	HDFG: 9 wild nene nests	in and around the Keauhou Sanctuary area (inc. 1 in HAVO NP)	1 July 1958-30 June 1959	(22)
790	HDFG: only one brood and no flightless birds were found	Keauhou nesting area	1 July 1958-30 June 1959	(22)
791	HDFG: practically all...had left (Keauhou) nesting area	by May (1959)	(22)	
792	Woodside: no recent sign after short search	lower seep, nest kipuka and seep, nest #2-58 areas	13 July 1959	(14)
793	Woodside: no recent sign after short search	lower seep, nest kipuka and seep, nest #2-58 areas	20 July 1959	(14)
794	Woodside: no recent sign after short search	lower seep, nest kipuka and seep, nest #2-58 areas	26,27 July 1959	(14)
795	Woodside: no recent sign after short search	lower seep, nest kipuka and seep, nest #2-58 areas	6,7 Aug. 1959	(14)
796	Woodside: no sign of nene visiting	complete search of Keauhou Sanctuary from Park boundary to Keawewai	27,28 Aug. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

797	Woodside: no droppings seen	from Park boundary side of Kekekaniho to nest #2-58, over to nest 1-58 (in Park) up to corner of goat drift fence and over and back into (Keauhou) Sanctuary to "last year's nest #2-58"	18 Sept. 1959	(14)
798	Woodside: flushed 1 pair...very few droppings indicate recent return of this pair	from near the pilo tree before cutting over across Kekekaniho to seep (near nest kipuka)	18 Sept. 1959	(14)
799	HDFG: birds began to return	Keauhou Sanctuary	by Sept. (1959)	(22)
800	Woodside: no birds but a few fresh droppings	at seep (near nest kipuka)	18 Sept. 1959	(14)
801	Woodside: a few fresh droppings (3-4 days old)	at lower seep	18 Sept. 1959	(14)
802	Woodside: no birds seen, droppings only at seep and Park edge of lava	after unloading construction materials for release pen) searched for nene at lower seep, nest kipuka area and last year's nest #2-58	30 Sept. 1959	(14)
803	Woodside: no birds seen but week-old droppings plentiful on seep and a few on lower seep	checked lower seep, nest kipuka and main seep	7 Oct. 1959	(14)
804	Woodside: checked for nene...nbn sign	boundary flow and Park area near nests #1-58 and #2-58	27 Oct. 1959	(14)
805	Woodside: none seen...droppings all old (2 weeks plus) and dried up	from seep and lower seep to Keawewai flow	28 Oct. 1959	(14)
806	Woodside: saw 1 pair unbanded; female not heavy...did not flush	at edge of last kipuka near strawberry kipuka	11 Nov. 1959	(14)

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PUU ULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

807	Woodside: fresh droppings	at lower seep and at all usual places to strawberry kipuka...at peperomia kipuka (see overlay) and up the line of lava to Yap's tree	11 Nov. 1959	(14)
808	Woodside: flushed 1 male...searched for nest but apparently none	near last year's nest #6-58	29 Nov. 1959	(14)
809	Woodside: flushed 1 male...probably same one flushed yesterday	red band ridge	30 Nov. 1959	(14)
810	Woodside: no droppings	nest kipuka	9 Dec. 1959	(14)
811	Woodside: no droppings	near nest #2-58	9 Dec. 1959	(14)
812	Woodside: searched for nene...none seen...not many fresh droppings	on lava from lower seep up red band ridge, nest kipuka to seep and down	16 Dec. 1959	(14)
813	Woodside: flushed 1 female	west side of nest kipuka	30 Dec. 1959	(14)
814	Woodside: pair (unbanded male, red banded female) seen...female not heavy but late in flushing	amongst the ohelo-pukeawe (scrub) about 100 yards from nest kipuka	30 Dec. 1959	(14)
815	Woodside: fresh droppings	koa long kipuka	30 Dec. 1959	(14)
816	Woodside: saw pair (green banded female, red banded male)...did not flush...female not heavy	on lava near last year's nest #7-58	30 Dec. 1959	(14)
817	Woodside: 1 pair flew over...red and green pair still visible	on hike down to yellow-band kipuka	30 Dec. 1959	(14)
818	Woodside: saw a pair...too far to see bands	on seep between yellow-band and nest kipuka	30 Dec. 1959	(14)
819	Woodside: 1 aluminum-banded male circled and landed...flushed, then joined by another nene...both then flew to lower seep...neither banded	on the seep	30 Dec. 1959	(14)
820	Woodside: saw 1 unbanded pair and 1 pair (male with aluminum band, female with no band)	lower seep	30 Dec. 1959	(14)

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PUUULAULA [Keauhou Nene Sanctuary, adjacent to Hawaii Volcanoes National Park] (Cont.)

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|-----|---|--|------------------------------|------|
| 821 | Woodside: saw 1 pair (red-banded female and unbanded male)...did not flush | on lava between nest kipuka and lower seep during longer search on Park side of Sanctuary and above cabin in Kekekaniho and from nest kipuka down to red band ridge and lower seep | 9 Dec. 1959 | (14) |
| 822 | Woodside: mapped location of fresh droppings found | in strawberry kipuka | 26 April 1960 | (14) |
| 823 | Woodside: mapped location of 5 freshly moulted primary feathers found | large kipuka NE and adjacent to strawberry kipuka | 26 April 1960 | (14) |
| 824 | HDFG: By September birds began to return...however unusual dryness and perhaps a dense volcanic haze, which lasted for about a month during January, seemed to disrupt nesting activity...no active nests located but 3 nests which had hatched or were destroyed were found...3 broods, 2 containing 2 young and 1 with a single young, were observed...banding not possible...the latter brood (2 adults and 1 gosling) was captured...taken to Pohakuloa...for breeding stock...20 young nene produced at Pohakuloa were placed in a 1-acre release pen in Keauhou Sanctuary in March and April...By the end of May all had left the pen and no longer returned to feed and water in it...at least 14 released birds remained in the vicinity of the pen during June...they were observed feeding on all of the native wild nene food plants and on one occasion were seen with 7 wild nene... | Keauhou Sanctuary | 1 July 1959-
30 June 1960 | (23) |

For history of HDFG Nene restoration in Keauhou Sanctuary 1959/60 to 1987/88 see Hawaii State Restoration Program, Part II.

KULANI

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|-----|---|--------------|--------|
| 825 | Elder: Shipman: often seen on trail; his father frequently shot 1 or 2 for family use / Keauhou Ranch | 1901 | (1) |
| 826 | A. Wall: flocks / above Waiakea (?Camp) | early 1900's | BALP45 |

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KULANI (Cont.)

827	D. Paris: saw flocks / Keawewai, a water hole...about 5 miles to the northeast of the Park	early 1900's	BALP45
828	Elder: Kimi (age 65 in 1956): flushed 12 / on Keawewai Pond (then an extension of Kapapala Ranch)	1924	(1)
829	Donaghho: Ranger Christ and Bryan reported nene nearly always seen / Keawewai	June-Aug. 1937	(4)
830	saw 6...considerably more wary than flock of 8 / in hike along Puu Oo trail above Keawewai toward Mauna Kea	12 Sept. 1937	DONW51c
831	saw 2 / further along Puu Oo trail above Keawewai, past open pastures, on hike toward Mauna Kea	12 Sept. 1937	DONW51c
832	Elder: Wingate (Park Superintendent): recalled sightings / 5000-7000 ft. and above Keawewai	1935-1938	(1)
833	Bryan: seen / toward Kilauea from Aina Hou...on the south side of the lava flow of 1852 along the Puu Oo-Volcano trail	1930's	BALP45
834	NPS: small flock seen / Keawewai	27 July 1940	(5)
835	Elder: Bryan: always seen when horses were token / where the Puu Oo trail crosses the 1852 lava flow	June and Sept. 1926-1940	(1)
836	Baldwin: found no droppings or other signs of use at waterhole...no adults seen / hike from end of Mauna Loa Strip Road to Keawewai waterhole and return	6 Aug. 1941	(7)
837	ranchers encountered a small flock and told of seeing others / Keawewai, a waterhole...about 5 miles to the northeast of the Park	July 1940-1944	BALP45
838	Elder: Forbes: saw several flocks, up to 11 (birds) / along Puu Oo trail from Keawewai Camp to Puu Kipu	1937-1947	(1)
839	Elder: HDFG: Wordworth: 1 illegally-captured nene seized / Waiakea Forest Reserve near Puu Oo trail and 1852 lava flow (See also No. 443)	30 Oct. 1949	(1)
840	Elder: HDFG: Wordworth: Bryan and Ah San saw 2 / Puu Oo trail near 1942 lava flow	24 Jan. 1950	(1)
841	Elder: Ah San and Bryan (from State Forestry daily ranger reports): saw 2 / 2 miles south of 1942 lava flow on Puu Oo trail	24 Jan. 1950	(1)

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KULANI (Cont.)

842	Elder: Paiva: saw 14 flying / toward Hawaii (Volcanoes) National Park from Keawewai	1952	(1)
843	Elder: Paiva: saw 14 flying / toward Hawaii (Volcanoes) National Park / Keawewai	1953	(1)
844	Elder: Manaupo via T. Lindsey: young were always raised on hill / Kipuka Nene (near Keawewai)	(unspecified date prior 1956 interview)	(1)
845	Elder: T. Lindsey: frequently flew over camp / Keawewai	(unspecified date prior 1956 interview)	(1)
846	Elder: Kahakua: saw 2 / ca. 1 mile above Keawewai	(unspecified date prior 1956 interview)	(1)
847	Elder: HDFG: Woodside and Lee: 12 seen / 1852 Lava Flow camp	8 Aug. 1959	(1)
848	Elder: McKenzie: saw 2 or 3 flying over / from Keawewai Camp towards Bates Camp	20 Dec. 1956	(1)
849	Elder: Paiva: saw 2 / Puu Oo trail, above Keawewai	Feb. 1957	(1)
850	Elder: Paiva: saw often / Puu Kipu waterhole	1952-1957	(1)
851	HDFG: ...a dead nene was reported by a pig hunter who brought in a red plastic band which he claimed to have removed from the carcass found in the Upper Waiakea Forest Reserve, stating that there was an identical band on the other leg...efforts to locate this dead nene failed...it was released at Keauhou in April 1961 and was last seen at the edge of Kipuka Kekekaniho, due west of the cabin, with its mate, an unbanded gander... / Upper Waiakea Forest Reserve	1 July 1965-30 June 1966	(29)
852	Conant: less than 1 bird per 40 ha. 31% occurrence frequency on monthly censuses, Kilauea Forest Reserve (Transect 92)	Dec. 1972-July 1973 Aug. 1974-Mar. 1975	(86)
853	Conant: (0) nene seen on monthly censuses, Kilauea Forest Reserve (Transect 91)	Dec. 1972-July 1973 Aug. 1974-Mar. 1975	(86)
854	Conant: Carpenter and MacMillan (pers. comm.): observed a flock of about 15 banded nene several times weekly...usually feeding in pastures in the late afternoon...In addition to this flock...which I (Conant) saw several times, I occasionally saw single pairs of birds feeding in pastures or near watering holes for cattle above ca. 1400 m. on Keauhou Ranch...near Keawewai Camp	July, Aug. 1974	(86)
855	6 censused, Christmas Count / Kulani Project, Transect 28 mauka (towards the mountain)	2 Jan. 1978	KATL78

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KULANI (Cont.)

856	2 seen, Christmas Count / Kulani	3 Jan. 1987	WILJ87
857	2 seen / Kulani Correctional Facility	23 Nov. 1987	PYLR88d

Hawaii Volcanoes National Park

UNDESIGNATED LOCALITY

858	Elder: Kimi: (age 65 in 1956): never saw Nene in Hawaii (Volcanoes) National Park	(1914-1930)	(1)
859	Elder: Konanui (old resident of Puna who travelled across Puna lowlands to Kau around 1894): Nene were plentiful above the inshore cliffs around 1,500 to 2,000 feet, but not on the flats which line the shore / seen as far to the east as Panau	(ca. 1894)	BALP45
860	though I saw none I was informed...numbers have apparently dwindled to 6 / on Mauna Loa in the National Park	May 1940	DONW40
861	Donaghho, P. Baldwin: about a dozen...seen from time to time...in flocks of two to five individuals / around the Park...most commonly...between the elevations of 6500 to 7500 feet on Mauna Loa but occasionally at lower elevations	recently (1940)	BALP41
862	a group of 12 and 5 seen / Hawaii (Volcanoes) National Park	1 April 1949	BAKJ51
863	group of 5...reported seen by Park Superintendent / Hawaii (Volcanoes) National Park	(1949)	SMIJ52
864	7 photographed / 6,200 feet elevation in Hawaii (Volcanoes) National Park	1 June 1951	BAKJ51
865	Elder: F. Waltjen: never saw Nene during 13 years employment / Hawaii (Volcanoes) National Park	(1944-1956)	(1)
866	HDFG: One goose from the Hawaii Volcanoes National Park was observed at the self-feeder in the Kahuku nene sanctuary: it was paired with an unbanded gander. This pair was last seen by National Park personnel / in Kapapala Ranch	1 July 1986- 30 June 1986	(93)

KIPUKA PAKEKAKE

867	mountain geese shot / ca. 6,071+ ft. el., Kilauea-Mauna Loa summit route	Dec. 1840	WILC45
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**Island of Hawai'i
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KIPUKA PAKEKAKE (Cont.)

868	(unsuccessful search) / hiked with others from end of Mauna Loa truck trail south to Kipuka Kaunaiu (Maunaiu)	20 July 1937	DONW51
869	Donaghho: found 8...thought to be found only in captivity before discovery in 3-Trees Kipuka	21 July 1937	(4)
870	Craddock: saw flock of 8 / in a small valley in kipuka about a half mile south from the end of the Mauna Loa truck trail (ca. 6,400 ft. el.)	21 July 1937	(13)
871	8 seen / small grassy kipuka barren except for 3 ohia...christened 3-Trees Kipuka	21 July 1937	DONW51a
872	Craddock, Donaghho: saw flock of 8 / 3-Trees Kipuka, 1/4 mile west Kipuka Kulalio, 6,250 ft. el.	21 July 1937	BALP45
873	nene found / 3-Trees Kipuka	22,23,26 July 1937	DONW51a
874	NPS: flock of 8 discovered / on the slopes of Mauna Loa (Hawaii National Park)	July 1937	(5)
875	Elder: Craddock: took 8 pictures of 8 nene / 3-Trees Kipuka	July 1937	(1)
876	Donaghho: found fresh droppings / 3-Trees Kipuka	30 Aug. 1937	(4)
877	saw five in eastward flight / Kipuka Kulalio...6,250 ft. el.	25 Aug. 1938	BALP45
878	NPS: flock of 6 seen / Mauna Loa trail	Setp. 1938	(5)
879	Baldwin: no droppings found / 3-Trees Kipuka	27 Nov. 1938	(7)
880	Baldwin: found only old...feces / 3-Trees Kipuka	6 Feb. 1939	(7)
881	Baldwin: found many feces, old and moderately recent; some weeks old, possibly... / 3-Trees Kipuka	6 July 1939	(7)
882	NPS: five seen flying / at the end of the Mauna Loa Truck Trail (Strip Road)	7 July 1939	(5)
883	Schulz: saw 5 flying at 400-500 ft. / Kipuka Kulalio, 6,700 ft. el.	7 July 1939	BALP45
884	Elder: Kaawaloa: frequently saw bunches up to 12 flying at 6500 ft. el. / Mauna Loa truck trail	CCC days (late 1930's or early 1940's)	(1)
885	saw flock of 3 on 3 days / 3-Trees Kipuka, 1/4 mile west Kipuka Kulalio, 6,250 ft.	Apr. 1940	BALP45
886	saw flock of 2 on 2 days, 1 on 1 day / 3-Trees Kipuka	May 1940	BALP45

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KIPUKA PAKEKAKE (Cont.)

887	saw flock of 3...and flock of 8 in flight / at 6,500 ft. and...6,000 ft. respectively, Kipuka Kulalio	16 June 1940	BALP45
888	NPS: none seen on frequent visits / 3-Trees Kipuka	(July 1940)	(5)
889	NPS: none found on several searches / upper end of Kipuka Kulalio, altitude 7,500 ft	(July 1940)	(5)
890	small flock in underbrush / Kipuka Kulalio, 6,700 ft.	31 July 1940	BALP45
891	saw 2/3-Trees Kipuka	22 Oct. 1940	BALP45
892	NPS: 2 observed / 3-Trees Kipuka	22 Oct. (1940)	(5)
893	2 roosted during the night / 3-Trees Kipuka	27 Nov. 1940	BALP45
894	small flock roosts regularly winter and spring...dwindling from 8 to 2 individuals since 1937 / 3-Trees Kipuka...6,250 ft. el.	(1937-1940)	BALP45
895	abundance of signs indicates heavy use by nene in May after little use in previous months / 3-Trees Kipuka	June 1941	BALP45
896	Baldwin: found droppings / between 6,250-6,500 ft. el. near the lower end of a pahoehoe strip east of the 1881 (1880) flow, near west (south) Park boundary	21 July 1941	(7)
897	few signs indicate light use during October...first since May / 3-Trees Kipuka	Oct. 1941	BALP45
898	NPS: one found / 3-Trees Kipuka	28 Nov. 1941	(5)
899	1 seen / 3-Trees Kipuka	28 Nov. 1941	BALP45
900	NPS: evidence of limited use found / 3-Trees Kipuka	Dec. 1941	(5)
901	1 flushed from ohelo shrubs / Kipuka Kulalio, 6,800 ft.	18 Dec. 1943	BALP45
902	2 flushed...circled to higher elevation / Kipuka Kulalio, 6,500 ft. el.	13 Jan. 1944	BALP45
903	NPS: 2 seen on 3 days / just above or below the end of the Mauna Loa truck trail	19 Jan. 1944	(5)
904	Elder: B. Sumner: saw 3 at 10 a.m. / Kipuka Maunaiu, 5,500 ft. el.	1946	(1)
905	NPS: droppings found / 3-Trees Kipuka	(Oct. 1947)	(5)
906	NPS: 5 seen / Kipuka Maunaiu	(Apr. 1949)	(5)

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KIPUKA PAKEKAKE (Cont.)

907	2 goslings and 1 adult seen / near the eastern boundary of the National Park	1950	SMIJ52
908	3 reported / near the eastern boundary of the National Park at the 6,500 ft. level	May 1951	SMIJ52
909	NPS: 7 seen / near the end of the Mauna Loa truck trail	5 June (1951)	(5)
910	photographed / 3-Trees Kipuka	7 June 1951	ANON52
911	flock of 7 seen / near the eastern boundary of the National Park at the 6,500 ft. level	June 1951	SMIJ52
912	Elder: "Tony" (A.B.) Medeiros: seen (no. not recorded) / 3-Trees Kipuka	1952	(1)
913	Elder: Forbes: 1 adult with 1 young seen recently / at 6,500 ft. el., Mauna Loa horse trail	8 Oct. 1956	(1)
914	Woodside: saw 6 nene flying low / across truck trail (below last bend) from 3 trees (Kipuka) toward nest kipuka (Keauhou Sanctuary); seemed to stop before lava flow (Park boundary); very noisy—circled to look at me. Went to end of road, left truck, walked over toward lava—searched fruitlessly for the 6 nene with binoculars then found them—2 adults with 4 unbanded young...watched them till they flew down the lava flow and north out of sight as if to go to the "Flat" seep below nest kipuka	28 Apr. 1957	(14)
915	Woodside: Takata: found gander and "very heavy" hiding goose, nest with 2 warm eggs...same place where 2 parents and 4 young seen on 2 occasions 2 years ago	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	20 Nov. 1958 (14)
916	Woodside w/ Walker: visited nest #1-58...3 eggs covered and cold...saw pair standing on the boundary lava flow where the trail and stone wall go on to it at 12:10 p.m...did not disturb them...did not see pair or go near nest #1-58 on return to jeep at 5:30 p.m.	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	23 Nov. 1958 (14)
917	Woodside: checked nest #1-58...gander on guard about 5 yards from nest...goose on nest...5 eggs with lots of down...incubation starts today	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	25 Nov. 1958 (14)

**Island of Hawai'i
Hawaii Volcanoes National Park**

KIPUKA PAKEKAKE (Cont.)

918	Woodside: checked nest #1-58...gander on guard...did not disturb them	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	29 Nov. 1958	(14)
919	NPS: Woodside: nest found	near the upper terminus of the Mauna Loa Strip Road	Nov. 1958	(5)
920	Woodside: checked nest #1-58...gander on guard...goose on nest	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	2 Dec. 1958	(14)
921	Woodside w/ Woodworth: checked nest #1-58...gander on guard, presume goose on nest...did not disturb	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	4 Dec. 1958	(14)
922	Woodside: checked nest #1-58 at 1:50 p.m...gander on guard...goose presumed to be on nest...did not disturb	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	6 Dec. 1958	(14)
923	Woodside: gander on guard at nest #1-58 when checked again at 5:50 p.m.	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	6 Dec. 1958	(14)
924	Woodside w/ Lee: checked nest #1-58...gander on guard...did not disturb	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	9 Dec. 1958	(14)

**Island of Hawai'i
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KIPUKA PAKEKAKE (Cont.)

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|-----|--|--|--------------|------|
| 925 | Woodside: checked nest #1-58...goose on nest, gander not seen...did not disturb the goose | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 11 Dec. 1958 | (14) |
| 926 | Woodside: met Dummire at 6 p.m. walking up truck trail to end...reported finding no nene or droppings in hike from 12:30 to 6 p.m. | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 11 Dec. 1958 | (14) |
| 927 | NPS: none found...3-man search | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 16 Dec. 1958 | (5) |
| 928 | Woodside: checked nest #1-58...goose on nest, gander near...did not disturb | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 17 Dec. 1958 | (14) |
| 929 | Woodside: checked nest #1-58...gander on guard...did not disturb | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 20 Dec. 1958 | (14) |
| 930 | Woodside: checked nest #1-58 at 2:35 p.m...goose on nest, gander not seen...checked again at 5:45 p.m., gander on guard | in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall | 23 Dec. 1958 | (14) |

**Island of Hawai'i
Hawaii Volcanoes National Park**

KIPUKA PAKEKAKE (Cont.)

931	Woodside: checked nest #1-58...pair away...no eggs or fragments in nest...found 5 shells about 4 ft. way under a thick mat of grass and pukeawe branches...eggs opened and contents eaten...all were fertile and 1 contained considerable yellow yolk...must have been mongoose...trail from the nest to spot where eggs were eaten was too low for cat...eggs had been taken from nest before pipping or at onset of pipping...took egg shells and nest	in Hawaii National Park at about 6000 ft. el. about 10 minutes hike from end of truck trail; nest located about 100 yards south of Boundary flow and about 100 yards mauka of stone wall	28 Dec. 1958	(14)
932	NPS: 1 nest discovered	on rough aa lava less than 1/4 mile NE of the shelter at the end of the Mauna Loa Strip) road, 6600 ft. el.	Dec. 1958	(5)
933	Woodside: found many recent droppings	along the flow below fence which cuts into the Park above nest #1-58	9 Jan. 1959	(14)
934	Woodside: checked for droppings...no fresh ones	in Park along boundary flow	20 Jan. 1959	(14)
935	HDFG: 2 nests located, both of which appeared to have hatched out young...1 brood banded	Keauhou, including adjacent Kapapala in the Park	(1957-58 breeding season)	(10)
936	NPS: pair seen	(near end of Mauna Loa Strip road)	Feb. 1959	(5)
937	NPS: one of the few places that wild birds were seen during the breeding season	3-Trees Kipuka	(1959-1960)	(5)
938	occasionally seen	on the slopes of Mauna Loa usually between 6,000 and 7,000 ft. (along Mauna Loa trail)	(1961)	DUNW61
939	occasionally seen	on the slopes of Mauna Loa (vicinity Kilauea) usually between 6,000 and 7,500 feet	(1961)	VANC73

**Island of Hawai'i
Hawaii Volcanoes National Park**

KIPUKA PAKEKAKE (Cont.)

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|-----|---|---|------------------------------|------|
| 940 | HDFG: ...the blue-banded goose and 7 other nene were sent to Maui for release in July...the blue-banded goose returned to Pohakuloa in January with a gander, presumably from the Maui release...this pair was caught and released at Keauhou...in February this pair had established a nest at 3-Trees Kipuka...2 of the 3 eggs laid was hatched in March...both goslings inherited the hairy-down characteristics of the goose...this family remained in this kipuka until the goslings and adults attained flight after their annual molt... | 3-Trees Kipuka | 1 July 1964-
30 June 1965 | (28) |
| 941 | NPS: 1 seen | on the strip Road at about 6,000 ft. | 10 Oct. 1965 | (5) |
| 942 | HDFG: ...follow-up surveys of previous releases (in Keauhou Sanctuary) were continued...these indicate concentrations of nene...at one of the small kipukas near 3-Trees Kipuka a pair of wild nene were observed to seek cover when an airplane flew overhead...the aircraft was at a considerable altitude, but its noisy progress was quickly detected by the wild nene at which time they hid under a bush...assuming this evasive action is normal...the use of aircraft to locate nene will be ineffective...this inference is reinforced by another instance in which the sound of an approaching jeep caused a pair of wild nene to seek shelter under a bush...the only effective method of nene surveys would be those conducted by personnel on foot | 3-Trees Kipuka | 1 July 1956-
30 June 1966 | (29) |
| 943 | HDFG: 4 eggs in nest...last seen 30 Nov...check on 12 Dec. revealed 3 hatched and departed nest...parents unbanded... | 500 yds within National Park (adjacent Keauhou Sanctuary) | 21 Nov. 1966 | (30) |
| 944 | HDFG: 3 1-week old goslings...one parent with aluminum band...reported by NPS employee... | 50 ft. from fence line above 3-Trees Kipuka | 1 Dec. 1966 | (30) |

**Island of Hawai'i
Hawaii Volcanoes National Park**

KIPUKA PAKEKAKE (Cont.)

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|-----|---|---|------------------------------|------|
| 945 | HDFG: 1 2-week old gosling by unbanded parents...reported by NPS employee... | 3-Trees Kipuka | 2 Dec. 1966 | (30) |
| 946 | HDFG: skeleton of unbanded adult nene found | aa lava flow near 3-Trees Kipuka | 1 July 1968-
30 June 1969 | (32) |
| 947 | HDFG: ...Evidence of nene utilization consisted of sparsely scattered old droppings and feathers...indicating continued use by nene... | searched Park to the west and south of Keauhou Sanctuary | 1 July 1971-
30 June 1972 | (51) |
| 948 | HDFG: on 26 January, a nest was discovered by park ranchers on the Kapapala boundary of the National Park. The parents were both banded birds and were incubating 2 eggs. A third egg was cold as it had rolled out of the nest. It was retrieved and taken to Pohakuloa where it failed to germinate after incubation. One egg from this nest hatched successfully and the second egg was infertile. | National Park on Kapapala boundary | 1 July 1972-
30 June 1973 | (36) |
| 949 | HDFG: 4 eggs being incubated...no parents at nest...when checked on 26 Dec. gander identified as Keauhou 1971 release...goose sneaked off...on 9 Jan. 1975 only 1 egg had hatched out...fully developed goslings died in 2 eggs and 1 egg was fertile but addled... | nest in dense kipuka on National Park side of Kekekaniho kipuka | 18 Dec. 1974 | (38) |
| 950 | HDFG: summary of nests and broods found: | National Park Strip Road area | 1 July 1975-
30 June 1976 | (40) |

Nest or Brood No.	Gander	Goose	Date Seen	Location / Observation
22	Keauhou 1971	unbanded	6 / 16 / 76	parents seen with 1 gosling near Keauhou Ranch fenceline...
23	Keauhou 1971	Ainahou 1974	6 / 16 / 76	parents seen along the Mauna Loa strip road...3 goslings able to fly...

**Island of Hawai'i
Hawaii Volcanoes National Park**

KIPUKA PAKEKAKE (Cont.)

951 HDFG: summary of nests and broods found (National Park Strip Road area) 1 July 1976- (41)
30 June 1977

Nest or Brood No.	Gander	Goose	Date Seen	Location / Observation
16	Keauhou 1971	unbanded	2/3 / 77	1 2-3 week old gosling in good health

952 1 censused, Christmas Count Mauna Loa Road, 4000-6600 ft. el. 2 Jan. 1978 KATL78

953 HDFG: summary of nests and broods found: (National Park Strip Road area) 1 July 1977- (42)
30 June 1978

Nest or Brood No.	Gander	Goose	Date Seen	Location / Observation
1	unbanded	unbanded	11 / 17 / 77	nest below stone wall near edge of Keamoku (lava flow) in grassy depression (apparently above 77-6)...1 egg freshly eaten by mongoose...

954 noted pair flying over study area for the first time 60-acre study area near end of Mauna Loa Strip Road 23 Oct. 1978 BAKJ79

955 1 to 3 seen on a number of occasions in or near 60-acre study area near end of Mauna Loa Strip Road 24 Oct. through Dec. 1978 BAKJ79

956 4 censused, Christmas Count Mauna Loa Road, 4000-6000 ft. el. 30 Dec. 1978 KATL79

PUU ULAULA

957 Elder: Peter: saw 10 flying (shot 1) SW from halfway cabin above Red Hill at 10,000 ft. el. on Mauna Loa trail 1926 (1)

958 NPS: 2 seen (Mauna Loa trail) Sept. 1931 (5)

959 Williams: reported from time to time Mauna Loa trail 1936 BALP45

960 Moomaw: saw 5 Mauna Loa trail, 7,500 ft. el. Sept. 1938 BALP45

961 Elder: Park Rangers saw an unrecorded number between 1899 and 1943 (1942) lava flows on north side of Mauna Loa 1935-1938 (1)

962 Christ: nesting observed 7,300 ft. el., Mauna Loa (probably along Mauna Loa trail) (ca. 1938) BALP41

963 Mollenhoff: saw 4 Mauna Loa trail, 7,500 ft. el. 14 Aug. 1939 BALP45

**Island of Hawai'i
Hawaii Volcanoes National Park**

PUU ULAULA (Cont.)

964	NPS: Mollenhoff: 4 seen	at about 7,500 ft. el., Mauna Loa trail	14 Aug. 1939	(5)
965	Quick: saw 2	Mauna Loa trail, 7,500 ft. el.	Apr. 1940	BALP45
966	Christ: reported 3 young	7,500 ft. el. (probably along Mauna Loa trail)	14 July 1940	BALP41
967	Christ: saw 3	Mauna Loa trail, 7,500 ft. el.	14 July 1940	BALP45
968	NPS: 3 young seen	7,500 ft. (Mauna Loa trail)	16 July 1940	(5)
969	NPS: small flock	6,700 ft. (Mauna Loa trail)	31 July 1940	(5)
970	Christ: saw 1	Mauna Loa trail, 7,000 ft.	15 Oct. 1940	BALP45
971	saw 1	Mauna Loa trail, 7,800 ft.	21 Aug. 1942	BALP45
972	Mitchell: saw 1	Mauna Loa trail, 7,500 ft.	3 Mar. 1943	BALP45
973	NPS: 1 seen	7,500 ft. on Mauna Loa (trail)	8 Oct. 1943	(5)
974	A.B. Medeiros: saw 1	Mauna Loa trail 7,500 ft.	8 Oct. 1943	BALP45
975	NPS: 1 seen	above the 6,700 ft. corral (end of Strip Road)	18 Dec. 1943	(5)
976	A.B. Medeiros: saw 1	Mauna Loa trail, 8,000 ft. el.	21 Feb. 1944	BALP45
977	Elder: Davis: saw 2 at 2 p.m.	Mauna Loa trail between 8,000 and 9,000 ft. el.	Mar. 1946	(1)
978	Elder: A.B. (Tony) Medeiros: 1 to 2 seen	to right of truck trail, 1 1/2 miles above Shelter House at 7,000 ft. el.	ca. Jan. 1950	(1)
979	NPS: (A.B) Medeiros: saw 8...first observation within the Park since 5 Sept. 1952	near the 8,500 ft. silver sword plantation on the Mauna Loa trail	22 Sept. 1958	(5)
980	HDFG: 1 active nest found	Hawaii National Park (plus 7 active nests in adjacent Keauhou)	summer 1958	(10)

**Island of Hawai'i
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PUU ULAULA (Cont.)

981	HDFG: first nest with 2 eggs found in large clump of ohelo bushes...5 fertile eggs destroyed by mongoose	Hawaii National Park, 6,000 ft. el., 1/4 mile from Keauhou Sanctuary boundary	found 20 Nov. 1958 incubation began 24 Nov. found destroyed 22 / 23? Dec.	(22)
982	HDFG: 2nd nest with 4 fertile eggs being incubated found under a pukeawe bush...hatched 1 egg (from deserted clutch) under duck at Pohakuloa	on edge of Park side of Kekekaniho, 6,000 ft. el., Keauhou Sanctuary	found 20 Nov. 1958 deserted 11 Dec. 1958	(22)
983	2 observed	along the Park boundary at about 6,600 ft.	17 Jan. 1965	(5)
984	USFWS: 2 seen flying (2:15 p.m.)	8,000 ft. el. Mauna Loa trail (Hawaii-Volcanoes National Park)	5 June 1972	(87)
985	USFWS: 2 flushed	near Mauna Loa Trail, about 7,900 ft. el.	15 Aug. 1972	(87)
986	4 censused	Mauna Loa Trail 6,600-8,000 ft. el.	30 Dec. 1972	GAGW73
987	saw 2	1/4 mile out north from the end of the Strip Road	ca. 20 Sept. (1974)	MCKK74
988	3 birds per 40 ha., 46% occurrence frequency	monthly censuses, subalpine shrub HVNP (Transect 9)	Dec. 1972- July 1973 Aug. 1974- Mar. 1975	(86)
989	(0) seen	eight censuses, tree line ecosystem HVNP (Transect 12)	Dec. 1972- July 1973 Aug. 1974- Mar. 1975	(86)
990	4 censused, Christmas Count	Mauna Loa trail 6,600-8,200 ft. el.	2 Jan. 1978	KATL78
991	1 censused, Christmas Count	Mauna Loa trail 6,600-8,200 ft. el.	30 Dec. 1978	KATL79

**Island of Hawai'i
Hawaii Volcanoes National Park**

PUU ULAULA (Cont.)

992	at least 6 pairs fledged 2 goslings from 9 hatched (of 21 laid) eggs in 8 nests (including 1 re-nest and 1 nest found post-breeding season); 3 goslings died at less than four, less than 11 and less than 14 days after what seemed inadequate growth	Ka'u Desert	1981-1982 breeding season	STOC82
993	3 goslings fledged from 10 eggs	lowlands, less than 2,625 ft. el. HVNP	1981-1982 breeding season	STOC82
994	2 seen, Christmas Count	Mauna Loa Trail 6,600-8,200 ft. el.	26 Dec. 1982	KATL85
995	2 seen, Christmas Count	Mauna Loa Trail 6,600-8,200 ft. el.	2 Jan. 1984	KATL85
996	2 seen, Christmas Count	Mauna Loa Strip Road and Trail	3 Jan. 1986	WILJ87

KILAUEA CRATER

997	2 flocks	near eastern side Kilauea Crater	(1823)	ELLW33
998	Nene were frequent items on the volcano House bill of fare of that day...facts from Baddam-Whetham who arrived in Honolulu February 1874 and soon after revisited Kilauea from Kau side via mule: "...found a very tempting repast ready, and amongst other luxuries was a strawberry-fed goose...Hawaiian wild geese frequent these mountains in great numbers and are sure to be found feeding on the wild strawberries which abound in the neighborhood...from a little patch of ohelo bushes I had the satisfaction of putting up three of the birds—small-sized fellows not much bigger than a large duck...they proved to be a pure sign of strawberries and the native who was with me quickly filled a basket with them..."	Volcano House	(1874)	OLSG41
999	there are still fair numbers to be found	on the hills above the renowned volcano of Kilauea	Sept. 1884	MACJ87
1000	flocks of some size...occasionally seen	near the Crater of Kilauea about 2 miles from the Volcano House	(1892-1896)	PERR03

**Island of Hawai'i
Hawaii Volcanoes National Park**

KILAUEA CRATER (Cont.)

1001	they fly around the crater	when the volcano (Kilauea) is unusually active	(1901)	BLAJ01
1002	Lycurgus: knew of flocks coming	to Kilauea Crater in the vicinity of the sulphur banks	1904-1907	BALP45
1003	Elder: E. Thompson: saw nene	mauka (toward the mountain) of the horse pasture, Kipuka Kulalio	1920's	(1)
1004	1 standing on lava	flew into Koa forest, 5,750 ft...Kipuka Kulalio	28 Aug. 1938	BALP45
1005	Kauhi: occasionally visit	the barren Kau desert to the southwest of (Kilauea Crater), though not so-called 'Kipuka o Nene' due south of the crater	(1944)	BALP45
1006	Elder: B. Waltjen (old-time employee Hawaii (Volcanoes) Nat. Park): saw nene only once when 6 landed	"Six Tanks", 3 miles above Bird Park on the truck trail (Strip Road)	1946-1947	(1)
1007	NPS: Breese: 8-12 seen	flying between the Crater Rim road and Halemaumau...on a course across the Kau Desert	25 Sept. (1951)	(5)
1008	Elder: Chief (Park) Ranger's reports say 5 seen	(flying) across Halemaumau Crater	31 Aug. 1952	(1)
1009	flock of 6 in flight	over Halemaumau	31 Aug. 1952	ANON52
1010	1 seen	entrance to Bird Park	5 Sept. 1952	ANON52
1011	NPS: 1 seen	Bird Park parking area	5 Sept. (1952)	(5)
1012	7 observed in flight	over Kilauea	11 Sept. 1952	ANON52

**Island of Hawai'i
Hawaii Volcanoes National Park**

KILAUEA CRATER (Cont.)

1013	HDFG: a goose which had been released at the Keauhou Sanctuary in 1971 was captured. It had a dislocated right wing which had apparently healed. It could not, however, fly because of this injury. This nene was of good bloodline so it was given to the Hawaiian Volcanoes National Park for use in their efforts to re-establish nene in the lower elevations of the Park. It was placed in an open-top breeder pen where it died several weeks later. The lack of adequate feed probably contributed to the death of this nene.	Hawaii National Park	1 July 1973- 30 June 1974	(37)
1014	censused 2	rim of Kilauea Crater	14 Dec. 1974	MULW75
1015	less than 1 bird per ha. 8% occurrence frequency	monthly censuses, lower mountain parkland, HVNP (Transect 5)	Dec. 1972-July 1973 Aug. 1974- Mar. 1975	(86)
1016	less than 1 bird per ha. 8% occurrence frequency	monthly censuses, lower mountain parkland, HVNP (Transect 7)	Dec. 1972-July 1973 Aug. 1974- Mar. 1975	(86)
1017	4 seen, Christmas Count	Kipuka Puauulu, Golf Course and vicinity	3 Jan. 1986	WILJ87
1018	2 seen, Christmas Count	Kipuka Puauulu, Golf Course and adjacent area	4 Jan. 1986	KATL86

KAU DESERT

1019	Elder: Mrs Pea (age 75 in 1956): seen but one—a family with young	Kipuka Nene	ca. 1900	(1) 244
1020	Warden (A.B.) Medeiros: reported one young with three adults	Kipuka Pepaiu (Pepeiau) (Pepeiao) about 2,000 ft. el.	22 July 1940	BALP41
1021	NPS: saw four...one young	Kipuka Pepaiu	22 July 1940	(5)
1022	The Park Warden (A.B. Medeiros) reported 4 or 5	Kipuka Pepeiau	July 1940	BALP45

**Island of Hawai'i
Kilauea District**

KAU DESERT (Cont.)

- | | | | | |
|------|--|---|--------------|--------|
| 1023 | Baldwin: unsuccessful search for signs of use (follow-up of previous sighting by Christ) | Kipuka Pepeiau | 26 June 1941 | (7) |
| 1024 | collected perhaps month-old droppings | at the 'Koa Oasis', two miles south of Kilauea Crater | Aug. 1941 | BALP45 |
| 1025 | NPS: (P. Baldwin) collected many droppings | 'Koa Oasis' 3,400 ft. el., Kau Desert | Aug. 1941 | (5) |
| 1026 | Elder: A.B. (Tony) Medeiros: 3 to 4 flushed | Kipuka Pepeiau | 1946 | (1) |
| 1027 | (flock of 6 seen) | Hilina Pali | 31 Aug. 1952 | ANON52 |

MAKAOPUHI CRATER

- | | | | | |
|------|---|----------------------|-------------|--------|
| 1028 | ...concentration of aircraft activity caused part of the flock of 18 Nene to discontinue social activity and leave Kipuka Kahalii | near Mauna Ulu, HVNP | 5 Dec. 1988 | TAYD89 |
|------|---|----------------------|-------------|--------|

KALAPANA

- | | | | | |
|------|---|----------------------------------|----------------------------|------|
| 1029 | Elder: G. Pea (age 52 in 1956): 2 visited their farmyard | 9 miles above Kalapana | before World War I | (1) |
| 1030 | HDFG: a farmer familiar with nene reported a pair...assume them to be from Mr. Herbert Shipman's flock at Aina Hou in Hawaii Volcanoes National Park, since several of his birds are free to roam at will | 100-acre papaya farm at Kalapana | (1 July 1967-30 June 1968) | (31) |

MULTIQUADRANGLE

- | | | | | |
|------|--|---|--------------|--------|
| 1031 | Along trail from Hilo to Kilauea, some 5 or 6 to 9 miles from the volcano, passed by "several pools of water which are often the resort of wild geese which frequent this part of the country and live on purple berries..." | | 28 June 1825 | BLOA25 |
| 1032 | Elder: Shipman's birds (at Keaau Ranch) regularly visited | Mountain View, Happy Home (north of Kurtistown), Makuu (6 miles north of Pahoa), and Poki | (1918-1949) | (1) |

**Island of Hawai'i
Kilauea District**

MOUNTAIN VIEW

- | | | | | |
|------|--|---|---------------|-----|
| 1033 | Elder: Kimi (age 65 in 1956): saw small flock flying mauka (toward the mountain) towards Nobriga Ranch | just below Mountain View, 15 3/4 miles above Hilo | 1937 | (1) |
| 1034 | NPS: (B.) Waltjen: 2 seen | Mountain View area | 25 March 1958 | (5) |

Mauna Kea District

UNDESIGNATED LOCALITY

- | | | | | |
|------|----------------------|--|--------------|--------|
| 1035 | Pickering: none seen | ascent of Mauna Kea from Hilo | 15 Jan. 1841 | (12) |
| 1036 | no geese were seen | journey from Hilo to summit of Mauna Kea | Jan. 1841 | WILC45 |

**Island of Hawai'i
Mauna Kea District**

UNDESIGNATED LOCALITY

1037 ...soon came in sight of a flock of geese feeding upon the strawberries with which this region abounds...passed some time in shooting and were fortunate enough to secure 8 fine geese, with which we returned to the tent...pursuing nearly the same route as before, we again fell upon the geese, but they had now, from experience, begun to know, or at least to guess, what a gun was, and gave us much more trouble and labor to approach within shot than upon the former occasion. We also encountered another serious and unexpected interruption to our hunting, in the shape of an immense bull, who, not at all alarmed at the report of our guns, stood pawing the ground...we then began to traverse in another direction, and had not gone far when we fell upon another large bull as daring as the first. We had now again to change our position, although with reluctance, as the geese kept in the neighborhood of those animals...I was accompanied by one of our natives and had succeeded in killing several geese, when I again found myself in the vicinity of two bulls; in fact directly between them, which position I soon changed, having no inclination to come again to such close quarters with such formidable animals, unless provided with ball, as shot could only enrage them. Upon rejoing Mr. Parker, we found ourselves in possession of sixteen geese, the greater portion of which he had shot, being more accustomed to the vicinity of the wild bulls...From the encampment, before the fog came on, we could look down into Byron's Bay, and could even distinguish a schooner in the harbor...We found here strawberries in great abundance and indeed never wanted them during the whole journey around the mountain...Today (Friday, 10th) we proceeded homeward and reached Mr. Parker's house about 3 p.m. having made the entire circuit of Mauna Kea (in 9 days), and having shot more geese in these wild regions than had ever before been done by Europeans and had thereby attained the principal object embraced in our excursion, we could now sit down and think with satisfaction of our adventures...

southeast slope of
Mauna Kea (on a trip
around the mountain
with Sam Parker and
native guides)

(1847)

ANON47

**Island of Hawai'i
Mauna Kea District**

UNDESIGNATED LOCALITY (Cont.)

1038	Payne via Mr. and Mrs. Nicholson: nene seen many times	while surveying (in Humuula) along a proposed Hilo to Kona road (Saddle Road)	(1937)	DONW51
1039	A. Wall: seen	along the Humuula Road and all over the country between Mauna Loa and Mauna Kea	(1890's)	BALP45
1040	unsuccessful inquiries of early presence	upper northern portion of Mauna Kea	(1945)	BALP45
1041	forest ranger reported two adults	along the Puu Oo trail in the Saddle Region	1950	SMIJ52
1042	saw 10...flying	in the saddle between Mauna Kea and Mauna Loa	late Aug. or early Sept. (1951)	BALH52
1043	Elder: HDFG: Woodworth: H. Baldwin saw 10 flying toward Mauna Loa	Puu Oo Trail	3 Oct. 1951	(1)
1044	Woodside: a flock of no less than 22	grassy flat near the Saddle Road above Hilo	28 July (1955)	ANON55
1045	Woodside: 2 flew over at 7:05 a.m...2 flying distantly at 8:15...4 in 1 group, 4 in another circled and appear to have landed 3/4 mile below camp at 8:16...at 8:30 2 took to the air and circled where they landed...	camp on 1852 lava flow	8 Aug. 1956	(14)
1046	Woodside: 5 seen headed toward Puu Oo	1852 lava flow	25 Oct. 1955	(14)
1047	Woodside: none seen	1852 lava flow	26 Oct. 1955	(14)
1048	Woodside: none seen	1852 lava flow	27 Oct. 1955	(14)
1049	3 wild nene reported seen	between Pohakuloa and Humuulu	(Sept. 1958)	BALH58
1050	HDFG: 3 seen...probably non-breeding 1 year olds	on a small hill in the Saddle area approximately 20 miles from Keauhou Sanctuary	Feb. (1959)	(10)
1051	HDFG: ...flights of paired birds...on 1 occasion a mixed pair (one Keauhou-banded mate)...noted	in the Saddle area between Mauna Kea, Mauna Loa and Hualalai	Nov., Dec., Feb. 1961-1962	(25)

**Island of Hawai'i
Mauna Kea District**

MULTIQUADRANGLE

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| 1052 | Elder: Kaa via Wassman: commonly seen | from Lomia (Laumaia) to Pohakuloa | ca. 1900 | (1) |
| 1053 | Elder: HDFG: Woodside: 19 to 24 seen | Puu Oo and 4 miles south to 1881 Lava Flow | Aug. 1955 | (1) |
| 1054 | flock of at least 24 discovered...however no nesting birds were found | on the NE slope of Mauna Loa...1852 lava flow visited most frequently...also observed landing on the 1881 flow...on daily flights from nightly roosting area north of Saddle Road near the lower end of 1935 lava flow...flight pattern observed for 10 weeks... | summer 1955...first 8 seen 21 July | WOOD56 |
| 1055 | Elder: HDFG: Woodside: 24 | Puu Oo and south to 1852 Lava Flow | Sept. 1955 | (1) |
| 1056 | Elder: Vredenberg (interviewed 28 Sept. 1956): "never saw nene..." | "on Parker Ranch where I worked most of my life" | (1956) | (1) |
| 1057 | Banko: Shipman (interviewed 18 Feb. 1970): never heard of nene nesting | on Mauna Kea | (1900-1970) | (9) |

NAOHUELEELUA

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| 1058 | Elder: Bryan: saw a pair | along military jeep trail near Greenwell Ranch | Sept. 1950 | (1) |
| 1059 | Banko: Bryan (interviewed 10 Dec. 1978): saw 2 | several hundred-acre mamane-naio kipuka (Kipuka Alala), land of Kaohe ca. 6,000 ft. el. | 19 Sept. 1950 | (9) |
| 1060 | Elder: Simeona (age 60 in 1956): often saw nene flying | between Ahuami (Heiau) and Puu Oo | in January (years ago) | (1) |
| 1061 | Elder: Wm. Paris, Sr.: saw nene | along the trail from Waikii to the Judd Trail | (years ago) | (1) |

**Island of Hawai'i
Mauna Kea District**

PUU KOLI

1062	Elder: Payne (interviewed 26 Sept. 1956): flocks of 4-12 seen almost daily in late afternoon	flying toward Hualalai...from Saddle Road...occasionally flying east in the morning	summers of 1936,1937	(1)
1063	P. Baldwin: found no signs	large kipuka between Puu Koli, 7,341 ft. el. and Kokoolau cone, north flank of Mauna Loa	17 Apr. 1943	(7)
1064	P. Baldwin: (S.) Nakamura of Pohakuloa and a Hawaiian boy: have seen (several)...early in the morning	at Red Hill...or the cones about 2 miles west of Puuhuluhulu	Apr. 1943	(7)
1065	Elder: Holt: saw 2 on ground	cinder cone, old Saddle Road opposite Pohakuloa	fall 1949	(1)
1066	Elder: HDFG: Yamamoto: 2 seen	1 mile west of end of Kona-Hilo Road and mauka (toward the mountain)	15 June 1955	(1)
1067	Woodside: Hansen: 2 adult unbanded nene sighted and approached within 3 feet...while guiding hunting party	atop unnamed 6,515 ft. el. Puu 1 1/4 miles south of the junction of Saddle Road and lava road bearing 216 T from junction (in Mauna Loa hunting area adjacent to Pohakuloa)	8 Feb. 1959	(14)
1068	Woodside: Victorino: reported 5 nene	flying over Saddle Road at about 32 mile marker	10 Feb. 1959	(14)
1069	A. Wall: saw flocks of 30 to 40	Aina Hou at 6,000 ft. el.	(1890's)	BALP45
1070	D. Paris: comparatively many	Aina Hou...(in) eastern half of the plateau between Mauna Kea and Mauna Loa, north Hilo district	(early 1900's)	BALP45
1071	Payne: had been seen	near the Puu Oo Ranch	3 Aug. 1937	DONW51b
1072	Lamb: Ignacio observed 18	Ainahou kipuka, land of Humuula	Aug. 1937	(13)
1073	Ignacio via Lamb: saw 18	Aina Hou (Mauna Kea-Mauna Loa plateau)	Aug. 1937	BALP45

**Island of Hawai'i
Mauna Kea District**

PUU KOLI (Cont.)

1074	von Holt: saw a number	Kipuka o Nene (6300-7000 ft.)...grassy kipuka above Aina Hou (Mauna Kea-Mauna Loa plateau)	1930's	BALP45
1075	D. Paris: saw comparatively few	Aina Hou...(in) eastern half of the plateau between Mauna Kea and Mauna Loa, north Hilo district	1930's	BALP45
1076	Kaneho via von Holt: found frequently...on regular trips	Kipuka o Nene , 6300-7000 ft....grassy kipuka above Aina Hou (Mauna Kea-Mauna Loa plateau)	1940-1941	BALP45
1077	signs indicate use of vicinity during May	1881 lava flow, 6500 ft. el.	June 1941	BALP45
1078	Baldwin: found droppings (actually in KIPUKA PAKEKAKE quadrangle, HVNP)	east of the 1881 flow at 6,450 ft. el. where...found before [near west (?north) Park boundary]	21 July 1941	(7)
1079	Elder: Bell: saw 2-3	Kipuka Aina Hou, above Puu Oo trail	1940-1941	(1)
1080	Elder: Bell: saw bunches up to 11 and flightless	3-4 miles west in Kipuka Aina Hou	1940-1941	(1)
1081	found droppings at several places	along the edge of a lava flow and near small ponds 3 miles south of the Puu Oo Ranch house at 5,400 to 5,750 ft. el.	Nov. 1942	BALP45
1082	Elder: Kubo: saw 5-6 frequently	Kipuka Nene	1933-1942	(1)
1083	Baldwin: (S.) Nakamura	Puu Oo lands along the Keanakolu road past ranch house	(Apr. 1943)	(7)
1084	S. Nakamura and Hawaiian boy reported nene independently	at the cinder cone Omaokoili	Apr. 1943	BALP45
1085	Elder: Awai: saw small flock	2 miles past Puu Oo Ranch gate	ca. 1943	(1)

**Island of Hawai'i
Mauna Kea District**

PUU KOLI (Cont.)

1086 Shipman: saw occasionally	on the Puu Oo Ranch	during the past 15 or 20 years	BALP45
1087 A. Wall: flocks of 30-40	At Aina Hou, a kipuka with grass and berry-laden shrubs on the north flank of Mauna Loa, in north Hilo district at 6,000 ft. el.	during this decade (1934-1944)	BALP45
1088 Elder: T. Lindsey: saw 12-14 on the ground	to left of horse trail, Puu Oo Ranch, ca. 6,000 ft. el.	ca. 1944	(1)
1089 Elder: Kamau, Sr. (spent many years on Mauna Kea): seen but once, when his dog caught 1 of a pair and the other flew off	Saddle Road south of Puu Oo Ranch	10 a.m. in June or July, 1944 or 1945	(1)
1090 Elder: T. Lindsey: saw pairs on several ponds	3/4 mile above Puu Oo Ranch	1948	(1)
1091 Elder: HDFG: Woodworth: hunters saw 1 with binoculars	cinder cone east of Pohakuloa	17 Nov. 1950	(1)
1092 2 adults reported	along the Puu Oo trail in the Saddle region	1950	SMIJ52
1093 NPS: P. Baldwin: flock of 10 seen	Humuula Saddle	Aug. (1951)	(5)
1094 NPS: Epes: 6 seen in flight	Humuula Saddle	24 Feb. (1952)	(5)
1095 Elder: Bryan: saw 5 including 3 young, all able to fly	Puu Huluhulu	Jan. 1953	(1)
1096 Elder: Awai: saw 6 on ground	above Ainahou, between Puu Huluhulu cinder cone and old prison road camp	Oct. 1953	(1)
1097 Elder Awai: saw 10	Ainahou Ranch, 2-3 miles mauka (toward the mountain) Puu Oo Ranch	Christmastime, 1953	(1)
1098 Elder: Awai: saw a small flock	Ainahou Ranch, 2-3 miles mauka (toward the mountain) Puu Oo Ranch	Feb. 1954	(1)

**Island of Hawai'i
Mauna Kea District**

PUU KOLI (Cont.)

1099	Elder: Kaneho: saw 2	flying to cinder cone just north of road to Pohakuloa	summer 1955	(1)
1100	Elder: J. Paulo (age 62 in 1956): saw 6-8 while hunting plover	upper Ainahou	(years ago)	(1)
1101	Elder: HDFG: Uemura: 3 seen	Ainahou	1 Aug. 1955	(1)
1102	Elder: HDFG: Pavao: 4 seen mauka (toward the mountain)	Ainahou	30 July 1956	(1)
1103	Woodside: found plentiful signs...droppings, down and contour feathers at most of the water holes...near the jeep trail...	in the mauka part of Kipuka Ainahou	1 Aug. 1956	(14)
1104	HDFG: By July, nene were seen in the summer range...3 were seen in Kipuka Ainahou...droppings and small contour feathers indicating considerable use...numerous semi-permanent water holes have attracted nene for many years.	Kipuka Ainahou	1 July 1957- 30 June 1958	(21)
1105	HDFG: 3 seen...sign indicating considerable use by a few birds...during the summer...contains numerous semi-permanent water holes which have attracted nene for many years	Kipuka Ainahou	summer of 1958	(10)
1106	HDFG: 3 were reported and they returned to this area for roosting...unsuccessful attempts were made to capture them at night with lights and nets...nene did not return...	Omaekoili hill	Aug. 1958	(22)
1107	HDFG: 3 reported	Omaekoili hill	Aug. 1958	(10)
1108	Woodside: Shipman reported in conversation that his cowboys saw 6 nene (2 adults, 4 young) last week or so	Puu Oo Ranch 5700 ft. el.	25 Apr. 1959	(14)
1109	HDFG: Droppings and feathers were again found in Kipuka Ainahou, but no nene were observed there	Kipuka Ainahou	1 July 1958- 30 June 1959	(22)
1110	HDFG: brood of 4 by wild parents seen	Kipuka Ainahou	1 July 1964- 30 June 1965	(28)
1111	HDFG: found nest belonging to a wild pair, the first record for this area...unfortunately the 2 eggs failed to hatch...nest ca. 300 yards from an area where a wild pair and its brood of 4 young were seen last year...	Kipuka Ainahou	1 July 1965- 30 June 1966	(29)

**Island of Hawai'i
Mauna Kea District**

PUU KOLI (Cont.)

1112	HDFG: Jimmy Lee, archery hunter: 3 3/4-grown goslings seen	Kipuka Ainahou	Mar. 1967	(30)
1113	HDFG: field trips made (results unreported)	Kipuka Ainahou	(1 July 1967- 30 June 1968)	(31)
1114	HDFG: many field trips were made...although fresh droppings indicated that nene used this area during the summer, no birds were actually seen...adverse weather largely responsible	Kipuka Ainahou	1 July 1968- 30 June 1969)	(32)
1115	HDFG: 4 nene observed by a game warden...unfortunately flushed before presence of bands could be determined...nene have not been observed in this area for more than 4 years...	Puu Omaokoili	1 July 1968- 30 June 1969	(32)
1116	HDFG: ...Evidence of nene use...consisted of old droppings and feathers. This may indicate use of this area for breeding purposes, or for loafing between breeding seasons. It is probable that only a restricted portion of the area is used for nesting. It affords good nesting habitat compared to the remainder...Approximately the middle third of Area 4, south of Saddle Road, has significant value for the nene. In addition to a nest seen there in 1964, it is possibly a destination for nene from Puu Oo summer flyway. Should our surveys confirm this use, the area should be established as a sanctuary and considered for restocking with pen-reared nene.	Kipuka Ainahou area	1 July 1970- 30 June 1971	(50)

For history of Nene restoration in Kipuka Ainahou Sanctuary 1972/73 to 1987/88 see Hawaii State Restoration Program, Part II.

1117	11 seen flying	Saddle Road nr. Puuhuluhulu	21 June 1986	PYLR86
1118	9 flying	Saddle Road nr. Puuhuluhulu	26 June 1986	PYLR86
UPPER PIHONUA				
1119	Elder: Wm. Paris, Sr.: saw many flocks of 6-8	Puu Oo Ranch	Oct. or Nov. 1910	(1)

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

1120	Elder: Kimi (age 65 in 1956): frequently flushed nene at 9 a.m. which always flew makai (toward the sea)	Waikoloa Pond, Puu Oo Ranch	1914-1920	(1)
1121	Elder: F. Waltjen: saw nene	Puu Oo Flat	1922	(1)
1122	Elder: Haa: seen	Waikoloa and Hilopa near Parker Ranch fence, Puu Oo Ranch	1923-1925	(1)
1123	Elder: Haa: seen when duck hunting	Hilopa Pond, Puu Oo Ranch	1923-1925	(1)
1124	Elder: Haa: seen	Omao Ponds, Puu Oo Ranch	1923-1925	(1)
1125	Elder: Immoto (age 90 in 1956): plenty big flocks	Omao, below Waikoloa, Puu Oo Ranch	ca. 1926	(1)
1126	Donaghho: Payne: flock of 9 seen	near the Waikoloa ponds on the southeast flank of Mauna Kea	(June-Aug. 1937)	(4)
1127	Elder: Bell: repeatedly saw small flocks	Omao ponds, Puu Oo Ranch	1940-1941	(1)
1128	P. Baldwin: found droppings	near small pond with aquatic vegetation at 5700 ft. about 3 miles SW of Waikoloa ponds...Puu Oo Ranch	13 Nov. 1942	(7)
1129	P. Baldwin: found droppings on pahoehoe hump	on about 3-4 mile hike through ohia and koa kipukas, Puu Oo Ranch between 5400-6000 ft. el. beginning at 5600 ft. on Saddle Road	13 Nov. 1942	(7)
1130	found recent droppings	on the flow of 1855 at 5900 ft. el.	Nov. 1942	BALP45
1131	Elder: T. Lindsey: flew over in moonlight	Puu Oo Ranch, Kipuka Nene	June / July 1947-1948	(1)
1132	Elder: HDFG: Woodworth: Bryan reported that hunters saw 10	13 miles above flume (Saddle Road crossing)	13 July 1951	(1)
1133	Elder: Wagner: saw 15	in the Big Paddock, Puu Oo Ranch	1950-1951	(1)

**Island of Hawai'i
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UPPER PIIHONUA (Cont.)

1134	Elder: Halawaty: saw 3 several times and heard other times	just south of the Saddle Road 8 miles makai (toward the sea) of the Humuula Road	June / July 1953	(1)
1135	HDFG: established...from 20 field trips in July, August and September...that from 19 to 24...spend the night...	near the 1935 lava flow and the Hilo Forest Reserve fence in Puu Oo Ranch	summer of 1954	(10)
1136	Elder: Silver (pig hunter): saw 8	makai (seaward) end of Kipuka Airahou	1954	(1)
1137	Elder: J. Lindsey: saw 12 across Saddle Road	Shipman telephone line	1974	(1)
1138	Elder: HDFG: Ah San: 8 seen	Puu Oo	22 July 1955	(1)
1139	Elder: HDFG: Woodside: 22 seen in groups of 13, 7, 2	Puu Oo	28 July 1955	(1)
1140	Woodside: Bryan: Ah San: heard nene flying	north into Puu Oo Ranch from junction of Saddle Road and Puu Oo trail to telephone line and down line to Hilo Forest Reserve fence	28 July 1955	(14)
1141	Woodside: Bryan: Ah San: saw 13 (groups of 5, 8 at first) flew north and out of sight	Hilo Forest Reserve—Puu Oo Ranch fence line	28 July 1955	(14)
1142	Woodside: Bryan: Ah San: heard nene on the ground...spotted a pair...7 more came in, apparently from the south, and landed...13 came back from the north...landed	on a grassy flat in the Hilo Forest Reserve—Puu Oo Ranch fence line area...(followed phone line out through the Forest to the Saddle Road)	28 July 1955	(14)
1143	Elder: HDFG: Woodside: 23 seen in groups of 11, 7, 5	Puu Oo	29 July 1955	(1)

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

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| 1144 | Woodside: Bryan: Ah San: waited on flat till noon...walked north 1 1/2 miles then returned and waited till 4:30 p.m...still no nene...then heard flying and saw 7 land on the flat at 5:00 p.m...may have come in from the south...am not sure...very foggy...saw 11 more on ground...eating rattle-tail...at 5:20 p.m. 5 more came in from the north...was able to count only 20 but may have been more...no young...unless hatched before February...possible some were on flat all day but I doubt it..have the feeling that the nene come to this place at about 4:00 or 5:00 p.m. and spend the night here, however there is no great accumulation of droppings or other sign...this may be a recent area for them or they may leave after 7:00 p.m...droppings on one large koa log indicate that 2 or 3 birds roosted on it... | arrived at flat in Puu Oo Ranch above forest fence (where previous sightings were made) at 0850 a.m...vegetation is grassy with rattle-tail and Paspalum dominant...this area is an old pahoehoe flow with thin soil...several marshy spots where sedges grow...none appeared to be really permanent...habitat strictly man-made in that the area was originally in heavy koa-ohia forest and is grazed by cattle...numerous logs laying about...and exposed rocky places | 29 July 1955 | (14) |
| 1145 | HDFG: report of 8 seen | Puu Oo Ranch | late July 1955 | (20) |
| 1146 | 24 passed an observation point...D. H. Woodside | (ca. milepost 20, Puu Oo Ranch) | July 1955 | ELD58a |
| 1147 | Woodside: Uemura field notes: nene droppings found in 3rd kipuka but not in others | search of several kipukas toward Mauna Loa flats from 21 milepost, Saddle Road | 1 Aug. 1955 | (14) |
| 1148 | Woodside: Uemura field notes: heard faint cries which sounded like 3 nene low in the air...ran toward the cries but heard no more...no other signs found on day-long hike to east end of Ainahou Kipuka from 21 milepost, Saddle Road | in 2nd. kipuka returning to vehicle much later | 1 Aug. 1955 | (14) |

**Island of Hawai'i
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UPPER PIIHONUA (Cont.)

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| 1149 | Woodside: none present 1:30-3:00 p.m...heard then saw 3 fly in and land at 4:30...counted 7 where 3 landed when fog lifted at 4:45...pair and group of 5...11 more flew in at 5:40...landing near the 7...another pair came in at 6:30...and another pair a few minutes later...watched them feed on rattail grass...from grouping on ground and order of arrival it appears that the flock is composed of: 4 pairs with no young, 1 pair with 2 young, and 2 pairs with 3 young each (1 or which may be a pair with 1 young and another pair) | flat above the forest fence in Puu Oo Ranch next to lava flow of 1935 | 2 Aug. 1955 | (14) |
| 1150 | Woodside: waited from 4:45 a.m. to 7:00 a.m...no nene seen | at about 22 mile marker on Saddle Road | 3 Aug. 1955 | (14) |
| 1151 | Elder: HDFG: Veriato: 28 seen | 1 1/2 miles south of 18 mile marker | 7 Aug. 1955 | (1) |
| 1152 | Woodside: no sign of nene on arrival at 4:00 p.m...at 5:15 heard large group come in from south and land on the flat in the fog...approached and counted 19...watched at close range till 6:30 when I left them...gathered some droppings at roosting places...droppings seem to be accumulating... | arrived on the flat in Puu Oo Ranch near 1935 flow and Forest (Reserve boundary) fence (hereinafter called the Puu Oo Ranch area) | 9 Aug. 1955 | (14) |
| 1153 | Woodside: waited from 4:45 to 6:45...no nene seen...at 5:30 p.m. motorist reported to me on road that 5 nene were seen to cross the (?Saddle) road about 1 mile below me... | on Saddle Road above the Puu Oo trail crossing | 10 Aug. 1955 | (14) |
| 1154 | Woodside: arrived on flat at 5:00 p.m...9 nene flew in from south and landed about 100 ft. away...at 5:30 5 more came in and tried to land even closer but saw me, circled and landed about 200 yards away...at 6:00 the 9 became noisy and took off (5 in 1 group, 4 in another), circled the flat and landed about 600 yards away...at 6:30 the other 5 became very noisy, took off and flew to the 9 that had moved...left the area at 7:10...no other nene arrived...don't know if any more came without my knowing it... | flat on Puu Oo Ranch | 17 Aug. 1955 | (14) |
| 1155 | Woodside: 5 came across at 5:00 p.m...flying low...saw me...circled and flew on...4 more were following and joined up with them...flew north to Puu Oo area (flat)...at 5:35 a pair came across...a little below me...flying very high | on Saddle Road .7 mile below the Puu Oo-Hilo trail | 18 Aug. 1955 | (14) |

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

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| 1156 | Woodside: Fuller: at 0727 17...in groups of 5 and 12...crossed road...at 1727 4 passed over | 1855 flow marker on Saddle Road | 19 Aug. 1955 | (14) |
| 1157 | Woodside: J. Veriato, Sr.: saw 27 or 28..flew up at close range, circled twice and flew toward Mauna Loa... | south about 1 1/2 miles from the Saddle Road at about the 18 mile marker | 21 Aug. 1955 | (14) |
| 1158 | Woodside: waited from 4:00 to 6:30 p.m...at 5:45 1 pair seen flying parallel to Road...crossing it and heading north just above 19 mile point | on Saddle Road at 1855 flow sign | 27 Aug. 1955 | (14) |
| 1159 | Woodside: Uemura field notes: first 5 then 11 nene flew in and landed approximately 300 yards away at 4:20 p.m...at 5:20 p.m. heard and saw 3 land about 100 yards away southeast from the 16...at 5:50 saw 3, then 2 more landed 50 yards northwest from the 16...all are usually in the tall rattail grass probably squatting, then peering out of the grass occasionally...seem to be confined to an area but have seen them more than several feet away from their area... | nene roosting area north of 21 and 22 mile posts on Saddle Road (Puu Oo Ranch flats) | 27 Aug. 1955 | (14) |
| 1160 | Elder: HDFG: Uemura: 19 seen | Puu Oo | 27 Aug. 1955 | (1) |
| 1161 | Woodside w/ Uemura: 9 crossed over going south at 7:52 a.m...seemed to be in groups of 5 and 4 each | Saddle Road, somewhere above 16 3/4 miles (?19 mile marker area) | 30 Aug. 1955 | (14) |

**Island of Hawai'i
Mauna Kea District**

UPPER PIHONUA (Cont.)

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| <p>1162 Woodside w/ Uemura: watched for nene in the afternoon...at 4:10 p.m. 3 nene came over the flow flying toward the Puu Oo area...at 4:17 4 more nene were seen coming in...tree top level...when they saw me they became noisy, circled close and landed about 100 yards away and watched me until 4:30...walked toward them not trying to conceal myself...to within 30 yards...they got noisy and flew, made a circle and 2 landed in the same place while 2 landed about 100 yards away...calling continuously...walked up to them at 4:40 p.m...they flew when they were within 25 yards...other pair also flew...all made a circle about and landed about 75 yards away...at 5:00 p.m. heard nene on the ground and saw 2 more about 250 yards from me...never did see these come in but they may have been there all the time...at 5:12 p.m. walked up to the 4 nene closest me and got 10 yards from them before they took off...flew straight for the other two...walked toward the 6...got to within 20 yards of all 6...when they flew...they made a circle coming by me very close and headed toward the Puu Oo area (flats)...on the rocks where the pair was found old droppings and a contour feather that had been there for some time...several days at least...5:53 p.m. 5 more nene came in from the south...very noisy, and when they saw me changed course to fly by me very close and then went on up to Puu Oo area...Eddy (Uemura) was watching below me and between us we saw 23 nene cross the flow...light fog...</p> | <p>made camp at a small kipuka in the 1881 lava flow at about 4700 ft. el...south from Saddle Road location 16 3/4 miles above Hilo...</p> | <p>30 Aug. 1955 (14)</p> |
| <p>1163 Woodside: Uemura field notes: heard, then saw 5 nene at 4:08 p.m. flying across the flow east from where I stood, heading northwest...at 4:10 heard then saw 3 flying almost directly over me...at 4:22 saw 4 far to the east flying very high to the northwest...then veering off more easterly to be in line probably to their roosting site at Puu Oo...very clear...could see city of Hilo very clearly...</p> | <p>after squaring away things at camp site on 1881 flow, viewed the southern horizon for nene...camp located at a small kipuka in the 1881 lava flow at about 4700 ft. el...south from Saddle Road about 16 3/4 miles above Hilo</p> | <p>30 Aug. 1955 (14)</p> |
| <p>1164 Elder: HDFG: Uemura: 12 seen</p> | <p>1881 lava flow</p> | <p>30 Aug. 1955 (1)</p> |
| <p>1165 Elder: HDFG: Uemura: 24 seen</p> | <p>1881 lava flow</p> | <p>31 Aug. 1955 (1)</p> |

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

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|------|---|---|--------------|------|
| 1166 | Woodside: Uemura field notes: at 7:54 a.m. heard then saw 9 nene flying west of me heading s.e...apparently 2 birds leading the other 7 in the flock...before the 9 were out of sight 4 more followed...then another 4...heard then saw another 7 as they flew past me approximately 300 yards west...5 together ahead of the other 2..whole observation of the flight of 24 took only 4 minutes so they must have flow up on flock after the other from their roosting site...could not get good bearing...estimated azimuth is 130... | initiated watch at 7:00 a.m. on 1881 flow to see whether nene would fly back on same flight from Puu Oo...near camp at a small kipuka in the 1881 lava flow at about 4700 ft. el...south from Saddle Road about 16 3/4 miles above Hilo | 31 Aug. 1955 | (14) |
| 1167 | Woodside: came across numerous droppings...mostly a week or two old but some may have been several weeks old...at one place there were piles of droppings where 4 birds had roosted...continued on up the flow...then down the finger (of lava) that heads east between the main flow and the road...then out to the (Saddle) Road about 5:40 p.m. at the 19 mile marker...when 3 nene passed over farther down the road headed for the Puu Oo area...followed at 5:41 by 7 nene in groups of 5 and 2 (heading unrecorded)... | walking up 1881 flow (from flyway area near camp about 4700 ft. el. south from Saddle Road about 16 3/4 miles above Hilo) | 31 Aug. 1955 | (14) |
| 1168 | Woodside: (several groups of nene encountered per accompanying itinerary of hike) | left truck at 16 3/4 miles on Saddle Road at 1:15 p.m...walked into the 1881 flow arriving 2:30...went up to the nene flight line and cut south through the forest on Az 135°...left the 1881 flow at 3:30...at 5:06 while cutting trail through the forest 2 nene flew over me going north on about Az 315°...got to the 1852 flow at 6:00 p.m...started up the flow but heard nene (6:35 p.m.) lower down...started toward them but it was getting dark, foggy and rainy...so stopped to make "camp" ...heard nene again at 6:50 p.m...sounded like 4 or 5 birds calling and taking flight...was awake most of the night and heard no nene...don't think any spent the night in the area... | 4 Sept. 1955 | (14) |

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UPPER PIIHONUA (Cont.)

- 1169 Woodside: no nene seen or heard in the morning until 7:37 a.m. when a pair came in on Az 315°...flew right over me and apparently went on past the flow but may have circled and landed...at 7:40 more nene were heard and 3 groups of 3-5-2 birds were seen...they circled as they got to the flow and some were seen landing about 1/2 mile below me near the edge of the flow...packed up my gear and left it and started toward those I saw land...flushed 1 pair from the flow at 9:00 a.m...they circled and landed near some others that were nearby...could not see them on the ground...started toward nene on the ground...very noisy...came across many droppings and at one place a few bits of down and small feathers...at 9:10 heard nene on the group ahead of me...5 took off followed by 2 other pairs...they joined company in the air, made a broad sweep of the flow and on the far side apparently split up...saw 2 come back and land near the center of the flow...don't know what happened to the other 7...looked around where the nene were...found many droppings from fresh to very old and disintegrated...judging from the location of most droppings nene are eating ohelo, kukaenene and *Heydotis centranthoides* (*Kadus* of Degener)...the latter very abundant here...nene seem to be eating the stems and leaves...groups of droppings were also abundant here...nene seem to be eating the stems and leaves...groups of droppings were also found on open rocks and under small ohia trees...stayed on the 1852 flow till 11:00 a.m. (nene seen to be more wary and less curious here than on the flyway or at the Puu Oo (flat) roosting area...left 1881 flow at 2:45...reached 1855 flow and truck at 4:00... at camp on 1852 flow (at this elevation the 1852 flow is split and surrounds a very large forested kipuka and nene may go to the south branch of the flow as well as the north 5 Sept. 1955 (14)
- 1170 Woodside: came across 1 pair of nene...first time nene have been seen in this flat...4:35 p.m. near telephone line reached by hiking from Puu Oo Ranch gate on Saddle Road vicinity of Forest Reserve fence and 1935 lava flow 9 Sept. 1955 (14)
- 1171 Woodside: saw 13 or 14 nene on ground at 4:55 p.m...at 5:00 4 more came in from the s.e. and landed...at 5:10 2 more came in...at 5:20 another pair arrived...total count 23 or 24...I stayed in the area till 6:00... continuing hike down telephoen line from Puu Oo Ranch toward Forest Reserve 9 Sept. 1955 (14)

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UPPER PIHONUA (Cont.)

- 1172 Woodside: no nene seen in duplicate coverage helicopter flights (Mr. Woodworth in 2nd helicopter) from 0945 to 1015 (from ?Puu Huluhulu) down the Saddle Road to the 1855 flow marker (on nene flyway) then south on Az 130° flying over the 1881 and 1852 flows where nene were seen from the ground...circling the 1852 flow...then up 1852 flow to grassy kipukas near the Puu Oo volcano flow...over the Kipuka Ainahou and up to the Saddle Road near Puu Huluhulu 13 Sept. 1955 (14)
- 1173 Woodside: arrived at flat 4:00 p.m.—no nene...at 5:30 7 came in from S.E...4 more came in but didn't land, continuing to fly on about Az 315°...these may have come back...fog coming and going...1 pair came in at 6:15 and landed...1 pair seen flying from the area south and out of sight on about Az 175°...these may have been from flock of 7...left area at 6:25... Puu Oo Ranch flat above Forest Reserve fence near 1935 flow 25 Sept. 1955 (14)
- 1174 Woodside: waited from 6:30-9:00 a.m...9 came over going south from Puu Oo area (flat)...4 more followed closely by another 4 came over at 8:28...at 8:30 7 more flew over...24 total seen... on the Saddle Road 30 Sept. 1955 (14)

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UPPER PIIHONUA (Cont.)

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| 1175 | HDFG: 20 field trips...establish that 19-24 spend the night...they leave this area in the morning (6:30-10 a.m.) and fly southeast to the 1881 and 1852 flows to feed...flight line has been followed as far as the 1852 flow (5 airline miles)...birds leave the feeding area in the afternoon and fly back to the Puu Oo area between 4:00 and 6:25 p.m...fly in pairs or in groups of 4-7...largest group seen was 13...quite noisy in flight and at times will circle to investigate people on their flyway...can usually be approached very easily on the ground, oftentimes to within 40 yards...they are very curious and have little fear unless approached to within 50 yards...recent sighting has been publicized in the hope that it will stimulate people to watch and report them... | Puu Oo Ranch roosting area near the 1935 lava flow and the Hilo Forest Reserve fence | July, Aug.,
Sept. 1955 | (20) |
| 1176 | Elder: Mrs. M. Holmes: 2 seen flying | over Saddle Road at half-way point | (?Nov.) 1955 | (1) |
| 1177 | flock of 8 discovered by Forest Ranger Ah San | near the forest boundary in Herbert Shipman's Puu Oo Ranch | 1955 | ELDW58 |
| 1178 | HDFG: 24...highest count obtained | on Puu Oo Ranch roosting area or...flying over Saddle Road | 1955 | (81) |
| 1179 | Elder: Silver: saw 2 | between 1881 and 1852 lava flow | 1955 | (1) |
| 1180 | Elder: Veriato: (interviewed 25 Sept. 1956): saw 28 | on the 1880 lava flow 2 miles below Volcano trail (N of Rest House) | late June
1956 | (1) |
| 1181 | Woodside: initiated watch at 6:15 a.m...1 pair crossed Road at 8:01 headed toward Puna...21 crossed Road headed towards Puna...2 flew over (heading undesignated)...1 pair flew over (heading undesignated)...23 total... | 18 1/2 mile area, Saddle Road | 20 July 1956 | (14) |
| 1182 | Elder: HDFG: Lee: 23 seen | Saddle Road | 20 July 1956 | (1) |
| 1183 | Woodside: initiated watch at 8:00 a.m...10 nene flew across Road at 8:24 breaking formation into groups of 6-2-2...seemed to be going more east than usual...at 8:24 4 nene crossed Road flying low, right on usual flight lane... | Saddle Road at 1855 flow marker | 24 July 1956 | (14) |

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UPPER PIIHONUA (Cont.)

1184	Elder: HDFG: Woodside: 14 seen	Saddle Road	24 July 1956	(1)
1185	Elder: HDFG: Uemura: 28 seen	Saddle Road	1 Aug. 1956	(1)
1186	Woodside: initiated watch at 0700...saw 6 in groups of 2 and 4, then all paired 2-2-2 at 0733...at 0740 saw flight of 10 grouped 2-8 then 2-4-4 then 2-3-5...another flight of 8 closely together...both flights headed about Az 130°...at 0745 saw 4 pretty closely together then grouped 3-3, headed about Az 140°...returned to Pohakuloa at 1157 a.m...28 total	above 1855 flow marker on Saddle Road	1 Aug. 1956	(14)
1187	Elder: HDFG: Woodside: 15 seen	Saddle Road	7 Aug. 1956	(1)
1188	Woodside: initiated watch at 7:30 a.m...9 flew across Road from Pui Oo Ranch on Az 135°...very noisy...at 8:24 6 nene crossed over Road...abandoned watch at 9:05...	1855 marker on Saddle Road	7 Aug. 1956	(14)
1189	Woodside: thought nene heard at 5:25 p.m.	camped on 1852 lava flow south of 16 3/4 mile location above Hilo on Saddle Road	7 Aug. 1956	(14)
1190	Woodside: heard nene at 7:05 a.m...saw 2 nene fly up the flow and apparently land 3/4 mile above camp...10 nene grouped 4-2-2-2 came over and flew down the flow toward camp...were very noisy but became quiet after landing...10:15 left camp after observing various activities of nene landing below camp...saw some recent droppings on 1881 flow near trail entrance (south side) on return hike to vehicle...	camped on 1852 lava flow south of 16 3/4 mile location above Hilo on Saddle Road	8 Aug. 1956	(14)
1191	Elder: HDFG: Uemura: 24 seen	Saddle Road	11 Aug. 1956	(1)
1192	Woodside: arrived 0628...saw 3 fly over Road at 0728...saw 4 flying over toward Mauna Loa on Hilo side of me at 0745...at 0823 saw groups of 2-2-9-4 fly over Road...left post at 1030...24 total	observation post at pipe near 1855 lava flow sign, Saddle Road	11 Aug. 1956	(1)
1193	Elder: Peacock (interviewed 12 Sept. 1956): saw 7 flying...about a month ago	crossed Saddle Road at half-way point...toward 1935 (lava) flow	ca. 12 Aug. 1956	(1)
1194	Elder: HDFG: Lee: 12 seen	Saddle Road	22 Aug. 1956	(1)

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UPPER PIIHONUA (Cont.)

1195	Woodside: arrived 0620...3 nene flew across Road at about 17 1/2 mile distance from Hilo headed Puna...2 flew over at 19 mile marker at 0820...7 flew over...3 telephone poles Hilo of 19 mile marker...departed post at 0935...	observation post near 18 mile marker, Saddle Road	22 Aug. 1956	(14)
1196	Woodside: arrived 0635...saw 2 flying 1 mile west of me at 0742...at 0817 heard then saw 3 flying about a mile east of me...apparently 1 male and 2 females...left post at 1030...5 birds total seen	observation post near 1855 lava flow sign, Saddle Road	28 Aug. 1956	(14)
1197	Elder: Peacock (interviewed 12 Sept. 1956): 2 seen flying...2 weeks ago	Saddle Road, 20 mile (highway) marker	30 Aug. 1956	(1)
1198	Woodside: Lee: Uemura: no signs found on the 1855 lava flow...piles of droppings appeared as if nene roosted there but some time ago...on the 1881 flow about 1 1/2 miles mauka of our old camp site...few droppings scattered here and there seemed as if they were this year's...several "brownuki grass" (<i>Cladium angustifolia</i>) were nipped at base presumably by nene...droppings inspected were found to contain abundant ohelo berry seeds with much papers believed to be from the "brown uki grass"...	Lee and Uemura hiked from Saddle Road on the old telephonen line trail for the 1881 lava flow heading toward Mauna Loa skirting the kipukas below on Hilo side...continued until met by Woodside and Elder...all returned to vehicles on trail to Saddle Road	10 Sept. 1956	(14)
1199	Elder: Veriato (interviewed 25 Sept. 1956): seen many times	on 1880 flow 2 miles below Volcano trail	(1956)	(1)
1200	Elder: T. Lindsey (interviewed 12 Sept. 1956): flocks of 5-25...frequently seen on ponds	opposite 1935 (lava) flow near 19 mile (highway) mark, Puu Oo Ranch	(1956)	(1)
1201	HDFG: 28...highest count obtained	on Puu Oo Ranch roosting area or...flying over Saddle Road	1956	(81)
1202	Elder: Cadio via Shipman: saw 16 on ground	below telephone line on flats below Puu Oo	26 June 1957	(1)
1203	cowboy reported 16	Saddle Road (flights)	26 June 1957	ELDW58
1204	pair with 4 young seen	Puu Oo Ranch summering ground	2	
1205	Elder: Carlsmith: saw 6 fly over	18 mile marker on Saddle Road	8 July 1957	ELDW58

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UPPER PIIHONUA (Cont.)

1206 pair with 2 young seen (color banded)	Saddle Road (flights)	7,9 July 1957	ELDW58
1207 pair with 2 young seen	Saddle Road (flights)	7,9 July 1957	ELDW58
1208 pair with 1 young seen	Puu Oo Ranch summering ground	10 July 1957	ELDW58
1209 trio seen	Puu Oo Ranch summering ground	10 July 1957	ELDW58
1210 pair with 3 young seen	Puu Oo Ranch summering ground	14 July 1957	ELDW58
1211 pair with 2 young seen	Puu Oo Ranch summering ground	10,14 July 1957	ELDW58
1212 pair with 2 young seen (color banded)	Puu Oo Ranch summering ground	10,14 July 1957	ELDW58
1213 pair with 1 young seen	Saddle Road (flights)	9,17 July 1957	ELDW58
1214 trio seen	Saddle Road (flights)	7,9,23 July 1957	ELDW58
1215 pair seen	Puu Oo Ranch summering ground	2 July; 7,10 Aug. 1957	ELDW58
1216 pair with 4 young seen	Saddle Road (flights)	7,8,9,17,20,23 July; 10 Aug. 1957	ELDW58
1217 pair with 3 young seen	Saddle Road (flights)	7,9,17,23 July; 10,11 Aug. 1957	ELDW58
1218 pair seen	Saddle Road (flights)	3,6,9,19,21,23 July; 10,27 Aug. 1957	ELDW58
1219 largest count was 35...probably all or nearly all that remain alive in the wild today	frequent counts...departing from this ranch (Puu Oo) in the morning made possible good population estimates	(1956-1957)	ELDW58

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UPPER PIIHONUA (Cont.)

1220	HDFG: 22...highest count obtained	on Puu Oo Ranch roosting area or...flying over Saddle Road	1957	(81)
1221	HDFG: 22 were observed crossing the Saddle Road on the morning of 17 July...cannot be considered a complete count...past experience has shown that the number making the daily flight from the roosting grounds to feeding areas varies daily...evidence of roosting has been found on the 1881 and 1852 lava flows which were in past years normally visited principally only during the day...by September very few droppings were found in the summer grounds...	Saddle Road flyway	1 July 1957- 30 June 1958	(21)
1222	HDFG: 22 observed...cannot be considered as a complete count of all the birds using the summer range, however...	flying over the Saddle Road	17 July 1958	(10)
1223	HDFG: evidence of roosting has been found...in past years normally visited principally during the day	on the 1881 and 1852 lava flows	summer of 1958	(10)
1124	Woodside: nobody...had seen the nene use the flyway this year	Saddle Road	mid-Aug. 1958	BALH58
1125	unsuccessful watches for morning/ evening flights...3 days	Saddle Road, 15 mile (highway) marker from Hilo	mid-Aug. 1958	BALH58
1226	HDFG: 3...highest count obtained	on Puu Oo Ranch roosting area or...flying over Saddle Road	1958	(81)
1227	HDFG: 15...highest count obtained	on Puu Oo Ranch roosting area or...flying over Saddle Road	1959	(81)
1228	HDFG: The bulk of the wild nene on Hawaii followed the same general pattern of movements and activities as has been observed the last four years. They moved north of the (Keauhou) breeding grounds to the lava fields and Puu Oo Ranch lands during the summer, establishing a daily pattern of roosting north of the Saddle Road and flying south to the various flows mostly within the Upper Waiakea Forest Reserve in the mornings. After spending the day on the flows, they would return to the ranch area before dark. By September they began to return to Keauhou Sanctuary.	Saddle Road flyway	1 July 1959- 30 June 1960	(23)

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UPPER PIIHONUA (Cont.)

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| 1229 | HDFG: Observations of wild nene proved that the basic pattern of breeding in the Keauhou "Mauna Loa Strip" area and moving north to the Puu Oo-Upper Waiakea area for the summer was followed as usual. However, the movement to the summer ground was apparently delayed until September by exceptionally dry weather. | Saddle Road flyway | 1 July 1960-
30 June 1961 | (24) |
| 1230 | HDFG: Wild nene exhibited the same seasonal tendencies as in previous years...as many as 37 birds noted at one time crossing the Saddle Road to and from the summer roosting area...one of these birds was a banded wild bird...it was not possible to identify the others...numbers seen tapered off until early September when it was assumed the flights had stopped...another extremely dry summer followed by substantial rains in September... | Saddle Road flyway | 1 July 1961-
30 June 1962 | (25) |
| 1231 | HDFG: Off-breeding season flights of nene between the feeding and roosting areas were again concentrated in July and August. The width of the strip of observation points on the Saddle Road was about 9 miles wide, and at one time a total of 30 nene were recorded flying over. Sightings were made as late as October, but at this time the birds were paired. | Saddle Road flyway | 1 July 1962-
30 June 1963 | (26) |
| 1232 | HDFG: ...a maximum of 9 was seen in August on their summer counts were greatly curtained due to lack of personnel to man the flyway stations...counts were made throughout the summer but yielded minimum results.. | Saddle Road-Puu Oo flyway | (1 July 1963-
30 June
1964) | (27) |
| 1233 | HDFG: ...all attempts to learn where nene go during their morning summer flight by following them in aircraft was thwarted by adverse weather conditions and poor ground-to-air communication...it is assumed that they go to the 1852 and 1881 lava flows to feed during the day since this is their approximate line of flight...moreover, none are seen in other areas indicating that all or most of the birds go to this remote area to feed during the summer... | Saddle Road-Puu Oo flyway | 1 July 1964-
30 June 1965 | (28) |

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UPPER PIIHONUA (Cont.)

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| 1234 | HDFG: ...observations indicated that nene followed usual pattern of seasonal movements...to Puu Oo during the summer and a return to the Keauhou nesting area during fall and winter...a maximum of 48 were counted on the summer flyway in August...extensive searching over the entire nesting area and adjacent Kipuka Keawewai indicated that nene were not in the area for all of July, August and up to mid-September...2 red banded, 1 green banded, and 1 goose released in 1961 at Keauhou Sanctuary, were positively identified at the summer Puu Oo roosting site in company with 32 unbanded nene...these banded birds have been seen at Keauhou Sanctuary during the nesting season for the past 4 years...however they were not seen in this same area during the summer. | Puu Oo | 1 July 1964-
30 June 1965 | (28) |
| 1235 | HDFG: ...greater efforts should be made to locate the nene summering place...areas should be sought where the unbanded nene seen at Puu Oo may be carrying out their breeding activities... | Puu Oo | 1 July 1964-
30 June 1965 | (28) |
| 1236 | HDFG: ...conducted reconnaissance surveys to determine nene usage...only the upper portions above 4,500 ft. el...where an abundance of preferred plant food, such as ohelo, kukainene, and pukeawe occurs, are suitable as nene habitat...the remainder consists of an extremely dense association of staghornfern, pukeawe, ukiuki grass, and scrub ohia in half of the area, and a dense ohia rain forest in the other half... | 1852 and 1881 Lava Flows | 1 July 1965-
30 June 1966 | (29) |
| 1237 | HDFG:...annual summer counts showed a significant increase...compared to a maximum of 37 nene counted in August 1964, 3 successive counts made in August 1965 totaled 76, 51, and 61 nene respectively... | Saddle Road-Puu Oo flyway | 1 July 1965-
30 June 1966 | (29) |

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UPPER PIIHONUA (Cont.)

1238 HDFG: re-release of a pair (originally liberated at Keauhou 2 in April 1965) was made near a flock of wild nene at Puu Oo in late July...these birds had been frequenting a 2-mile stretch of the Holualoa Road in Holualoa, Kona, for more than a month when they were caught by two juveniles...confiscated by Warden Crisafi and taken to Pohakuloa...to release them at Keauhou 2 would have resulted in their capture again since they were quite tame...it was hoped that this banded pair would remain with the flock of wild nene...assisting in tracing movements, survivability and productivity of this wild flock...unfortunately the banded pair has not been seen since their release at Puu Oo...

Puu Oo

1 July 1965- (29)
30 June 1966

1239 HDFG: The "Blue Goose", her mate, the Maui Gander, and their 2 young (females) returned to Pohakuloa in August and were captured. The "Blue Goose" was culled since she had the undesirable, hairy-down character and had made a nuisance of herself by repeatedly returning to the pens at Pohakuloa and greatly disturbing the nene breeders. Three other nene that had the hairy-down characteristic proved themselves unsuitable for release. They were unable to adapt to the wild state and had to be returned to the pens, each of them in an emaciated condition. The Maui Gander and his 2 young, the latter being color-banded at Pohakuloa, were released at Puu Oo near a flock of wild nene in late August 1965.

Puu Oo

1 July 1965- (29)
30 June 1966

On October 12, 1965, the Maui Gander, one of his young, and a goose released at Keauhou Sanctuary in March 1965, returned to the nene pens at Pohakuloa and were captured. The goose (#239) was of breeding age, having been released the second year after hatching. She appeared to be mated to the Maui Gander and apparently tolerated the presence of the young goose, since the pair was not actively nesting at the time of the capture. This captive trio was re-released in the Keauhou release pen on October 14, 1965, the third and final release.

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UPPER PIIHONUA (Cont.)

1240	HDFG: Flyway counts during the month of August produced maximum daily totals of 44 and 45 nene crossing the Saddle Road between the 18 and 20 mile post...a total of 54 nene was checked on the Puu Oo roosting grounds for bands, of this total 48 were identified as unbanded or otherwise wild birds...remaining 6 were banded, 4 from 1960 Keauhou release, one from the 1961 release, and the 6th was from a brood of 2 goslings captured at Keauhou in January 1957, banded and released immediately...	Saddle Road-Puu Oo flyway	1 July 1966- 30 June 1967	(30)
1241	HDFG: Summer flyway counts were conducted during August and September...counters at the 19 and 20 mile posts on Saddle Road...the 2 positions found to be the most productive for counting nene flying between Puu Oo Ranch, where they spend the night, to slopes of Mauna Loa where they spend the day...high count of 46 made in August...compared with 45 in 1966...numbers gradually tapering as usual until only a few pairs were counted in September...field trips was made into the Puu Oo Ranch pastures and Kipuka Ainahou in order to compare the number seen there with the numbers seen on the flyway...observations indicated approximately 40 wild unbanded nene were utilizing Puu Oo Ranch pastures...2 banded nene seen...a wild goose banded at Keauhou Sanctuary, the other goose raised at Pohakuloa and released at Keauhou...these totals compare with 48 wild nene and 6 banded birds observed at Puu Oo in 1966...there may have been more nene in the Ranch pastures than were observed...most observations were made late in the day when fog and rainy weather normally associated with this elevation often prevailed...	Saddle Road-Puu Oo flyway	1 July 1967- 30 June 1968	(31)
1242	HDFG: 15 counted, annual flyway survey	Puu Oo pastures	22 July 1968	(32)
1243	HDFG: 3 counted, annual flyway survey	Saddle Road flyway	23 July 1968	(32)
1244	HDFG: 45 counted, annual flyway survey	Saddle Road flyway	2 Aug. 1968	(32)
1245	HDFG: 26 counted, annual flyway survey	Puu Oo pastures	8 Aug. 1968	(32)
1246	HDFG: 9 counted, annual flyway survey	Puu Oo pastures		
1247	HDFG: 8 counted, annual flyway survey	Saddle Road flyway	23 Aug. 1968	(32)
1248	HDFG: 8 counted, annual flyway survey	Puu Oo pastures	29 Aug. 1968	(32)

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UPPER PIIHONUA (Cont.)

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| 1249 | HDFG: 14 counted, annual flyway survey | Puu Oo pastures | 30 Aug. 1968 | (32) |
| 1250 | HDFG: A gander released at Keauhou in 1965, mated with an unbanded goose, was the only banded bird seen during the summer flyway surveys...this pair successfully raised 4 goslings which were seen frequently in the Keauhou Sanctuary. As juveniles, they were still accompanying their parents during the summer flights...the observation of only 1 banded bird on the flyway this year, compared with 6 banded birds in 1967, was disappointing... | Saddle Road-Puu Oo flyway | July, Aug. 1968 | (32) |
| 1251 | HDFG: 2 arrived at Pohakuloa on New Year's day and were captured a few days later...subsequently both were released at Keauhou Sanctuary...one of the birds was a gosling captured at Keauhou in Feb. 1969 and reared at Pohakuloa for 2 months before being returned to the sanctuary for release...the other bird was reared at Pohakuloa and released at Keauhou Sanctuary in 1968...these records are of interest because the former returned to Pohakuloa and was not seen at Puu Oo, while its sibling, which was also reared at Pohakuloa for 2 months, was observed at Puu Oo...the latter, a goose, is the first Kahuku release nene to appear in the summer flyway...July 1969... | Saddle Road flyway | 1 Jan. 1970 | (33) |

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UPPER PIIHONUA (Cont.)

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| 1952 | HDFG: Annual summer flyway counts were conducted 29, 30 July and 6 Aug. 1969...July counts in the Puu Oo pastures and the Aug. count on the Saddle Road flyway...only 87 on the flyway, whereas 114 and 106 were counted in the pasture...high count of 114 nene recorded as the birds flew into the pastures in the evening...nearly 3 times more than last year (45)...the 106 were counted as they departed from the pasture early in the morning...highest number counted on the Saddle Road flyway was 87...far exceeding the 45 bird total counted last year...though actually lower than the number that traversed the flyway...fog obscuring portions where nene were heard though could not be counted by 3 observers in good coverage provided...only 12 of the 80 nene examined on the ground (July 1968) were banded...banded individuals represented...1 captured as a gosling at Keauhou in 1957, banded and released in the field; 4 1960 Keauhou release; 1 1961 Keauhou release; 3 1965 Keauhou released; 1 1967 Kahuku release; 1 captured as a gosling at Keauhou in Feb. 1968, reared at Pohakuloa and released again at Keauhou; and 1 captured as a gosling at Keauhou in Apr. 1968, banded and released in the field. | Saddle Road flyway | 1 July 1969-
30 June 1970 | (33) |
| 1253 | HDFG: Annual summer flyway counts...produced totals of 15, 9, 21, and 2 nene on successive days in July, while only 12 were seen in August...variation in number observed being caused, in part, by adverse weather conditions...fog and rain reducing vision...on foggy days nene were heard as they flew south across Saddle Road but they could not be seen or counted...maximum count of 21 thus compares very unfavorably with the maximum of 87 counted on the flyway the previous years...

Flyway counts during the period 1961 through 1969 indicated an increase in the population utilizing the flyway...from 37 in 1961 to 114 in 1969...although 76 were counted in 1965, low counts of 42, 46 and 45 were recorded for 1966, 1967 and 1968, respectively...these data lead us to believe that the few nene counted this year represent a decline in usage of the flyway and Puu Oo pastures, rather than a decline in the population. | Saddle Road-Puu Oo flyway | 1 July 1970-
30 June 1971 | (83) |

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UPPER PIIHONUA (Cont.)

1253 Ground checks of the Puu Oo pastures were made to locate birds on the
(Cont) roosting areas...totals of 31 and 27 were seen on 2 successive days in
July...none were seen in August...as with flyway counts...fog and rain made
it very difficult to observe nene in the pastures.

Saddle Road-Puu Oo flyway

1 July 1970- (83)
30 June 1971

A comparison of flyway counts and ground counts indicates that the latter
may be a better index to the population which utilizes the flyway and
pastures. It also provides information on movements and dispersal through
identification of individual banded birds. When manpower limitations
dictate the use of only 1 technique, ground counts will be used to obtain
an index of population.

Two Kahuku released nene were identified in the Puu Oo pastures. Both
were released in Kahuku in 1968...observations represent dispersal of
approximately 35 miles from the release site...these are the second and
third Kahuku released nene to be observed at Puu Oo.

1254 HDFG: following data summarize the highest counts...during each of the
last 15 years of summer observations...there are many more birds observed
on the flyway counts and on the roosting grounds than can be accounted
for in the Keauhou Sanctuary during the nesting season...about 90% of the
nene on the roosting grounds are unbanded and presumed to be wild
birds...many spend the day on the 1852 and 1881 lava flows, but efforts to
locate other feeding and resting grounds on the slopes of Mauna Loa have
been unsuccessful...birds may be coming to this summer area from as far
away as South Kona...

observed on the roosting area in 24 1955
Puu Oo Ranch or seen across 28 1956
Saddle Road 22 1957

3 1958
15 1959
32 1960
37 1961
30 1962
9 1963
48 1964
76 1965
42 1966
46 1967
45 1968
114 1969
(incomplete
count) 1970
113 1971

HAWS74

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

1255 HDFG: ...annual summer flyway counts started the first week of August...counts across the Saddle Road produced maximum total counts of 59 and 106 nene...counts in Puu Oo Ranch pastures appeared to produce more accurate data besides such additional information as band combinations, condition of the birds and family groups...some of the juveniles can still be recognized as such, especially when they are still with their parents in a family group...therefore more time was devoted to counting the nene as they flew in or out of the pastures...this method also provided a higher total count...Puu Oo pasture counts producing totals of 113, 109, 10, 113 and 85 nene within a 2-week interval in August...the large reduction on the 3rd count due to very inclement weather which obscured the birds, or discouraged them from leaving ground. More counts were actually made but have not been reported because adverse weather conditions made many tallies so incomplete that they were not valid...only 7 nene were seen flying out of Puu Oo ranch pastures on 24 September 1971.

Saddle Road-Puu Oo flyway

1 July 1971- (35)
30 June 1972

...count this year compares very favorably with the trend indicated by the preceding years...data indicating that population utilizing Puu Oo pastures has been steadily increasing since the first counts were made in 1955.

...it was possible to check approximately 90% of the 113 nene observed in the pastures for color bands...17 color band combinations were recorded...indicating that released birds comprise 18% of the summer flyway population...the remaining 82% being unbanded wild birds.

...one of the 17 banded birds observed at Puu Oo pastures was from a release at the Kahuku Sanctuary...it had been observed here previously...15 banded individuals were from Keauhou Sanctuary...origin of 1 color band combination is a mystery as the bands indicated that the individual was released on Maui...our opinion is that this individual had lost a band identifying it as a bird released on the island of Hawaii.

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

1256 HDFG: The initial summer flyway census was conducted during the first week of August in the Puu Oo Ranch pastures and along the Saddle Road. It was soon apparent that the nene were not using their customary routes and roosting areas. The Puu Oo Ranch foreman also noticed that the birds were not utilizing the pastures this summer.

Saddle Road-Puu Oo flyway

1 July 1972- (36)
30 June 1973

Frequent trips to Puu Oo Ranch during the early part of August failed to reveal more than 6 nene using the area on any one day. The flyway counts on the Saddle Road did not reveal any nene flying towards Puu Oo. The highest flyway count made during the month of August was 11 nene flying towards Mauna Loa. This flock proved to be the highest number counted during the entire summer. The number of nene sighted each day decreased rather than increased in September.

Ground surveys in the Puu Oo pastures revealed that the birds flying in were all wild, unbanded birds; no banded birds were recorded during the summer.

The few seen contrast with the high numbers of nene counted last year when 113, 109, and 85 were seen on a single day and when 17 banded birds were recorded. The reason for this lack of usage of the summer roosting areas during certain years is unknown. Since the flyway counts were started in 1955, there have been several years when the nene have not utilized the summer roosting grounds and this is not the first time the counts have been so low. There is, however, an overall trend of increased use of the summer flyway.

There were several reports of flocks of nene numbering 20 or more crossing the Saddle Road at the 22 to 23 mile posts late in the season. Subsequent trips into this area failed to reveal nene on a regular basis. It appears that this flock of nene were merely wanderers that occasionally crossed the Saddle Road.

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Mauna Kea District**

UPPER PIIHONUA (Cont.)

- 1257 HDFG: The first summer flyway census was conducted on 30 July 1973 and a total of 72 nene was counted as they flew across the Saddle Road towards Mauna Loa from the Puu Oo pastures. A substantive count made on the following day revealed only 68 nene utilizing the flyway. This number continued to decline until the middle of September. The counts indicated that the summer flyway had peaked by the end of July and started declining in August. This same phenomena occurred in September during the previous year's census. Only 7 nene served during the first week of September and the flyway was considered abandoned by September 13.
- The maximum count of 72 nene was higher than the maximum of 11 nene seen in August 1972, but considerably lower than the high of 113 counted in 1971.
- Ground surveys in the Puu Oo pastures revealed the presence of 5 banded nene. Four of them were from the Keauhou Sanctuary: 1 from the 1960 release, and 3 from the 1970 release. The fifth nene was a bird released on Maui in 1962. This nene was subsequently taken to Pohakuloa with a broken wing on 13 January 1974.
- Saddle Road-Puu Oo flyway 1 July 1973- (37)
30 June 1974
- 1258 HDFG: The first summer flyway count on the Saddle Road was made on 22 July 1974, and only four nene were observed on that day. The next day the Puu Oo Ranch pastures were searched and no nene were seen in the Ranch. Ranch employees confirmed that the regular summer flight had not yet started and that no flocks of nene had been seen in any of the pastures.
- Saddle Road-Puu Oo flyway 1 July 1974- (38)
30 June 1975

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

- 1258 Subsequent flyway counts showed that very few nene were using the Puu Oo pastures. The highest count made in a single day during the summer was 58 nene, but some of these birds were recently released birds from the Kipuka Ainahou Sanctuary and not regular flyway birds. The majority of the birds counted this summer were Kipuka Ainahou birds that were disoriented and wandering aimlessly in search of feeding and roosting areas. The proximity of this newly created sanctuary apparently disrupted the normal flight pattern of many of the regular summer birds. The Kipuka Ainahou birds also joined flocks of summer flyway birds and followed these older birds on their way to Mauna Loa and Keauhou.
- The Puu Oo Ranch pastures were checked during the summer, but all the color bands recorded were those of Kipuka Ainahou released birds.
- 1259 HDFS: The first summer flyway count was made on 19 August 1975. A total of 50 nene was counted flying across Saddle Road. Twenty-three of this number were observed flying from Puu Oo toward Mauna Loa, which is the normal pattern. The remaining 27 were actually flying in the opposite direction from the slopes of Mauna Loa towards the Puu Oo Ranch pastures. A total of 25 nene was counted flying towards Mauna Loa on the following day, as well as a week later. The largest number of nene counted flying towards Mauna Loa in the morning was the 39 nene seen during the last week of August. Considerably fewer nene were counted using the regular summer flyway this year, compared to the previous year's high of 58 nene.
- A large number of nene were seen flying every morning from the Kipuka Ainahou Nene Sanctuary into the Puu Oo Ranch lands, as well as adjacent lava flows. The proximity of the sanctuary and the newly released nene from there, greatly affected the normal flyway pattern. Many of the regular flyway birds apparently joined the flocks of newly released birds and discontinued the usual flyway pattern. It was not possible to determine the exact number of nene utilizing the flyway because of the random movement of the young nene released in Kipuka Ainahou.
- | | | | |
|--|---------------------------|------------------------------|------|
| | Saddle Road-Puu Oo flyway | 1 July 1974-
30 June 1975 | (38) |
| | Saddle Road-Puu Oo flyway | 1 July 1975-
30 June 1976 | (45) |

**Island of Hawai'i
Mauna Kea District**

UPPER PIIHONUA (Cont.)

- | | | |
|---|----------------------------------|--|
| <p>1259 Nearly all of the color banded nene recorded in the Puu Oo pastures this
(Cont) summer were those from the 1974 and 1975 Kipuka Ainahou releases. Only one 1970 Keauhou released nene, paired with an unbanded bird, was observed in Puu Oo Ranch.</p> | <p>Saddle Road-Puu Oo flyway</p> | <p>Saddle Road-
Puu Oo
flyway (45)</p> |
| <p>1260 HDFG: No nene were observed on the summer flyway in September, when they are usually observed. In addition, only a few birds were seen in the Puu Oo pastures, mostly from the Kipuka Ainahou releases. Only one unbanded pair was observed in the pastures this year. Normally at least two-thirds of the birds observed there are unbanded nene. The effects of drought are probably responsible for the usual distribution of nene this year.</p> | <p>Saddle Road-Puu Oo flyway</p> | <p>1 July 1976-
30 June 1977 (46)</p> |
| <p>1261 HDFG: No nene were seen on their traditional summer flyway across the Saddle Road. None were observed during late August and early September when flyway counts are usually conducted.</p> <p>A check of the Puu Oo pastures revealed the presence of a few nene. Some birds were also seen in the Humuula pastures of Parker Ranch. Most of the birds observed were near or around the edges of the cattle waterholes in these pastures. Nearly all the banded nene were from Kipuka Ainahou Nene Sanctuary releases. The decline in banded nene from the Keauhou Sanctuary is believed to be related to the disrupted movement patterns of nene in response to the prolonged drought.</p> | <p>Saddle Road-Puu Oo flyway</p> | <p>1 July 1977-
30 June 1978 (47)</p> |
| <p>1262 HDFG: 2 young nene seen with group of 4 banded adults</p> | <p>Puu Oo Ranch</p> | <p>6 May 1980 (44)</p> |
| <p>1263 HDFG: ...38 unbanded nene observed...the majority of nene sighted this year</p> | <p>Puu Oo Ranch pastures</p> | <p>1 July 1979-
30 June 1980 (44)</p> |
| <p>1264 HDFG: ...searched for nene during the summer of 1981 and a high count of 29 was recorded one morning. Fourteen were unbanded wild birds and 15 were banded; all were released at Kipuka Ainahou except for 2 with lost band combinations.</p> | <p>Puu Oo Ranch pastures</p> | <p>1 July 1981-
30 June 1982 (58)</p> |

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UPPER PIIHONUA (Cont.)

1265 HDFG: The largest flock of nene seen this summer in the Puu Oo Ranch pastures was 13 birds. Nine were unbanded, the four banded birds were all Kipuka Ainahou releases, two from 1974 and two from 1975

Puu Oo Ranch pastures

1 July 1984- (89)
30 June 1985

One pair of nene was seen repeatedly in the Parker Ranch pasture just above the Puu Oo trail on the Saddle Road. This pair was seen here during the 1982-83 breeding season and attempted a nest then. The gander was an unbanded bird and the goose was a banded 1975 Kipuka Ainahou released bird. Although this pair was seen sporadically in this area for at least two months during the breeding season, no nesting attempt was observed.

PIIHONUA

1266 Elder: Veriato: saw 2

Pukamaui
Falls, north
of Saddle
Road above
Kaumauna

1941

(1)

HILO

1267 Elder: man shot 1

where Hilo
High School
now stands

late 1930's

(1)

1268 HDFG: unbanded nene captured...turned over to Division personnel...It was taken to Pohakuloa where it was examined by Dr. Renata Gassman-Duvall. It was an older, five year plus, bird with a slipped tendon that causes its right foot to turn outward. It was an old injury, and there was no remedy for its ailment, so it was re-released along the Saddle Road in the company of other Nene.

in the
Waiakea-Uka
area of Hilo

1 July 1986- (99)
30 June 1987

**Island of Hawai'i
Mauna Kea District**

KEAAU RANCH

- | | | | | |
|------|--|---------------------------------------|--------------------------|--------|
| 1269 | from 2 pairs in 1918 his (Shipman's) flock grew to 42 birds...reduced by tidal wave and other tragedies to a remnant of 11 birds in 1949 | at his estate near Hilo (Keaau Ranch) | (1918-1949) | SMIJ52 |
| 1270 | HDFG: Four (2 pairs) nene intended for release into Keauhou Sanctuary were given to Shipman Estate to re-establish a breeding colony at Keaau. This is where nene were originally reared by Herbert Shipman and it was from here that the State of Hawaii received the original nene to start the propagation project at Pohakuloa in 1979 | Shipman's Keaau Ranch | 1 July 1983-30 June 1984 | (60) |
| 1271 | HDFG: 1 young gander (presumably produced at Pohakuloa) was released | Shipman's Estate, Keaau | 1 July 1985-30 June 1986 | (93) |

KEAMUKU

- | | | | | |
|------|--|--|------------|-----------|
| 1272 | Elder: Vredenberg (interviewed 26 Sept. 1956): saw 30-40...came to old water trough...where they were fed weekly | (near Puu Keekee, Parker Ranch) | | 1914-1915 |
| 1273 | Elder: Vredenberg (interviewed 26 Sept. 1956): frequently saw a few pairs | at Puu Kapele, on the Saddle Road | up to 1918 | (1) |
| 1274 | T. Lindsey: saw some | south of (Waiulaula Gulch) at Keamuku in Waikoloa at ca. 3,250 ft. el. | 1925 | BALP45 |
| 1275 | Elder: Harry Kawai (life-long employee of Parker Ranch): seen only once when he flushed a pair | near Keaumuku House | 1936 | (1) |

**Island of Hawai'i
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KEAMUKU (Cont.)

1276	Elder: Horner: saw a pair at a distance of 40 ft.; they hissed but did not fly (? nesting)	near Keamuku House, Puu Waawaa side of Keamuku lava flow	1936 and following years	(1)
1277	Donaghho: Payne: 1 or 2 other flocks	near Puu Ka Pele	(June-Aug. 1937)	(4)
1278	Rickard: 1 circled in flight	over the Parker Ranch cabin a few mileseast of Puu Ka Pele	1939	BALP45
1279	Elder: Bell: saw flock of about 30, 3-4 times	1 mile south Keumoku (Keamuku) House, few miles from Puu Waawaa	1939	(1)
1280	D. Paris: pair built a nest	rough ground 3 miles northeast of Keamuku at 3,750 ft. el.	1940	BALP45
1281	Vrederberg: small flock	on the Keamuku Lava Flow immediately south of Puu Ka Pele, 6,000'	1942	BALP45

**Island of Hawai'i
Mauna Kea District**

KEAMUKU (Cont.)

1282 P. Baldwin, 13 Apr. 1943: Vredenberg: recently saw a flock...we did not find any droppings...though we did not make exhaustive search...	Puu Ka Pele...just outside...to the east...Parker Ranch sheep-proof fence (land of Waikoloa)	1942	(7)
1283 P. Baldwin, 13 Apr. 1943: Vredenberg: seen...in this kipuka	Kipuka Kalawamauna and vicinity	(ca. 1942)	(7)
1284 P. Baldwin, 13 Apr. 1943: Bryan: flushed some when...hiked across driest part	Kipuka Kalawamauna and vicinity	(ca. 1942)	(7)
1285 Elder: Cambra: saw up to 15 nene many times	7 miles SE of road between 1859 (lava) flow and Kuainiho	1936-1943	(1)
1286 Vredenberg: occurred	mamane groves above Kipuka Kalawamauna	during recent years	BALP45
1287 Vredenberg: flocks of nene seen	in Waikii Gulch at 4,150 feet...on the gentle slopes of Mauna Kea in south Kohala	in recent years	BALP45

**Island of Hawai'i
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KEAMUKU (Cont.)

1288	Elder: Bell: saw 2-3 at tank only a few miles from flock sighting of 1939, probable remains of flock after military occupation	Puu Keekee	1948-1949	(1)
1289	Elder: HDFG: Walker: saw 12 fly makai (seaward)	Waikii	end of Oct. 1951	(1)
1290	Elder: E. W. Low: seen	upper Keamoku lava flow at Kalawarnauna in saddle between Hualalai and Mauna Kea	(years ago)	(1)
1291	Elder: S. Kahola (interviewed 28 Sept. 1956): found nest on trail	mauka (toward the mountain) of the prison water tank nr. Kuainiho...4 mi. from main road	(1956)	(1)
1292	HDFG: ...an unbanded nene was recorded...a considerable distance from any areas of known wild nene populations	in the patures of Waikii	1 July 1962- 30 June 1963	(26)
1293	HDFG: ...a bird released at Keauhou-2 in 1962 was observed by Parker Ranch employees in the Waikii area...approximately 18 miles distant...surviving at least 7 years in the wild...	Waikii area	1 July 1968- 30 June 1969	(32)

AHUMOA

1294	2 pairs placed in pens	Pohakuloa	Aug. 1949	SMIJ52
1295	Honolulu Zoo gander and wild-caught goose placed in pen	Pohakuloa	1950	SMIJ52
1296	only 1 pair produced young...3 sent to England and produced no young	Pohakuloa	(1950,1951)	BAKJ51

For history of production of captive-reared Nene at Pohakuloa Propagation Facility 1949/50 to 1987/88 see Hawaii State Restoration Program, Part II

**Island of Hawai'i
Mauna Kea District**

AHUMOA

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|------|---|--------------------------------|----------------------------|------|
| 1297 | HDFG: one 1-week old gosling by a pair of 1957 wild-banded parents captured in January on Upper Seep, Keauhou Sanctuary, and taken to Pohakuloa for breeding stock...no other wild stock will be needed for the propagation phase... | Pohakuloa propagation facility | (1 July 1963-30 June 1964) | (27) |
| 1298 | HDFG: ...3 of 5 eggs found in nest 64-5 on Keawewai Flow, Keauhou Sanctuary, brought to Pohakuloa for incubation. Two eventually hatched but 1 was rotten... | Pohakuloa propagation facility | (1 July 1963-30 June 1964) | (27) |
| 1299 | HDFG: ...on one of the field trips into the Hualalai area a goose from the 1963 release was caught and returned to Pohakuloa...some primaries on both wings had grown out crooked, preventing normal flight...this bird was in a very emaciated condition when found, weighing about half its normal weight... | Pohakuloa propagation facility | (1 July 1963-30 June 1964) | (27) |
| 1300 | HDFG: ...the blue-banded goose and 7 other nene were sent to Maui for release in July...the blue-banded goose returned to Pohakuloa in January with a gander, presumably from the Maui release...this pair was caught and released at Keauhou...in February this pair had established a nest at Three Trees Kipuka...2 of the 3 eggs laid were hatched in March...both goslings inherited the hairy-down characteristics of the goose...this family remained in this kipuka until the goslings and adults attained flight after their summer moult... | Pohakuloa propagation facility | (1 July 1964-30 June 1965) | (28) |
| 1301 | HDFG: ...captured a nene released in March 1965 near the Kekekaniho waterhole...unable to fly...appeared to have lost its motor reflexes...veterinarian diagnosed that it was suffering from an acute wasted condition and not from botulism as first suspected...it has recovered somewhat after being kept in an isolation pen at Pohakuloa...however it is useless except as a skeleton...it still does not have much control of its motor reflexes. | Pohakuloa propagation facility | (1 July 1965-30 June 1966) | (29) |
- ...pair (originally liberated at Keauhou-2 in April 1965) seen frequenting a 2-mile stretch of the Holualoa Road...became very tame...captured by juveniles...confiscated by Warden Crisafi...taken to Pohakuloa...re-released near a flock of wild nene at Puu Oo in late July...not been seen since...

**Island of Hawai'i
Mauna Kea District**

AHUMOA (Cont.)

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|----------------|---|--------------------------------|----------------------------|------|
| 1301
(Cont) | The "Blue Goose", her mate the Maui Gander and their 2 young returned to Pohakuloa in August and were captured...the "Blue Goose" was culled since she had the undesirable hairy-down character and made a nuisance of herself by repeatedly returning to the pens at Pohakuloa and greatly disturbing the breeders...3 other hairy-down nene proved themselves unsuitable for release...unable to adapt to the wild state and had to be returned to the pens, each in an emaciated condition...the Maui gander and his two young (banded at Pohakuloa) were released at Puu Oo near a flock of wild nene in late August 1965.

...the Maui Gander, his mate, and a young gander presumed to be their young, returned to Pohakuloa on 28 June 1966...this pair had not been seen since their re-release at Keauhou on 14 October 1965...they left at dusk on the 28th and flew in a southeasterly direction toward Kipuka Aina Hou and Keauhou... | Pohakuloa propagation facility | (1 July 1965-30 June 1966) | (29) |
| 1302 | HDFG: ...a "dropped" egg found in Haleakala Crater proved infertile after incubation | Pohakuloa propagation facility | Feb. 1967 | (30) |
| 1303 | HDFG: ...the relatively low numbers of Pohakuloa-raised Maui-released birds seen suggests that perhaps these birds might be returning to the island of Hawaii which is clearly visible from the release site on Maui...witness the "Blue Goose" which has returned to Hawaii after being released on Maui... | Pohakuloa propagation facility | (1 July 1966-30 June 1967) | (30) |
| 1304 | HDFG: 2 goslings by banded pair taken from Bottom Seep, Keauhou, to Pohakuloa, banded and re-released on 11 Apr. 1968 | Pohakuloa propagation facility | 12 Feb. 1968 | (31) |
| 1305 | HDFG: Three 3-week old goslings (banded gander and unbanded goose) taken from Kipuka Kekekaniho to Pohakuloa; banded and re-released on 11 Apr. 1968 | Pohakuloa propagation facility | 14 Feb. 1968 | (31) |

**Island of Hawai'i
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AHUMOA (Cont.)

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|------|--|--------------------------------|----------------------------|------|
| 1306 | HDFG: ...2 broods of very young nene (2 and 3 ca. 5 days old) captured (at Keauhou Sanctuary) and taken to Pohakuloa for rearing to insure their safety and provide a source of wild nene for banding...this was done because of the difficulty of banding in the field requiring packing a portable stove to heat the plastic bands, water to cool and harden the bands, and other equipment...it was felt that the banding conditions at Pohakuloa would simplify the banding and reduce the chances of banding injury to the young nene...the brood of 3 goslings was by a 1-year-old gander released at Kahuku in May 1967, mated to an unbanded goose...1 gosling of this brood died shortly after capture...the remaining 4 were reared at Pohakuloa, later banded with colored bands and placed in the release pen at Keauhou before their primaries attained maximum growth... | Pohakuloa propagation facility | (1 July 1967-30 June 1968) | (31) |
| 1307 | HDFG: 2 banded nene seen during July / August flyway counts along Saddle Road...a wild goose banded at Keauhou Sanctuary and another raised at Pohakuloa and released at Keauhou... | Pohakuloa propagation facility | (1 July 1967-30 June 1968) | (31) |
| 1308 | HDFG: 2 nene from 1968 Kahuku release with damaged flight feathers were confiscated from Kau High School...taken to Pohakuloa for care...one retained for breeding when damage prove permanent, the other released after regrowing new flight feathers... | Pohakuloa propagation facility | (1 July 1968-30 June 1969) | (32) |
| 1309 | HDFG: ...2 emaciated nene with the same shaky condition associated with a vitamin deficiency were recovered at Kahuku Sanctuary...taken to Pohakuloa but failed to survive... | Pohakuloa propagation facility | (1 July 1968-30 June 1969) | (32) |
| | 1968-1969 breeding season was very poor compared with previous years...fewer nests found...hatching success considerably below that of previous year...extremely cold weather during the breeding season probably contributed to the poor hatchability, which was also the case at the Pohakuloa propagation facility | Pohakuloa propagation facility | 1 July 1968-30 June 1969 | (32) |

**Island of Hawai'i
Mauna Kea District**

AHUMOA (Cont.)

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|------|--|--------------------------------------|-------------------------------|------|
| 1310 | HDFG: ...2 arrived and were captured a few days later...subsequently both were released at Keauhou Sanctuary...one of the birds was a gosling captured at Keauhou in Feb. 1969 and reared at Pohakuloa for 2 months before being returned to the sanctuary for release...the other bird was reared at Pohakuloa and released at Kahuku Sanctuary in 1968...these records are of interest because the former returnee to Pohakuloa and was not seen at Puu Oo, while its sibling, which was also reared at Pohakuloa for 2 months, was observed at Puu Oo...the latter, a goose, is the first Kahuku release nene to appear in the summer flyway...July 1969... | Pohakuloa
propagation
facility | 1 Jan. 1970 | (33) |
| 1311 | HDFG: ...of the Nene released (at Keauhou Sanctuary) on 2 June 1970, five had not dispersed from the release pen...and were caught for holding at Pohakuloa until they were able to fly...they were unable to fly due to deformed primaries...some had twisted primaries while others had no re-growth of primaries because of dead feather germs...1 was emaciated and failed to survive the trip... | Pohakuloa
propagation
facility | 1 July 1970-
30 June 1971 | (33) |
| 1312 | HDFG: ...2 banded birds observed during the annual summer flyway count at Puu Oo pastures were from wild goslings caught at Keauhou Sanctuary, reared at Pohakuloa, and released at Keauhou in 1968 | Pohakuloa
propagation
facility | 1 July 1971-
30 June 1972) | (35) |
| | ...110 produced at Pohakuloa during the 1970-71 breeding season were color-banded in October...flight feathers plucked...and placed in Keauhou release pen...16 were unable to fly out of the release pen by 24 May 1972...they were captured and returned to Pohakuloa for closer examination...those that will be able to fly will be released later...those permanently disabled will be used for breeding stock. | | | |
| | ...2 banded birds returned to Pohakuloa and were re-released for the second time at Keauhou on 6 Dec. 1971...this pair had returned to Pohakuloa previously on 1 Jan. 1970, and were released at Keauhou on 24 Feb. 1970. The gander was a wild-released at Keauhou on 11 April 1968. The goose was a Pohakuloa-reared bird released at Kahuku on 3 Sept. 1968. These Nene were also observed at Puu Oo Ranch during the summer flyway counts. | Pohakuloa
propagation
facility | 1 July 1971-
30 June 1972) | (35) |

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AHUMOA (Cont.)

- 1313 HDFG: Nine of the 16 Nene which were returned from Keauhou to Pohakuloa on May 24, 1972, because of twisted primaries were re-examined and it was determined that another release would be worthwhile. The damaged flight feathers were removed a second time and they were placed in the Keauhou release pen on August 1, 1972. By November 15, 1972, 5 of the original 9 were still unable to fly out and were returned to Pohakuloa. Only 2 succeeded in flying out of the release pen and 2 died soon after they were placed there. One of the five birds which was returned to Pohakuloa had started a nest in the release pen and had laid one egg before she was returned to Pohakuloa. The egg was recovered and returned to Pohakuloa but failed to germinate after it was incubated.
- A pair of Nene sighted in the Kahuku Sanctuary had color band combinations which indicated that they had flown to Hawaii from Maui. The gander was released on Maui in 1968 and the goose in 1962. The goose appeared very weak and was unable to fly. She was caught and examined and proved to be in an emaciated condition. To avoid possible transmission of disease, the bird was released rather than returned to the captive flock at Pohakuloa.
- One randomly laid egg was recovered in a grassy flat in Kahuku Sanctuary and taken to Pohakuloa for incubation. It failed to germinate and the shell was saved for comparison with others.
- One nest was discovered by park rangers on the Kapapala boundary of the National Park. The parents were both banded birds and were incubating 2 eggs. A third egg had rolled out of the nest and was retrieved and taken to Pohakuloa. This egg also failed to germinate after incubation. One egg from this nest hatched successfully and the second egg was infertile.
- 1314 HDFG: Ground surveys in the Puu Oo pastures revealed the presence of 5 banded nene. Four of them were from the Keauhou Sanctuary: 1 from the 1960 release and 3 from the 1970 release. The fifth nene was a bird released on Maui in 1962. This nene was subsequently taken to Pohakuloa with a broken wing on January 13, 1974.
- Pohakuloa propagation facility
1 July 1972-30 June 1973) (36)
- Pohakuloa propagation facility
(1 July 1973-30 June 1974) (37)

**Island of Hawai'i
Mauna Kea District**

AHUMOA (Cont.)

- | | | | | |
|------|--|--------------------------------|--------------------------|--------|
| 1315 | HDFG: One female that was hatched at Pohakuloa in October 1974, and released at Kipuka Ainahou in January 1975, returned to the Pohakuloa propagation pen in March 1975. It was captured April 1, 1975 and re-released in the Kipuka Ainahou pen with another group of younger nene that were just ready for release. This same female returned to Pohakuloa a few days later and was again captured. This time she was transported to Keauhou Sanctuary and released at the Keauhou cabin on April 28, 1975. Four days later this bird reappeared at Pohakuloa and was then trapped and retained as a breeder for the project. | Pohakuloa propagation facility | 1 July 1974-30 June 1975 | (38) |
| 1316 | Nene was readily reared in captivity as evidenced by the past successes of both private and governmental efforts to raise them as pets, zoological specimens, and stock for release to the wild. The States' project, beginning in 1949, has gone through several phases including, (1) developing techniques of production, (2) mass production and release to the wild in sanctuaries, (3) gearing down production and release efforts to test the self-reliability of wild populations, and (4) gearing up production to prevent a demonstrated decline of wild populations in recent years. Future options for captive rearing of nene are, (1) continuing present levels of production at the existing State facility, (2) increasing production at a new, larger State facility, (3) farming-out production to other public agencies (zoos, Federal government), (4) establishing individual rearing sites on State sanctuaries and / or within the National Parks, or (5) contracting with private entities (zoos, game bird farmers, ranchers) to rear birds for the State. Whatever the option chosen, for the foreseeable future, captive rearing will be an integral part of the overall State Nene Restoration Program. The ultimate goal is to eliminate the necessity for captive propagation. | Pohakuloa propagation facility | 1949-1982 | WALR82 |
| 1317 | HDFG: ...1 randomly-laid egg found on lava flow near Puu 6677 (PUU OO quad.) taken to Pohakuloa, placed under an incubating goose but broke in nest. | Pohakuloa propagation facility | 22 Nov. 1982 | (58) |
| 1318 | HDFG: ...found an egg being incubated near nest on 30 Nov. 1982 (unbanded gander x Ainahou 1975 goose); took egg to Pohakuloa on 4 January 1983 to candle and found it infertile... | Pohakuloa propagation facility | 1 July 1982-30 June 1983 | (59) |

**Island of Hawai'i
Mauna Kea District**

AHUMOA (Cont.)

- | | | | | |
|------|---|--------------------------------|--------------|------|
| 1319 | HDFG: Nest with 3 eggs (2 broken) found on Puu 6677, unbroken egg taken to Pohakuloa for incubation, found infertile | Pohakuloa propagation facility | 12 Dec. 1984 | (89) |
| 1320 | HDFG: Randomly-laid single egg found on Puu 6677, taken to Pohakuloa and placed in incubator where it later hatched (18 January 1985) | Pohakuloa propagation facility | 18 Dec. 1984 | (89) |
| 1321 | HDFG: one of the 6 nene that was placed in the release pen in March 1984 was caught and returned to Pohakuloa with twisted and distorted flight feathers. It was not able to fly and closer examination revealed that the damage might be permanent. If so, this bird will be used as a breeder at Pohakuloa. | Pohakuloa propagation facility | 18 Dec. 1984 | (89) |

MAUNA KEA

- | | | | | |
|------|---|-----------------|------------|-----|
| 1322 | Elder: Rock (age 73 in 1957): seen flying | near Lake Waiau | Sept. 1910 | (1) |
|------|---|-----------------|------------|-----|

PUU AKALA

- | | | | | |
|------|---|---|------------|--------|
| 1323 | rancher relayed report by Blacow: seen about 40 years ago | near Hopuwai Ponds | ca. 1905 | BALP45 |
| 1324 | range along the eastern slopes of Mauna Keau ended on the northeast flank...did not continue on around Mauna Kea to the north...mention of Nene absent from early accounts of the trail around the... | north and northwest slopes of Mauna Kea | (ca. 1905) | BALP45 |
| 1325 | Elder: McKenzie: saw Nene | Hopuwai Pond | ca. 1935 | (1) |
| 1326 | Elder: McKenzie: saw Nene | 0.2 mile makai (seaward) on sand flats below Nauhi Forest Station | ca. 1935 | (1) |

MAKALAHAU

1327 HDFG: 4 Nene were observed during Division of Forestry and Wildlife feral sheep and goat eradication work near Kernole cabin Sept. 1981 (58)

UMIKOA

1328 Elder: Horner: received 2 as pets; they flew off when grown Kukaiau Ranch 1893 (1)

1329 HDFG: District Forester reported seeing 14 Nene flying over tree tops...may have been a group from Puu Oo Ranch...none observed on subsequent field trips Kukaiau Ranch summer 1968 (32)

PAPAALOA

1330 Elder: Murray: saw 1 mauka (toward the mountain) land of Piha, 2 miles mauka of the ocean 1935 (1)

KUKAIAU

1331 Elder: Deleres: saw 1 on ground near home of Manuel of Kukaiau, above Laupahoehoe 26 June 1957 (1)

Island of Maui

ISLANDWIDE INFERENCE

- 1332 HDFG: it was determined through a visit (localities undesignated) that there are some 9,000 acres of excellent nene habitat and an additional 30,000 acres of poor to good habitat on Maui and that releases of pen-reared nene should have a good chance of success... June 1960 (23)

UNDESIGNATED LOCALITY

- 1333 Caswell (born 22 March 1898): remembered seeing nene when a small boy (ca. 1905) PRAJ72
- 1334 Elder: J. Fleming via Munro: shot last nene / on Maui (years ago) (1)
- 1335 Schulz, (NPS) Park Naturalist, from unpublished research report dated 20 Mar. 1939, indicated that he was satisfied the nene nested on Maui during historical times...Park Naturalist J. Doerr agreed (1972) PRAJ72
- 1336 HDFG: ...a few months later (than 12 July) a second nene (Haleakala National Park release) was caught (undesignated area) and returned to the Crater... 1 July 1977-30 June 1978 (67)

West Maui

LAHAINA

- 1337 Elder: Kaopuiki (grew up on Maui): saw 4 captive nene / Lahaina pond of Keaukai family ca. 1905 (1)

WAILUKU

- 1338 Elder: C. Thompson: seen flying / at Kaunene above the highway / Camp on north side of Wailuku District 1889-1905 (1)
- 1339 flock of half a dozen / domesticated by Dr. Edward Armitage of Wailuku "some years since" ANON02
- 1340 Caswell (born 22 Mar. 1898): ...senior Caswells (parents) spoke of the nene nesting on Puunene (goose hill), site of present community of Puunene (ca. 1905) PRAJ72
- 1341 Elder: R. von Tempsky: saw at marsh / Lake Waiale ca. 1912 (1)

East Maui

UNDESIGNATED LOCALITY

- 1342 breeds / in the gigantic crater Haleakala (July 1879) FINO80

**Island of Maui
East Maui**

HANA (Cont.)

- | | | | | |
|------|--|------------------------------|-----------|------|
| 1379 | HDFG: This year as in previous years, several pairs were seen flying over... | Kula Game
Management Area | Nov. 1980 | (72) |
| 1380 | HDFG: As in previous years, the sighting of nene outside of Haleakala Crater most frequently are made or reported just prior to the onset of the breeding season. Again this year, nene were seen in flight over the Kula Game Management Area by the person manning the hunter check station during the November game bird season. A pair of nene reported by a hunter near the hunter shelter could not be found during a check of the area. | Kula Game
Management Area | Nov. 1981 | (73) |

LUALAILUA HILLS

- | | | | | |
|------|--|---|------------------------------|---------|
| 1381 | Elder: C. Thompson: saw 3 | Kahikinui | 1904 | (1) 177 |
| 1382 | HDFG: hikers reported the presence of Nene...observation of 9 verified hiker's report | Kahikinui area,
southern slopes of
Haleakala | Sept. 1975 | (56) |
| 1383 | HDFG: ...reports of Nene became quite regular at approximately the same time each year...thorough checks of these areas produced no evidence of attempted nesting or range expansion...on most occasions these Nene did not remain in the area for more than a week... | near the Kahua
hunter's cabin and
the "Baseball Park"
area | since early fall
of 1977 | (56) |
| 1384 | HDFG: ...3 nene seen in flight...on a survey trip of the southern slope of Haleakala | Waiopai area,
Haleakala Ranch
below Kahikinui
forest | 1 July 1977-
30 June 1978 | (67) |
| 1385 | HDFG: ...2 nene observed...during several survey trips into the Kahua and Kahikinui areas... | near the Kahua
hunter's shelter | 1 July 1977-
30 June 1978 | (67) |
| 1386 | HDFG: ...other nene heard...but never located | below the Kahua
hunters' shelter | 1 July 1977-
30 June 1978 | (67) |

**Island of Maui
East Maui**

LUALAILUA HILLS (Cont.)

- | | | | | |
|------|---|---|------------------------------|------|
| 1387 | HDFG: ...most of the nene sightings outside of Haleakala Crater were made in mid to late fall...2 birds were seen again during survey trips...several follow-up checks of these various areas of nene sightings indicated that the birds were not permanently established in a new area...however, the sightings seemed to indicate frequent nene movements outside the Crater area prior to the breeding season...speculation is that these flight movements may be part of the prenesting courtship behavior of nene in the "wild". | in the vicinity of the Kahua hunters' shelter | 1 July 1978-
30 June 1979 | (68) |
| 1388 | HDFG: Nene were heard flying over the KGMA on the southern slopes of Haleakala...could not be seen due to thick cloud cover...occasional presence of Nene in the area was evidenced by their droppings and feathers in the higher grassy meadows...sightings of Nene in flight over the public hunting area continued to be reported in November...again, as stated in previous reports, Nene sightings outside Haleakala Crater most frequently are made just prior to the onset of the breeding season. | Kahikinui Game Management Area | Oct. Nov. 1982 | (70) |

KAUPO

- | | | | | |
|------|--|--|------------------------------|--------|
| 1389 | HDFG: ...feeding and watering of the 1962 release group was discontinued on 1 April 1963...(after which) 2 were seen | Kaupo Gap, about 4 miles distant (from Paliku) | 26 June 1963 | (80) |
| 1390 | sometimes wander down...stayed in the area most of last summer and another unsuccessfully attempted to nest | Seven Pools area, Kipahulu Valley | (1974) | JOYG74 |
| 1391 | HDFG: ...only 1 nene, a September 1976 released birds, was sighted during a survey trip...people living in the area reported that this particular bird was observed in the area for nearly a year, and on several occasions was seen in the company of another bird... | Kaupo Ranch | 1 July 1977-
30 June 1978 | (67) |
| 1392 | HDFG: 1 captured and transported back to Haleakala National Park for release during 5-year study period | Kaupo Village | (1975-1980) | (56) |

Island of Lana'i

UNDESIGNATED LOCALITY

1393 one gander and two geese released and seen for one month thereafter

(1952)

SMIJ52

Island of Moloka'i

UNDESIGNATED LOCALITY

1394 Whyte: saw 2 adults, 1 on nest / 2000 ft. el., south side of Molokai	Jan. 1926	MUNG52
1395 Wilder: reported pair had nested for two or three seasons back	Jan. 1926	MUNG52
1396 Elder: Munro (age 90 when interviewed in 1956): saw Nene / on pond at Fagan's Ranch	1936	(1)
1397 4 pairs released	(ca. 1936)	SMIJ52
1398 Elder: J. D. Smith: reported 3 seen by J. S. Medeiros / product of Fagan's in 1936	14 Apr. 1950	(1)
1399 3 adults seen	1950	SMIJ52
1400 J. S. Medeiros: identified 3 adults	1950	PRAJ72

MOLOKAI AIRPORT

1401 Elder: Paupu (age 77 in 1956 when interviewed): small noisy bunches visited ponds seasonally / Palaau	until 1922	(1)
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KAUNAKAKAI

1402 Elder: Paupu (age 77 in 1956): small noisy bunches visited ponds seasonally / Kalamaula	until 1922	(1) 25
1403 Elder: (A.) Smith: shot 1 Nene while poaching ducks / brackish pond at Kalaupapa	1940-1945	(1) 69
1404 Elder: Carlson via Sundquist: saw a pair / Meir (Meyer) Lake, 1700 ft. el.	ca. 1950	(1) 70
1405 Elder: Sundquist: saw 1 / brackish pond at Kalaupapa	1951	(1) 68
1406 Elder: E. Meyer (age 66 in 1956): seen / pond at Kamaloa (Kamaloloa)	(before 1956)	(1) 224

KAMALO

1407 McCoriston: thought there were about a half dozen birds and that they went down to a fish pond on the Coast / when a small boy living in Kamalo	(early 1900's?)	MUNG52
1408 three persons independently told me that nene frequented / a hill called Keono Kuino, near Kamalo	(early 1900's?)	MUNG52
1409 Elder: C. Meyer: saw 3 several times / above Meyer Lake	ca. 1954	(1) 220
1410 Elder: Robbins: saw 4 on ground / near Meyer Lake	ca. 1954	(1) 221

Island of Kaua'i

ISLANDWIDE

- 1414 HDFG...total population size could not be ascertained, as the birds were dispersed most of the year...3 pairs known to have nested in Kipu Kai and only 16 birds could be accounted for at any given time (Karen Caires, Cooperator)...survival was apparently good, the only known mortality was a gosling which drowned in a cattle watering trough...individual flocks of up to 7 (apparently mostly family groups) reported outside of Kipu Kai on several occasions...some families appeared to habituate certain localities outside of Kipu Kai on a frequent basis, indicating possible dispersion to new habitat...the most distant sightings were near Polihale Beach, 28 miles west, and Pooku Stables, 21 miles north of Kipu Kai...judging from the localities where they have been seen, they preferred pasture habitat below 1,000 ft. el...here is considerable pasture habitat within this range on Kauai...much of which could have been used by Nene unnoticed...some other habitats frequented by Nene were not so favorable, as they would be vulnerable to predation, development, zoonoses, etc...conservatively estimated that there were 20 adult and sub-adults on Kauai during the year plus 9 surviving goslings from the 3 known broods making a total population of 29 in 1988...
- 1 July 1987- (105)
30 June 1988

UNDESIGNATED LOCALITY

- 1415 observed occasionally; does not breed (1893) WILS93
- 1416 said...to have been seen...occurrence...probably in nature of an accident, if indeed it was not mistaken for one of the species of American geese which are now known to visit the islands not rarely... (1902) HENH02
- 1417 Holt: mother, who lived on Kauai, spoke of seeing them there (early 1900's?) BALP45
- 1418 censused 6...not penned nor restrained in any way, Christmas Count / Paradise Pacific, in the lagoons along the north fork of the Wailua River 15 Dec. 1974 SEAW75
- 1419 no geese (nene or Canada) should be included on the 1974 Lihue Christmas Bird Count / Paradise Pacifica (1974) ZEIF75
- 1420 ...about 5...of roughly 15...seen recently...in the Lihue area and around Mahaulepu on the south side...flock originated from a freed captive flock at Kipu Kai ranch of the late Jack Waterhouse...first acquired from Herbert Shipman on Hawaii... (14 Dec. 1986) TENJ86
- 1421 Nene from the free-flying group introduced at Kipu Kai...widely reported a year ago, were reported again / various localities in S. Kauai fall, 1987 PYLR88e

MAKAHA POINT

- 1422 HDFG: unconfirmed helicopter pilot report: Nene have been seen / Nualolo Aina on the Na Pali Coast 13 Jan. 1987 (106)

Island of Kaua'i

MAKAHA POINT (Cont.)

1423 HDFG: Dowty: saw 1 adult near rocky cliffs / Polihale Beach 22 Oct. 1987 (105)

HANAIEI

1424 HDFG: Tanji: pair seen near Pooku Stables, Princeville 5 May 1988 (105)

WAIALEALE

1425 HDFG: Abreu: saw 7 / mauka Kilohana Crater 28 May 1988 (105)

KAPAA

1426 single free-flying Nene observed (presumably from the group of banded escapees reported last season) / Smith's Tropical Gardens in Kapa'a 30 Dec. 1986 PYLR88b

KEKAHA

1427 HDFG: Momohara: 1 adult / Barking Sands, Pacific Missile Range Facility 30 Sept. 1987 (105)

KOLOA

1428 5 banded Nene / from a captive flock at Kipu Kai turned up 11 km. distant at Ahukini Landing. After a newspaper story solicited observations from the public, sightings of free-flying Nene were reported from 5 other localities in s.e. Kauai. These are the first "wild" Nene reported from Kauai. 3 Nov. 1986 PYLR87a

1429 17 seen, Christmas Count / Kipu Kai 20 Dec. 1986 WILJ87

1430 HDFG: Schweig: saw 4 adults (1 w / red leg band, 1 w / aluminum leg band, 2 w / 9 bands) / Mahaulepu 4 Oct. 1987 (105)

1431 With assistance of Mrs. Karen Caires of Kipu Kai, three nesting pairs of Nene have been observed and monitored at Kipu Kai Ranch, Kauai. Two pairs produced twin goslings and a third pair produced 6 goslings. The family of 6 and 1 pair of goslings survived through the end of March. One gosling is known to have drowned in a water trough, and the adults and sibling were not seen, but may still survive. Non breeding birds have been reported at Kipu Kai Ranch, the Westin breeding birds have been reported at Kipu Kai Ranch, The Westin Kauai (Hotel), and Aweoweonui Valley during the report period. Individual capture and marking will be attempted next quarter. Jan.-Mar. 1988 TELT88

Island of Kaua'i

KOLOA (Cont.)

- | | | | |
|------|---|-----------------|---------|
| 1432 | small introduced population of Nene...produced 11 goslings from 3 nests...adults continue to range over most of the southern lowlands of Kauai...hopes are high that Nene may do well on Kauai where lowland habitat suitable for raising goslings is also free of mongoose... / Kipu Kai | early Feb. 1988 | PYLR88b |
| 1433 | 2 more juveniles spotted...raised to 10 the total of fledglings produced there this year / Kipu Kai | Mar.-May 1988 | PYLR88b |
| 1434 | 2 nests produced 11 goslings / in different parts of Kipu Kai | early Feb. 1988 | PYLR88e |
| 1435 | HDFG: Briton: saw 5 in flight / over Mahaulepu | 26 May 1988 | (105) |
| 1436 | HDFG: Killerman: saw 5 / Aweoweonui Valley, Mahaulepu | 27 May 1988 | (105) |
| 1437 | HDFG: 8 seen regularly, 2 with bands / Grove Farm rockcrusher scale, Mahaulepu | 5 Aug. 1988 | (106) |
| 1438 | HDFG: flights of 3 and 7 seen regularly / Mahaulepu | 9 Sept. 1988 | (106) |
| 1439 | HDFG: Nene "roosted" on bluffs / between Mahaulepu and Kipu Kai in dense bushes for past month | 1 Oct. 1988 | (106) |

LIHUE

- | | | | |
|------|---|------------------------------|---------|
| 1440 | single free-flying Nene observed (presumably from the group of banded escapees reported last season) / pond near Lihue Airport | 30 Dec. 1986 | PYLR37b |
| 1441 | 9 seen, Christmas Count...first recorded on Lihue CBC last year / Lihue Area | (1987) | PYLR38g |
| 1442 | HDFG: Thane Pratt determined that the Kipu Kai Nene came from Carlsmith stock at Puuwaawaa Ranch, which in turn came from the Shipman flock at Ainahou Ranch at Kilauea, Hawaii. These were apparently of lowland origin. | 1 July 1987-
30 June 1988 | (105) |
| 1443 | Telfer: Pratt: 4 adults in old pens / Kipu Kai | 24 Sept. 1987 | (105) |
| 1444 | Telfer: Pratt: 4 adults / "East Beach" | 24 Sept. 1987 | (105) |
| 1445 | Telfer: Pratt: 4 adults / Kipu Bridge Pasture | 24 Sept. 1987 | (105) |

Island of Kaua'i

LIHUE (Cont.)

- 1446 HDFG: Two nests were located at Kipu Kai, 1 by an older pair of the original captive birds which nested within a large clump of Three Heliotrope (*Messerschmidia argentea*) about 75 feet seaward from the manager's residence and about the same distance from the ocean's edge in substrate of coral sand, leaf and twig litter from the heliotrope. The 2nd nest was located on the beach strand, approximately 1/2 mile ESE of the manager's residence positioned beneath a wind-blown clump of Kiawe (*Prosopis pallida*) and Lantana (*Lantana camara*) in an open Bermuda grass beach pasture, not more than 50 feet from the ocean's edge. A 3rd. nest was not located, but a pair with 2 goslings were located about 3/4 or a mile west of the manager's residence on sand dunes sparsely forested with beach ironwoods (*Casuarina equisetifolia*). It is presumed that the 3rd nest was somewhere in this vicinity as the goslings were still young and the habitat was somewhat similar to that of the other nests. No other nesting is known to have occurred, but it is possible that other nests outside Kipu Kai existed. Birds were frequently seen in the Aweoweonui Valley and Mahaulepu areas west of Kipu Kai although no goslings were reported. The nest located near the manager's residence had a clutch of 6 eggs, all of which successfully hatched. The 6 goslings are known to have survived to fledgling age, and it is assumed that they are still alive. The nest east of the manager's residence had a clutch of 2 eggs, both hatched, but one gosling was found dead in a cattle water trough, apparently having drowned, being unable to get out of the tank. The surviving gosling and adults were only seen for a couple of weeks thereafter, and the status of these is unknown. The 3rd brood seen, which apparently nested west of the manager's residence, had a clutch of at least 2 eggs, and 2 survived to fledgling age. The Nene appeared to have dispersed during the summer, and were seen in various locations near Lihue, Mahaulepu and in more distant areas. Although the exact time of nesting of these Nene was not determined, they are believed to have hatched early in February 1988.
- 1447 HDFG: Mock: saw 4 adults / Kauai Comm. College, Puhi 2 Oct. 1987 (105)
- 1448 HDFG: Placidio: saw 4 adults / Ulu Ko Subdivision, Lihue 5 Oct. 1987 (105)
- 1449 HDFG: Caires: seen regularly in Aweoweonui / Mahaulepu 14 Oct. 1987 (105)
- 1450 HDFG: saw 4 adults / Ulu Ko Subdivision, Lihue 23 Oct. 1987 (105)
- 1451 HDFG: Caires: saw 2 adults + 2 goslings / East Beach, Kipu Kai 8 Feb. 1988 (105)
- 1452 HDFG: Caires: saw 2 adults + 6 goslings / Manager's Res., Kipu Kai 8 Feb. 1988 (105)
- 1453 HDFG: Telfer: saw 1 dead gosling in water tank / East Beach, Kipu Kai 17 Mar. 1988 (105)
- 1454 HDFG: Telfer: saw 2 adults + 6 goslings / Manager's Res., Kipu Kai 17 Mar. 1988 (105)

Island of Kaua'i

LIHUE (Cont.)

1455	HDFG: Telfer: saw 2 adults + 2 goslings / 3/4 mile west, Kipu Kai	17 Mar. 1988	(105)
1456	HDFG: Rice: saw 3 frequenting Residence #2, Kipu Ranch	25 Mar. 1988	(105)
1457	HDFG: Martin: saw 2 / Ulu Ko Subdivision, Lihue	12 May 1988	(105)
1458	HDFG: Vallejos: saw 7-8 flying / Menehune Fishpond, Nawiliwili	26 May 1988	(105)
1459	HDFG: Telfer: captured, banded 2 / Niunalu (Lihue), released	26 July 1988	(106)
1460	HDFG: 8 seen at Vidinha Stadium baseball field, Lihue	28 July 1988	(106)
1461	HDFG: pair seen repeatedly on "Bird Island", Westin Hotel Lagoon, Nawiliwili	16 Nov. 1988	(106)
1462	HDFG: 3 nests found by Ranch Mgr.: Nest 90-01 in vicinity of nest 88-01 evidently produced 3 goslings not seen again; nest 89-02 fledged 3 goslings; nest 89-03 again not located but 2 adults with 3 goslings seen in area of nest 88-03; thus in 1988-89 nesting season 3 known nests hatched 3 goslings each; assuming 3 died from nest 89-01 only 6 fledged.	23 Jan. 1989	(106)

Island of Ni'ihau

UNDESIGNATED LOCALITY

- | | | | |
|------|---|--------|--------|
| 1463 | observed occasionally | (1893) | WILS99 |
| 1464 | said...to have been seen...occurrence...probably in nature of an accident, if indeed it was not mistaken for one of the species of American geese which are now know to visit the islands not rarely... | (1902) | HENH02 |

Appendix B

Reporters of Nene Cited in Appendix A.

Jesse Abreu	James A. Caswell	George Halawaty
John Ah San	Yee Chee	John Hansen
Worth Aiken	J. H. Christ	Homer Hayes
Solomon Akau	Sophie Cluff	Frank Henriques
William Akau	Harold G. Craddock	Gregory Henriques
James Andrews	O. Crosby	Joe Henriques
Dr. Edward Armitage	Cliff Davis	Leighton Hind
James Armitage	Andres DeLeres	Robert Hind, Sr.
Henry Awai	William S. Devick	Robert Hind, Jr.
Helen Baldwin	John E. Doerr, Jr.	Theonodora Hocoba
Paul Baldwin	Sanford B. Dole	J. J. Holland
Winston Banko	Walter Donaghho	Mrs. Mona Holmes
Paul Banko	C. Dowty	Albert Holt
H. W. Baybrook	William H. Elder	Eugene Horner
Peter Beamer	William Ellis	E. Y. Hosaka
Bob Beck (Pecky Bob)	Albert Epes	Curtis P. Iaukea
Teddy Bell	Paul Fagan	J. J. Ignacio
C. E. Blacow	D. Fleming	Toshi Immoto
Paul Breese	J. Fleming	Kelsey Isenberg
Otto Breithaupt	Manual Fontes	T. A. Jaggar
Leonard Britton	Donald Forbes	J. D. Johnson
Francois I. Brown	Tony Frcitas	Jonny Johnston
L. W. Bryan	C. Glover	Charles Kaa
Gene Burke	Johiro Goto	Sam Kaawaloa
Cadio (1st name unknown)	J. M. Gouveia	Mahone Kaeo
Karen Caires	F. R. Greenwell	Robert Kahakua
Anthony Cambra	J. Greenwell	Charles "Sonny" Kahola
Merrill Carlsmith	M. Greenwell	J. K. Kaiamakini
Norman Carlson	N. Greenwell	William Kamau, Sr.
F. L. Carpenter	Henry Haa	Willie Kaneho

George Kaono	M. Martinson	Frank Pavao
Mrs. Happy Kaopuiki	Ben Matsuoka	W. J. Payne
David Kauae, Sr.	George McCorrison	Gabriel Pea
David Kauae (Jr.?)	Benny McCumber	Mrs. Pea
Sam Kauhane	R. E. MacMillen	John Peacock
C. Kauhi	Albert McKenzie	John Perez
George Kawaha	A. B. (Tony) Medeiros	Flavius Peter
Duke Kawai	Edwin B. Medeiros	Charles Pickering
Harry Kawai	J. S. Medeiros	M. Placidio
Henry Kawai	William Meinecke	Jeff Podmore
Allan Killerman	Charles Meyer	Thane Pratt
Henry Kimi	Ernest Meyer	J. Pritchard
Jack Kobayashi	Manual Miranda	Ernest Pung
Sam Konanui	A. L. Mitchell	Richard Punihoale
Harold Kubo	Marshall Mock	H. J. Quick
S. H. Lamb	Emelio Molcilio	Mr. Robin Rice
Ah Fat Lee	E. S. Mollenhoff	Robert Richards
Jimmy Lee	Daniel Momohara	W. Rickard
David Lima	B. F. Moomaw, Jr.	Gene Robbins
A. Lindsey	George C. Munro	Joseph Rock
J. Lindsey	Charles L. Murray	Anabelle Ruttle
Mrs. Kaluma Lindsey	Richard Nakamura	Fred Schattauer
Tommy Lindsey	S. Nakamura	Paul Ernest Schulz
William Lindsey	Mr. and Mrs. Nickolson	Leslie Schweig
Lona (1st name unknown)	Nick (last name unknown)	Mrs. Seigfried
Maheo Lono	Willie Paiva	Herbert Shipman
Eben W. Low	Henry C. Palmer	Julian Silva
George Lycurgus	David Paris	Silver (?Silva), (1st name unknown)
Bill Malia	William Paris, Sr.	Kaulo Simeona
Kaliko Manaapu	William Park, Jr.	Arnold Smith
E. E. Marks	Eddie Paulo	Clyde Stanley
(Ranger) Marteen	Jack Paulo	Charles Stillman
Timothy Martin	Daniel Paupu	

Bradford (Hoale) Sumner	E. G. Wingate
Ted Sumner	Leslie Wishard
Carl Sundquist	Palmer Wood
Michio Takata	David Woodside
Wayne Tanji	Richard Woodworth
Tom Telfer	Yukichi Yamamoto
Charley Thompson	Harold Yamayoshi
Eddie Thompson	Julian Yates
Willie Thompson	
Edward Uemura	
John Verbiske	
Joe Veriato	
Mrs. von Holt	
Ronald von Holt	
Lorna von Tempsky	
Robert von Tempsky	
Edward Vallejos	
Victorino (1st name unknown)	
Theodore Vredenberg	
Ed Wagner	
Abraham Waipa	
Ronald Walker	
Allan Wall	
Charles Wall	
Roy Wall	
Mrs. Roy Wall, Sr.	
Bernard (W.?) Waltjen	
Fred Waltjen	
Henry Wassman	
Sir Frederick Whyte	
Jimmy Wilder	
William Wiley	
K. J. Williams	

Appendix C

Reporting of Field Investigations (1954-1988) Management Techniques Employed

Sexing and Banding

Island of Hawaii:

Information contained in the initial Federal-Aid reports from the island of Hawaii do not include where or when banding was first accomplished, how sex was determined or even what might be learned from banding. For example, the 1957/58 report stated only that one brood of 2 goslings was banded with Territorial aluminum bands. The 1958/59 report mentioned that a 2-year-old red-banded goose was seen nesting, a 3-4 week-old brood of 4 were banded with black and white plastic bands, and a parent goose was captured and banded with a green band. The purpose of banding, type of materials used, colors, methods employed, etc. were unfortunately never reported, thus obscuring important details pertinent to understanding the "dropped band" problem which arose later.

The loss of bands was acknowledged for the first time in 1966/67, the report stating:

Dropped bands, no doubt, accounted for birds showing up with only 1 band or with color combinations not recorded for birds released on Maui. One bird with a color combination recorded for a bird released on Hawaii was recorded as seen on Maui and Hawaii in the same month. The most likely explanation of the phenomenon is that a Maui released bird lost one band of a two band combination on one leg.

The following comments reported the next year (1967/68) tell something of the methodology employed and why the banding of goslings in the wild with the initial materials was subsequently halted:

Two broods of very young nene were captured at the Keauhou Sanctuary and taken to Pohakuloa for rearing to insure their safety and to provide a source of wild nene for banding... This was done because of the difficulty in banding wild nene in the sanctuary. Such banding operations would require the field investigators to carry a portable stove to heat the plastic bands, water to cool and hard-

en the bands, and other equipment. It was felt that the banding conditions at Pohakuloa would simplify the banding operations and also reduce the chance of banding injury to the nene.

The next mention of missing bands is contained in the 1971/72 report. Of 17 banded Nene reported seen in Puu Oo Pastures, 1 was listed as "may have lost a band", and another having lost an aluminum band. The probable loss in one case confounds statistical evaluation of band retentiveness in this case, but the report went on to state:

The problem of the possibility of lost bands is a perplexing one. A gander was observed standing over a nest in the Keauhou 2 Sanctuary. The band records showed this nene to be a goose which was released at Keauhou in 1961. All our nene are sexed by examination of the cloaca. Since we do not believe there is an error in sexing, it must be an example of lost bands. The band combination of a bird seen at Puu Oo is noted in our records as being one used on Maui. It is our opinion, however, that this is another example of lost bands.

While the method of sex identification was revealed, a solution addressing interpretation of banding data did not emerge until 1975/76 when it was indicated that banding information in the computer master file was being stored for eventual analysis, as follows:

Band combinations were collected on all field surveys for storage in the computer master file for analysis. Data from all 4 sanctuaries, as well as reports of nene from other areas, was included and stored.

Further suspected incidents of lost bands were recorded during the year. This problem may be significantly greater than expected.

The plan to use neck bands was not consummated, as was planned. The banding material was unavailable from the manufacturer for this test. After further consideration of this proposal it was suggested that it might be detrimental in the wild. The nene's habit of sneaking through heavy brush to avoid detection during their molt, might create mortality by nene being "hung up" on the neck

bands. Then too, the problem of capturing wild birds remained.

After the rejection of neck-bands, the problem of Pohakuloa-banded Nene losing bands again lay dormant for several years, then cropped up again in the 1978/79 report, as follows:

Sixteen distinct band combinations were sighted on nene in the Kahuku Sanctuary this year. Two of these 16 were from the Keauhou 2 1976 release, and only 2 were complete color band combinations from Kahuku releases. The remaining 12 banded nene represented lost band combinations. This indicated that 75% of the banded nene sighted at Kahuku had lost band combinations. It can be assumed that a portion of the 67 unbanded nene, including duplications, sighted during the year could have been banded birds at one time, but had lost all their color bands. The bands which were used at Kahuku during the three years that nene were released there in 1967, 1968 and 1969 were suspected of being of inferior quality.

A total of 282 Pohakuloa-banded Nene released in Kahuku Sanctuary in 1967, 1968, and 1969—some 57 percent of all Nene released on the island of Hawaii from inception of program through 1969—were thus apparently released with faulty bands.

In a 4-year study related to survival of released captive-raised Nene on Hawaii, two to three man teams repeatedly surveyed all four HDFS sanctuaries and, insofar as the colored leg bands could be observed, recorded band combinations on all Nene observed. Except for unreported data recorded in 1976/77 from Kipuka Ainahou, and in 1977/78 from Keauhou, percentages of Nene observed with lost bands are shown below in Table C1.

Overall analysis of colored leg bands recorded for 606 Nene exhibited in Table C1 shows that some 106 (17.49 percent) were wearing incomplete band combinations, reflecting one or more lost bands. More detailed examination of survey results in Table C1 reveals not only great year-to-year variation in percentages of Nene with lost bands in the same sanctuary, but similarly wide disparity between 4-year age classes of Nene with lost bands observed between various sanctuaries. The 80.77 vs 3.23 per-

cent of Nene with incomplete band combinations noted in 1977/78 vs 1979/80 in Kahuku is an example of the first type of variation calculated, while the 4.87 vs 56.42 average percentages recorded in Kipuka Ainahou vs Kahuku for the 4-year period 1976/77 to 1979/80 typifies the second kind of variation. Although similar spreads of variation are also evident in Nene observed in Keauhou and Keauhou 2, Kahuku wins hands down when extremes are considered. Clearly, Kahuku is unique because, as previously mentioned and the footnote in Table C1 indicates, bands suspected of being inferior were used to mark some 282 Nene in 1967, 1968, and 1969.

The extreme example provided by banded stock released in Kahuku Sanctuary does not mean that the lost band factor was insignificant for captive-reared Nene liberated in other areas. Other proportions of Nene observed to have lost bands such as the 25, 13.64, and 50 percentages at Keauhou; 12.05 percent at Keauhou 2, and 10.71 percent at Kipuka Ainahou are significant enough to seriously skew the results of any long-term study.

Band Loss on Maui

Early annual progress reports on captive-reared stock released on Maui do not seem to mention Nene actually being banded on that island, but do recognize the problem of identifying the release site of Nene observed with missing colored bands. The initial recognition of band loss on Maui seems to be found in the 1966/67 Federal-Aid Report, as follows:

Another problem noted for the first time during the period was the loss of bands. Dropped bands, no doubt, accounted for birds showing up with only one band or with color combinations not recorded for birds released on Maui. One bird with a color combination recorded for a bird released on Hawaii was recorded as seen on Maui and Hawaii in the same month. The most likely explanation of this phenomenon is that a Maui released bird lost one band of a two band combination on one leg.

In the next annual report, that for the period 1967/68, the dimensions of the problem became

Table C1

Loss of Bands on Individual Nene in HDFG Sanctuaries Island of Hawaii, 1967/77-1979/80

Year	Nene with Complete Band Combinations	Nene with Incomplete Band Combinations	Total Banded Nene reported	Percent Nene With Lost Bands
Keauhou				
1976-77	39	13	52	25.00
1977-78	30	n.a.	n.a.	n.a.
1978-79	38	6	44	13.64
1979-80	7	7	14	50.00
Totals	84	26	110	Ave. = 29.55
Keauhou 2				
1976-77	97	4	101	3.96
1977-78	73	10	83	12.05
1978-79	42	4	46	8.70
1979-80	13	1	14	7.14
Totals	225	19	244	Ave. = 7.96
Kahuku*				
1976-77	9	18	27	66.67
1977-78	5	21	26	80.77
1978-79	4	12	16	75.00
1979-80	30	1	31	3.23
Totals	48	52	100	Ave. = 56.42
Kipuka Ainahou				
1976-77	8	n.a.	n.a.	n.a.
1977-78	74	3	77	3.90
1978-79	19	0	19	0.00
1979-80	50	6	56	10.71
Totals	143	9	152	Ave. = 4.87
Grand Total	500	106	606	
Average percent Nene observed with lost band combinations for all 4 years = 17.49				

Legend

*"The bands...used at Kahuku...in 1967, 1968 and 1969 (on 282 Nene released)...suspected of being of inferior quality."

more apparent when it was noted that "six of 45 individuals released either on Hawaii or Maui seemed to have lost one or more bands".

The 1968-1971 report years passed without comment on the subject of band loss, although the Federal-Aid Progress Report for 1970/71 questioned whether two Nene seen on Hawaii were actually released on Maui, as their band combination indicated.

The annual report the following year, 1971/72, stated that 55 Nene which were released during the prior period "were banded with identical aluminum bands so these birds could be identified as to origin and release time, but not as to individuals". Banding objectives were thus clearly compromised in this instance for no apparent reason, though the practice of using aluminum bands was reversed at least by 1977/78 when it was noted that the Pohakuloa-reared stock released on Maui "were banded with different combinations of plastic colored bands so they could be identified as to individuals."

By report year 1975-76 however, records of both retained and lost bands observed on Nene breeding in Haleakala Crater were kept in a fashion which, assuming that negative observations were recorded equally, permitted the assembly of comparative information shown in Table C2 below. These data clearly show the seriousness of the band loss problem among breeding Nene from 1975-76 to 1979-80, its sudden reduction in 1980-81 and, apparently, its complete almost magical disappearance from 1981-82 to 1985-86.

However, among Nene seen at large, Federal-Aid Progress Reports for the 4-year period beginning in 1982-83 continue to mention the problem, as follows:

1982-1983

Although 14 nene could be identified as individuals they could not be placed in release classes due to disruption of their color band combinations. The loss of release year class identity of these birds is probably the result of band wear and the eventual "dropping" of color bands.

Sixty-four nene were individually identified either by band combination or sight. Two

nene with identical band combinations were seen near each other, so separate identification was possible. The identical color combinations probably resulted from the loss of a band by one of the birds...

1983-84

The mean ratio of 52% banded nene to 48% unbanded nene was computed from the five monthly counts conducted during this report period. A total of 62 banded nene were identified individuals this past year. The two individuals with identical band combinations were sighted again in close proximity to each other. As reported last year, this identical band combination may be the result of loss of bands from one or both birds.

As a result of disruption in color band arrangements on 11 nene, their placement into release classes was not possible. Last year, 14 nene were in the unidentifiable release class category. Although release class placements may not be possible, individual identity has usually been maintained. The disruption of color band combinations is probably the result of band wear and the eventual loss of one or more bands.

1984-1985

Identification of release classes could not be determined for 11 nene (same as last year) due to disruptions in band combinations. Although release class identification was not possible, differentiation of banded birds in most cases was maintained. The result of band wear and loss of one or more birds is probably the cause for the disruption of color band arrangements.

1985-1986

No release of captive-reared nene has been made in Haleakala Crater since 1977...Release classes...for 9 Nene...obtained (in) the eastern section of Haleakala Crater...could not be determined.

The stark contrast between the plainly evident band loss problem among Nene monitored at large in the early 1980's just cited, and the perfect record of band retention of breeding Nene indicated for the 5-year period beginning in 1981-82, is difficult to reconcile. One possible influential factor might, however, be mentioned. It will be recalled that an unusually high degree of band loss, thought to be due to faulty material, was recorded for Pohakuloa-banded Nene released at Kahuku, island of Hawaii,

Table C2

Breeding Nene Observed With Lost Bands Haleakala Crater, Maui, 1975/76 to 1985/86

Report Year	Banded Birds Observed		Total Banded Birds	Percent with Lost Bands
	Lost Bands	Retained Bands		
1975-76	1	4	5	20.0
1976-77	1	7	8	12.5
1977-78	1	1	2	50.0
1978-79	1	4	5	20.0
1979-80	3	14	17	17.6
1980-81	1	21	22	4.5
1981-82	0	7	7	0.0
1982-83	0	12	12	0.0
1983-84	0	13	13	0.0
1984-85	0	9	9	0.0
1985-86	0	5	5	0.0
Totals	8	97	105	

in 1967, 1968 and 1969. A total of 42 Pohakuloa-reared Nene were also released on Maui in 1967-68 and 1968-69, possibly banded with the same material. Band loss on Maui before 1975-76 was not regularly reported, but disappearance of the problem among breeding Nene after 1980-81 suggests that if faulty band material was the factor, the opportunity for it to affect Nene released on Maui coincided closely with the maximum breeding age of this species in the wild, presently understood as being about 10 years, thus accounting for the sharp decline and disappearance of the problem beginning in 1980-81. Such a possibility does not explain the significant band loss problem which continued among Nene seen at large for the 4-year period 1982-83 to 1985-86.

Brailing, "Pinioning" and Removal of Flight Feathers

As previously mentioned, captive-reared nene were banded at Pohakuloa prior to liberation in the various sanctuaries on the island of Hawaii. Chick-en-wire release pens of about an acre in size were constructed at each release site to hold liberated Nene until they had settled down after move and adapted to their new environment—the so-called "gentle" release method.

Several techniques were employed to insure the confinement of liberated Nene to the release pen for the required period, as follows:

- (1) Fastening a wing-harness (brail) to one wing restricting extension of flight feathers;
- (2) Physical removal of all 9 primary wing feathers to prevent flight until regrowth of replacement quills. (Evidently occasionally confounded with "pinioning" in some reports.)
- (3) Releasing flightless goslings wherein the period of confinement is determined by the time required to complete growth and learn to fly.

Unfortunately for those interested in biological details, readers of Federal-Aid Progress Reports were not kept well informed as to which method(s) were employed for each release. To further confuse the record, Progress Reports and Pohakuloa records frequently differ on the number of Nene released during the same reporting period.

The first mention of flight restriction techniques was found in the 1968-1969 Nene Field Survey Report (Project W-5-R-20) which stated that all of the 184 Nene released at Kahuku Sanctuary were fitted with brails and placed in the release pen for not more than 5 days after which the brails were removed. (Pohakuloa records indicate that only 122 were released at Kahuku in 1968/69). The report continued:

Brails were used in an effort to minimize damage to the primary feathers as occurred when the primaries were plucked during previous releases.

Flight restriction of liberated captive-raised Nene was mentioned again in the 1969-70 Progress Report, as follows:

A total of 110 nene produced at Pohakuloa during the 1969-1970 breeding season was placed in the release pen at the Keauhou Sanctuary on June 2, 1970. The first nine primaries from the left wing of each bird were plucked when the Nene were color-banded at Pohakuloa. The birds were still being checked at the end of the fiscal year because of their inability to leave the pen until their primaries were replaced.

(Again, Pohakuloa records show only 106 were released at Keauhou in 1969-1970). The following year's Progress Report (1970-1971) states that of the 110 released, 5 "unable to fly because of deformed primaries" were captured and taken to Pohakuloa until they could fly. The report added that "some had twisted primaries, while others had no re-growth of primaries because of dead feather germs. One...in emaciated condition...failed to survive the trip to Pohakuloa."

The 1971-1972 report states that 110 Pohakuloa-reared Nene (perhaps the same previously mentioned group) were pinioned (? flight feathers pulled) and released at Keauhou Sanctuary

on October 21, 1971 to await re-growth of flight feathers (Pohakuloa records show 94 liberated at Keauhou in 1970/71). Of the 1971 release the report states:

There were a number of birds which developed twisted primaries, and some had no re-growth because of dead germs. Sixteen...were unable to fly out of the release pen by May 24, 1972. These birds were captured and returned to Pohakuloa for closer examination. Those that will be able to fly will be released later. Those that are permanently disabled will be used for breeding stock.

The next year's 1972-1973 Progress Report continued to follow the fate of the 16 disabled Nene returned to Pohakuloa, stating:

Nine of the 16 Nene which were returned to Pohakuloa...were re-examined and it was determined that another release would be worthwhile. The damaged flight feathers were removed a second time and they were placed in the Keauhou release pen on August 1, 1972. By November 15, 5 of the original 9 were still unable to fly out and were returned to Pohakuloa. Only 2 succeeded in flying out of the release pen and 2 died soon after they were placed there. One of the five birds which was returned to Pohakuloa had started a nest in the release pen and had laid one egg before she was returned to Pohakuloa. The egg was recovered and returned to Pohakuloa but failed to germinate after it was incubated.

...Three months later on December 13, 1972, 10 Nene still remained in the pen as a result of damaged flight feathers. These were returned to Pohakuloa for examination.

...On May 17, 1973, 13 Nene which had previously developed damaged flight feathers were placed in the Keauhou Sanctuary release pen. These included 10 returned on December 13, 1972 from the Keauhou 2 Sanctuary, and 3 from previous releases at Keauhou. These birds were released with the hope that after their natural molt their flight feathers would be developed sufficiently to permit them to leave the pen.

The above extended effort appears to have ended attempts to temporarily restrain flight and dispersion of newly-liberated captive-reared Nene using flight hampering methods. The 1973-1974 Progress Report states that 129 Pohakuloa-reared Nene were released in Kipuka Ainahou Sanctuary in

1974 (Pohakuloa records show only 123 liberated at Kipuka Ainahou in 1974) "before they attained flight as it was felt that this would prevent damage to the primaries, as was experienced last year. None of the Nene so released suffered wing damage and they were able to fly out of the release pen within weeks." Thus ended the brailing and pinioning of newly-released captive stock on the island of Hawaii.

Flight restriction appears to have been mentioned only once in Federal-Aid Progress Reports originating from Maui (1972-1973), indicating that similar methodology was also employed there but for an unknown period, as follows:

The usual procedure of pulling flight feathers and keeping the birds in a predator-proof pen until the flight feathers developed was followed. No problems were experienced.

Biotelemetry

As detailed later, repetitive counts of Nene utilizing the Summer Flyway and Puu Oo Ranch pasturelands was initiated in 1955/56 and peaked in 1969/70 when more than 114 were "censused"; since the maximum number of breeding birds and goslings known from Keauhou Sanctuary reached 34 and 32 respectively in 1967/68, it was then assumed that the breeding range of a significant proportion of the total population was unknown.

Following failure of extensive surveys to locate the breeding grounds of a major component of the Flyway populations by 1970/71, attention was directed toward the possibility of using biotelemetric equipment to advantage. Manufacturer's literature and bio-instrumentation manuals were obtained and reviewed. Technical assistance was solicited from U. S. Fish and Wildlife Service. Budget requests were submitted for acquisition of the needed equipment and a work plan utilizing biotelemetric techniques to locate heretofore undiscovered habitats was prepared.

Except for recommending employment of biotelemetric techniques, no progress toward utilizing electronic methodology seems to have been made in 1971/72. The Federal-Aid Progress Report for the

following year (1972/73) fails to mention biotelemetry but suggest aerial survey methods be considered, as follows:

Areas other than the established sanctuaries be searched for nests and broods during the breeding season. This can be accomplished most efficiently with the aid of a rented helicopter which would be more dependable than a military helicopter.

The 1973/74 report describes testing "Davidson transmitters" on Nene, concluding that these devices were unsatisfactory because of limited battery life and non-uniform construction. However, transmitters manufactured by a firm named Electronics Unlimited appeared promising, leading to recommendations that both Davidson and EU transmitters be compared in future studies.

No progress on testing of biotelemetric equipment was reported the following year (1974/75) but in 1975/76 Davidson transmitters were again tested, preliminary findings showing "good results". In the end, however, one of the transmitters fell off, apparently because of a faulty harness, while the other failed due to a broken whip antenna. Further efforts that year were abandoned, however, more attempts were recommended.

The Federal-Aid Progress Report in 1976/77 mentions that no tests of biotelemetric equipment were made because a satisfactory source of supply could not be located in time. The nesting season was over before new transmitters received from Wildlife Materials, Inc. could be tested; however, the thought was expressed that "this technique holds promise for determining brood survival and movement of family groups"—an entirely different goal than originally envisioned.

In 1977/78 preliminary tests of solar-powered transmitters received from Wildlife Materials failed due to "jumped frequency"; however, monitoring was scheduled to continue with the hope expressed that:

If these tests are successful, transmitters for attachment to Nene with broods will be acquired next year. The poor habitat conditions, low nesting activity, and expected poor

reproductive success also influenced the decision not to instrument Nene this year.

Much the same situation prevailed the following year (1978/79) when "No Nene were fitted with transmitters since no satisfactory instruments were located that were suitable for use"; however, recommendations were made to make "a concerted effort to locate, instrument and monitor Nene with broods to determine survival rates." The next year (1979/80) however, the Federal-Aid Progress Report states that "Transmitters were not used this year due to lack of funding." The year 1979/80 thus seems to have marked the end of testing and development of biotelemetric techniques to locate and monitor Nene. On Maui, where conditions are much more favorable for biotelemetric monitoring, advanced electronic methodology has yet to be attempted as a research tool.

Census Techniques

The first and central focus of any serious endangered species restoration program is often the development of systematic survey procedures and record-keeping methods. The overriding need to design census techniques compatible with requirements of statistical analysis is often overlooked. Generalizations concerning these needs were set forth in the Federal-Aid Progress Report of 1957/58 after 2 or 3 years of field work, as follows:

1. To determine the number of wild Nene in the Territory.
2. To determine, if possible, details of the life history of the wild nene.
3. To establish a method by which a continuous and comprehensive record can be maintained of the nene seen and reported by various persons on the island of Hawaii.

As it turned out, these 3 goals were to survive countless convoluted rephrasings for more than 30 years without ever being satisfied.

While the need to establish useful record-keeping procedures was recognized as early as 1957/58, some 12 years were to elapse before any concerted effort was made to analyze the information collected. The accumulated data was first scheduled for "compilation" in 1970/71, simultaneously with the per-

ceived need to address statistical treatment and design. Attempts were made to locate someone qualified, first with University of Hawaii and then with U. S. Fish and Wildlife Service staff members. Although the 1970/71 report-year ended before assistance was secured, confidence was expressed that the services of a "biostatistician" would be obtainable soon.

The Federal-Aid report for the following year (1971/72) contains the first indication that field surveys were conducted to collect statistically sound data on Nene numbers, survival and distribution using methods suggested by a statistician. Information recorded previously was also compiled that year for comparative analysis and evaluation. In addition, biologist John Sincock (USFWS) met with HDFG personnel in Hilo to review the Nene program and suggest methods for collecting statistically sound data. It is not clear whether John Sincock was the "biostatistician" previously mentioned, but data were collected from each of three Sanctuaries in 1971/72; however, according to the Federal-Aid Progress Report for that year, insufficient time and prior commitments prevented an analysis of the data so obtained.

Information on Nene numbers, survival and distribution continued to be gathered in all four Sanctuaries, known areas of concentration, and habitat suspected of harboring this species in 1972/73. The Federal-Aid Progress Report for that year included a recommendation that "all data compiled and gathered to date be analyzed and evaluated by a biostatistician as soon as possible."

Efforts directed toward statistical evaluation of previously gathered data and design of future recording methods continued in 1973/74. Field surveys were carried out in ways similar to those of the previous year. HDFG Fisheries biologist (W. S. Devick?) was consulted as a statistician since assistance from the University of Hawaii or U. S. Fish and Wildlife was unobtainable. All of the previously compiled data was reviewed, discussed and evaluated. Data collection techniques were also

reviewed with improvement for statistical analysis in mind.

The Federal-Aid Progress Report for 1974/75 next states that two biostatisticians were consulted. The possibility of conducting a valid census of Nene within sanctuary boundaries was discussed. Several techniques were considered and transect routes were set up in all four sanctuaries to determine the feasibility of estimating the population by a transect method. Trial runs were made on several transect routes. However, the lack of Nene sightings during the molting season made the results from these trials inconclusive. Nevertheless, Fisheries biologist W. S. Devick completed compilation of field data collected over the years and subjected it to statistical analysis to determine the status and trend of the Nene population. He reported on band retention, movements, survival, population size, mortality, trend, and breeding success—all related to the status of the Nene on the island of Hawaii from program inception to 1975.

Federal-Aid Project W-18-R-1, approved during reporting year 1975/76, stated:

Although nene observations have been compiled in the sanctuaries and elsewhere, no statistically reliable method had been devised to use these data to obtain an estimate of the nene population throughout its range. Banded- unbanded ratio data have been used to estimate the nene population on the sanctuaries, as well as determine the population curve...The lack of a reliable means for determining the (size of) nene (population) over all of its range was evident. This job was designed to meet this need...A transect census was tested in June. Eight staff members participated in this census, being divided into four 2-man teams.

Insufficient data was collected during the first day's census in Keauhou Sanctuary due to a lack of Nene, but good data was obtained from the adjacent habitat in Hawaii Volcanoes National Park where most of the balance of the work week was expended gathering information. According to the 1975/76 Report, there was insufficient time to subject the data obtained to statistical analysis, but a separate report

of this census effort was promised the following year, 1976/77. It was also recommended that:

1. The result be analyzed before additional work on this job is continued.
2. promising aspects of the transect census technique be further tested during the next job reporting period.
3. ...a census technique incorporating ideas from the first and second segments of this job be used to estimate nene populations in the sanctuaries, then applied to other habitats.

Further history of the development of Nene census techniques is set forth in detail in Federal-Aid Progress Reports W-18-R-1, Job R-I-B for the five year period 1975/76 to 1979/80. However, the problems are summarized in Federal-Aid Progress Report W-18-R-5, Study R-I, Job R-I-E covering the same reporting period, as follows:

First Year 1975/1976

Difficulty in developing an acceptable census technique prevented implementation of the transect and census portion of the job during this segment.

Second Year 1976/1977

The planned Nene census was not conducted this year due to the effects of the drought...(which) created unusual movement patterns...most of the Nene leaving the sanctuaries searching for more favorable areas...The census techniques were further refined...toward simplification...permitting duplication by any 2-man team with reasonable instructions. Consideration was given to modify the objectives and census procedures to compensate for the continued drought and subsequent nene movements; however, this was never accomplished. Beginning this year, Nene sightings...on the sanctuaries...were grouped into the "banded", "unbanded" or "unidentified" category.

Third Year 1977/1978

The census procedures were tested in February 1978, with very poor results. Few or no Nene were observed on the transects where one would expect to see many birds...the prolonged drought, which was in its second year, was responsible...virtually no food available...Nene responded...by deserting the sanctuaries for pastures with more favorable conditions...evident that this was not a typical year so the test of census proce-

dures was abandoned...all Nene observations gathered during sanctuary surveys continue to be grouped "banded", "unbanded" or "unidentified".

Fourth Year 1978/1979

The established transect routes through each of the four nene sanctuaries were monitored during this reporting period. The routes and census blocks used by the district biologist in the Keauhou II Nene Sanctuary were remodeled and re-established after his resignation...This was done to standardize the Keauhou II transects with the other three sanctuaries.

There were several quarters when the transects were not done as previously planned due to complications. The principle investigator for the project was on sick leave for several months. The investigator who previously made field trips to the Keauhou II Sanctuary resigned this year and those transects were redesigned. The land owner for two of the four nene sanctuaries denied access to everyone for a few months, including the Division's field crew.

In the Kipuka Ainahou Nene Sanctuary, which is established on State-owned land, archery mammal hunting was permitted during the nene non-breeding season. Hunters continuously removed the flagged tapes on the transect routes. Here the transects were remodeled using geological features and the new transects were censused, but produced no nene sightings.

Fifth Year 1979/1980

No counts were conducted along the established census transects in any of the four nene sanctuaries due to lack of available manpower. The game management assistant assigned to the nene project was promoted and assumed new responsibilities and duties. No replacement was appointed to assist the project biologist. The reorganization of the Wildlife Branch into the Forestry Division left the principal investigator with increased responsibilities and office work, thereby reducing the amount of time that could be spent in the nene sanctuaries.

The 9-year long effort to develop statistically valid Nene census procedures appears to have ended unsatisfactorily. The 1979/1980 Federal-Aid Progress Report (W-18-R-5, Job R-I-B) recommended that:

1. ...data recorded on censuses completed in the past 5 years be critically evaluated and included in Job R-I-E.
2. ...the existing census methods be re-evaluated to reflect changes in available manpower and related projects.
3. ...a monitoring procedure be established to reflect Nene population changes resulting from the implementation of habitat improvement practices including self-feeders and water units.

Search of Federal-Aid reports from 1980/81 to 1987/88 turned up only a single objective; to "monitor Nene population trends." Technical descriptions or parameters of data necessary for censusing or monitoring populations were not mentioned, nor were any trends for the last 8-year (1980/81-1987/88) period indicated.

On Maui where Nene confine themselves to a comparatively limited habitat, reliable estimates of total population size are projected using banded:unbanded ratio as a basis. Description and results of such calculations are cited in Hawaii State Restoration Program, Part II.

Appendix D

Factors Influencing Comparability of Population Data

A. Weather

The outstanding climatic features of the Hawaiian Islands include mild and equable temperatures year-around, moderate humidities, persistence of northeasterly trade winds, remarkable differences in rainfall within short distances, and infrequency of severe storms (S. Price in Armstrong, 1983). While Nene populations on the island of Hawaii ranged historically from sea-level to over 1829 m. (6,000 ft.) elevation, wild populations which survived to the 1950's were found principally at elevations above 1524 m. (5,000 ft.)—the extreme upper limits of their traditional range. While such factors as rainfall, temperature, and infrequency of severe storms may not have greatly affected former Nene populations because of their naturally wide geographical and elevational distribution, such elements may significantly influence relict populations which breed solely in high elevation habitats. Moreover, recent restoration activities such as propagation, establishment of sanctuaries, release of captive-raised Nene, and field observations have been carried out almost exclusively in habitats above 1524 m. (5,000 ft.).

The approximate elevations of the propagation and release sites of captive-raised Nene are cited as follows: Pohakuloa Propagation Facility - 1981 m. (6,500 ft.); Keauhou - 1860 m. (6,100 ft.); Keauhou 2 - 1585 m. (5,200 ft.); Kahuku - 1980 m. (6,500 ft.); Kipuka Ainahou-Puu Oo - 1705 m. (5,600 ft.); and Paliku (Maui) - 1950 m. (6,400 ft.).

Unfortunately for comparative analysis, long-term weather records representative of four of the five established Nene Sanctuaries do not exist, that for Keauhou being the only exception. Even simple rainfall data were only intermittently collected in Sanctuary areas since inception of the Nene restoration program in the mid-1950's. Rainfall for Sanctuary release-sites cannot be reliably estimated because of isolation of release-sites from nearest weather stations and typically large differences in rainfall within short distances. The comparatively low value of Nene population data some years also weighs against trustworthy analysis. While reliable comparisons between weather and Nene breeding success patterns are thus not feasible, widely scattered commentary in Federal-Aid reports correlating these subjects have been added to what little published rainfall data exists to at least document what correlations may be possible for each Sanctuary.

All rainfall data in Tables D1, D2, and D3 were calculated from that in HDFG's (1972) A Report of the Nene Restoration Program. Precipitation for Keauhou, Hawaii and Paliku, Maui was recorded by National Park Service at Hawaii Volcanoes National Park and Haleakala National Park. Table D4 integrates data from Tables D1-D3 and integrates comments on the reported effects of weather on Nene populations for the years indicated. The text in Table D4 is extracted verbatim from HDFG Federal-Aid reports.

Table D1

Breeding Season (Oct.-Mar.) Rainfall¹, 1956-1969
Keauhou, Keauhou 2, Kahuku Sanctuaries, Island of Hawaii

	1956-1957	1957-1958	1958-1959	1959-1960	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965	1965-1966	1966-1967	1967-1968	1968-1969
Kahuku (cm.)	143.0	113.3	100.6	81.9									
(in.)	56.3	44.6	39.6	32.2									
Keauhou (cm.)					42.6	115.6	58.3	91.8	84.4	82.2	125.0	134.2	121.0 ²
(in.)					16.8	45.5	23.0	36.1	33.2	32.4	49.2	52.8	47.6 ²
Keauhou 2 (cm.)											26.0 ^{3,4}	37.8 ⁵	42.3 ³
(in.)											10.2 ^{3,4}	14.9 ⁵	16.7 ³

Kahuku:

4-year average = 109.7, range = 81.9 - 143.0 cm.

4-year average = 43.2, range = 32.2 - 56.3 in.

Keauhou:

9-year average = 95.0, range = 42.6 - 134.2 cm.

9-year average = 37.4, range = 16.8 - 52.8 in.

Keauhou 2:

3-year average = 35.4, range = 26.0 - 42.3 cm. [4 of 18 months (22 percent) data missing]

3-year average = 13.9, range = 10.2 - 16.7 in. [4 of 18 months (22 percent) data missing]

Legend

¹calculated from HDFG (1972) A report of the Nene Restoration Program

²November data missing

³October data missing

⁴February data missing

⁵March data missing

Table D2

Rainfall at Paliku, Haleakala National Park, Maui 1967-1986

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Jan.	23.00	38.00	48.90	23.05	83.00	19.60	1.83	10.50	52.20	28.60
Feb.	23.50	13.00	55.50	3.05	9.95	27.90	7.10	13.50	33.80	6.30
Mar.	23.25	10.50	29.75	5.25	27.50	4.30	15.34	21.43	10.60	32.00
Apr.	25.00	48.20	17.50	25.05	44.00	21.20	16.86	36.00	19.10	10.20
May	13.10	7.75	12.75	12.50	6.30	6.00	5.95	14.95	5.00	6.60
June	10.30	13.00	2.25	2.50	3.02	3.90	6.40	8.70	1.50	0.00
July	17.00	2.60	17.75	10.00	4.62	7.50	2.00	10.40	7.06	0.07
Aug.	26.55	9.25	16.24	12.45	4.16	10.20	1.96	3.20	5.65	3.00
Sep.	8.25	15.20	8.30	8.25	13.35	9.50	7.70	0.80	5.20	2.85
Oct.	8.00	10.25	5.25	14.25	10.00	15.00	3.90	4.60	9.35	4.75
Nov.	50.00	5.90	15.25	12.00	30.96	10.40	39.00	15.50	0.00	3.05
Dec.	15.26	36.80	28.30	80.50	8.04	8.00	10.20	41.30	30.30	0.50
Total (in)	243.21	210.45	257.74	208.85	244.90	143.50	118.24	180.88	179.76	97.92
Total (cm)	617.75	534.54	654.66	530.48	622.05	364.49	300.33	459.44	456.59	248.72

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Jan.	1.00	5.23	31.61	53.01	2.22	48.85	0.00	14.10	17.97	1.10
Feb.	1.10	7.00	52.20	4.06	11.90	12.69	0.70	14.10	8.70	4.10
Mar.	44.10	9.00	14.50	103.25	2.01	48.00	0.80	1.50	81.00	19.60
Apr.	11.30	9.91	14.20	8.95	2.58	59.50	7.30	29.50	28.50	53.60
May	12.00	13.52	1.09	13.02	2.25	7.05	5.60	10.60	11.80	8.70
June	1.06	17.52	13.15	16.70	0.21	1.30	2.70	0.50	3.81	12.80
July	9.71	5.80	6.55	4.00	6.80	8.50	1.50	3.90	2.10	
Aug.	12.10	12.55	4.10	1.56	12.20	32.95	15.80	9.00	4.20	
Sep.	3.22	9.90	3.08	1.80	3.05	17.40	9.30	2.50	3.50	
Oct.	2.53	2.02	10.06	2.85	13.90	11.00	11.70	1.60	16.30	
Nov.	5.62	27.00	19.07	0.42	32.30	9.75	6.60	19.10	9.55	
Dec.	6.00	22.70	18.10	1.49	7.25	20.80	12.90	28.90	8.80	
Total (in)	109.74	142.15	187.71	211.11	96.67	277.79	74.90	135.30	196.23	
Total (cm)	278.74	361.06	476.78	536.22	245.54	705.59	190.25	343.66	498.42	

19-year Breeding Season Rainfall

Ave. = 271.48 cm. (106.88 in.)

Range = 53.06-527.18 cm. (20.89-207.55 in.)

19-year Calendar Year Rainfall

Ave. 443.43 cm. (174.58 in.)

Range = 190.25-705.59 cm. (74.90-277.79 in.)

Table D3

**Breeding Season (Oct.-Mar.) Rainfall
Paliku, Haleakala National Park, Maui
1967-1986**

	67/68	68/69	69/70	70/71	71/72	72/73	73/74	74/75	75/76	76/77
Oct.	8.00	10.25	5.25	14.25	10.00	15.00	3.90	4.60	9.35	4.75
Nov.	50.00	5.90	15.25	12.00	30.96	10.40	39.00	15.50	0.00	3.05
Dec.	15.26	36.80	28.30	8.50	8.04	8.00	10.20	41.30	30.30	0.50
Jan.	38.00	48.90	23.05	83.00	19.60	1.83	10.50	52.20	28.60	1.00
Feb.	13.00	55.50	3.05	9.95	27.90	7.10	13.50	33.80	6.30	1.10
Mar.	10.50	29.75	5.25	27.50	4.30	15.34	21.43	10.60	32.00	44.10
in. =	134.76	187.10	80.15	155.20	100.80	57.67	98.53	158.00	106.55	54.50
cm. =	342.29	475.23	203.58	394.21	256.03	146.48	250.27	401.32	270.64	138.43

	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86
Oct.	2.53	2.02	10.06	2.85	13.90	11.00	11.70	1.60	16.30
Nov.	5.62	27.00	19.07	0.42	32.30	9.75	6.60	19.10	9.55
Dec.	6.00	22.70	18.10	1.49	7.25	20.80	12.90	28.90	8.80
Jan.	5.23	31.61	53.01	2.22	48.85	0.00	14.10	17.97	1.10
Feb.	7.00	52.20	4.06	11.90	12.69	0.70	14.10	8.70	4.10
Mar.	9.00	14.50	103.25	2.01	48.00	0.80	1.50	81.00	19.60
in. =	35.38	150.03	207.55	20.89	162.99	43.05	60.90	157.27	59.45
cm. =	89.87	381.08	527.18	53.06	413.99	109.35	154.69	399.47	151.00

(19-yr. ave. = 106.88 in.) (range = 20.89-207.55 in.)

(19-yr. ave. = 271.48 cm.) (range = 53.07-527.18 in.)

Table D4

HDFG Notes on Weather and Breeding Season (Oct.-Mar.) Rainfall in Release Areas on Hawaii and Maui, 1954-1987

1954-1956		
Keauhou:	(No comments or data reported.)	the summer grounds (was) apparently delayed until September by exceptionally dry weather...
1956-1957		
Keauhou:	(No comments or data reported.)	
Kahuku:	Breeding Season Rainfall = 143.0 cm. (56.3 in.)	1961-1962
1957-1958		
Keauhou:	(No comments or data reported.)	Keauhou: Another extremely dry summer was followed by substantial rains in September...indications of breeding activity...were limited, and it is not known whether this was due to dryness or shifting of breeding range (not demonstrated)...
Kahuku:	Breeding Season Rainfall = 113.3 cm. (44.6 in.)	Breeding Season Rainfall = 115.6 cm. (45.5 in.)
1958-1959		
Keauhou:	(No comments or data reported.)	Keauhou-2, Kahuku, Kipuka Ainahou-Puu Oo,
Kahuku:	Breeding Season Rainfall = 100.6 cm. (39.6 in.)	Paliku: (No comments or data reported)
1959-1960		
Keauhou:	...unusual dryness and perhaps a dense volcanic haze, which lasted for about a month during January, seemed to disrupt nesting activity...	1962-1963
Kahuku:	Breeding Season Rainfall = 81.9 cm. (32.2 in.) [4-year average = 109.7 cm. (43.2 in.); range = 81.9 -143.0 cm. (32.2 -56.3 in.)]	Keauhou: ...more normal weather conditions prevailed on the Keauhou breeding grounds this year with substantial rains falling in the fall and winter months... Breeding Season Rainfall = 58.3 cm. (23.0 in.)
1960-1961		
Keauhou:	Weather on the breeding ground was for the most part drier than normal...usual winter fog sparse and relatively infrequent...think that this may have played a part in the apparent lack of reproduction... Breeding Season Rainfall = 42.6 cm. (16.8 in.)	Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo,
Keauhou 2:	(No comments or data reported.)	Paliku: (No comments or data reported)
Kipuka Ainahou-Puu Oo:	...basic pattern of breeding in Keauhou area and moving north to the Puu Oo-Upper Waiakea area for the summer following as usual...however movement to	1963-1964
		Keauhou: Breeding Season Rainfall = 91.8 cm. (36.1 in.)
		Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo,
		Paliku: (No comments or data reported)
1964-1965		
Keauhou:	Breeding Season Rainfall = 84.4 cm. (33.2 in.)	1965-1966
Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo,		Keauhou: Breeding Season Rainfall = 82.2 cm. (32.4 in.)
Paliku:	(No comments or data reported)	

Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo, Paliku: (No comments or data reported)

1966-1967

Keauhou: Breeding Season Rainfall = 125.0 cm. (49.2 in.)

Keauhou 2: Breeding Season Rainfall (except Oct. data missing): 26.0 cm. (10.2 in.)

Kahuku, Kipuka Ainahou-Puu Oo, Paliku: (No comments or data reported)

1967-68

Keauhou: Breeding Season Rainfall = 134.2 cm. (52.8 in.)

Keauhou 2: Breeding Season Rainfall (except Mar. data missing): 37.8 cm. (14.9 in.)

Kahuku: (No comments or data reported)

Kipuka Ainahou-Puu Oo:

...trips in the (Puu Oo) pastures were made late in the afternoon and evenings to observe Nene as they came into the pastures...most of the time these observations were hampered by fog or rainy weather associated with this elevation (ca. 6,000 ft. el.) during that time of day...

Paliku: Breeding Season Rainfall = 342.29 cm. (134.76 in.)

1968-1969

Keauhou: The 1968-1969 breeding season was very poor when compared with previous years...The extremely cold weather experienced during the breeding season probably contributed to the poor hatchability which was also the case at the propagation facility at Pohakuloa.

Breeding Season Rainfall (except Nov. data missing) = 121.0 cm. (47.6 in.). [9-year average = 95.0 cm. (37.4 in.); range = 42.6 - 134.2 cm. (16.8 - 52.8 in.)]

Keauhou 2: Breeding Season Rainfall = 42.3 cm. (16.7 in.)

[3-year average = 35.4 cm. (13.9 in.); range = 26.0 - 42.3 cm. (10.2 - 16.7 in.)]

Kahuku: (No comments or data reported)

Kipuka Ainahou-Puu Oo:

Many field trips were made...although fresh droppings indicated that Nene used this area during the summer, none were actually seen...adverse weather conditions were largely responsible...

Paliku: Hail and heavy rains during the nesting season appeared to cause Nene to abandon nests. Only 2 of the 14 nests observed hatched out. Three of 5 goslings were seen and subsequently retrieved when found dead...Weather conditions in January were very unfavorable...25.5 inches of rain fell between the 4th and 10th, and hail plus 36 inches of rain was experienced the last 2 days of January and on February 1st...

Breeding Season Rainfall = 475.23 cm. (187.1 in.)

1969-1970

Keauhou: The 1969-1970 breeding season was significantly more successful than the previous year...Better climatic conditions are largely responsible for this improvement.

Keauhou 2, Kahuku: (No comments or data reported)

Kipuka Ainahou-Puu Oo:

The highest number of Nene counted on the Saddle Road was 87...far exceeding the 45 total counted last year...the total, however, was actually lower than the number traversing the flyway...fog obscuring portions of flyway and Nene were heard but could not be counted although good coverage was provided by the 3 counters used in this effort...

Paliku: Breeding Season Rainfall = 203.58 cm. (80.15 in.)

1970-1971

Keauhou, Keauhou 2, Kahuku: (No comments or data reported)

Kipuka Ainahou-Puu Oo:

Flyway counts (1961-1969) indicated an increase in the population utilizing the flyway...A total of 31 and 27 Nene were

seen on two successive days in July, while none was seen in August. As with the flyway counts, fog and rain made it difficult to observe Nene in the pastures.

Paliku: Of 15 nests found, twelve were abandoned, and 3 successfully hatched. Two goslings were found dead as a result of severe weather...

In February, (4 adult Nene) were found dead in Paliku following a violent wind and rainstorm. Deaths were attributed to this (storm) record and the highly unusual violent storm in which the high winds even damaged the release pen and uprooted brush (pukiawe and ohelo).

Breeding Season Rainfall = 394.21 cm. (155.2 in.)

1971-1972

Keauhou, Keauhou 2, Kahuku:

(No comments or data reported.)

Kipuka Ainahou-Puu Oo:

Ground checks in the Puu Oo pastures produced totals of 113, 109, 10, 113 and 85 Nene within a 2-week interval in August. The large reduction on the third count can be attributed to very inclement weather which obscured the birds or discouraged them from leaving ground. More counts were actually made, but have not been reported because adverse weather conditions made many tallies so incomplete that they were not valid.

Paliku: Breeding Season Rainfall = 256.9 cm. (100.8 in.)

1972-1973

Keauhou: Although several nesting attempts were apparently successful, it was very doubtful that many goslings survived the drought which existed during the breeding season.

Keauhou 2: This Sanctuary was also extremely dry during the season, and it is very doubtful that any of the goslings found enough food to survive.

Kahuku, Kipuka Ainahou-Puu Oo:

(No comments or data reported.)

Paliku: Breeding Season Rainfall = 146.48 cm. (57.67 in.)

1973-1974

Keauhou: ...a total of 24 nests...compared with 11 discovered last year...the optimum habitat conditions this year are believed to have triggered increased productivity...

Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (No comments or data reported.)

Paliku: Breeding Season Rainfall = 250.27 cm. (98.53 in.)

1974-1975

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (No comments or data reported.)

Paliku: Breeding Season Rainfall = 401.32 cm. (158.0 in.)

1975-1976

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (No comments or data reported.)

Paliku: Breeding Season Rainfall = 270.64 cm. (106.55 in.)

1976-1977

Keauhou, Keauhou 2, (Kahuku):

The obvious conclusion from observations was that this was a very poor year for Nene in the wild. Effects of the extended drought are believed to have adversely affected the total population. Very few broods are thought to have survived because of poor food conditions. At best, the nene population was static this year; at worst, it may have declined because of no population increment and attrition of older birds.

Adverse habitat conditions resulting from the drought were undoubtedly responsible for poor nesting activity this year. Many pairs observed had apparently made no attempt to nest.

Survival of broods was expected to be very poor, but could not be positively verified. The recurring problem of not making subsequent or repeat sightings

of broods was most severe this year. Nearly all of the broods were seen only once. Broods from successfully hatched nests were never seen. Obviously, the major problem in determining reproductive success was the lack of ability to monitor survival and growth of the goslings...

Severe drought caused poor habitat conditions, especially in the Keauhou 2 and Kipuka Ainahou Sanctuaries. Conditions were extremely bad in Keauhou 2 where in some portions about 75 percent of the pukiawe was killed. There was virtually no ohelo berry production this year and the ulei berries were consumed by turkeys as well as nene.

Kipuka Ainahou-Puu Oo:

No Nene were observed on the summer flyway in September, when they are usually observed...only a few birds, mostly from the Kipuka Ainahou releases, were seen in Puu Oo pastures...The effects of drought are probably responsible for the unusual distribution of Nene this year.

Paliku: Breeding Season Rainfall = 138.43 cm. (54.5 in.)

1977-1978

Keauhou, Keauhou 2, Kahuku:

This area (Keauhou Sanctuary) was in the second consecutive year of severe drought, and habitat conditions were very poor, probably the worst since inception of the nene restoration project. A few rains finally occurred during early summer, but they were too late to have a significant effect on improving survival of goslings...

Extremely poor habitat conditions (in Kahuku Sanctuary) were responsible for this outward movement of nene this year. Due to prolonged drought, there was no green feed available and the usual berry crops (ohelo, pukiawe and ulei) failed. This left the sanctuary in poor condition to support even the small amount of birds that remained there...

In general, all four sanctuaries were in the throes of the prolonged drought. The resultant adverse habitat conditions are undoubtedly responsible for the poor breeding season results. Most of the pairs seen in the sanctuaries apparently made no effort to nest this year. There probably was no stimulus to nest due to poor nutrition available to the nene in the sanctuaries...

It was believed that survival of broods this year was minimal because of the adverse conditions due to drought extending into the second consecutive year...

Kipuka Ainahou-Puu Oo:

Very few birds (and no nests) in the Sanctuary this year due to poor habitat conditions caused by the prolonged drought...No Nene were seen on their traditional summer flyway...a few on Puu Oo pastures...some...in the Humuula pastures of the Parker Ranch...most...near or around the edges of cattle waterholes...nearly all Kipuka Ainahou release birds...decline in banded Nene from Keauhou...believed ...related to the disrupted movement patterns...in response to the prolonged drought...

Paliku: Breeding Season Rainfall = 89.7 cm. (35.38 in.)

1978-1979

Keauhou: No broods were sighted this year in the Keauhou sanctuary although weather conditions improved the habitat remarkably. A wetter than normal year was experienced and some extremely heavy rainfall occurred during the month of February. The one hour, 24 hour and 48 hour rainfall records were all surpassed during one rainstorm.

Keauhou 2: (No comments or data reported)

Kahuku: (Kahuku) sanctuary received considerably more rainfall this year than in the past and conditions improved remarkab-

ly. It is anticipated that the broods sighted this year will have a better chance for survival...

Kipuka Ainahou-Puu Oo:

(No comments or data reported)

Paliku:

...total amount (recorded) this year...was...more than twice...experienced...a year ago...The rain and wind storms began and continued throughout the Nene breeding season...Two attempts to conduct an early season nesting survey in December were aborted due to severe weather conditions. Subsequent surveys in January were successful in locating a total of eight nests...

Breeding Season Rainfall = 381.08 cm. (150.03 in.)

1979-1980

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (no comments or data reported)

Paliku:

...No Nene were counted in January and February due to extremely severe weather conditions encountered during the scheduled trips...The storm in January with wind speeds up to 80 miles per hour at the summit (of Haleakala) dropped 160.05 cm. (63.01 in.) of rain in the Paliku area...The death of at least 5 goslings hatched from various nests this year can be attributed to apparent exposure to severe weather conditions shortly after leaving the nest.

Breeding Season Rainfall = 527.18 cm. (207.55 in.)

1980-1981

Keauhou: This Sanctuary was extremely dry due to a prolonged drought, and the Nene never returned during the breeding season. Two trips were made...and neither time were any Nene seen, so no more time was devoted there...

Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo:

(No comments or data reported)

Paliku:

Breeding Season Rainfall = 53.06 cm. (20.89 in.)

1981-1982

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (No comments or data reported)

Paliku:

...Although moisture is important for embryonic survival during incubation, heavy downpour may cause lethal chilling of eggs or destroy nests through runoff. The storm in January—124.08 cm. (48.85 in.)—may have caused the abandonment of a nest with two eggs that contained fully developed embryos. Death of the two embryos was probably caused by chilling just prior to hatching...

Breeding Season Rainfall = 413.99 cm. (162.99 in.)

1982-1983

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: No nesting activity was noted in this sanctuary (Keauhou) during this breeding season as the entire island was experiencing a prolonged drought.

Paliku:

There was no recorded rainfall in January and February, during which time moisture is extremely critical for the survival of goslings...A total of 6 wild nests...an additional 3 pairs seen either with goslings or fledged young-of-the-year were listed as "location unknown" nest sites...The death of 9 goslings was presumed when identified parent pairs were resighted without the previously recorded number of hatchlings and/or goslings...the extremely low rainfall in January and February may have caused the death of the 9 goslings due to malnutrition or exhaustion...
Breeding Season (Oct.-Mar.) Rainfall = 109.35 cm. (43.05 in.)

1983-1984

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-Puu Oo: (No comments or data reported)

Paliku:

Since the early stages of brood rearing occur during January and February, moisture is extremely important for the survival of goslings. In January and February of last year, only 1.78 cm.

(0.70 in.) of rain was registered at the rain gauge as compared to 71.63 cm. (28.20 in.) during the same period this year...

Breeding Season (Oct.-Mar.) Rainfall = 154.69 cm. (60.9 in.)

1984-1985

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-

Puu Oo: (No comments or data reported)

Paliku: ...The early stages of brood rearing occur during January and February for most successful nesting pairs, and as a result this moisture was vital for gosling survival. This early phase of brood rearing had an accumulated rainfall of 67.76 cm. (26.67 in.) similar to the 71.63 cm. (28.20 in.) recorded at the rain gauge last year. Three years ago, the January and February rainfall total was a mere 1.78 cm. (0.70 in.).

Breeding Season Rainfall = 399.47 cm. (157.27 in.)

1985-1986

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-

Puu Oo: (No comments or data reported)

Paliku: The brood rearing period of January and February experienced a combined rainfall of 13.21 cm. (5.20 in.) as compared to 67.74 cm. (26.67 in.) last year and 71.63 cm. (28.20 in.) in 1984...

Breeding Season Rainfall = 151.0 cm. (59.45 in.); [19-year average = 271.48 cm. (106.88 in.); range = 53.06-527.18 cm. (20.89-207.55 in.)]

1986-1987

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-

Puu Oo: (No comments or data reported)

Paliku: No field work accomplished.

1987-1988

Keauhou, Keauhou 2, Kahuku, Kipuka Ainahou-

Puu Oo: (No comments or data reported)

Paliku: A total of 75.52 inches of rainfall was recorded in the eastern portion of Haleakala Crater during the Nene breeding season (November-February). The early brood rearing period of January and February had a combined total rainfall of 21.59 inches as compared to 5.20 inches in 1986 and 26.67 inches in 1985. (see comments under 1984-1985 on importance of adequate rainfall in early brood rearing period for gosling survival.)

Commentary on Effects of Weather Conditions

Keauhou, Hawaii

Although field studies in Keauhou were initiated in 1956/57, the first suggestion that weather patterns might affect Nene breeding success did not appear until 3 years later (1959/60). Possibly no weather effects were observed during the first 3 years, or perhaps this period simply gave biologists time to become familiar with prevailing weather and population conditions on the Keauhou breeding grounds. In any event observations linking weather conditions to Nene breeding success and gosling survival appeared at irregular intervals during the next 28 years.

On the island of Hawaii, drought conditions were the most frequently mentioned weather factor influencing Nene populations. At Keauhou, expressions of rainfall deficiency varied from "unusual dryness" and "dense volcanic haze" (fumes) (1959/60), "drier than normal" (1960/61), and "another extremely dry summer...followed by substantial rains in September" (1961/62). Later, such remarks included "drought" (1972/73), "extended drought" (1976/77), "second consecutive year of severe drought" (1977/78), "extremely dry...prolonged drought" (1980/81), and "prolonged drought" (1982/83).

Impressions of the effect of dry conditions on Nene breeding success ranged from "seemed to disrupt nesting activity" (1959/60), "may have played a role in the apparent lack of reproduction" (1960/61), "indications of breeding activity...were limited...not known whether this was due to dryness or shifting of breeding range" (1961/62), "very doubtful that many goslings (from only 2 successful nests) survived the drought" (1972/73); to "extended drought...believed to have adversely affected the total population...very few broods are thought to have survived" (1976/77), "extremely poor habitat...responsible for...outward movement of Nene this year...no green feed available...due to extreme drought...usual berry crops (ohelo, pukiawe, ulei) failed" (1977/78), "extremely dry...Nene never returned during the breeding

season" (1980/81), "no nesting activity noted...extreme drought" (1982/83).

Only once (in 1968/69) was colder-than-normal breeding season temperature thought to have a detrimental influence, as follows: "extremely cold weather...probably contributed to the poor hatchability, which was also the case at Pohakuloa". Unfortunately, the systematic recording of temperature on Nene breeding grounds was never initiated, thus quantitative data are not available for comparative purposes.

Conversely, recording biologists thought that improved weather conditions may have improved reproduction and/or survival some years, as follows: "breeding (in 1969/70)...significantly more successful" (than in 1968/69 when cold weather prevailed); "better climatic conditions (in 1973/74) are largely responsible for improvement...total of 24 nests...compared with 11 discovered last year...optimum habitat conditions this year are believed to have triggered increased productivity"; "no broods sighted this year (1978/79)...although weather conditions improved the habitat remarkably".

Precipitation measured for 9 years (1960/61 to 1968/69) at the National Park Service rain gauge located at the end of the Strip Road (2042 m. = 6,700 ft. elevation), adjacent to Keauhou Sanctuary, ranged from 42.6-134.2 cm. for an average of 95.0 cm. (37.4 in.) per breeding season.

Keauhou 2, Hawaii

Unfortunately, the Keauhou 2 breeding grounds lack weather data or comment for the years when unusually dry weather was first thought to have adversely affected Nene reproductive success at Keauhou, viz. 1959/60, 1960/61, and 1961/62. Later reports, in 1972/73, 1976/77, 1977/78 and, by inference, in 1982/83 linked drought conditions with poor Nene breeding success. Also, the "extremely cold" temperatures believed responsible for poor hatching success and gosling survival at Keauhou

and Pohakuloa in 1968/69 would presumably have had the same negative effect that year at Keauhou 2.

Rainfall was measured and recorded at Keauhou 2 only in 1966/67, 1967/68, and 1968/69. During this short period (with data missing in October and February 1966/67, in March 1967/68, and in October 1968/69) precipitation during the breeding season averaged only 35.4 cm. (13.9 in.), ranging from 26.0-42.3 cm. (10.2-16.7 in.).

It thus seems probable, based on the same 1966-1969 3-year average rainfall records for both areas—35.4 cm. (13.9 in.) at Keauhou 2 vs. 126.7 cm. (49.9 in.) at Keauhou—that Keauhou 2 received roughly about a third of the breeding season rainfall as that recorded at Keauhou.

Kahuku, Hawaii

Given the sparse nature of rainfall and Nene records at Kahuku, it is not possible to implicate weather as a possible factor influencing breeding success or gosling survival. The HDFG report for the 1977/78 breeding season noted that "Extremely poor habitat conditions were responsible for...outward movement of Nene this year. Due to prolonged drought, there was no green feed available and the usual berry crops (ohelo, pukiaawe and ulei) failed...this left the sanctuary in poor condition to support even the small amount of birds that remained there." Natural foods at Kahuku were thus reported to be grossly depleted in 1977/78, and by inference, the previous year (1976/77) as well (the same years Nene were observed to be adversely affected by drought conditions at Keauhou and Keauhou 2). Records show that Keauhou received "a few rains" during the early summer of 1978 but it is not known whether precipitation fell in the Kahuku area at that time.

It is inferred that Nene at Kahuku were adversely impacted by "a prolonged drought" experienced "island wide" in 1982/83 (when no nesting activity at all was noted in their most populous breeding ground at Keauhou). It might also be postulated that the exceptionally cold temperatures believed to have

depressed Nene breeding success at Keauhou and Pohakuloa in 1968/69 probably had a similar effect at Kahuku, thus adding two more hardship breeding seasons to Kahuku's weather history.

Only 4 years of breeding season rainfall records for Kahuku could be found (1956/57, 1957/58, 1958/59, and 1959/60)—all of which precede Sanctuary status and release of captive-raised stock there. While not directly comparable to rainfall data compiled later at other Sanctuaries, the average of 109.7 cm. (43.2 in.) and range of 81.9-143.0 cm. (32.2-56.3 in.) measured at Kahuku, seem to be somewhat greater than the average of 95.0 cm. (37.4 in.) and range of 42.6-134.2 cm. (16.8-52.8 in.) computed for a later 9-year period at Keauhou, and much greater than the 35.4 cm. (13.9 in.) 3-year average tallied some 7 to 10 years later at Keauhou 2.

Kipuka Ainahou-Puu Oo, Hawaii

Although the Kipuka Ainahou-Puu Oo area was the last to receive captive-stock transplants, HDFG biologists were more familiar with it over a longer period of time than even that of Keauhou. Not only was the Kipuka-Puu Oo area that in which HDFG biologists first discovered the surviving Nene population in 1955/56, but multiple surveys along the trans-island Saddle Road through this area had been conducted annually every year since.

Fog and/or rainfall in the Kipuka Ainahou-Puu Oo area were noted to have severely hampered the gathering of Nene population data on a number of occasions. While the handicap of limited visibility was to some extent mitigated by repeated surveys, there seems little question that more valid population data would have been recorded had visibility more representative of other areas prevailed.

Fog and/or rain was noted to have restricted field surveys in the Kipuka Ainahou-Puu Oo area for 5 consecutive years—from 1967/68 to 1971/72. On at least one occasion—in 1971/72—the "large reduction" in the third count was attributed to very inclement weather which either obscured the birds or discouraged them from leaving the ground, or both.

Drought was believed likely responsible for depressed reproduction and/or survival in Kipuka Ainahou-Puu Oo for only 3 years and then only by inference. That the exceptionally dry weather prevailing during 1976/77 may have had an effect on reproduction is indicated by the following observation: "No Nene were observed on the summer flyway in September when they are usually observed...only a few birds, mostly from the Kipuka Ainahou releases, were seen in Oo pastures...The effects of drought are probably responsible for the unusual distribution of Nene this year".

The following year (1977/78) it was noted that "all 4 sanctuaries were in the throes of the prolonged drought...resultant adverse habitat conditions...undoubtedly responsible for the poor breeding season results...Most of the pairs seen in the sanctuaries apparently made no effort to nest this year...survival of broods...minimal...due to drought extending into the second consecutive year". In addition, the prolonged island-wide drought in 1982/83 was believed responsible for poor reproduction at Kipuka Ainahou-Puu Oo since no nesting activity was noted on any of the Sanctuaries that year, even at Keauhou.

Weather records were apparently never kept in the Kipuka Ainahou-Puu Oo area, hence no rainfall data were available for comparison and comment.

Paliku, Maui

Weather patterns at Paliku on the floor of Haleakala Crater are greatly different than those found in any of the Sanctuary areas on the island of Hawaii, especially during the breeding season. Violent wind and rain storms—sometimes accompanied by hail—have been known to lash the Crater, and more than once exert a clearly adverse impact on Nene breeding success and survey frequency.

For some 7 years after 1961/62 when captive-raised Nene were first introduced in Haleakala Crater, HDFG reports contained no references linking weather to Nene breeding success or survey efficiency. However, in 1968/69 the same breeding season that unusually cold temperatures were noted

to have depressed breeding success at widely different locations on the island of Hawaii (Keauhou and Pohakuloa), hail and heavy rains, especially in January, were related to widespread nest desertion which was observed. In 1968/69 only 2 of 14 nests under observation hatched with 3 of the resulting 5 goslings being found dead. Some 64.8 cm. (25.5 in.) of rain fell from January 4 to 10, while hail plus 91.4 cm. (36 in.) of rain was experienced the last 2 days of January and February 1. Breeding season rainfall at Paliku in 1968/69 totaled 475.23 cm. (187.1 in.).

Two years later, in 1970/71, a heavy rainstorm with violent winds was again suspected of causing abandonment of some 12 of 15 nests. The deaths of 2 goslings and 4 adult Nene were also noted with no fledglings subsequently observed. The breeding season rainfall at Paliku in 1970/71 totaled 394.21 cm. (155.2 in.).

The next 7 years (1971/72 to 1977/78) passed without any reported effects of weather on Nene populations or survey efficiency.

The 1978/79 report stated that "...rain and wind storms began and continued throughout the Nene breeding season...two attempts to conduct an early season nesting survey in December were aborted due to severe weather conditions." Although breeding season rainfall was substantial—381 cm. (150.03 in.)—no nest abandonment or gosling mortality was reported.

Much worse conditions over a long period of time was observed at Paliku during the 1979/80 breeding season, the pertinent report stating, "No Nene were counted in January and February due to the extremely severe weather conditions encountered during the scheduled trips...the storm in January with wind speeds up to 80 m.p.h. at the summit (of Haleakala Crater) dropped 160.0 cm. (63.01 in.) of rain in the Paliku area...the death of at least 5 goslings hatched from various nests this year can be attributed to apparent exposure to severe weather conditions shortly after leaving the nest." Breeding season rainfall in 1979/80 totaled the heaviest of the 19 years of record—527.2 cm. (207.55 in.).

The 1980/81 report was free of any comment on effects of weather. But in 1981/82, conditions were apparently severe enough to adversely impact breeding success, as follows: "...although moisture is important for embryonic survival during incubation, heavy downpour may cause lethal chilling of eggs or destroy nests through runoff. The storm in January—124.08 cm. (48.85 in.)—may have caused the abandonment of a nest with 2 eggs that contained fully developed embryos. Death of the 2 embryos was probably caused by chilling just prior to hatching...".

Breeding season rainfall during 1981/82 was 413.99 cm. (162.99 in.) with no mention of effects on Nene or surveys. There were also no comments on the effects of weather for the next 3 years—1983/84, 1984/85, and 1985/86. No field surveys were conducted in 1986/87.

Breeding season (Oct.-Mar.) and annual rainfall records for Paliku are shown by month in Table D2 for the 19 years of record—from October 1967 through March 1986. The computed averages and ranges for these years are also given.

Conclusions

As described, noticeable weather abnormalities such as above-average rainfall, drought, unusually cold temperatures, and severe wind, rain and/or hailstorms were reported to adversely impact Nene breeding success. Such perceptions in this respect reduce year-to-year comparability of observational data. Numbers of Nene observed in at least two areas (Kipuka Ainahou-Puu Oo and Paliku) may also be rendered non-comparable on occasion by such weather elements as fog, rain, or winds which limit or preclude observer visibility. Assessment of all such factors during the total number of survey years are listed by Sanctuary in Table D5 which follows.

Recurring drought, unusual cold, or notably favorable rainfall conditions reportedly influenced breeding success (and related comparability of data) on Keauhou Sanctuary a total of 11 time or 34 percent of the 32-year (1956/57 to 1987/88) period as follows: 1959/60, 1960/61, 1961/62, 1968/69, 1969/70,

1972/73, 1973/74, 1976/77, 1977/78, 1980/81, and 1982/83.

Similar correlative impressions were variously suggested, or may be inferred, for a number of specific breeding seasons on the remaining Sanctuaries on Hawaii, as follows: Keauhou-2, 9 years (1961/62, 1968/69, 1969/70, 1972/73, 1973/74, 1976/77, 1977/78, 1980/81, 1982/83), or 33 percent of the 27-year survey period; Kahuku, 8 years (1968/69, 1969/70, 1972/73, 1973/74, 1976/77, 1977/78, 1980/81, 1982/83), or 36 percent of the 22-year observation record; and Kipuka Ainahou, 6 years (1972/73, 1973/74, 1976/77, 1977/78, 1980/81, 1982/83), or 38 percent of the 16-year survey period (since captive-raised stock were released there in 1972/73).

Weather conditions were unfortunately not reported for Keauhou, Keauhou-2, Kahuku, or Kipuka Ainahou for the 5-year period following 1982/83, so no recent information on the possible effects of weather on Nene breeding success on island of Hawaii sanctuaries is available.

At Paliku, Haleakala National Park, Maui, severe wind, rain, and/or hail storms during the Nene breeding season were related to widespread nest desertion and, in some cases, adult and gosling mortality for 5 of the 27-year breeding seasons (1968/69, 1970/71, 1979/80, 1981/82, 1982/83) some 19 percent of the time since surveys were initiated at Paliku with the release of captive-raised stock there in 1961/62.

High winds and/or hail during severe storms seemed to result in especially high mortality. For example, in 1978/79 when the 381 cm. (150 in.) of breeding season rainfall was heavy enough to deter field surveys, no ill effects on productivity were reported, while in 1968/69, 1970/71, and 1979/80 when either violent winds or hail were present, extensive mortality was observed.

HDPG field observations were not carried out in Haleakala Crater in 1986/87 while in 1987/88 a relatively modest total rainfall of 21.59 in. received during the early brood rearing season (Jan. and Feb.) apparently did not affect gosling survival.

Table D5

**Number of Years Various Weather Elements Were Reported to Actually
or Inferentially Affect Nene Breeding Success on
HDFG Study Areas, 1959/60-1987/88**

Area	Total No. of Survey Years	No. of Years Weather Influence Reported	Percent Weather Influence Data Reported
Keauhou	32	11	34
Keauhou-2	27	9	33
Kahuku	22	8	36
Kipuka Ainahou	16	6	38
Paliku	27	6	22
Average	25	8	28

In sum, then, for an average of 25 survey years, such reported weather elements as fog, rain, severe wind-rain-hail storms, drought, or favorable rainfall patterns influenced comparability of breeding success data on all five areas an average of 28 percent of the time.

B. Operational and Reporting Deficiencies

In addition to the effects of weather, Federal-Aid accounts included operational and reporting inconsistencies which altered comparative values of the observations recorded. Deficiencies encountered by an in-house statistician who worked directly with data in field notebooks were presented previously in Part II. (5). *Data Analysis by W. S. Devick.*

Reporting or operational changes judged to have influenced data comparability as well as periods free of such defects are identified and arranged chronologically by area in Table D6. Sentences beginning with "failed" represent subjective evaluation. Text accompanied by dotted lines are wholly or essentially in Federal-Aid report language.

As summarized in Table D7 which follows, year-to-year comparability of population data from all study areas was seriously compromised by operational and reporting inconsistencies over a period of many years. On Keauhou, 10 years of major and 2 years of minor deficiencies flawed data comparability for 12 of 31 report years. Similarly, comparative data analysis on Keauhou-2 is hampered by 10 years of major and 2 years of minor inconsistencies in the 28-year study. Information reported from Kahuku ranks about the same with 9 years of major

and 1 year of minor deviations tending to confound results of that 22-year study.

With 8 years of major and 6 years of minor inconsistencies noted in 14 years, comparability of data from Paliku at first appears to be more seriously compromised than that from any of the three preceding areas. However, the limited size of the habitat known to be frequented by Nene in Haleakala Crater permitted higher standards of original study design and subsequent execution. Meaningful results were thus actually achieved despite the various deficiencies noted.

Population information reported from the Kipuka Ainahou-Puu Oo area consisted essentially of two different types—that of nesting success and gosling survival obtained from a small hill (Puu 6677) adjacent to Kipuka Ainahou—and flyway and ground counts of the summer population that traditionally rested and roosted on nearby Puu Oo Ranch. Table D7 indicated that comparability for data from Kipuka Ainahou-Puu Oo is complicated by 15 years of major inconsistencies and 6 years of minor variables during the 31-year study. However, 20 of the 32 years of flawed data derive from counts of the flyway population which frequented Puu Oo Ranch. On Puu 6677, where information on nesting success and gosling survival is gathered, the relatively small size of the kipuka promotes survey efficiency. Thus, in spite of infrequent visits some years, comparable population data have been collected there for many years.

Table D6

Operational and Reporting Variables Influencing Comparability of Data

Islands of Hawaii and Maui, 1954/55-1987/88

Reporting Period	Operational Deficiency	Area	Reporting Defect	Effect On Comparability
1954/55	...inactive most of year. A few field trips taken but no positive sightings	Hawaii		not evaluated
1955/56	No report found in files (HDFG pers. comm.)	Hawaii		not evaluated
1956/57	(breeding surveys initiated)	Keauhou	[results of surveys not reported in Federal-Aid reports but were covered later by Elder (1958 a,b,c) and Elder and Woodside (1958)]	not evaluated
1957/58	...time...manpower...available for field work...limited	Keauhou K. Ainahou-Puu Oo		mincr mincr
1958/59	...little time was available during the summer months...project... reduced in scope	K. Ainahou-Puu Oo	failed to report numbers of Nene using summer flyway	major
1959/60		K. Ainahou-Puu Oo	failed to report numbers of Nene using summer flyway	major
1960/61		K. Ainahou-Puu Oo	failed to report numbers of Nene using summer flyway	major
1961/62	No operational deficiencies or reporting defects apparent			
1962/63	No operational deficiencies or reporting of defects apparent			
1963/64	...flyway counts greatly curtailed due to lack of personnel	K. Ainahou-Puu Oo		major
1964/65	No operational deficiencies or reporting defects apparent			
1965/66	failed to conduct ground count of Nene	K. Ainahou-Puu Oo		major

Reporting Period	Operational Deficiency	Area	Reporting Defect	Effect On Comparability
1966/67	No operational deficiencies or reporting defects apparent			
1967/68	No operational deficiencies or reporting defects apparent			
1968/69	No operational deficiencies or reporting defects apparent			
1969/70	failed to conduct nesting surveys	Paliku		major
1970/71	...somewhat fewer nests and goslings observed...part of the decline can be attributed to a reduction in...survey effort of about 25 percent due to changes in personnel assignments, illness and injury suffered by the survey crew...	Keauhou Keauhou-2 Kahuku		minor minor minor
	failed to conduct nesting surveys	Paliku		major
1971/72	failed to conduct nesting surveys	Paliku		major
1972/73	proximity of release site disrupted movement pattern of wild flocks	K. Ainahou-Puu Oo		minor
1973/74	proximity of release site disrupted movement pattern of wild flocks	K. Ainahou-Puu Oo	failed to report number of wild Nene seen in Puu Oo pastures	minor
	...only breeding activity surveyed after Feb...due to lack of personnel	Paliku		minor
1974/75	proximity of release site disrupted movement pattern of wild flocks	K. Ainahou-Puu Oo	failed to discriminate between numbers reported on flyway and wild or captive-raised stock counted on the ground	minor
1975/76	proximity of release site disrupted movement pattern of wild flocks	K. Ainahou-Puu Oo		minor
		K. Ainahou-Puu Oo	failed to discriminate between numbers reported on flyway and wild or captive-raised stock counted on the ground	minor
1976/77	No operational deficiencies or reporting defects apparent			
1977/78	K. Ainahou-Puu Oo		failed to report simultaneous ground counts of wild and captive-raised Nene	minor

Reporting Period	Operational Deficiency	Area	Reporting Defect	Effect On Comparability
1977/78 (Cont.)	failed to conduct surveys in Sept.-Oct.-Dec.	Paliku		minor
1978/79	...principal investigator was on sick leave...Nov. and Dec...landowner lock-out of field crew from Keauhou for nearly 2 months during the end of breeding season...	Keauhou		major
	principal investigator resigned... project personnel locked-out during the period of controversy over land management practices	Keauhou-2		major
	failed to conduct annual flyway count	K. Ainahou-Puu Oo		major
	failed to conduct surveys in June	Paliku		insignificant
1979/80	assistant position vacant... reorganization of Division...reduced time available for field work	Keauhou Keauhou-2 Kahuku		major major major
	failed to conduct annual flyway count	K. Ainahou-Puu Oo		major
	failed to conduct surveys in July, Sept., Mar. and June	Paliku		minor
1980/81	lack of personnel and more duties with higher priority resulted in significant reduction of field trips to all 4 sanctuaries...failure to find Nene on two trips to Keauhou (extremely dry) resulted in "no more time devoted there"...failed to conduct annual flyway count	Keauhou Keauhou-2 Kahuku K. Ainahou-Puu Oo		major major major major
	...projects requiring more immediate attention prevented... conducting... surveys...during...Sept., Apr. and June	Paliku		minor

Reporting Period	Operational Deficiency	Area	Reporting Defect	Effect On Comparability
1981/82	<p>...due to lack of personnel...the amount of time spent...was drastically reduced...failed to conduct annual flyway count</p> <p>...more extensive than usual maintenance requiring immediate attention prevented a complete once-a-month survey...</p>	<p>Keauhou Keauhou-2 Kahuku K. Ainahou-Puu Oo Paliku</p>		<p>major major major major</p> <p>minor</p>
1982/83	<p>few data collected</p> <p>...no visit was made...</p> <p>...several groups of Nene were observed during the few trips...made...but no signs of nesting were noted...</p> <p>failed to conduct annual flyway count</p> <p>...monthly comparison (with last year) could not be made due to limited number of survey trips this year...</p>	<p>Keauhou Keauhou-2 Kahuku</p> <p>K. Ainahou-Puu Oo Paliku</p>		<p>major major major</p> <p>major</p> <p>major</p>
1983/84	<p>failed to conduct population surveys</p> <p>...no field trip was made this period...</p> <p>...one field trip was made...this period...</p> <p>failed to conduct annual flyway count</p> <p>...this year as in the previous year surveys were conducted for only 5 months...</p>	<p>Keauhou Keauhou-2 Kahuku</p> <p>K. Ainahou-Puu Oo Paliku</p>		<p>major major major</p> <p>major</p> <p>minor</p>
1984/85	<p>failed to conduct population surveys</p> <p>failed to conduct population surveys</p>	<p>Keauhou Kahuku</p>		<p>major major</p>

Reporting Period	Operational Deficiency	Area	Reporting Defect	Effect On Comparability
1984/85 (Cont.)	...no field trip was made this period... failed to conduct annual flyway count ...once-a-month surveys...limited to 5 months...	Keauhou-2 K. Ainahou- Puu Oo Paliku		major major major
1985/86	failed to conduct population surveys failed to conduct population surveys failed to conduct population surveys failed to conduct annual flyway and ground counts ...only 3 surveys were conducted due to manpower limitations and other project priorities...	Keauhou Keauhou-2 Kahuku K. Ainahou- Puu Oo Paliku		major major major major major
1986/87	failed to conduct population surveys failed to conduct population surveys failed to conduct population surveys failed to conduct annual flyway and ground counts ...due to manpower commitment for construction of new...propagation facility at Olinda...no field work was conducted (pers. comm. M. Ueoka)	Keauhou Keauhou-2 Kahuku K. Ainahou- Puu Oo Paliku		major major major major major
1987/88	failed to conduct population surveys failed to conduct population surveys failed to conduct population surveys failed to conduct annual flyway and ground counts ...only 6 survey trips...made...during the past year	Keauhou Keauhou-2 Kahuku K. Ainahou- Puu Oo Paliku		major major major major major